Explaining the effects of individual differences on learners' use of Hypermedia Learning Systems

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Abstract

Providing visual instructional aids, such as maps and visual orientation cues, in Hypermedia Learning Systems (HLS) has been argued to reduce the disorientation experienced by learners with specific individual differences. In turn, it has been suggested that providing such aids may lead to improvements in learning performance and learner attitude. This paper builds on an earlier quantitative study which explored the effects of, and between, three individual differences (domain knowledge, computer experience and cognitive style) on disorientation, learning performance, and learner attitudes in relation to two versions of HLS – with and without visual instructional aids. The paper analyses qualitative data, gathered using a semi-structured interviews, to add depth to the previous study and to explore whether the qualitative data support the previously-published findings. The findings from the semi-structured interview data are shown to be in-line with the analysis of the published quantitative data reported in the previous study in relation to disorientation, learning performance and learner attitudes, adding weight to the findings and providing explanations related to key findings which could not be determined from the published quantitative study.

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1. INTRODUCTION

Hypermedia Learning Systems (HLS) are widely used in the educational sector (Somyürek & Yalin, 2014; Paans, Segers, Molenaar, & Verhoeven, 2019). A defining characteristic of HLS is their non-linearity, which offers learners the opportunity to determine their own navigation paths within the system to support their learning (Alhajri, Councell, & Liu, 2013a; Jessica, Yvonne, Anjo, Ingo, Ulrich, & Peter, 2016). However, some learners find this difficult (Jessica et al., 2016), and experience high levels of disorientation as a result (Amadieu, Gog, Paas, Tricot, & Mariné, 2009; Shih, Huang, Hsu, & Chen, 2012). Disorientation refers to a user's uncertainty about where they are and what they need to do to reach another location in the information space. Typically, the disoriented user is unable to gain an overview of the learning material and encounters problems in deciding if the information that they require is available, where to look for the information and how to navigate to reach it, leading to feelings of being 'lost in hyperspace' (Zang & Wang, 2010).

Studies suggest that a common consequence of the different types of disorientation in HLS is a degradation in learners' learning performance (Amadieu, Tricot, & Marine, 2010; Zang & Wang, 2010). Researchers suggest that while using HLS, some learners perform less well in learning tasks than those who use linear systems because these learners fail to set their own paths through the HLS to achieve their learning goals. When learners underperform because of disorientation, they show negative attitudes towards the non-linear learning environment and, consequently, may feel less motivation to learn using HLS (AL-Tamini & Shuib, 2009; Yang & Lin, 2010). This reflects the finding from Shih et al. (2012), suggesting that when levels of disorientation are low, learners show motivation and interest in navigating through the HLS, thus increasing their learning effort and progress in relation to their learning goals.

It has been argued that the disparity among learners in relation to the use of, and learning in, HLS is related to the different characteristics that these learners possess, implying that the individual differences that these characteristics represent are critical to HLS design (Alhajri, Councell, & Liu, 2013b). In the past decade, many studies have found that individual differences, including cognitive style (Ku, Hou, & Chen, 2016; Chen & Yeh, 2017), domain knowledge (Amadieu & Salmero, 2014)

and computer experience (Naumann & Salmeron, 2016), influence learners' levels of disorientation in HLS.

To reduce disorientation, visual instructional aids, in the form of maps and a set of visual orientation cues – breadcrumbs, context highlighting, and so on – have been suggested (Amadieu et al., 2010; Somyurek & Yalin, 2014; Amadieu & Salmeron, 2014). Since there were no studies where all of these visual instructional aids had been provided in a single HLS and their effects explored in relation to individual differences, Ruttun and Macredie (2012) conducted a study, through exploration of a set of research questions and research hypotheses, in order to better inform the design of effective HLS. Essentially, they examined the effects between cognitive style (CS) (using the Field Dependent/Field Independent styles classification[1]), domain knowledge (DK) (using a low and high domain knowledge classification) and computer experience (CS) (using a low and high computer experience classification) on learners' disorientation, learning performance and attitudes in a HLS that provided visual instructional aids and a HLS that provided no instructional aids. A quantitative approach was used, exploring the interactions between these three human factors (CS, DK and CE) in relation to a HLS that includes the same set of visual instructional aids considered in this paper. The study's high-level findings are presented in Tables 1A and 1B.

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[1] Field Independent (FI) learners tend to rely on internal references, adopt an active approach to learning and process information using an analytical approach. Conversely, Field Dependent (FD) learners tend to rely on external references, adopt a passive approach to learning and accept information in exactly the way it is presented to them (Chou, 2001; Witkin, Moore, Goodenough, & Cox, 1977).

Table 1A: High Level findings in the HLS that provided no instructional aids (summarised from Ruttun and Macredie (2012))

User measure	Low DK and Low CE	Low DK and High CE
Learning performance: post-test score	FD learners performed less well than FI learners	FD learners underperformed compared to FI leaners
Learning performance in practical task	Same as above	Same as above
Learning performance: gain score	FD learners achieved lower gain scores than FI learners	FD learners achieved lower gain scores than FI learners
Tutorial and practical task – time efficacy	Compared to FI learners FD learners spent more time to complete their prescribed tasks	Compared to FI learners FD learners spent more time to complete their prescribed tasks
Disorientation	FD learners experienced more disorientation than FI learners	FD learners experienced more disorientation than FI learners
Attitudes towards the HLS	FD learners showed more negative attitudes towards the HLS than FI learners	FI learners were happier using the HLS than FD learners

User measure	High DK and low CE	High DK and high CE
Learning performance: post-test score	FD learners performed equally well as FI learners	FD learners performed as well as FI learners
Learning performance in practical task	Same as above	Same as above
Learning performance: gain score	Both FD and FI learners achieved low gain scores	Both FD and FI learners achieved low gain scores
Tutorial and practical task – time efficacy	No difference between FD and FI leaners, both spent the same amount of time to complete their prescribed tasks	No difference between FD and FI leaners, both spent the same amount of time to complete their prescribed tasks
Disorientation	FD learners experienced more disorientation than FI learners	FD and FI learners did not experience any disorientation
Attitudes towards the HLS	FD learners showed more negative attitudes towards the HLS than FI learners	Both FD and FI learners showed a positive attitude towards the HLS

Table 1B: High Level findings in the HLS that provided visual instructional aids (summarised from Ruttun and Macredie (2012))

User measure	Low DK and Low CE	Low DK and High CE
Learning performance: post-test score	FD learners performed equally well as FI learners	FD learners performed equally well as FI learners
Learning performance in practical task	Same as above	Same as above
Learning performance: gain score	Higher scores were gained by both FI and FD learners	Higher scores were gained by both FI and FD learners
Tutorial and practical task – time efficacy	FD learners and FI learners spent the same amount of time to complete their prescribed tasks	FD learners and FI learners spent the same amount of time to complete their prescribed tasks
Disorientation	FD and FI learners experienced little or no disorientation. But FD learners depend more on the visual instructional aids to overcome disorientation than did FI learners	FD and FI learners experienced little or no disorientation. But FD learners depend more on the visual instructional aids to overcome disorientation than did FI learners
Attitudes towards the HLS	Both FD and FI were happy with the version of HLS that was provided to them	Both FD and FI were happy with the version of HLS that was provided to them

User measure	High DK and low CE	High DK and high CE
Learning performance: post-test score	FD learners performed equally well as FI learners	FD learners performed equally well as FI learners
Learning performance in practical task	Same as above	Same as above
Learning performance: gain score	Both FD and FI learners achieved lower gain scores	Both FD and FI learners achieved lower gain scores
Tutorial and practical task – time efficacy	FD learners and FI learners spent the same amount of time to complete their prescribed tasks	FD learners and FI learners spent the same amount to complete their prescribed tasks t of time
Disorientation	FD and FI learners experienced little or no disorientation. But FD learners depend more on the visual instructional aids to overcome disorientation than did FI learners	Irrespective of the visual instruction aids, FD and FI learners experienced little or no disorientation
Attitudes towards the HLS	Both FD and FI learners satisfied with the learning system	There were no negative attitudes by FD and FI learners towards the learning system. They were both satisfied with it

While Ruttun and Macredie's study (2012) revealed significant results, there is a lack of understanding of the reasons behind the results, leading to six research questions (see Table 2).

Table 2: Research Questions related to HLS, visual instructional aids, individual differences

RQ1: Why are different levels of disorientation experienced by different groups of learners in the HLS that provided no instructional aids?	**RQ4:** Why were no, or very low levels of, disorientation experienced by learners in the HLS that provided visual instructional aids?
RQ2: Why are different scores attained by different groups of learners using the HLS that provided no instructional aids?	**RQ5:** Why, when learning in the HLS that provided visual instructional aids, did learners perform well?
RQ3: Why do different groups of learners have different levels of satisfaction as a result of using the HLS that provided no instructional aids?	**RQ6:** Why, when learning in the HLS that provided visual instructional aids, did learners express satisfaction?

To address the above research questions the study reported in this paper was undertaken to collect and analyse relevant qualitative data. The rest of this paper is structured as follows: section 2 will describe the methodological approach used to address the research questions; section 3 will present analysis of the collected data; section 4 will present a discussion of the analysis and provide answers to the stated research questions; and, finally, section 5 will draw conclusion from the analysis.

2. METHODOLOGY

2.1 Research Design

Ruttun and Macredie (2012) designed an experimental study with a set of independent variables – two HLS (one with visual instructional aids and one without), and individual differences of CS, DK and CE – and a set of dependent variables – levels of disorientation, learning performance and attitudes towards the HLS. A between-subjects design was used to avoid participants' scores being influenced by factors such as fatigue or boredom as a result of participating in both treatments (use of the HLS with visual instructional aids; and use of the HLS without instructional aids).

The participants were first tested for their type of cognitive style using the Riding's (Nielsen, 2000) Cognitive Styles Analysis (CSA) test. Then, their level of domain knowledge and computer experience were assessed using a three-point Likert scale questionnaire. With this technique, the study was able to identify the participants with appropriate cognitive style types, and experience profiles.

Once the study had gathered 192 participants, the participants were randomly assigned to interact with one of the two versions of the HLS ((i) no instructional aids; and (ii) visual instructional aids). Participation was voluntary.

A descriptive study was employed to address research questions 1-6 (see Table 2), the aim being to develop an improved understanding of learners' attitudes, beliefs, experiences, and preferences with respect to the HLS with which the participants interacted with, and their characteristics (in terms of CS, DK and CE). The descriptive study employed a qualitative approach, in which learners were interviewed (Adhabi & Anozie, 2017).

2.2 Description of Participants

In Ruttun and Macredie (2012), a three-way ANOVA was used to allow the examination of the effects between the three individual differences – cognitive style [FD or FI], domain knowledge [low or high], and computer experience [low or high], leading to the requirement for a minimum of 12 participants in each group to ensure a sample that had the potential for revealing significant results (see Table 3). This gave a total of 192 participants. In order not to create any bias, for this study, the same number of participants, with the same characteristics, was recruited.

Table 3: Distribution of participants according to their cognitive style, DK and CE

HLS that provided no instructional aids				HLS that incorporated visual instructional aids			
N=192	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

2.3 Materials and data collection methods

2.3.1   HLS

The same versions of HLS were used in this study as in the quantitative study by Ruttun and Macredie (2012). The HLS with no instructional aids allowed learners to set their own learning paths in relation to their learning goals, with high levels of freedom of navigation. An index page was also provided to

direct learners easily and quickly to the information that they needed. The version of the HLS that provided visual instructional aids was similar to the HLS that provided no instructional aids, in that learners could make use of the non-linear features. In addition, however, this HLS provided the following: a conceptual map; different link colours; graphic visualisation; highlighting context; link annotation; breadcrumb; pagination and page labels; and a history-based mechanism.

2.3.2   Interview Technique

To develop a detailed understanding of participants' attitudes, feelings, preferences, experiences, levels of satisfaction, experiences of disorientation, and suggestions with respect to the HLS that they used – and to identify new issues that may not have been considered or identified in the original quantitative study (reported in Ruttun and Macredie (2012)) – interview techniques were employed (Aliyu, Bello, Kasim, & Martin, 2014). A semi-structured interview form was designed to capture a set of questions representing major themes in the study, including HLS structure, navigation, disorientation, overall satisfaction, and dependency on and distraction by visual element features. This approach was considered suitable as the topics and associated questions could be raised by the researcher without preventing participants from stating freely their ideas and opinions in relation to the research questions (Stuckey, 2013; Alshenqeeti, 2014).

2.4 Data Analysis

With respect to each research question, to analyze the interview data, steps were taken in line with advice given by Rabiee (2004) (see Figure 1). For instance, with regards to RQ1, responses related to the theme (levels of disorientation) in the HLS that provided no instructional aids and in relation to each user group (set out in Table 3) were first transcribed and then cleaned (for example, writing out abbreviations and acronyms as full words, making fragments into full and valid sentences, etc.). Similarities within the theme and with respect to each user group were then identified, before a report

was prepared on these similarities. The same procedure was applied for the remaining RQs and in relation to their respective themes.
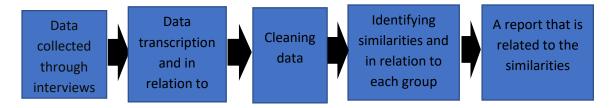

Figure 1: Procedure for analyzing the interview data in relation to the different groups of participants and the theme for each research question

3. FINDINGS

This section will present the research questions and detailed findings from the qualitative data that was gathered through semi-structured interviews. As stated in section 2.2, and summarised in Table 3, the participants were grouped according to their cognitive style (CS: FD or FI), domain knowledge (DK), and computer experience (CE).

RQ1: Why are different levels of disorientation experienced by different groups of learners in the HLS that provided no instructional aids?

For RQ1, two themes were highlighted from the analysis as high level findings: the first centred on levels of disorientation and types of disorientation in the HLS; the second was about opinions on the structure provided by the HLS. Table 4 summarises the findings in relation to each of these two themes and presents illustrative quotes from participants. With regards to FD participants, for each experience profile, a large proportion (over 67% in each case) asserted that they experienced high levels of disorientation in the HLS and did not like the structure that it provided, preferring to be guided throughout their learning (83% of the FD participants with low DK & low CE (i.e., 10 out of 12), 83% of the FD participants with low DK & high CE, 10 (i.e., 10 out of 12), and 67% of the FD participants with high DK & low CE (i.e., 8 out of 10) were not comfortable learning in the HLS that provided non-linear structure, and experienced high levels of disorientation).

Table 4: FD learners with one of the following experience profiles (low DK and low CE, low DK and high CE, high DK and low CE)

FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Levels of disorientation and types of disorientation in the HLS (Evidence)	Theme 2: Opinions on the structure provided by the HLS (Evidence)
FD with low DK & low CE	**N = 12** 10/12 (83%)	They do experience high level of disorientation, do not like the non-linear structure, and prefer to be guided throughout their learning	*Interviewer (I):* "Overall, did you have major difficulty navigating through the HLS?" *Participant (P):* "I would say yes. I just can't learn in this LS." *I:* "Do you know where you are going, what you have visited before, where you are coming from and so on in the HLS?" *P:* "No. I feel I have been left over learning in this HLS, without any support. I do not know where I am going, where I am coming from, where best to go and how to go back to my visited pages." *P:* "Sometimes, I keep coming to the same page which I had already visited."	*I:* "Do you like the structure that is provided by the HLS?" *P:* "Not at all." *I:* "Why that?" *P:* "I simply do not know what I am doing. Since I am a novice of, I don't know where I am going, what needs to be looked, at, how many pages a topic has and so on. The structure is making it difficult for me to successfully navigate through the LS to complete learning tasks." *I:* "The HLS has provided information content using a non-linear structure. It seems you are not comfortable learning with this structure and that is why you are feeling 'lost', experiencing high levels of disorientation." *I:* "Would you prefer to learn in a learning environment where a linear structure is provided or with instructional aids, either ones which will assist you in achieving your learning goals?" *P:* "If that would help, then why not. That would motivate me to continue using e-learning."
FD with low DK & high CE	**N = 12** 10/12 (83%)			
FD with high DK & low CE	**N = 12** 8/12 (67%)		*I:* "Were you able to find all the information that you needed in relation to your learning goals." *P:* "No." *I:* "It seems like you are feeling 'lost' while navigating in the HLS to do your learning." *P:* "You are right. I am 'lost' in this LS." *P:* "I just don't know where I am going and what I am doing in this learning system."	*I:* "Do you like the structure provided by the HLS?" *P:* "No, although most of the time I know what to view, I could not find my way reaching the information in the HLS." *I:* "The HLS has provided information content using a non-linear structure. It seems you are not comfortable learning with this structure and that is why you are experiencing high levels of disorientation." *I:* "Would you prefer to learn in a learning environment where a linear structure is provided or with instructional aids, either ones which will assist you in achieving your learning goals?" *P:* "Yes."

Specifically, in relation to theme 1, the illustrative quotes from FD participants in these groups illustrate that they could not successfully navigate through the HLS to perform their learning, thus leading to them feeling 'lost', experiencing high levels of the disorientation related to where they currently were, where they were coming from, what they had viewed, where best to go next, and how to reach the desired destination.

In terms of theme 2, the participants reported that they did not like the non-linear structure that was provided by the HLS as it provided too much flexibility, making it difficult from them to navigate through the HLS to achieve their learning goals. As the illustrative quotes in Table 4 show, these participants preferred to use a linearly structured learning system or a HLS that provided instructional aids.

For those participants with FI cognitive style and an experience profile of low DK and low CE, or low DK and high CE, a large proportion (over 75% in each case) reported that they experienced low levels of disorientation in the HLS, preferred the structure that was provided, and would continue to learn with this type of structure in the future (see Table 5) (83% of the FI participants with low DK &low CE (i.e., 10 out of 12), and 75% of the FI participants with low DK & high CE (i.e., 9 out of 12) experienced low level of disorientation and were comfortable to learn with the non-linear structure that was provided by the HLS).

Focusing on theme 1, FI participants in these groups said that although they experienced some difficulties navigating through the tutorial because their knowledge of 'XHTML' was low, they were able efficiently and effectively to find the information that they needed in relation to their learning goals. These views are illustrated by the quotes presented under theme 1 in Table 5. The quotes also suggest that these FI participants experienced only low levels of disorientation and that they were able to address the minor disorientation concerns that they encountered.

Regarding theme 2, the illustrative quotes illustrate that the FI participants in these groups were comfortable learning using the HLS' non-linear structure and that it allowed them to decide their own learning paths and to enjoy freedom of navigation while learning.

Table 5: FI learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Levels of disorientation and types of disorientation in the HLS (Evidence)	Theme 2: Opinions on the structure provided by the HLS (Evidence)
FI with Low DK & low CE	**N = 12** 10/12 (83%)	They only experience low level of disorientation, are comfortable working using the non-linear structure that is provided by the HLS	*I:* "Overall, did you have major difficulty navigating through the HLS?" *P:* "I find it a little bit difficult navigating through the HLS, feeling a little lost in the HLS because my level of knowledge of XHTML is low. However, it is not a major issue. I can address such issue." *I:* "Do you know where you are going, what you have visited before, where you are coming from and so on in the HLS?" *P:* "Yes. At the beginning I may feel a bit lost, but sooner later I am comfortable navigating through the HLS to perform my learning." *I:* "Were you able to find all the information that you needed in relation to your learning goals." *P:* "Yes, no problem at all."	*I:* "Do you like the structure that is provided by the HLS?" *P:* "Yes, I like it." *I:* "Why that?" *P:* "It provides flexibility, allowing me to decide my own learning path, which I prefer to learn with." *I:* "The flexibility that you mentioned earlier is because of the HLS which provides the information content using a non-linear structure." *I:* "Would you prefer a LS with a structure where you can have freedom of navigation or would you prefer a LS with linear structure?" *P:* "I prefer the first one, I enjoy being given freedom of navigation."
FI with low DK & high CE	**N = 12** 9/12 (75%)			

Finally, of the remaining participants (the groups of FD learners with high DK and high CE; FI learners with high DK and high CE; and FI learners with high DK and low CE), a significant proportion (over 83% in each case) responded that they did not experience any disorientation in the HLS, and that they were happy with the structure that the HLS provided (see Table 6) (83% of the FD participants with high DK & high CE (i.e., 10 out of 12), 100% of the FI participants with high DK & high CE (i.e., 12 out of 12), and 92% of the FI participants with high DK & low CE (i.e., 10 out of 12) experienced no disorientation and were comfortable to learn with the non-linear structure that was provided by the HLS).

Specifically, in relation to theme 1, the illustrative quotes from the learners in these groups show that they were easily able to navigate through the HLS to complete learning tasks without any sense of feeling 'lost' – in relation to the tutorial and practical task they knew: where they were; where they were coming from; what they had viewed; how to go back to their visited pages; and so on. With respect to theme 2, the illustrative quotes in Table 6 reflect that the participants in these groups showed positive attitudes towards the structure that was provided by the HLS, asserting that with this type of structure they did not need to expend much effort in moving from one place to another in the HLS and that it permitted them to have control over the tutorial.

Table 6: FI learners with one of the following experience profiles (high DK and low CE, high DK and high CE); FD learners with high DK and high CE

FD and FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Levels of disorientation and types of disorientation in the HLS (Evidence)	Theme 2: Opinions on the structure provided by the HLS (Evidence)
FD with high DK & high CE	**N = 12** 10/12 (83%)	They experience no disorientation; comfortable with and like the non-linear structure	*I:* "Overall, did you have major difficulty navigating through the HLS?" *P:* "No. I am comfortable navigating through the HLS". *I:* "Do you know where you are going, what you have visited before, where you are coming from and so on in the HLS?" *P:* "Yes. I know where I am, where I am going, where best to go next, how to go back to my previous pages, etc." *I:* "Were you able to find all the information that you needed in relation to your learning goals." *P:* "Yes."	*I:* "Do you like the structure that is provided by the HLS?" *P:* "Absolutely." *I:* "Why?" *P:* "It provides high levels of flexibility, permitting high degree of freedom of navigation." *P:* "I do not need to expend much effort in moving from one location to another during my learning in the HLS." *I:* "The HLS has provided information content using a non-linear structure." *I:* "Would you prefer to learn with this type of structure all the time?" *P:* "Yes, because I enjoy having control over the content that is provided in the HLS"
FI with high DK & high CE	**N = 12** 12/12 (100%)			
FI with high DK & low CE	**N = 12** 10/12 (92%)			

RQ2: Why are different scores attained by different groups of learners using the HLS that provided no instructional aids?

As was the case for RQ1, two themes were highlighted from the analysis as high level findings in relation to RQ2. The first theme was related to the cause of the level of performance in learning tasks; the second theme was the level of learner dependency on the HLS to achieve the learning goals. Tables 7-9 summarise the findings in relation to each theme and present quotes from different learner groups.

Table 7 summarises the findings for FD learners with the following experience profiles: low DK and low CE; and low DK and high CE. A large proportion (over 83% in each case) of learners in these groups argued that they may not have performed well in learning tasks (the post-test and the practical task) because of the high levels of disorientation that they suffered; they also depended significantly on the XHTML tutorial to achieve their learning goals (92% of the FD participants with low DK & low CE (i.e., 11 out of 12), and 83% of the FD participants with low DK & high CE (i.e., 10 out of 12) asserted that they were fully dependent upon the HLS to achieve their goals, but because they experienced high levels of disorientation in the HLS their goals were not met, and they therefore underperformed).

In relation to theme 1, the illustrative quotes in Table 7 suggest that because these learners suffered high levels of disorientation in the HLS, they could not complete the tutorial (that is, opening and viewing the topics that were related to XHTML), meaning that they underperformed in the post-test and did not complete all the tasks in the practical task session. This, in turn, may have had a negative impact on their learning performance.

In terms of theme 2, as the illustrative quotes in Table 7 show, since the participants in these groups had low levels of knowledge of 'XHTML' they had to interact heavily with the HLS to go through the learning content (the seven topics that were related to 'XHTML'), and to understand it, before completing the exercises in the practical task, and being able to do well in the post-test.

Table 7: FD learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Cause of level of performance in learning tasks (Evidence)	Theme 2: Level of dependency upon the HLS to achieve learning goals(Evidence)
FD with low DK & low CE	**N = 12** 11/12 (9%)	They reported that they did not do well in learning tasks, and this was because of the high levels of disorientation they experienced in the HLS; they were fully dependent on the HLS to perform their learning	*I:* "Overall, you didn't do well in your learning tasks (that is gain scores from pre and post-test; practical task)" *P:* "Yes, you are right." *I:* "What do you think may have caused you to underperform?" *P:* "I think it is because I was experiencing high levels of disorientation. Because of this issue, I was not able to successfully open each or most of the pages for each topic that was related to XHTML and read the learning materials." *P:* "Hence, this may have caused a significant impact on my learning performance." *I:* "Yes, you mentioned earlier that you were you not able to find all the information that you needed in relation to your learning goals." *I:* "Would you say that had you not experienced high levels of disorientation you would have enhanced your learning performance?" *P:*"Definitely."	*I:* "You had to complete the tutorial; the practical task (where you can refer to the learning content in the HLS); and the post-test." *I:* "How much did you depend on the HLS to complete learning tasks, with an aim to achieve learning goals?" *P:* "A lot. I did not know much about 'XHTML', hence I needed to interact a lot with the HLS to learn all topics that were provided in the tutorial." *I:* "Would you say that your learning performance depended upon the type of learning environment (here, the HLS) that you were using." *P:* "Yes. I had difficulty learning in this type of learning system. If that would not have been the case, I think I would have done better in learning tasks."
FD with low DK & high CE	**N = 12** 10/12 (83%)			

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Those FI learners with low DK, irrespective of their level of CE, had different perspectives in relation to the two themes identified in relation to RQ2, as can be seen from Table 8. Over 58% of these FI participants said that they performed well in learning tasks because they learned effectively and efficiently in the HLS, and that they had to have a high level of interaction with the HLS to achieve their learning goals (58% of the FI participants with low DK & low CE (i.e., 7 out of 12), and 75% of the FD participants with low DK & high CE (i.e., 9 out of 12) were fully dependent upon the HLS to achieve their goals, and that they successfully completed the tutorial and practical task in the HLS needed to meet their goals).

In relation to theme 1, then, the illustrative quotes in Table 8 suggest that these learners were able to go through all the topics and understand them which, in turn, allowed the learners to perform well in the post-test and complete all the exercises, and get most of the answers right, in the practical task.

In terms of theme 2, the illustrative quotes in Table 8 suggest that FI learners with low DK, irrespective of their level of CE, reported similar experience to their FD counterparts: since their knowledge of 'XHTML' was low, they needed to study, depending significantly on the HLS to complete the tutorial and practical task, and to achieve their learning goals (performing well in the post-test and in the practical tasks exercises).

Table 8: FI learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Cause of level of performance well in learning tasks (Evidence)	Theme 2: Level of dependency upon the HLS to achieve learning goals (Evidence)
FI with low DK & low CE	**N = 12** 7/12 (58%)	The participants in these groups argued that they did well in learning tasks because they successfully completed the tutorial efficiently and effectively that was provided in the HLS; they had to interact lot with the HLS to complete their learning tasks, with an aim to achieve their learning goals.	*I:* "Overall, you did well in your learning tasks (that is gain scores from pre and post-test; practical task)." *I:* "What do you think may have caused you to perform well?" *P:* "Simple, by going through the 'XHTML tutorial. I went through all sections for each topic." *P:* "I was able to grasp the learning content, which helped me to get most of the questions right in the post-test." *I:* "What about the practical task? you did well here as well." *P:* "Here, I could interact with the HLS to refer to the tutorial while completing the exercises. Basically, I went through the respective topics, tried to apply its information content to write the piece of code needed to complete a given part of an exercise." *P:* "I was able to complete all of the exercises too." *I:* "Ok."	*I:* "You had to complete the tutorial; the practical task (where you can refer to the learning content in the HLS); and the post-test." *I:* "How much do you depend on the HLS to complete learning tasks, with an aim to achieve learning goals?" *P:* "I would say I am totally dependent upon the HLS to perform my learning. *P:* "I haven't done XHTML before. Hence I needed to go through the topics, understand them, before I could complete the practical task and be ready to answer the M.C.Q in the post-test." *I:* "Would you say that your learning performance depends on the type of learning environment (here, the HLS) that you are using." *P:* "True."
FI with low DK & high CE	**N=12** 9/12 (75%)			

Finally, of the remaining participants – the groups of FD and FI learners with high DK and CE, and the groups with high DK and low CE – a significant proportion (over 83% in each case) asserted that their prior knowledge of the learning content of 'XHTML' allowed them, irrespective of the HLS, to perform well in the learning tasks, stressing that they did not depend on the HLS to achieve their learning goals (see Table 9) (83% of the FD participants with high DK & low CE (i.e., 10 out of 12), 92% of the FD participants with high DK & high CE (i.e., 11 out of 12), 83% of the FI participants with high DK & low CE (i.e., 10 out of 12), and 83% of the FI participants with high DK & high CE (i.e., 10 out of 12) performed well in learning tasks without having to be dependent upon the HLS as they already knew the learning content of 'XHTML').

In relation to theme 1, the illustrative quotes in Table 9 demonstrate, unsurprisingly, that for the learners in these groups, it was their prior knowledge of the learning content of 'XHTML' and 'HTML' that helped them to successfully complete (and correctly answer) the practical task exercises. Further, the quotes explain the lack of difference in their test gain scores (that is the difference between the pre- and post-test scores) being as a result of them already knowing about the 'XHTML' learning content.

Moving on to theme 2, the illustrative quotes in Table 9 suggest that in the practical task the participants in these groups barely interacted with the HLS to look for information in order to complete the exercises, meaning that they did not depend on the HLS at all for their learning. As might therefore be expected, the quotes also suggest that, in the tutorial session, the participants in these groups did not go through all of the topics, or sections and subsections of each topic, but that this lack of engagement did not have a negative impact on their learning performance (in term of their post-test scores).

Table 9: FD learners with one of the following experience profiles (high DK and low CE, high DK and high CE); FI learners with one the following experience profiles (high DK and low CE, high DK and high CE)

FD and FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Cause for underperforming or performing well in learning tasks (Evidence)	Theme 2: Level of dependency upon the HLS to achieve learning goals (Evidence)
FD with high DK & low CE	**N = 12** 10/12 (83%)	Irrespective of the learning content of 'XHTML' provided in the HLS, their prior knowledge of 'XHTML' allowed the participants in these groups did well in learning tasks; and did not depend on the HLS to enhance their learning performance.	*I:* "Overall, you did well in your learning tasks (that is no much difference in terms of gain scores from pre and post-test; practical task)" *I:* "What do you think may have caused you to perform well?" *P:* **"**My prior knowledge of 'XHTML'. I have knowledge of both 'HTML' and 'XHTML'." *P:* "That is why there is not much difference between my pre-test score and post-test score." *I:* "What about the practical task? You did well here too." *P:* "Overall, my prior knowledge of 'XHTML' allowed me to correctly answer all the exercises well." *I:* "You did not take that long too to complete the exercises in the practical task too." *P:* "Yes, as said earlier, this is because of my prior knowledge of 'XHTML' and 'HTML'. I didn't need to fully complete the tutorial including all the topics."	*I:* "You had to complete the tutorial; the practical task (where you can refer to the learning content in the HLS); and the post-test." *I:* "How much did you depend on the HLS to complete learning tasks, with an aim to achieve learning goals?" *P:* "Not at all." *P:* "I didn't go through all topics or/and all the sections of each topic. I was randomly going through different pages, just to find out things which I was specifically interest of. And that didn't make any difference in my post-test, I still achieved good score." *P:* "I hardly interacted with the HLS while completing the practical task." *I:* "I can imagine, and that's why your participation time in the experimental study was not that long." *P:*"Had my knowledge of 'XHTML was low or it was a completely different learning content which I didn't know at all, then it would have been different. I would have been depended a lot on the HLS at that time."
FD with high DK & high CE	**N = 12** 11/12 (92%)			
FI with high DK & low CE	**N=12** 10/12 (83%)			
FI with high DK & high CE	**N = 12** 10/12 (83%)			

RQ3: Why do different groups of learners have different levels of satisfaction as a result of using the HLS that provided no instructional aids?

For RQ3, there were two themes that were highlighted from the analysis as high level findings. The first theme emphasised learners' levels of satisfaction with the HLS. The second theme stressed learners' willingness to use the HLS in the future. Tables 10-12 summarise the findings for these two themes and present illustrative quotes from the corresponding participants within this study. Table 10 summarises findings for FD participants with experience profiles of low DK and low CE, low DK and high CE, and high DK and low CE.

With regards to FD participants, for each experience profile a significant proportion (over 67% in each case) reported dissatisfaction with the HLS with which they had interacted to perform their learning, preferring to learn in a learning system which provided guidance (92% of the FD participants with low DK & low CE (i.e., 11 out of 12), and 83% of the FD participants with low DK & high CE (i.e., 10 out of 12) were not satisfied with the learning system because they experienced high levels of disorientation and in turn, could not learn effectively the learning content of 'XHTML'; and would definitely like to learn in a learning system that provides instructional aids. On the other hand, 67% of the FD participants with high DK & low CE (i.e., 8 out of 12) were unsatisfied with the learning system not because they could not go through the learning content of XHTML (they in fact had prior knowledge of the learning content), but because they could not effectively navigate through the HLS, experiencing disorientation, and would have preferred to learn in a learning system that provides instructional aids).

However, as can be seen in relation to theme 1, different reasons were given by these FD learners for their negative attitudes towards the learning system. For instance, as the illustrative quotes in Table 10 show, FD learners with low DK, irrespective of their level of CE, were not comfortable with the structure that was provided by the HLS, and experienced high levels of disorientation. These quotes also suggest that because these learners did not have any knowledge of 'XHTML' they were fully dependent upon the HLS to achieve their learning goals, but the high level of disorientation that they suffered prohibited them from exploring the tutorial, which consequently may have hindered their learning performance and led them to lose interest in using this version of HLS.

However, for FD learners with the experience profile of high DK and low CE, the illustrative quotes suggest that because they already knew the learning of material of 'XHTML' it did not affect their overall learning performance, but what was disappointing for them was that they suffered high levels of disorientation in the HLS, and in turn, lost interest in using the learning system.

In terms of theme 2, as the illustrative quotes in Table 10 show, the FD learners in these groups would not use this version of HLS in the future, preferring to learn using a system which provided instructional aids and navigation support, or which presented learning material using a linear structure.

Table 10: FD learners with one of the following experience profiles (low DK and low CE, low DK and high CE, high DK and low CE)

FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Overall satisfaction with the HLS (Evidence)	Theme 2: Will they use this type of HLS in the future? (Evidence)
FD with low DK & low CE	**N=12** 11/12 (92%)	The participants justified why they didn't favour the HLS; and would prefer to learn in a learning system which provide support	*I:* "Overall, how satisfied are you with this type of learning system?" *P:* "I am least satisfied with it." *I:* "Can you please explain why you didn't like the HLS." *P:* "As we discussed earlier, the non-linear structure doesn't suit me. It is too complex, prohibiting me from successfully navigating through the HLS, thus causing me to feel 'lost' in the HLS." *P:* "Because of that, I am unable to successfully complete the tutorial and the practical task, which in turn hinder my learning performance. I did very badly in the post-test too."	*I:* "Would you use this type of HLS again." *P:* "No. I am just not learning effectively in this type of learning system." *I:* "Would you prefer to learn in a learning environment where a linear structure is provided or with instructional aids, either ones which will assist you in achieving your learning goals?" *P:* "Definitely. If that would help, then why not."
FD with low DK & high CE	**N=12** 10/12 (83%)			
FD with high DK & low CE	**N = 12** 8/12 (67%)	The participants justified why they didn't favour the HLS; and would prefer to learn in a learning system which provide support	*I:* "Overall, how satisfied are you with this type of learning system?" *P:* "I am not satisfied with it." *I:* "Can you please explain why." *P:* "Since my knowledge of 'XHTML' is high I did not need to go through all the topics. I did well in learning tasks too." *P:* "I just do not understand how the information is presented in the HLS. I am feeling 'lost' when navigating through it. I could not view all the information I wanted". *P:* "You mentioned earlier that the structure provided by the HLS didn't suit me, where I was experiencing disorientation. You are right. "	*I:* "Would you use this type of HLS again." *P:* "No. this learning system is complex. I just lost interest using it during the experimental study. I didn't enjoy it all." *I:* "Would you be happy to learn in a learning system that provides navigational support, reducing the disorientation issue." *P:* "Yes, definitely. "

For the FI participants with an experience profile of low DK and low CE; or low DK and high CE (see Table 11), a large proportion (over 83% in each case) asserted that they were satisfied with the HLS and that if this type of learning system was given to them again they would not hesitate to use it (83% of the FI participants with low DK & low CE (i.e., 10 out of 12), and 92% of the FI participants with low DK & high CE (i.e., 11 out of 12) depended a lot on the HLS to learn 'XHTML', but overall, they were satisfied to continue learning in this version of HLS as the structure that the HLS provided allowed some flexibility).

Specifically, in relation to theme 1 the illustrative quotes in Table 11 suggest that they were happy with the learning system because: (i) they enjoyed the flexibility that it offered, allowing them to set their own learning paths; (ii) although they experienced some levels of disorientation, they knew how to handle it; and (iii) because their level of expertise in relation to 'XHTML' was low, they needed to interact significantly with the HLS to complete the tutorial, understand the subject material and achieve their learning goals.

For theme 2, the illustrative quotes in Table 11 show that the learners in these groups would be happy to continue to learn using this version of HLS in the future, and that they were confident that, using this learning system, they would learn other subjects effectively and efficiently to achieve their learning goals.

Table 11: FI learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Overall satisfaction with the HLS (Evidence)	Theme 2: Will they use this type of HLS in the future? (Evidence)
FI with low DK & low CE	**N = 12** 10/12 (83%)	The participants justified why they favour the HLS; and happy to continue learning in this version of HLS	*I:* "Overall, how satisfied are you with this type of learning system?" *P:* "I have no issue with the LS. I am very satisfied with it." *I:* "Can you please give us reasons for your preference of this HLS." *P:* "I am happy with the way the HLS was structured, allowing some flexibility in the tutorial, I am allowed to set my own learning paths which I prefer to learn with." *P:* "Although I do feel a bit 'lost' in the HLS I am able to address this issue." *P:* "Most important, since my knowledge of 'XHTML' is low, I was heavily depended on the HLS to achieve learning goals, enhancing my learning performance, and it was well paid off: I successfully completed the tutorial, went through all topics, which assisted me in completing the exercises in the practical task and with a good score in the post-test. Overall, I would say I learned effectively in this HLS."	*I:* "Would you use this type of HLS again." *P:* "Yes, of course. I am very satisfied with this learning system." *P:* "I am sure I will be able to learn effectively and efficiently for any other fields of study."
FI with low DK & high CE	**N = 12** 11/12 (92%)			

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Finally, of the remaining participants (the groups of FD learners with high DK and high CE; FI learners with high DK and low CE; and FI learners with high DK and high CE), a large proportion (over 75% in each case) were satisfied using this version of the learning system and would have no issue with using it in the future (see Table 12) (100% of the FI participants with high DK & low CE (i.e., 12 out of 12), 75% of the FI participants with high DK & high CE (i.e., 9 out of 12), and 83% of the FD participants with high DK & high CE (i.e., 10 out of 12) were satisfied with the HLS as they could decide their own learning path and could navigate without any difficulties in such a non-linear learning environment).

With regards to theme 1, the illustrative quotes from the learners with these experience profiles explain that they enjoyed using the HLS because: (i) its structure allowed them high levels of flexibility, permitting the learners a high degree of freedom of navigation in the tutorial; and (ii) they were able to access and sequence information in relation to their learning goals.

In terms of theme 2, the illustrative quotes (presented in Table 12) from the learners in these groups show that this type of learning system suited them because it allowed significant control over the tutorial. They further suggest that these learners would use this version of HLS in the future to support their learning.

Table 12: FI learners with one of the following experience profiles (High DK and low CE, high DK and high CE); FD learners with high DK and high CE

FI and FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme 1: Overall satisfaction with the HLS (Evidence)	Theme 2: Will they use this type of HLS in the future? (Evidence)
FI with high DK & low CE	**N=12** 12/12 (100%)	The participants gave reasons for showing positive attitudes towards the learning system ; and have no issue learning in this learning environment in the future	*I:* "Overall, how satisfied are you with this type of learning system?" *P:* "I am very satisfied." *I:* "Why are you satisfied learning in this HLS? Any reasons?" *P:* "I am happy with the overall features that are offered by the HLS." *P:* "The structure provided by the HLS permits me to enjoy high level of freedom of navigation. I can navigate easily and quickly through the HLS to locate particular information. Index tool was handy."	*I:* "Is this the type of LS you prefer to interact with to perform your learning." *P:* "Yes." *P:* "I want to have a lot of control over the tutorial, which I did in this HLS."
FI with high DK & high CE	**N=12** 9/12 (75%)			
FD with high DK & high CE	**N=12** 10/12 (83%)			

RQ4: Why were no, or very low levels of, disorientation experienced by learners in the HLS that provided visual instructional aids?

For RQ4, one theme was highlighted from the analysis as a high-level finding, related to the reasons for experiencing no, or only low levels of, disorientation in the HLS that provided visual instructional aids. Tables 13-15 summarise the findings in relation to the theme and present illustrative quotes from the different learner groups. Table 13 summarises the findings for FD learners with the following experience profiles: low DK and low CE; low DK and high CE; and high DK and low CE.

A significant proportion (over 67% in each case) of learners in these groups asserted that they experienced no, or very low levels of, disorientation in the HLS because of the visual instructional aids that were provided, and were totally dependent upon them in this respect (83% of the FD participants with low DK & low CE (i.e., 10 out of 12), 83% of the FD participants with low DK & high CE (i.e., 10 out of 12), and 67% of the FD participants with high DK & low CE (i.e., 8 out of 12) were assisted by the visual instructional aids to reduce their level of disorientation in the HLS).

In relation to the theme, the illustrative quotes in Table 13 show that FD participants in these groups reported that the map and graphical overview diagram helped them in seeing relationships between different pieces of information presented in the HLS and the way in which these aids were structured 'guided' them towards information that they needed to achieve their learning goals. Further, the quotes explain that these learners used the history based mechanism to assist them in viewing and accessing the last two pages that they had visited, and a range of mechanisms (the breadcrumb facilities, different colours and disabled nodes in the graphical overview diagram, pagination, link annotation, different coloured links, and page labels in the form of headings and sub-headings) to increase their orientation or enhance their navigation efficacy while interacting with the HLS to complete the tutorial and practical task.

Also, the quotes explain that the learners in these groups were not comfortable learning using the HLS's non-linear structure, and were dependent on the visual instructional aids to reduce the high levels of disorientation that they were experiencing so that they could perform their learning.

Table 13: FD learners with low DK and low CE, low DK and high CE, or high DK and low CE)

FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Reasons for experiencing low or no levels of disorientation in the HLS (Evidence)
FD with low DK & low CE	**N=12** 10/12 (83%)	They experienced no or very low level of disorientation thanks to the visual instructional aids; and were totally depended upon these visual instructional aids to reduce their high level of disorientation that they were experiencing.	*I:* "Overall, do you know: where you are going; what you have visited before; where you are coming from, etc. in the HLS?") when navigating through the HLS?" *P:* "Without the visual instructional aids, I would say no." *I:* "Was it high or low levels of disorientation." *P:* "High." *I:* "So, with the visual instructional aids you experienced low or no disorientation while learning in the HLS." *P:* "Correct." *I:* "Tell us a bit more about these visual instructional aids.
FD with low DK & high CE	**N=12** 10/12 (83%)		*P:* "The visual instructional aids such as map and graphical overview diagram helped me to impose a structure on the learning content. In this way, I knew what I was learning, where best to go next and so on in relation to my learning goals." *P:* "[..] (can we have a look at the HLS please,…what do you call it)?" *I:* "Breadcrumbs." *P:* "Thanks. They assisted me in finding my current location and the path that led me to my current location in the HLS, very helpful." *P:* "The pagination and page labels orientated me while going through the sections and subsections of a topic. So, even when you are going deeper and deeper in the HLS, you don't feel being 'lost'." *P:* "The history-based mechanism supported me in tracking down where I have been lately and also, how to get back to these visited pages. Had these visual instructional aids not been provided I would have difficulty navigating through the HLS, and experienced high levels of disorientation." *I:* "Any other visual instructional aids you can remember?" *P:* "The different colours and disables nodes in the graphical overview diagram, link annotation, and different colours link increased my orientation."
FD with high DK & low CE	**N=12** 8/12 (67%)		*I:* "How much are you are dependent upon the visual instructional aids to reduce the major disorientation issues that you encountered?" *P:* "I would say fully dependent." *I:* "The information in the HLS are presented using a non-linear structure and that is why you were experiencing high levels of disorientation." *P:* "Ok. "Without the visual instructional aids, it would have been difficult for me to successfully navigate through the learning system to perform my learning."

For FI participants with an experience profile of low DK and low CE, or low DK and high CE, a significant proportion (over 67% in each case) reported that they experienced no, or very low levels of, disorientation in the HLS, and did not depend upon the visual instructional aids to any overcome disorientation that they experienced (see Table 14) (75% of the FI participants with low DK & low CE (i.e., 9 out of 12), and 67% of the FI participants with low DK & high CE (i.e., 8 out of 12) either did not experience disorientation or, if did they did, did not depend on the visual instructional aids to reduce it).

Table 14: FI learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Reasons for experiencing low or no levels of disorientation in the HLS (Evidence)
FI with low DK & low CE	**N=12** 9/12 (75%)	Irrespective of the visual instructional aids, they experienced no or very low level of disorientation; and were not depended upon these visual instructional aids to reduce disorientation (if any) that they were experienced in the HLS.	*I:* "Overall, did you experience any disorientation (I mean feeling very lost – you did not know: where you are going; what you have visited before; where you are coming from, etc. in the HLS?") when navigating through the HLS?" *P:* "I experienced very low levels of disorientation." *P:* "Because the HLS provided some flexibility and my knowledge of 'XHTML' was low I may have experienced on the rare occasions some disorientation, but they were of low levels." *P:* "But it was not a major issue, I knew how to address it." *I:* "Any reasons for experiencing low levels of disorientation in the HLS?" *P:* "I don't have any difficulties navigating through the HLS to perform my learning. I know what I am doing and how to find my way to learn effectively in the learning system." *P:* "I am used to this type of learning system, setting my own learning paths to perform my learning in the HLS."
FI with low DK & high CE	**N=12** 8/12 (67%)		*I:* "Some visual instructional aids were provided in the HLS to support those learners who experienced disorientation." *I:* "Did you use any of them?" P: "Yes, I did (one or two), but, only once or twice, that was on the rare occasion I was feeling 'lost' in the HLS." *I:* "Which ones did you use?" *P:* "History based mechanism and breadcrumbs facilities." *I:* "OK." *I:* "So, how much are you are dependent upon the visual instructional aids to reduce disorientation issues that you encountered?" *P:* "I would say not at all." *P:* "As said earlier, I may have used two of them and that was on the rare occasion that I was feeling 'lost' in the HLS." *I:* "Ok." *P:* "Had these visual instructional not provided I would still have no major difficulty navigating through the HLS to perform my learning. I can manage without them. I don't need them." *I:* "OK."

Centring on the identified theme, the illustrative quotes in Table 14 show that the lack of disorientation that the FI learners within these groups experienced while performing their learning in the HLS was not because of the visual instructional aids that were provided by the HLS, but because they knew how to address the disorientation issues and were comfortable with this type of HLS.

The quotes further suggest that the FI learners in these groups were not totally dependent upon the visual instructional aids to reduce disorientation or to support the learners successfully navigating the HLS to perform their learning, and that they only used one or two of the visual instructional aids on the rare occasions that they felt 'lost' in the HLS. The quotes also suggest that, had the visual instructional aids not been provided, the learners in these groups would have still managed to overcome the disorientation issues.

Finally, of the remaining participants (groups of FD learners with high DK and high CE; FI learners with high DK and low CE; and FI learners with high DK and high CE), a significant proportion (over 92% in each case) reported that they neither experienced any disorientation nor depended significantly upon the visual instructional aids to overcome disorientation in the HLS (see Table 15) (92% of the FI participants with high DK & low CE (i.e., 11 out of 12), 100% of the FI participants with high DK & high CE (i.e., 12 out of 12), and 92% of the FD participants with high DK & high CE (i.e., 11 out of 12) did not experience any disorientation and did not use any of the visual instructional aids).

In relation to the theme, the illustrative quotes in Table 15 suggest that the lack of disorientation in the HLS for the learners was not because of the visual instructional aids, but because of their prior knowledge of the learning content of 'XHTML', and/or because of their level of computer experience, which allowed them to successfully understand how the information was structurally presented in the HLS to achieve their learning goals. Further, the quotes suggest that since these learners did not experience disorientation in the HLS, they did not need nor depend on any of the visual instructional aids to accomplish their learning goals.

Table 15: FI learners with one of the following experience profiles (high DK and low CE, high DK and high CE); FD learners with high DK and high CE

FI and FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Reasons for experiencing low or no levels of disorientation in the HLS (Evidence)
FI with high DK & low CE	**N=12** 11/12 (92%)	Irrespective of the visual instructional aids, the participants in these groups experienced no disorientation issues and did not use any of the visual instructional aids either	*I:* "Overall, did you experience any disorientation (I mean feeling very lost – you did not know: where you are going; what you have visited before; where you are coming from, etc. in the HLS?") when navigating through the HLS?" *P:* **"**I didn't experience any disorientation in the HLS**."** *I:* **"**Is it because of the visual instructional aids that were provided in the HLS?" *P:* "Not at all, I didn't even use any of the visual instructional aids." *P:* "I am just comfortable navigating through the HLS. Maybe it is because I possess high knowledge of the learning content and computer experience. " *I:* "Ok."
FI with high DK & high CE	**N=12** 12/12 (100%)		
FD with high DK & high CE	**N=12** 11/12 (92%)		

RQ5: Why, when learning in the HLS that provided visual instructional aids, did learners perform well?

For RQ5, one theme was highlighted from the analysis as a high-level finding: the cause of performing well in the learning tasks that were related to 'XHTML'. Tables 16-18 summarise the findings for this theme and present illustrative quotes from different learner groups. Table 16 summarises the findings for FD learners with the following experience profiles: low DK and low CE; and Low DK and high CE. A high proportion (over 75% in each case) of learners in these groups asserted that they performed well in the learning tasks (the post-test and the practical task) because they learned effectively and efficiently in the HLS with the visual instructional aids, on which they depended (75% of the FD participants with low DK & low CE (i.e., 9 out of 12), and 92% of the FD participants with low DK & high CE (i.e., 11 out of 12) performed well in learning tasks but would not have done so without the visual instructional aids which helped them to reduce their levels of disorientation to complete the tutorial and the exercise).

Specifically, in relation to the theme, the illustrative quotes in Table 16 from FD learners in these groups illustrate that the reason for enhancing their learning performance in the post-test and the practical task was that they were able to complete the 'XHTML' tutorial and understand each topic.

The quotes further suggest that because their knowledge of 'XHTML' was initially low, the learners in these groups were totally dependent on the HLS to achieve their learning goals. The quotes also suggest the dependence of these learners on the visual instructional aids to overcome the high levels of disorientation, allowing them to successfully interact with the HLS to achieve their learning goals. Finally, the quotes suggest that without the visual instructional aids, these leaners would have failed to enhance their learning performance.

Table 16: FD learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Cause of performing well in learning tasks (Evidence)
FD with low DK & low CE	**N= 12** 9|/12 (75%)	They enhanced their learning performance because they learned effectively and efficiently, thanks to the HLS and the visual instructional aids which they were totally dependent on	*I:* "You did well in your learning tasks (that is gain scores from pre and post-test; practical task)". *I:* "What do you think may have caused you to perform well?" *P:* "I was able to successfully complete the tutorial related to 'XHTML'." *P:* "The tutorial assisted me to successfully complete all exercises, which I got most of them correct too; and to perform well in the post-test. Overall, I enhanced my learning performance." *I:* "Ok." *I:* "How much did you depend on the HLS to complete learning tasks?" *P:* "A lot. I did not know anything about 'XHTML', I had to interact a lot with the HLS to learn all topics that were provided in the tutorial." *I:* "What about the visual instructional aids that were provided by the HLS? Did they contribute for your overall performance? *P:* "At first I was experiencing high levels of disorientation in the HLS. I started to use the visual instructional aids and I was able to reduce the disorientation issues, and achieve my learning goals. Had these visual instructional aids not provided I would not have been able to enhance my learning performance? *I:* "You are saying that you were dependent upon the HLS to learn 'XHTML' to complete learning tasks, required to achieve learning goals, as well as the visual instructional aids." *P:* "True."
FD with low DK & high CE	**N=12** 11/12 (92%)		

For those participants who were FI and had an experience profile of low DK and low CE, or low DK and high CE, a large proportion (over 83% in each case) reported that they performed well in the learning tasks because they learned effectively and efficiently, and needed to accomplish their learning goals; and they were totally dependent upon the learning environment (the HLS), but not on the visual instructional aids, to achieve their learning goals (see Table 17) (83% of the FI participants with low DK & low CE (i.e., 10 out of 12), and 83% of the FI participants with low DK & high CE (i.e., 10 out of 12) performed well in learning tasks because they could successfully use the HLS to effectively and efficiently learn 'XHTML', and the visual instructional aids, which they only used once or twice, did not contribute to this achievement).

Table 17: FI learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Cause of performing well in learning tasks(Evidence)
FI with low DK & low CE	**N=12** 10/12 (83%)	They reported that they did well in learning tasks because they successfully completed the tutorial efficiently and effectively that was provided in the HLS; since their level of knowledge of 'XHTML' was low they had to interact lot with the HLS (but excluding the visual instructional aids) to complete their learning tasks, with an aim to achieve their learning goals.	*I:* "Overall, you did well in your learning tasks (that is gain scores from pre and post-test; practical task)". *I:* "What do you think may have caused you to perform well?" *P:* "I was able to learn efficiently and effectively." *P:* "I completed the tutorial (that is all topics), which assisted me in performing well in post-test." *P:* "Acquiring knowledge from the tutorial also enabled me to complete the exercises in the practical task." *I:* "How much did you depend upon the HLS to complete learning tasks, with an aim to achieve learning goals?" *P:* "A lot. In terms of programming languages, I am a novice, so needed to interact with the HLS to learn from the beginning to the end." *I:* "What about the visual instructional aids that were provided by the HLS? Did they contribute for your overall performance?" *P:* "No. I would say I used one or two of the visual instructional aids and that was only once or twice while completing the learning tasks." *I:* "Ok."
FI with low DK & high CE	**N=12** 10/12 (83%)		

Focusing on the identified theme, the learners in these groups mentioned that they successfully completed all of the topics in the tutorial, and understood them, which later assisted them in gaining a good score in the post-test and in completing all the exercises, achieving good scores in the practical

task. These views are illustrated by the quotes presented under the theme in Table 17. The quotes also suggest that since their levels of knowledge of 'XHTML' were initially low, FI learners in these groups depended heavily on the HLS to go through the 'XHTML' tutorial, in order to allow them to achieve their learning goals (performing well in the post-test and in the practical task). However, the quotes also suggest that the visual instructional aids did not contribute at all to enhancing their performance and that they were rarely used.

Finally, of the remaining participants – the groups of FD and FI leaners with high DK and high CE, and high DK and low CE – a significant proportion (over 92% in each case) reported that their high domain knowledge allowed them to enhance their learning performance irrespective of the HLS or the visual instructional aids (see Table 18) (92% of the FD participants with high DK & high CE (i.e., 11 out of 12), 100% of the FI participants with high DK & high CE (i.e., 12 out of 12), 92% of the FD participants with high DK & low CE (i.e., 11 out of 12), and 92% of the FI participants with high DK and low CE (i.e., 11 out of 12) performed well in learning tasks because of their prior knowledge of 'XHTML', irrespective of the visual instructional aids that were provided in the HLS).

In relation to the theme, the illustrative quotes presented in Table 18 suggest that because the learners in these groups already knew the 'XHTML' learning content and related programming languages, they achieved good scores in the practical task, though obviously low test gain scores (because of little or no difference between pre- and post-test scores). Further, the quotes suggest that the learners in these groups barely interacted with the HLS as they went through each topic in the tutorial or while completing the exercises in the practical task (where they could still refer to the HLS tutorial for guidance), meaning they had little dependence on the HLS to enhance their learning performance. Finally, the illustrative quotes suggest that the learners in these groups were not interested in the visual instructional aids, did not use them and were not at all dependent on them at all while learning in the HLS.

Table 18: FD learners with one of the following experience profiles (high DK and low CE, high DK and high CE); FI learners with one the following experience profiles (high DK and low CE, high DK and high CE)

FD and FI Individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Cause of performing well in learning tasks (Evidence)
FD with high DK & high CE	**N=12** 11/12 (92%)	Their prior knowledge of 'XHTML' allowed the learners in these groups to perform well without being dependent upon the HLS (including the visual instructional aids)	*I:* "Overall, you did well in your learning tasks (that is no much difference in terms of gain scores from pre and post-test; practical task)" *I:* "What do you think may have caused you to perform well?" *P:* "I already knew "XHTML". I have knowledge of other programming languages such as Java, C++, Visual Basic. So, this is very easy for me." *I:* "You did not take that long too to complete the exercises in the practical task." *P:* "Yes, because I knew the learning material it was very easy for me to complete the exercises and within a short period of time." *I:* "From what you are saying, it doesn't seem that you were dependent upon the HLS (including the visual instructional aids) to enhance your learning performance." *P:* "Correct, I hardly interacted with the HLS to complete the tutorial and practical task. I didn't use the visual instructional aids either. I don't need them."
FI with high DK & high CE	**N=12** 12/12 (100%)		
FD with high DK & low CE	**N=12** 11/12 (92%)		
FI with high DK & low CE	**N=12** 11/12 (92%)		

RQ6: Why when learning in the HLS that provided visual instructional aids, did learners express satisfaction?

For RQ6, one theme was highlighted from the analysis as a high-level finding: the cause for showing satisfaction with the HLS. Tables 19-22 summarise the findings in relation to this theme and present quotes from different learner groups reflecting the differences in the groups' expressed causes for showing satisfaction. Table 19 summarises the findings for FD learners that had low DK and low CE, or low DK and high CE.

With regards to FD participants, for each experience profile, a significant proportion (over 92% in each case) reported that they were satisfied learning using the HLS that provided visual instructional aids because these visual instructional aids allowed them to reduce their levels of disorientation and learn effectively in the HLS (92% of the FD participants with low DK & low CE (i.e., 11 out of 12), and 92% of the FD participants with low DK and high CE (i.e., 11 out of 12) were satisfied with the

HLS and would continue to use it in the future because the visual instructional aids assisted them to reduce their high levels of disorientation, which in turn led them to enhance their learning).

Table 19: FD learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Cause of satisfaction with the HLS (Evidence)
FD with low DK & low CE	N=12 11/12 (92%)	The learners in these groups justified why they favoured the HLS; and would prefer to learn in this kind of learning system	*I:* "Having used the HLS to learn 'XHTML', overall, how satisfied are you with this type of learning system?" *P:* "I am very satisfied with it." *I:* "Why are you satisfied learning in this type of HLS?" *P:* "The learning system was very easy to use to perform my learning." *P:* "The visual instructional assisted me in successfully navigating and orientating through the learning, and as a result I was able to successfully complete the tutorial and exercises in the practical task, and later enhancing my learning performance. So, I learned effectively in this type of learning system." *I:* "Would you use this type of HLS again." *P:* "Definitely."
FD with low DK & high CE	N=12 11/12 (92%)		

The illustrative quotes in Table 19 from FD learners in these groups suggest that their satisfaction with the learning system was related to their initially low levels of 'XHTML' knowledge, which meant that they needed to interact with the HLS to complete the tutorial, which then assisted them in completing the practical task and post-test.

The quotes further suggest that because they were experiencing high levels of disorientation, it would have been difficult for learners in these groups to complete their learning efficiently and effectively; but thanks to the visual instructional aids, which assisted in reducing these learners' levels of disorientation, they were able to successfully complete the prescribed learning tasks efficiently and effectively.

83% (i.e., 10 out of 12) of the group of FD learners with high DK and low CE were satisfied learning in the HLS too, but not because their learning performance was enhanced. Rather, it was because they could successfully navigate and locate the information that they were interested in the tutorial, as can be seen in Table 20.

Table 20: FD learners with high DK and low CE

FD individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Cause of satisfaction with the HLS (Evidence)
FD with high DK & low CE	**N=12** 10/12 (83%)	The learners in these groups justified why they favoured the HLS; and would continue to learn in this type of learning system	*I:* "Having used the HLS to learn 'XHTML', overall, how satisfied are you with this type of learning system?" *P:* "I am satisfied." *I:* "Can you please explain why." *P:* "I do not feel disoriented in the learning system. This is because the visual instructional aids assisted me in reducing high levels of disorientation that I was experiencing." *P:* "Because of the low levels of disorientation I can easily reach the information I am interested. I do not get frustrated while using the learning system". *I:* "Would you use this type of HLS again." *P:* "Yes, I am comfortable learning in this learning environment."

Specifically, the illustrative quotes in Table 20 suggest that satisfaction with the HLS centred on the visual instructional aids which helped to reduce disorientation, making it easier for these learners to successfully navigate through the HLS to reach the information that they wanted to view, and helping them to not become frustrated while moving through the learning system.

Those FI learners with low DK and low CE, or low DK and high CE, had different perspectives on the cause for showing satisfaction, as can be seen from Table 21. A high proportion (over 75% in each case) of learners in these groups asserted that they were satisfied with the HLS because of the flexibility that was provided in the HLS; they could use the visual instructional aids if needed, and they were not distracted by the visual instructional aids (75% of the FI participants with low DK & low CE (i.e., 9 out of 12), and 75% of the FI participants with low DK and high CE (i.e., 9 out of 12) were satisfied with the HLS and would continue to use it in the future because they learned effectively and efficiently in the HLS, enjoyed the flexibility that were provided by the non-linear structure, and were not distracted by the visual instructional aids, on which they did not depend to perform their learning).

Specifically, the illustrative quotes in Table 21 suggest that the learners in these two groups were satisfied with the learning system for three reasons: first, the level of flexibility was high, allowing them to set their own learning path to reach the information that they needed or to have more control over the tutorial; second, they were able to use the visual instructional aids on the rare occasions when

they found it difficult to navigate through the HLS; and, third, though they did not use all of the visual instructional aids, neither were they distracted by them.

Table 21: FI learners with one of the following experience profiles (low DK and low CE, low DK and high CE)

FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Cause of satisfaction with the HLS (Evidence)
FI with low DK & low CE	**N=12** 9/12 (75%)	The participants justified why they favour the HLS; and happy to continue learning in this version of HLS	*I:* "Overall, how satisfied are you with this type of learning system?" *P:* "I am very satisfied with it." *I:* "Why are you satisfied with this learning system?" *P:* "I learned the learning content of 'XHTML' efficiently and effectively, with good scores in the post-test and practical task." *P:* "Additionally, I enjoyed the flexibility that was given in the tutorial, which I normally prefer to learn with." *P:* "Finally, I do not really feel lost while navigating through the HLS, experiencing low levels of disorientation." *I:* "Anything about the visual instructional aids."
FI with low DK & high CE	**N=12** 9/12 (75%)		P: "I did use them on the rare occasions I experienced high levels of disorientation. But I didn't depend upon them. I was not distracted by them either. I like the way the learning system is designed: providing instructional aids to those who need them without causing a disturbance to those who don't need them." *I:* "Would you use this type of HLS again." *P:* "Yes. I am very satisfied with this learning system." *P:* "I am sure I will be able to learn effectively and efficiently for any other subjects."

Of the remaining participants (the groups of FD learners with high DK and high CE; FI learners with high DK and high CE; FI learners with low DK and high CE), a large proportion (over 83% in each case) gave similar reasons for showing satisfaction with the learning system with which they interacted to learn (see Table 22) (92% of the FI participants with high DK & low CE (i.e., 11 out of 12), 83% of the FI participants with high DK and high CE (i.e., 10 out of 12), and 92% of the FD participants with high DK and high CE (i.e., 11 out of 12) were satisfied learning in this version of HLS as, firstly, they liked being given freedom of navigation, and, secondly, they were not distracted by the visual instructional aids that were provided).

The illustrative quotes from the participants in these groups explain that they were happy to perform their learning in the learning system for the following reasons: the non-linear structure offered

in the HLS allowed them to enjoy high levels of freedom of navigation; they were able to learn at their own pace and had more control over the XHTML tutorial; and, despite the fact that they did not experience disorientation in the HLS and so did not need the visual instructional aids, neither were they distracted by them

Table 22: FI learners with one of the following experience profiles (High DK and low CE, high DK and high CE); FD learners with high DK and high CE

FD and FI individual difference group	Proportion of group displaying high level finding	High level finding	Theme: Cause of satisfaction with the HLS (Evidence)
FI with high DK & low CE	**N=12** 11/12 (92%)	The participants gave reasons for showing positive attitudes towards the learning system and have no issue learning in this learning environment in the future	*I:* "Overall, how satisfied are you with this type of learning system?" *P:* "I am satisfied." *I:* "Why are you satisfied learning with this HLS?" *P:* "I can enjoy high levels of freedom of navigation in the HLS, and have control over the tutorial too." *P:* "A lot of visual instructional aids are provided, but I do not use them and do not get distracted by them." *I:* "Would you use this learning system again?" *P:* "Yes."
FI with high DK & high CE	**N=12** 10/12 (83%)		
FD with high DK & high CE	**N=12** 11/12 (92%)		

4. DISCUSSION

In the preceding sections, the high-level findings from the qualitative strands of the study were presented. This section builds on the findings to posit 'answers' to each of the research questions and to develop guidelines for the design of the HLS with an aim to reduce disorientation, improve learning performance and increase satisfaction in the use of the HLS.

RQ1: Why are different levels of disorientation experienced by different groups of learners in the HLS that provided no instructional aids?

For the groups of participants that had 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 – the analysis of the semi-structured interview data revealed that, compared to the corresponding FI learners, the FD learners experienced high levels of disorientation. The analysis suggests that when DK was low or when CE was low FD learners had greater difficulties imposing a structure on the learning content that is presented in the

HLS, or mapping a mental representation of the information that is presented in the HLS, than did FI learners with the same experience profile. This study therefore suggests that unless FD learners are provided with guidance when performing their learning in non-linear environments, they will experience high levels of disorientation, which can consequently hinder their learning performance or make them lose interest in learning using the HLS. This suggestion is reinforced by the analysis of the semi-structured interview data, suggesting that FD learners in these groups would prefer linear structure or instructional aids when learning in HLS. This makes it an important issue in the design of the HLS.

For learners with an experience profile of high DK and high CE, the qualitative approach of the semi-structured interviews in this study revealed that neither FD nor FI learners in this group experienced any disorientation in the HLS and showed positive attitudes towards the structure that was provided by the HLS. The analysis suggests that the reason for this finding is that learners' prior knowledge of the learning content (XHTML) and their expertise in using computers supported them in being comfortable learning in the non-linear environment offered by the HLS. This finding seems not to be consistent with the results of previous research (for example, Dufresne & Turcotte (1997), and Chen & Macredie (2004), 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 may assist designers in gaining an improved understanding of cognitive style's impact on disorientation in the HLS use.

RQ2: Why are different scores attained by different group of learners using the HLS that provided no instructional aids?

For the groups of participants that had one of the following experience profiles – i) low DK and low CE; ii) low DK and high CE – FD learners performed less well than did FI learners within the same experience profile. The analysis of the qualitative data from the semi-structured interviews showed that these FD learners' lower performance in learning tasks arose because their low knowledge of 'XHTML' meant that they had to depend heavily on the HLS to complete learning tasks to enhance their learning performance, but because they were experiencing high levels of disorientation they failed to complete all the learning content needed to achieve their learning goals. Conversely, FI learners within the same experience profile, while still depending heavily on the HLS, did not report high levels of disorientation and reported that they successfully completed all of the tasks needed to achieve their learning goals, explaining why they performed better than FD learners. These insights from the qualitative data analysis help us to understand that when DK is low, learners will depend heavily on the HLS to enhance their learning performance. FD learners in these experience profile groups underperformed in the HLS because of the high levels of disorientation that they may have encountered. As such, guidance/support needs to be provided to FD learners in these groups, with the aim of reducing disorientation so as to enhance learning performance.

For the group of participants that had either high DK and low CE, or high DK and high CE, analysis of the semi-structured interview data in this study revealed that the reasons for both FD and FI within the same experience profile performing equally well was because of the learners' high domain knowledge prior to the use of the HLS. This finding is not consistent with the results of most existing studies in the area (for example, Graff (2003), and Umar & Maswan (2007)), which found that cognitive style influenced learning performance in HLS, with FD learners performing less well than FI learners in learning tasks. As noted in relation to RQ1, 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, level of computer experience or of 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 influences learning performance in HLS.

RQ3: Why do different groups of learners have different levels of satisfaction as a result of using the HLS that provided no instructional aids?

For the group of participants that had low DK and low CE or low DK and high CE, analysis of the qualitative data revealed that compared to FI participants with one of these experience profiles, FD participants with the same experience profile were much less satisfied learning in this version of HLS. Whereas these FI learners were satisfied because the structure of the HLS allowed them flexibility in terms of navigation, without leading to high levels of disorientation, and it also enhanced their learning performance, the corresponding FD leaners were less satisfied because the non-linear structure of the HLS made it difficult for them to successfully navigate through the learning system, causing them high levels of disorientation. This, in turn, led them to underperform in learning tasks or lose interest in using the system. This raises a concern in relation to attitudes for FD learners in these groups and is an issue that should be considered when seeking to develop guidance for HLS design.

For participants with low DK and high CE, again, the FD learners showed lower satisfaction towards the HLS that the FI learners. The analysis of the interview data suggests that, unlike the FI learners, the FD learners suffered high levels of disorientation, leading them to lose interest in using the learning system. This study has shown that while learning performance may still be enhanced where learners' have low prior knowledge of the content, disorientation can still persist as a result of cognitive style, which may in turn demotivate learners (especially FD learners). Designers need to take these issues into consideration when developing non-linear web-based learning systems by seeking to counter disorientation for this group.

With regards to those learners with an experience profile of high DK and high CE, the analysis from the interview data revealed that both FD and FI learners showed a positive attitude towards and overall satisfaction with the HLS. They were satisfied using this version of the HLS because they enjoyed high levels of freedom of navigation that were permitted through the non-linear structure, did not encounter disorientation, and enhanced their learning performance. As a result, it is unsurprising

that they showed a positive attitude towards the learning system. As already discussed, this could be because their prior knowledge of the learning content of 'XHTML' and of using computers permitted the learners 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 & Au (2004), Chen & Macredie (2004) and others – see section 2.4.1) has mostly suggested that cognitive style influences learners' attitudes towards HLS, with FD learners tending to show a generally negative attitude towards HLS when compared to that shown by FI learners. One possible explanation for the difference in this finding is that, again, 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 learners with an experience profile of high DK and high CE showing the same preference for non-linearity features in the HLS. This makes it an important area to consider in the design of the HLS.

RQ4: Why were no, or very low levels of, disorientation experienced by learners in the HLS that provided visual instructional aids?

For the groups of participants that had 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 – FD and FI learners within the same experience profile experienced no, or low levels of, disorientation. However, different reasons were given for this by the FD and FI learners. For the FD learners, it was because of the visual instructional aids that were provided, on which they heavily depended. For the FI leaners, it was not because of the visual instructional aids (although the learners used the aids on the rare occasions that they felt 'lost'), but because they could mostly successfully navigate through the HLS without the aids to perform their learning and could manage the disorientation issues.

As discussed in relation to RQ1, when DK or CE are low FD learners have difficulties learning in the HLS, experiencing high levels of disorientation. This study argues that providing visual

instructional aids seems to overcome this issue for FD leaners with low DK or low CE. Additionally, this study suggest that FI learners with low DK or low CE use the visual instructional aids on the rare occasions that they feel lost, and that this could be because of their low level of knowledge of the learning content.

For participants with high DK and high CE, the analysis of the interview data revealed that both FD and FI learners within this experience profile did not experience any levels of disorientation nor did they depend on any of the visual instructional aids. Neither issue is surprising because the findings related to RQ1 suggested that learners in this group are comfortable navigating and learning in HLS environments.

RQ5: Why, when learning in the HLS that provided visual instructional aids, did learners perform well?

For the groups of participants with low DK and low CE, or low DK and high CE, the findings from the semi-structured interviews suggest that FD learners were supported by the visual instructional aids, helping them to overcome the higher levels of disorientation in the HLS and allowing them to successfully complete their learning tasks, and consequently to achieve their learning goals with fewer issues than the FI learners with the same experience profile. This stresses the important role of visual instructional aids for some learners in relation to achieving learning goals, making it an important area to consider in the design of HLS.

Another finding from the analysis of the semi-structured interviews for these groups is that both FD and FI learners were heavily dependent on the HLS to achieve their learning goals. This suggests that when low DK is low, irrespective of cognitive style or level of CE, learners will (unsurprisingly) be heavily dependent on the HLS and its learning content to successfully achieve their learning goals, which makes it critical when designing the HLS.

For participants with high DK and low CE, or high DK and high CE, the findings from the semi-structured interviews suggest that neither FD nor FI learners significantly interacted with the HLS to perform learning tasks, nor did they use the visual instructional aids, but that they still performed

well in their learning tasks. For these groups, having existing domain knowledge was obviously the driving factor that determined their approach to (and lack of) interaction with the HLS.

RQ6: Why when learning in the HLS that provided visual instructional aids, did learners express satisfaction?

Finally, this study sought to explore why, when learning in the HLS that provided visual instructional aids, learners expressed satisfaction. The qualitative study and semi-structured interviews provided answers to this question. For participants with experience profiles of low DK and low CE, or low DK and high CE, the findings from the interviews suggest that both FD and FI learners were satisfied with the HLS because it supported to learn effectively and efficiently, addressing their low prior knowledge of XHTML.

However, for learners with these experience profiles, and for the group with high DK and low CE, cognitive style this time had an impact on the reasons for favouring the HLS. FD learners with one of these three experience profiles reported that they showed a positive attitude towards the HLS mainly because the visual instructional aids, on which they depended, assisted them in: (i) mapping a mental representation of the document structure; (ii) imposing a conceptual structure on the learning content; and/or (iii) successfully navigating through the HLS to locate the information that they needed in relation to their learning goals. In contrast, FI learners with the same experience profiles said that they favoured the HLS mostly because: (i) its non-linearity features, which gave them more flexibility in the tutorial and offered 'permission' to set their own paths to accomplish their learning; and (ii) although they (albeit infrequently) used one or two visual instructional aids, they were not distracted by the visual instructional aids that they did not use.

With regards to those learners with an experience profile of high DK and high CE, the analysis of the qualitative data with respect to cognitive style did not highlight differences, with both FD and FI learners in this group reporting that they showed a positive attitude towards the HLS because: (i) of its non-linearity features which allowed them to have high levels of freedom of navigation and to have more control over the tutorial; and (ii) they were not disturbed by the visual instructional aids, which they did not use at all.

5. CONCLUSION

In Ruttun and Macredie (2012), three research questions were addressed in relation to disorientation, learning performance and attitudes in the use of two versions of a HLS (with and without visual instructional aids) by learners with different cognitive styles, and levels of domain knowledge and computer experience. For each research question, significant findings were revealed through the analysis of quantitative data from attitude and disorientation questionnaires and learning performance assessed through pre-post-tests scores, time efficacy and practical tasks scores.

This paper has explored qualitative data gathered through semi-structured interviews with the same user group, triangulating the findings from the previously reported quantitative study, while adding depth to the previous study in relation to the answers to six research questions.

Based on the preceding analysis, important design issues can be framed when considering domain knowledge and computer experience alongside cognitive style. First, whenever domain knowledge is low, irrespective of cognitive style, learners will depend heavily on the learning environment to enhance their learning performance. If the learning environment is not suitable for these learners (e.g., there are no instructional aids to support learning, or learners are unable to set own paths to perform learning), then it is likely that learners will show negative attitudes towards the HLS. Second, 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; though it may be beneficial for some learners, it can also have detrimental effects for those learners who do not use them.

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