

# The Effects of Visual Elements and Cognitive Styles on Students' Learning in Hypermedia Environment

Rishi Ruttun

**Abstract**—One of the major features of hypermedia learning is its non-linear structure, allowing learners, the opportunity of flexible navigation to accommodate their own needs. Nevertheless, such flexibility can also cause problems such as insufficient navigation and disorientation for some learners, especially those with Field Dependent cognitive styles. As a result students learning performance can be deteriorated and in turn, they can have negative attitudes with hypermedia learning systems. It was suggested that visual elements can be used to compensate dilemmas. However, it is unclear whether these visual elements improve their learning or whether problems still exist. The aim of this study is to investigate the effect of student's cognitive styles and visual elements on student's learning performance and attitudes in hypermedia learning environment. Cognitive Style Analysis (CSA), Learning outcome in terms of pre and post-test, practical task, and Attitude Questionnaire (AQ) were administered to a sample of 60 university students. The findings revealed that FD students performed equally to those of FI. Also, FD students experienced more disorientation in the hypermedia learning system where they depend a lot on the visual elements for navigation and orientation purposes. Furthermore, they had more positive attitudes towards the visual elements which escape them from experiencing navigation and disorientation dilemmas. In contrast, FI students were more comfortable, did not get disturbed or did not need some of the visual elements in the hypermedia learning system.

**Keywords**—Hypermedia learning; cognitive styles; visual elements; support; learning performance; attitudes and perceptions.

## I. INTRODUCTION

AS the World Wide Web (WWW) evolves into an important instructional platform, educational hypermedia is gaining increased attention. Hypermedia is made up of nodes that can contain text, graphics, audio, video, and is an open system that allows users to read from, append or write materials to shared structures. Two main advantages of using hypermedia instruction are that it presents learning material in a non-linear structure and allow learners to control their pace [5]. These features make hypermedia instructions a useful learning technology, thus offering advantages over traditional learning methods [16]. With regards to non linear interaction,

learners can access and sequence information in accordance with their information needs [19], which may improve learning and cognitive flexibility [24], [37].

In terms of learner control, learners are capable of having some control over the instruction [18]. Learner control has been one of the most heavily researched dimensions of hypermedia learning in recent years. Hypermedia learning system relies on learner control to be effective, since it is the student who determines which path to take or which node to visit. The type of learner control can range from sequencing – learners may be allowed to decide the order the order in which they would like to access different information units, through content control – learners may decide on which content to accept or receive and to representation control – learners may decide on how a specific content should be displayed [22], [25]. In addition to these aspects of learner control, learners can also set their own pace of instruction.

These features that allows the learner to decide which, and in what sequence, information will be accessed may make hypermedia learning systems to provide a rich learning environment [2]. However, the very flexibility of the hypermedia learning systems also creates problems to some users [23]. There are studies showing that some students do not succeed in non-linear and learner control hypermedia learning systems [7]. In order to cope with the specific constraints of a non-linear presentation, learners have to acquire specific strategies such as knowing where they are, where to go next and building a cognitive representation of the network structure. Therefore, not all individuals can develop their own navigation paths within a hypermedia-based instruction program. They may have trouble in monitoring their own learning [7]. Therefore it is vital to examine how different learners perceive the features of hypermedia learning. Evaluation of learners' individual differences become paramount because such evaluation can provide solid recommendations for designing and developing hypermedia learning system that can match with the particular needs of each learner.

In the past decade, significant amount of research have been done where it has been found that individual differences had significant effects on student learning in hypermedia systems, including cognitive styles [8], gender difference [11] and prior knowledge [14]. Among these differences, cognitive

Author is with Department of Information System and Computing, Brunel University, United Kingdom.

styles play an important role in the development of hypermedia learning systems because they refer to manner in which information is perceived and processed [26]. Researchers revealed that students possessing different cognitive styles showed different learning preferences and required different navigational support in hypermedia systems [4]. Furthermore, findings from previous studies stated that FD cognitive styles experienced more problems when learning in hypermedia learning systems. To overcome such difficulties, several visual elements, including maps, menus, index, highlighting context, link annotation and graphic visualization have been applied or suggested. However, although those visual elements help to reduce disorientation and ease navigation, little research, in regards to FD and FI cognitive styles, support the notion that these visual elements improve students' learning performance and lead to positive attitudes with hypermedia learning systems. Also, it is not clear whether these techniques enhance the learning of FD students in hypermedia learning or whether differences still remain. Furthermore, it is unclear whether these visual elements enhance or disturb FI students even though they feel confident to learn in hypermedia learning environment. In this vein, this study aims to examine whether the suggested visual elements enhance student learning in hypermedia environment. The next section examines Cognitive styles in hypermedia learning. Section III discusses the research method. The results are then presented in the IV section. Section V shows a discussion part followed by a conclusion in section VI.

## II. COGNITIVE STYLES

The term "cognitive styles" refers to the actual way an individual perceives and processes information [33]. The construct of Cognitive Style was originally proposed by Allport [1], referring to an individual's habitual way of perceiving, remembering, thinking and problem solving. The literature shows more than nineteen cognitive styles such as holistic and serialist, convergent and divergent, field dependent and independent. Field dependence is the cognitive style associated with the most substantive research in the past thirty years. Hence, in this study we focus on the field dependence/field independence continuum.

### *Field Dependence/Independence*

Field dependence/independence is generally considered to describe learners along a testable, value neutral, bipolar continuum. As suggested by Witkin et al., [42], there are three field - related cognitive styles: field independent (FI), field dependent (FD), and field neutral (FN). They contended that individuals have different cognitive styles according to each individual's way of disembedding figures from the distracting surroundings. A field independent person tends to perceive surroundings analytically, separating objects discretely from their backgrounds, while a field dependent person tends to perceive things in a relatively global fashion, being easily

influenced by a prevailing field or context [42]. According to Witkin et al., [41], field independent (FI) and field dependent (FD) learners have different characteristics. Some of the characteristics that best describe the field independent learner are: analytical, individualistic, competitive, internally directed, intrinsically motivated, generates structure, insensitive to social cues, less affected by structure and format individualistic, visually perceptive and ignores stress [15]. A Field dependent learner may be described by the following attributes: global, accepts structure, influence by salient features, influenced by structure and format, externally directed, sensitive to social interaction and criticisms, externally motivated, externally referential, passive, not visually perceptive and affected by stress [15]. Characteristics of field independent and field dependent learners are summarized in Table I.

TABLE I  
CHARACTERISTICS OF FIELD-DEPENDENT AND FIELD INDEPENDENT  
LEARNERS (GARGER AND GUILD, 1987)

FIELD-DEPENDENT (FD)	FIELD-INDEPENDENT (FI)
Perceives globally	Perceives analytically
Experiences in a global fashion, adheres to structures as given	Experiences in an articulate fashion, imposes structures of restrictions
Makes broad general distinctions among concepts, sees relationships	Makes specific concept distinctions, little overlap
Social orientation	Impersonal orientation
Learns material with social content best	Learns social material only as an intentional task
Attends best to material relevant to own experience	Interested in new concepts for their own sake
Requires externally defined goals and reinforcements	Has self-defined goals and reinforcements
Needs organization provided	Can self-structure situations
More affected by criticism	Less affected by criticism
Uses spectator approach for concept attainment	Uses hypothesis-testing approach to attain concepts

### *Field Dependence/Independence and Hypermedia Learning*

In the past ten years, studies have examined the influence of Field Dependence on hypermedia learning. Among the variables explained in previous studies, non-linear and linear learning, learning effectiveness, navigation and disorientation are the main issues discussed in previous works. In terms of non-linear and linear learning, the degree of field dependency has been shown to impact on preferred pathways (linear or non linear) through hypermedia learning environment. FD individuals tend to prefer a more restricted interface [8] and follow a linear route [21] whereas FD individuals tend to prefer a flexible interface and take non-linear approach.

In terms of learning effectiveness, mixed results have been collected in the past few years. Several works indicated that FD students performed better than FI students in hypermedia learning [10]. Conversely, a number of studies have proved that FD learners could perform equally to those of FI in a congruent instructional method [12].

With respect to navigation, research suggests that index, search, or other visual navigation tools that can be applied to locate specific information or that can be allowed to jump freely from one point to another are favoured by FI students [4]. On the other hand, FD students prefer to use tools that are well structured or where sequence can be followed from the beginning to the end, such as maps or menus [3]. Researchers have also stated that FD students are ready to accept the structure provided by the system [15] whereas FI students are more likely to provide organisation for ambiguous information and to restructure new information [43].

With regards to disorientation problem, previous studies have found that FD students have been found to perform worse than FI students when there is no explicit structure within the interface [30], becoming confused and disoriented [38]. Studies suggest that FD students tend to have more difficulty in learning when the learner himself is required to provide organisation as an aid to learning [41]. This is so because FD students are more reliant to salient cues in learning. In contrast, FI students, who employ more active approaches and are better at transferring concepts to new situations, are more comfortable navigating autonomously in hyperspace. Therefore, it is suggested that FD students should be provided instructional guidance, which can help them finding out relevant information to reduce disorientation.

In summary, recent studies suggest that learners of FD cognitive styles are most likely to face difficulties in an unstructured or non-linear environment when they have to restructure new information because they demonstrate fewer proportioning skills [5]. Learners with such characteristic prefer guide navigation or linear format representation. They show heavy reliance on the use of their memory as well as strongly depend on external references such as their course tutors who dictate the information to be learnt [5]. In contrast, FI students are more comfortable with non linear format presentation. They are characterised as individuals who enjoy working alone, prefer free navigation, more likely to provide organisation for unambiguous information and to restructure new information [43]. Consequently, there is a need to provide additional support to FD students when learning in hypermedia environment.

#### *Supporting FD students in hypermedia learning*

With regards to additional support, as discussed earlier, certain techniques are suggested at helping FD students to ease navigation and to reduce disorientation problems within hypermedia learning systems. These include visual elements to ease navigation and to reduce disorientation within hyperspace. These issues are discussed next.

#### *-Visual elements to ease navigation*

Research has revealed that FD and FI students show different preferences to, and gain benefit, from different navigational aids. It is suggested to provide navigation tools such as index, search or embedded links within the hyperspace to FI students. These visual elements provide them with free navigation and find specific information that they need. In contrast, it is suggested to provide navigation tools such as maps, menus to FD students. Visual elements of maps and menus can show FD students the global picture of the tutorial.

#### *-Visual elements to reduce disorientation*

As discussed earlier, FD students meet more disorientation problems towards non linear learning. In this situation, the user interface, which serves as the major medium for such engagement of the learners [13], is a major determinant of effective communication [34]. Different visual elements have been suggested to reduce disorientation dilemmas in the design of hypermedia learning systems. These issues are further discussed below:

#### *~Where are they?*

Users' current location is viewed in two different levels: (a) relative to the learning content as a whole; (b) relative to specific topics. The former can be shown by providing visual breadcrumb facilities which track out where they were in relation to the homepage or which path they have taken to come to the current page. The latter can be given by highlighting the area where the current page is located. This is done by providing visual elements such as headings, page labels and different link colours [9]. Also, a visual graphical overview diagram with different colours is also provided where users could locate their current location within the information hyperspace [6], [27].

#### *~Where have they been?*

Visual elements such as different link colours are provided to give learners information on where they have been in the tutorial [28]. Also, visual link of the backtrack facility could show them where they have been.

#### *~Where can they go next?*

A visual element such as pagination is provided where it enable students to cut down on unnecessary routes. Additionally page labels that clearly indicated the role of a particular page help users successfully to decide which next best path to take in the tutorial [20]. Furthermore visual link annotation, indicating where a link will take the user, is provided as a means to choose the next best route in the learning system [29].

Results from these studies imply that individual differences play a vital part in the use of hypermedia instructions. These studies also argue that some users tend to face difficulties while others enjoy their freedom of navigation in hypermedia instructions. Some students, for example, Field Dependent learners, may need greater support and guidance from the

instructors, while others may be able to follow hypermedia learning programmes independently. It has been suggested that visual elements for navigation and orientation aids can actually support FD students in hypermedia environment so as to try to reduce the disparity in performance with FI students. However, how far this is true, it remains inconclusive. Therefore, it is needed to discover whether these visual elements enhance FD students or whether problems still exist. Also, it is imperative to examine whether FI students get disturbed with these visual elements that are required to support FD students or whether they enhance their learning in hypermedia environment. The study also seeks to examine students' attitudes and perceptions towards the hypermedia learning system associated with the suggested visual elements.

### III. METHODS

#### Sample

Subjects of this study consisted of 60 undergraduates from Brunel University. They were students from different courses and had at least some basic computer and Internet skills necessary to operate hypermedia instructional program. Among the 60 students, 19 of the subjects were identified as Field Dependent (FD), 18 of them were identified as Field Mixed (FM) and 23 of them were identified as Field Independent (FI).

#### Research Instrument

For this study, different instruments were needed, which is discussed below:

#### -Hypermedia learning system

A Hypermedia learning system was developed to host the Extensible Hypertext Mark-up Language (XHTML) tutorial. The tutorial consisted of 50 pages where the content was divided into seven lessons and with a maximum of 7 sections. Each lesson was provided with pseudocode alongside with examples and the output in terms of screen shots, all in one page. The interface of the system was a two-dimensional one which consisted of a left navigation column along with the main content appearing on the right. The left navigation included internal links, which could be linked to the homepage, main menu, resources, and "Frequently Asked Questions". Backtracking link to revisit latest pages were also supported by the hypermedia tutorial.

Visual elements of search drop menus (refer to Fig. 1), map (refer to Fig. 3) and main menu (refer to Fig. 1) were provided to ease the navigation for FD students within the hyperspace. The search drop menus provide scrollable content lists of all the nodes in the tutorial. The map and the main menu provide a visual representation of the structure of the hypermedia information space. They also illustrate the relationship between the nodes of the information. Additionally, the map provided an overview of the entire tutorial and it could be expanded to present the learners with advance organisers for specific lessons being studied.

The FI students also had the opportunity to enjoy the non-linear and learner control features with the provision of the visual elements such as tag indexes (refer to Fig. 1), search tool (refer to Fig. 1) and index tool (refer to Fig. 2) and embedded links within the tutorial (refer to Fig. 1). The index and the tag indexes show a list of all the links in alphabetical order. The search tools allow the user to type a query for locating their desired information in the tutorial.

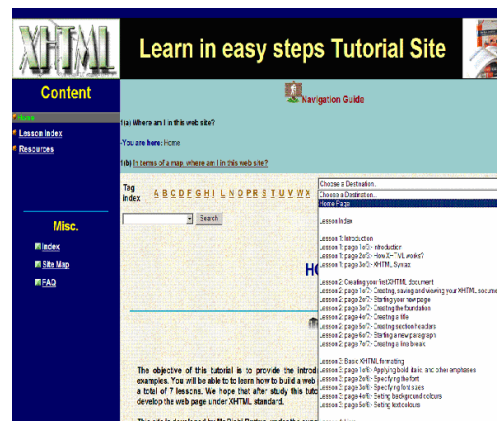


Fig. 1 Visual elements of tag indexes, search tools, menus for navigational aid

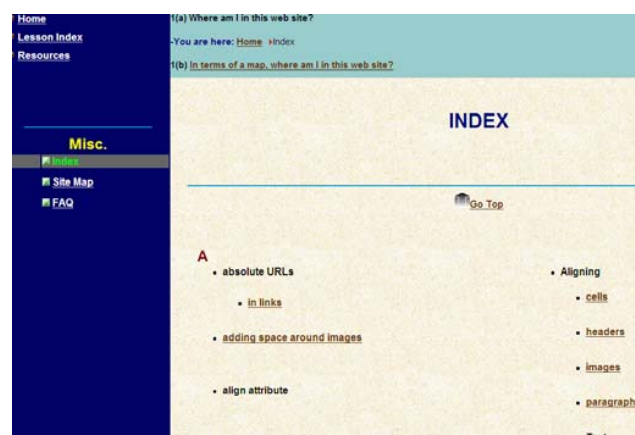


Fig. 2 Visual element of index tool for navigational aid

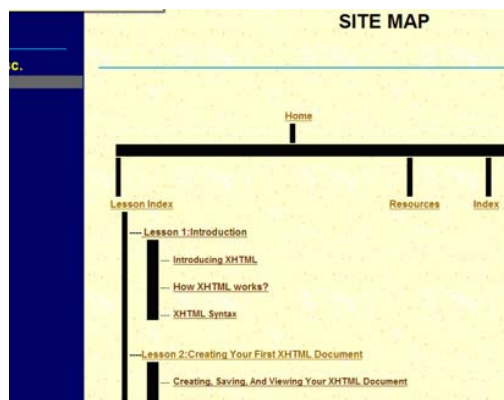


Fig. 3 Visual element of map for navigational aid

The hypermedia learning system also provided some visual elements reduce the problem of disorientation that is experienced by FD students. These include breadcrumb, different link colours, link annotation, page labels, pagination and highlighting context (refer to Fig. 4) and a graphical overview diagram (refer to Fig. 5).



Fig. 4 Visual elements to reduce disorientation

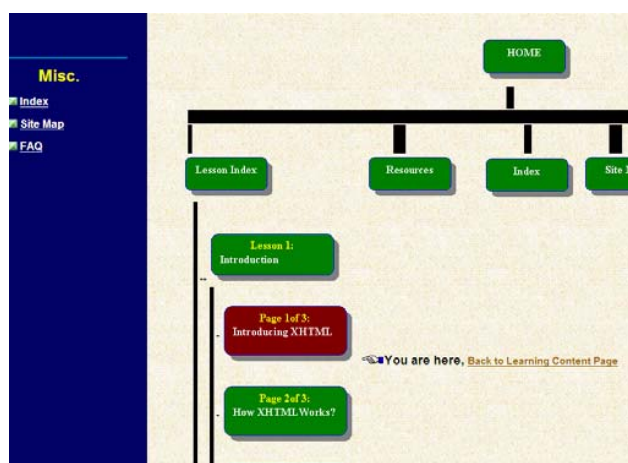


Fig. 5 Visual element of graphical overview for orientation and navigation purposes

#### -Cognitive Style Analysis (CSA)

The Cognitive Styles Analysis (CSA) was used to determine preferred learning styles, either as Field Dependent (FD) or Field Independent (FI). Such instrument is a computer-presented test which consists of three sub-tests: the first assesses the Verbaliser-Imager dimension, and the second and the third assess the Wholistic-Analytic dimension. The test taker is required to respond to a series of items by simply pressing either a "true" or "false" button. Cognitive Styles Analysis (CSA) measures an individual's position on its two orthogonal dimensions: V-I and W-A. The V-I dimension is indicative of whether the individual, while thinking, tends to represent information either verbally or in mental pictures. On the other hand, the W-A style dimension describes whether an individual is inclined to organize information into wholes or parts [33]. The computer then calculates the individual's scores. In terms of measurement, Riding noted that whoever scores below 1.03 is classified as Field Dependent, and those who score higher than 1.36 are classified as Field Independent. Anyone in the ratio between 1.03 and 1.36 are classified as Field Mixed.

#### -Pre-test, post-test and test-gain scores

Pre-test and post-test were used to measure a student's acquired knowledge of program concepts and the success of the prevention program's design. With the pre-test, students were measured the amount of their pre-existing knowledge on the lesson topic. A post-test was used to indicate the learning assessments after having learned the topics from the given learning system. The test-gain scores would be the difference between the pre-test and the post-test scores and it was used to find out how much the students have improved after having learned the XHTML tutorial from the learning system. Each test contained 20 multiple choice questions. Each question carries a list of four possible answers and an "I do not know" option where students have to circle the best answer. The questions were all about XHTML topics, covered in the seven lessons available from the tutorial in the learning system. Creating similar questions in the post-test was achieved by either rewriting the question but with possible answers in different order, or where appropriate, by substituting different numbers or variables into the questions.

#### -Task sheet

The students were given a set of exercises to complete in order to assess their practical learning performance. The exercises comprised of three to five sections where it was all about building web pages. Students were also allowed to interact with the learning system to find the answers. There were no time limits to complete the practical tasks. The students could only use notepad as an application to do the exercises where they had to save and stored all their work in a folder. The task achievement was evaluated by the overall tasks scores and the overall tasks completion time. Overall tasks scores would be the sum of marks scored in each task (a total of five) by each student. Overall tasks completion time



would be the overall time taken to complete the whole exercise by each student.

#### *-Questionnaire*

Two questionnaires, entry and exit form were used in this study. The entry, given at the start of the experiment was more of a closed type format where it was used to capture students' demographic information and attributes like sex, age, course area, experience of using Internet, computers and XHTML.

The exit questionnaire consisted of open-ended questions and closed statements to collect student responses to the given hypermedia learning system. The open-ended questions were used to collect students' likes and dislikes about the hypermedia learning system. With this type of questionnaire, students could briefly write their opinions in their own words. The closed statements were designed to collect information about students' attitudes towards the given learning system. It was split in different sections, each labeled with a heading like navigation aids, orientation aids structure and so on. A 7-point semantic differential scale was applied with responses ranging from 1 (strongly disagree) to 7 (strongly agree).

#### *Procedure*

Students (N=60) took part in the experiment. Each of them, working individually was given a computer with instructions. The experiment consisted of seven stages where students were asked to perform the following tasks:

1. Take part in the CSA test to determine their level of field dependence
2. Complete entry questionnaire
3. A maximum of 15 minutes were given to complete the pre-test
4. Interact with the hypermedia learning system to learn XHTML tutorial
5. Complete the practical task where they could still interact with the hypermedia tutorial to find the answers.
6. A maximum of 15 minutes were given complete the post-test
7. Complete the exit questionnaires (open and closed)

#### *Data Analysis*

The independent variable was the user's cognitive style as measured by CSA (refer to section III). The dependent variables were the questionnaires responses as well as the tests and practical task from learning assessments.

Data were analysed using the Statistical Package for Social Science, Personal Computer Version (SPSSx/PC). Analyses of data included frequencies, standard deviations, and means. One way ANOVA (ANalysis Of Variance) was used to observe whether there were significant differences between students with different cognitive styles on learning performance and on attitudes and perceptions when using the

given hypermedia learning system. A significance level of .05 was adopted.

## IV. RESULTS

### *Learning Performance*

The students' knowledge of the learning material (XHTML) was examined through post-test scores, test-gain scores, time performance and practical tasks scores. ANOVA analysis was conducted to see whether there were significant differences among students with different cognitive styles in their learning performance. The results showed no significant differences in the post-test and in the practical task (refer to Table II). This result does not support the findings from some of the previous studies [32], [40], [39] where most of the time FI students outperformed FD students. However, it is supported from those studies conducted by [35], [36], and [12] where FD and FI students have been performed equally.

Also, there were no significant differences among students with different cognitive styles in the test-gain scores. Nonetheless, it is observed that all students progressed from their pre-test scores to post-test scores (refer to Table II). Such result shows that all students who took part in this experiment made an improvement with the given learning system. Furthermore, ANOVA revealed no significant differences among student with different cognitive styles and time completion for the tutorial and the practical task (refer to Table II).

TABLE II  
MEAN SCORES FOR STUDENTS WITH DIFFERENT COGNITIVE STYLES ON  
LEARNING PERFORMANCE

Assessments	Total	Cognitive Styles		
		Field Dependent	Field Independent	Field Mixed
	N = 60	N = 19	N = 23	N = 18
<b>Post-Test</b>				
Mean		12.79	13.09	13.56
SD		2.96	2.88	2.15
No Significance: F= .376, p> 0.05				
<b>Test gain</b>				
Mean		.4342	.3913	.4444
SD		.1491	.2344	.2275
No Significance: F= .384, p> 0.05				
<b>Overall Practical Task</b>				
Mean		69.58	83.87	82.72
SD		25.42	17.92	17.00
No significance : F= 2.995, p> 0.05				
<b>Time taken to complete the overall practical</b>				

<b>tasks</b>				
Mean		.3553	.3404	.3694
SD		.0743	.0893	.1087
No significance: $F = .513, p > 0.05$				
<b>Time taken to complete the lessons</b>				
Mean		.3700	.3478	.3750
SD		.0785	.0991	.1115
No significance : $F = .467, p > 0.05$				

*Attitudes towards non linear interaction, navigation, structure and additional support*

In relation to the questions of the tutorial structure and navigational complexity, the responses from the closed questionnaire (refer to Table III), indicated that FD students had more difficulties in hypermedia environment and depend a lot on the additional support that was provided by the learning system, including visual elements of highlighting context, link annotation, change of link colours, breadcrumb facilities, page labels, graphical overviews than FI students. This result reflects the data from the open questionnaire where FD students mentioned that they felt disorientation in hypermedia learning and depend a lot on the visual elements to orientate themselves within the hyperspace. In contrast FI students stated that they felt confident and comfortable in hypermedia learning where they did not need of the visual elements for orientation purposes. These students who are more analytic and active can create and find their own path in the tutorial.

TABLE III

COGNITIVE STYLES AND THEIR VIEWS ON THE VISUAL ELEMENTS THAT REDUCE DISORIENTATION

Question: I depend heavily on the visual elements to escape from disorientation in the hypermedia tutorial						
	<b>Cognitive Styles</b>					
	Field Dependent		Field Independent		Field Mixed	
	N	%	N	%	N	%
Strongly disagree	0	0	9	39	1	6
Disagree	0	0	6	26	7	39
Slightly disagree	4	21	3	13	2	11
Neither	3	16	2	9	5	28
Slightly agree	1	5	3	13	0	0
Agree	6	32	0	0	3	17
Strongly agree	5	27	0	0	0	0
Total	19		23		18	
Significance	$F = 14.178, p = 0.000$					

With respect to the structure, FD students, who were struggling with non linear feature in hypermedia tutorial, had a strong preference towards the structure in visual elements such as of menu and the map (refer to Table IV), which made it easier for them to navigate and to complete their tasks effectively. Such result reflects the data from the open questionnaire where FD students mentioned that they could easily learn with the map and the menus in the tutorial. The maps helped them to see the conceptual structure of the learning content within the hypermedia instructional program. In addition, it facilitated their navigation by providing them with a contextual overview of the structure of the application. Moreover, the structure in the main menu enabled them to cut down on unnecessary routes and to reach their desired destination without facing difficulties. They also stated that they could not use the index, tag indexes or in the embedded links as they were of network structure. These results are supported by the characteristic of FD students who tended to accept global structure such as the site map, and menus or the graphical overview map [43]. In contrast, as seen in Table III, FI students had a negative towards the structure that was given in the map and the menus. Such response was further supported by those from the open questionnaire where FI students wrote down that they would simply not use map or menus as they had too many levels. Instead, they preferred to use the index, tag indexes and embedded links that were provided in the tutorial. These results support the characteristics of FI, who tend to represent concepts through analysis, internally directed and prefer a discovery approach [21].

TABLE IV

COGNITIVE STYLES, VISUAL ELEMENTS AND VIEWS ON THE STRUCTURE

Question: I prefer the structure in the map and menus where it eases my navigation in the hyperspace						
	<b>Cognitive Styles</b>					
	Field Dependent		Field Independent		Field Mixed	
	N	%	N	%	N	%
Strongly disagree	0	0	4	17	2	11
Disagree	1	5	10	43	2	11
Slightly disagree	2	11	4	17	4	22
Neither	3	16	2	9	4	22
Slightly agree	3	16	3	13	4	22
Agree	6	32	0	0	2	11
Strongly agree	4	21	0	0	0	0
Total	19		23		18	
Significance	$F = 17.792, p = 0.000$					

In terms of navigation, it seems that different level of students' cognitive style influence their perception of the navigation support in the tutorial. In analysing the students' responses to the question whether they would like to use certain type navigation tool, the results indicate that the main effects of students' cognitive styles and hypermedia instruction was significant at  $p < 0.05$  (refer to Table V). Students with FD cognitive styles had more difficulties surfing in hypermedia learning and needed navigation tool such as maps and menus. Such response reflects the data from the open questionnaire where FD students stated that the hierarchical map displayed the content topics and sub topics. Also, with such visual representation, they could be recommended to use a certain path or be given clues as to what path should be taken through the information space. Additionally, annotation links provided these students with additional information about the links. This visual technique also supported their navigation by limiting the browsing space within which they could be likely to "get lost". Conversely, FI students, who is more comfortable, and who had preference of freedom of navigation had more negative attitudes towards the map and menus for navigation (refer to Table V). Such negative attitude and perception reflects the data from the open questionnaire where they preferred to use the index, embedded links and search tool strong to surf the tutorial.

TABLE V  
COGNITIVE STYLES, VISUAL ELEMENTS AND VIEWS ON NAVIGATION

Question: I depend on the map and menus which enable me to surf and complete the XHTML tutorial effectively						
	Cognitive Styles					
	Field Dependent		Field Independent		Field Mixed	
	N	%	N	%	N	%
Strongly disagree	0	0	5	22	2	11
Disagree	0	0	8	35	2	11
Slightly disagree	2	11	3	13	4	22
Neither	2	11	3	13	1	6
Slightly agree	3	16	3	13	4	22
Agree	6	32	1	4	4	22
Strongly agree	6	32	0	0	1	6
Total	19		23		18	
Significance	F=17.496, p= 0.000					

## V. DISCUSSION

In response to the research question, "whether the suggested visual elements can improve FD learners' learning" seem to be fully supported. One significance of this research is that it provides designers with design guidelines based on empirical evidence that they can implement to support FD and FI individuals. The hypermedia learning system which incorporates the visual elements for navigation and orientation

aids facilitate their learning. For instance, visual elements such as highlighting context, link annotation, graphical overviews, and change of link colours reduced the tendency for the FD students to become lost in hyperspace and provided better opportunities for more efficient processing of information. In terms of navigation support, visual elements, maps and menus were very beneficial for these students. The former facilitated their navigation by providing them with a contextual overview of the structure of the application. The latter enabled them to cut down on unnecessary routes and to reach their desired destination without facing difficulties within the hyperspace.

In response to the research question, "whether the suggested visual elements can enhance FI students although they feel confident and comfortable in hypermedia learning seemed not to be supported. FI students seemed to be comfortable and confident in hypermedia learning. They do not face any disorientation problem where they do not need any of the suggested visual elements. Also, the provision of the index, search tool, tag indexes and embedded links were more than enough to satisfy them learning in hypermedia environment. What is important to consider is that these adaptations did not adversely affect the performance of FI individual and that our design was inclusive in this important respect. This study thus demonstrates that it is possible to accommodate FD students and FI students in hypermedia instructions. Designers also need to pay attention that FI students need their preferred tools so that they can enjoy their learning in hypermedia environment.

The results from the post-test, practical task and the test-gain scores show that Witkin's Field-dependence/Field-independence is not a significant predictor of student assessment score. This shows that the suggested visual elements have successfully supported FD students and their learning. Those who were FD performed equally to those who were FI. In the previous study FI students had performed significantly better than FD students where the hypermedia instructions may have been less structured and with little support in regards of the FD [31].

The responses from the questionnaire survey revealed that FD students, who normally experience disorientation and navigation problems where they have more negative attitudes with hypermedia learning seemed to be solved with this study. In other words, FD students had more positive attitudes with hypermedia learning when the suggested visual elements are given. This shows that FD students can be attracted to hypermedia learning when they meet their requirements. On the other hand, although FI students did not like or did not need any of the visual elements in the learning system, they still had a positive attitude with hypermedia learning. This shows that so far these students are not disturbed with other elements and are provided with their preferred tools, they will have a positive attitude with hypermedia learning. Therefore there is a need to provide some support to some students without disturbing others when learning in hypermedia environment.



## VI. CONCLUSION

We have shown that it is possible to redesign instructional environments so as to balance the performance of FD and FI students. The findings from this study also conclude that FI learners do not get disturbed by the suggested techniques that are provided to FD students so far they are provided with their preferred features such as visual element of index tools, search tools, tag indexes, embedded links, which enable them to enjoy their freedom of navigation in hypermedia learning systems. However, this study was only of a small scale study. Larger sample need to be taken into consideration when conducting this type of study. Furthermore, research on other individual differences such as domain expertise, age and gender need to be conducted so as to see the impact on learning. Also, research on how cognitive styles, especially FD and FI students perform with the use of multimedia or other kind of audio elements in hypermedia learning would be worthy to investigate in the near future.

## REFERENCES

- [1] Allport, G.W. (1937). *Personality: A Psychological Interpretation*. New York Holt and Co.
- [2] Becker, D. A., & Dwyer, D. A. (1994). Using hypermedia to provide learner control. *Journal of Educational Multimedia and Hypermedia*, 3(2), 155-172.
- [3] Chen, S.Y., & Ford, N.J. (1998). Modelling user navigation behaviours in a hypermedia-based learning system: An individual differences approach. *International Journal of Knowledge Organization*, 25(3), 67-78.
- [4] Chen, S.Y., Ford, N.J. 2000. Individual differences, hypermedia navigation and learning: An empirical study. *Journal of Educational Multimedia and Hypermedia* 19 4, pp. 281-312.
- [5] Chen S.Y. & Macredie R.D. (2002). Cognitive styles and hypermedia navigation: development of a learning model. *Journal of the American Society for Information Science and Technology*, 53, 1, 3-15.
- [6] Chen, C. and Rada, R. (1996) Interacting with hypertext: A meta-analysis of experimental studies. *Human-Computer Interaction*, 11 (2), 125-156.
- [7] Cho, Y. (1995). The nature of learner's cognitive processes in learner- and program-controlled hypertext learning environments. UMI, DAI-A 56/06, p. 2207, Publication Number, AAT 9534749.
- [8] Dufresne, A., & Turcotte, S. (1997) Cognitive style and its implications for navigation strategies. In Boulay, B., Mizoguchi, R. (eds.): *Artificial intelligence in Education Knowledge and Media Learning System*. Amsterdam IOS Press, Kobe, Japan, pp. 287-293
- [9] De La Passardiere, B. d. and Dufresne, A. 1992. Adaptive Navigational Tools for Educational Hypermedia. In *Proceedings of the 4th international Conference on Computer Assisted Learning* (June 17 - 20, 1992). I. Tomek, Ed. Lecture Notes In Computer Science, vol. 601. Springer-Verlag, London, 555-567.
- [10] Ernesti F (2002) The effect of individual difference variables, learning environment, and cognitive task on statistical learning performance, Unpublished PhD dissertation, West Virginia University.
- [11] Felix U (2001) A multivariate analysis of students' experience of web based learning. *Australian Journal of Educational Technology* 17, 1, 21-36.
- [12] Ford N and Chen S Y (2001) Matching/mismatching revisited: an empirical study of learning and teaching styles *British Journal of Educational Technology* 32, 1, 5-22.
- [13] Hildreth, C.R. (1995). The GUI OPAC: Approach with caution [online]. *The Public Access Computer Systems Review* 6(5)
- [14] Hölischerl C and Strubel G (2000) Web search behaviour of Internet experts and new users *Computer Networks* 33, 1, 337-346.
- [15] Jonassen, D.H., and Grabowski, B.L. (1993). *Handbook of individual differences, learning, and instruction*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- [16] Khalifa M. and Lam R. (2002). Web-based learning: effects on learning process and outcome. *IEEE Transactions on Education*, 45, 350-356.
- [17] Kim (2001), Implications of user characteristics in information seeking on the World Wide Web *International Journal of Human-Computer Interaction* 13, 3, 323-340.
- [18] Large A. (1996) Hypertext instructional programs and learner control: a research review. *Education for Information*, 4, 95-106
- [19] Lawless and Brown, 1997. Multimedia learning environments: Issues of learner control and navigation. *Instructional Science*. v25 i2. 117-131.
- [20] Lewis and Polson, 1990. C. Lewis and P.G. Polson, Theory-based design for easily learned interfaces, *HCI* 5 (1990), pp. 191-220.
- [21] Liu, M., & Reed, W.M. (1995) The effect of hypermedia assisted instruction on second-language learning through a semantic-network-based approach. *Journal of Educational Computing Research*, 12(2), 159-175.
- [22] Lunts, E. (2002). What does the literature say about the effectiveness of learner control in computer-assisted instruction? *Electronic Journal for the Integration of Technology in Education*, 1(2).
- [23] Marchionini, G. (1995). *Information Seeking in Electronic Environments*. Cambridge University Press.
- [24] Mendes, M. E. X., & Hall, W. (1999). Hyper-authoring for education: a qualitative evaluation. *Computers and Education*, 32, 51-64.
- [25] Merrill, D. M. (1980). Learning control in computer based learning. *Computers & Education*, 4, 77-95.
- [26] Messick S. (1976). *Individuality in learning*. San Francisco: Jossey-Bass.
- [27] Nielsen, J. (1990). The art of navigating through hypertext. *Communications of the ACM*, 33 (3), 298-310.
- [28] Nielsen, J. (1995). *Multimedia and hypertext: The internet and beyond*. Cambridge, MA: Academic Press.
- [29] Nielsen, J. (2000), *Designing web usability: The practice of simplicity*, New Rider Publishing, USA (2000).
- [30] Palmquist, R.A., Kim, K.-S. (2000). Cognitive style and on-line database search experience as predictors of Web search performance. *Journal of the American Society for Information Science*, 51(6), 558-566.
- [31] Parkinson, A.P., Redmond, J.A "The impact of cognitive styles and educational computer environments on learning performance" *Computer Sc Dept Trinity College Dublin. Ireland*. 2002
- [32] Post, Paul E. (1987). The effect of field independence and field dependence on computer assisted instruction achievement. *Journal of Industrial Teacher Education* V25, n2, p60-67, Fall 1987.
- [33] Riding R and Rayner S G (1998) *Cognitive styles and learning strategies* David Fulton, London.
- [34] Sims, R. (1998). Futures for computer-based training: Developing the learner-computer interface. *Australian Journal of Educational Technology*, 4, 123-136.
- [35] Tannenbaum, R.K. (1982). An investigation of the relationships between selected instructional techniques and identified field dependent and field independent cognitive styles as evidenced among high school students enrolled in studies of nutrition. *Diss. Inter*. 43, 68.
- [36] Thompson, M.E and Thompson, G. (1987) Field dependence-independence and learning from instructional text. (ERIC Document No.ED258 563)
- [37] Triantafyllou, E., Pomportsis, A., & Demetriadis, S. (2003). The design and formative evaluation of an adaptive educational system based on cognitive styles. *Computers and Education*, 41(1), 87-103.
- [38] Wang, P., Hawk, W.B., & Tenopir, C. (2000) Users' interaction with World Wide Web resources: An exploratory study using a holistic approach. *Information Processing & Management*, 36, 229-251
- [39] Weller H G, Repman, J., William, L and G. Rooze (1995). Improving the effectiveness of learning through Hypermedia and based instruction. *The Importance of Learner characteristics*. *Computers in Human Behavior*, Vol 11, No.3-4, pp 451-465.
- [40] Wey, P., Waugh, M.L. (1993). The effects of different interface presentation modes and users' individual differences on users' hypertext information access performance. Paper presented at Annual Meeting of American Educational Research Association Atlanta, Ga.
- [41] Witkin H, Moore C, Goodenough D Cox,P (1977) Field dependent and field cognitive styles and their educational implications. *Review of Educational Research*, 47, 1-64.
- [42] Witkin, M.A., Oltman, P., Raskin, E., Karp, S. (1971). *A Manual for the Embedded Figures Test*. Palo Alto, CA: Consulting Psychologists Press.
- [43] Witkin, H.A and Goodenough D R (1981) *Cognitive styles: essence and origins*, International Universities Press, Inc, New York.