THE EFFECTS OF VARIED INSTRUCTIONAL AIDS AND FIELD DEPENDENCE-INDEPENDENCE ON LEARNERS’ STRUCTURAL KNOWLEDGE IN A HYPERMEDIA ENVIRONMENT

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Abstract

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This study examined the effects of instructional aids and the cognitive style of field dependence-independence (FDI) on students’ structural knowledge and attitude toward program design in a hypermedia learning environment. Participants were 75 undergraduates enrolled in classes whose curricula dealt with technology applications in Education course. Prior to the treatment, the Group Embedded Figures Test (GEFT) was administered to determine the extent to which participants were field dependent, field mixed, or field independent. Next, participants were asked to complete a pretest and a Web Attitude Scale Questionnaire. Participants were randomly assigned to either navigational map treatment group or content list treatment group based on their scores of GEFT. Data analysis consisted of two 3X2 ANCOVA to examine the effect of FDI and instructional aids on students’ structural knowledge and attitude toward program design as measured by the post test. Data analysis revealed no significant interaction between FDI and instructional aids in both structural knowledge performance and attitude toward program design. No significant main effects for instructional aids or field type on both structural knowledge performance and attitude toward program design were detected. Additional analysis of MANOVA on the attitude toward program design revealed that students’ feelings of disorientation were significantly decreased by using the navigational
map approach when compared with those using the content list approach. Students in the navigational map treatment reported feeling significantly less disoriented than the students in the content list group.

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Chapter One: Introduction

Background of the Study

With advances in computer technology, hypermedia has played a vital role in the delivery of instruction. The use of hypermedia as a learning medium has prompted much research in the field of educational technology. However, how cognitive styles of field dependence/independence (FDI) influence learning in hypermedia systems is still unclear. The aim of this study was to examine the effectiveness of two common instructional aids, a navigational map and a content list, on the structural knowledge performance of subjects with different cognitive style of FDI in a hypermedia environment.

In a hypermedia environment, how to represent information effectively in order for meaningful learning to occur is important to explore for hypermedia designers (Umar, 1999). Meaningful learning, compared with rote learning, is a very important concept in cognitive learning theory. New knowledge, according to Ausubel (1963a, 1968), if it is to be meaningful, would need to be incorporated, or subsumed, into existing knowledge structures. Information processing theory offers a framework in which new information can be incorporated into existing knowledge (Wedge, 1994). Information processing theory examines the learner’s organization of thinking, one’s strategies for problem solving, the process of learning, and the role of meaning in learning (Ayersman, 1993). It focuses on how the human memory system acquires, transforms, compacts, elaborates, encodes, retrieves, and uses information (Burton, Moore, & Holmes, 1995). The memory model can be traced to Atkinson and Shiffrin (1968) who assume that there are three stages of information processing: sensory memory, short-term memory, and long-term
memory. Information is transferred first from the sensory register, then passes through the short term store, and finally ends up in the long term store.

Organization is a memory strategy that a subject may use to lead to an improvement in performance (Atkinson & Shiffrin, 1968; Byrnes, 2001). Organizational theorists place organization as a key role in learning. The importance of organization is emphasized by Bruner (1961) who states that “Perhaps the most basic thing that can be said about human memory…is that unless detail is placed into a structured pattern, it is rapidly forgotten” (p. 24).

Learning, according to Jonassen, Beissner, and Yacci (1993), is a process of acquisition of structural and declarative as well as procedural knowledge. Declarative knowledge is simply knowing about a concept, including its attributes and the attributes that relate it to other concepts (Wedge, 1994). Procedural knowledge is the application of declarative knowledge and is about knowing how to use the concepts in performing tasks (Jonassen et al., 1993). Structural knowledge is a type of knowledge that “mediates the translation of declarative into procedural knowledge and facilitates the translation of declarative into procedural knowledge” (Jonassen et al., 1993, p. 4). It emphasizes “the pattern of relationships among concepts in memory…” (Preece, 1976, p.1). Jonassen et al. (1993) proposed the following reasons for studying structural knowledge:

1. “Structure is inherent in all knowledge” (Jonassen et al., 1993, p. 8).
2. “Structural knowledge is essential to recall and comprehension” (Jonassen et al., 1993, p. 8).
3. “Learners assimilate structural knowledge” (Jonassen et al., 1993, p. 9).
4. “Memory structures reflect the world” (Jonassen et al., 1993, p. 9).
5. “Structural knowledge is essential to problem solving” (Jonassen et al., 1993, p. 10).

6. “Expert’s structural knowledge differs from novices” (Jonassen et al., 1993, p. 10).

Hypermedia technology, one of the main features of the Web, possesses distinctive characteristics that present the information in a way that indicates the numerous and multiple interrelations between concepts (Puntambekar, Stylianou, & Hübscher, 2003). This facilitates human learning according to the individual differences (Jonassen, 1988, 1991; Land & Hannafin, 1996; Liu & Reed, 1994).

The concept of ‘hypermedia’, according to Reed, Ayersman, and Liu (1996), is related to the concepts of ‘hypertext’ and ‘multimedia’ (Reed & Oughton, 1998). Thompson, Simonson, and Hargrave (1992) defined ‘hyper’ as a navigation process that allows learners to access information in a nonlinear or random manner. Media refers to various formats of information such as text, graphics, audio, video, animation, etc. Hypermedia, according to Marchionini (1988), consists of nodes such as paragraphs, images, articles, individual lessons, and links which are associations among nodes.

Research (Jonassen & Wang, 1993; Paolucci, 1998) has provided evidence that hypermedia learning environments can improve and develop students’ higher cognitive skills such as analysis and synthesis. Marchionini (1988) argues that hypermedia can improve learning because it can “model human associative memory and thus can serve as powerful cognitive amplifiers” (p. 8).

Specifically, hypermedia systems resemble Quillian’s (1968) semantic-network theory (Daniels, 1996). Semantic-network theory is a long-term memory model in which
nodes are interconnected by associative links (Quillian, 1968). It is the interrelationships between nodes that give them meaning (Jonassen, 1988).

In addition, supporters of hypermedia technology claim that hypermedia systems are learner controlled environments that adapt to the individual differences of learners and provide instruction in accordance with their cognitive needs. This results in the best learning effect (Ayersman, 1993; Marchionini, 1988; Park, 1991). Unlike traditional strictly sequential print texts, the major feature of hypermedia is that it presents information as a network of nodes and links that are arranged nonlinearly. A nonlinear tool that offers a new direction, rather than the conventional step-by-step concept allows more for random access, tends to be more interactive, and offers overt ways of reading (Tierney, 1994). The flexibility and nonlinearity of hypermedia systems, the strongest advantages over linear text, have also been viewed as a disadvantage. Reviews of literature (Conkin, 1987; Hammond & Allinson, 1989; Marchionini, 1988) have indicated that users may encounter cognitive overload and disorientation problems when browsing hypermedia environments. In order to decrease the potential learner’s disorientation and cognitive overload, researchers have suggested that structural knowledge learning strategies such as concept maps (Su & Klein, 2006), indexes (Ford & Chen, 2000), and content outlines (Archer, 2003) can be used to help in navigation and enhance efficiency in learning performance in hypermedia environments. This experimental study will focus on two strategies, concept maps and content lists.

Concept maps are a technique that can be used to represent structural knowledge. Concept maps visually depict the interrelationships among concepts, present information on domain knowledge hierarchically, and allow learners to gain an overview of the topic
to be learned. The idea of concept maps falls under Ausubel’s meaningful learning theory (Novak & Gowin, 1984). Novak (1991) suggests that concept maps can serve as an efficient cognitive means to enhance students’ meaningful learning. Concept maps are an instructional strategy that can help learners organize information and uncover the relationship among ideas in a visual way (Novak & Gowin, 1984).

Novak and Gowin (1984) emphasize two key factors that influence success in constructing a concept map. One is the subject’s prior knowledge about the concepts, and the other is how much the subject knows the possible relationships among ideas. Novak (1993) claims that in order to understand how to explore the relationships between ideas, it is important to know the mechanism of cognitive information process theory. Meaning making takes place in the short-term memory. The limited capacity of the short-term memory may prohibit learners from processing a larger amount of information (Novak, 1993). In order for learners to successfully incorporate new knowledge into their existing knowledge, hypermedia designers should consider the features of human memory and how to display information effectively (Umar, 1999).

A content list is another type of instructional aid. It is used to provide a linear flow of information. Rather than providing an overview of the information structure, it only partially shows knowledge areas of information. The unit titles serve as headings and subheadings in the traditional text. Compared with a concept map, a content list does not show the interrelationship between concepts and spatial orientation connected with concepts. Therefore, it may reduce learner control and cognitive flexibility (Su & Klein, 2006).
Hypermedia can be an instructional tool for addressing individual learning style differences. As Ayersman and Minden (1995) suggest, hypermedia technology holds promise that can accommodate the needs of learners with different cognitive styles because of its flexibility and its potentially high level of learner control as well as its multimedia environment. Researchers (Chen & Macredie, 2002; Liu & Reed, 1994; Liu & Reed, 1995) believe that such rich environments hold a potential for offering multiple tools to learners; and thus can meet the needs of learners with different cognitive styles.

Individual differences are becoming a focus in current instructional designs and practices. In their comprehensive literature review, Riding, Richard, Cheema, and Indra (1991) contend that individuals differ in cognitive styles. They classify cognitive styles into two main categories: wholist-analytic cognitive styles and verbalizer-imager cognitive styles. Wholist-analytic cognitive style include FDI, impulsivity-reflectivity, holist-serialist, leveler-sharpener, simultaneous-successive, diverging-converging, tolerant-intolerant, flexible control-constricted automatisation v. restructuring, compartmentalization, conceptual articulation, etc. Verbalizer-imager cognitive styles include sensory modality preferences, verbalizer-imager, and verbalizer-visualiser. Among the various dimensions of cognitive styles, FDI is seen as the most widely studied (Witkin, Moore, Goodenough, & Cox, 1977). The concept of FDI was first developed by Witkin in 1954 (Burton et al., 1995; Chinien & Boutin, 1993; Cross, 1976; Haaken, 1988).

Messick (1984) describes cognitive style as “information-processing habits” (p. 60), and Davis and Cochran (1989) claim that FDI is related to the information processing stages of attention, encoding in the short term memory, and storage and
retrieval processes of the long term memory. According to Witkin et al. (1977), field independent (FI) individuals can break information into parts and analyze them without being distracted by the context. However, they may not be able to get a balanced view of the whole. Analysis and structuring are the main features of FI individuals (Witkin & Goodenough, 1981). They are competent in reconstructing, recognizing and selecting important information from its disorganized surrounding fields and capable of comprehending information from a very clear content structure.

In contrast, field dependent (FD) individuals are more reliant on the surrounding environments and may have difficulty extracting relevant information from the whole field when they are distracted by the surrounding environment (Jonassen & Grabowski, 1993). They are less competent in using cognitive strategies such as analysis and structuring or general rules to drive their information processing system. They fail to separate the relative information from the context (Globerson, Weinstein, & Sharabany, 1985).

Roberston (1982) claims that FI learners are expected to benefit more from the hypermedia learning environments where information is presented in a nonlinear way. In these situations, they will “restructure any random or non-hierarchically presented information for better retention and retrieval” (Wallace & Gregory, 1985, p. 22). This is similarly noted by Jonassen and Grabowski (1993), with their claim that FI individuals prefer to construct information rather than to have it constructed for them. Many studies support Roberston’s (1982) statement (Chou & Lin, 1998; Leader & Klein, 1996; Lin & Davidson-Shivers, 1996; Lyons-Lawrence, 1994; Weller, Repman, & Rooze, 1994; Yoon, 1994; Zehavi, 1995).
FD individuals are expected to perform as well as FI individuals when given structural or organizational support because it is assumed that structural or organizational support might compensate for their lack of restructuring ability (Davis, 1991). In his comprehensive review, Davis (1991) found that outcomes are mixed. Only small a few studies support this assumption. More often research reports that no significant difference is found between cognitive style, treatments, or the interaction of the two. Davis believes that the inconsistent results might be attributed to the fact that “cognitive style effects override the effects of instructional manipulations” (p. 160). He calls for more studies to be conducted.

**Statement of the Problem**

Advocates of hypermedia technology claim hypermedia systems can increase learners’ motivation and interest (Mohler, 2000). Different types of hypermedia-assisted instructions have been designed, but not all learners have benefited from the instruction. What factors may contribute to individuals’ success or failure in a hypermedia environment? Concerning the flexibility and nonlinearity of hypermedia, perhaps FDI is such a factor that may create a difference for some students, who perform better at processing the information embedded in a hypermedia environment than other students. What factors should be considered in order for all students to benefit from the hypermedia environment when attempting to create effective hypermedia environments?

Researchers assume that with the help of a concept map to provide an overview of the information structure, FD learners might perform just as well as FI learners in the construction of structural knowledge. Although hypermedia provides the learner with immediate and constant access to a large quantities of information (Jonassen, 1988), it
provides obstacles for FD users. Hsu and Dwyer (2004) suggest that FD individuals may have difficulty comprehending a large and complex amount of information. A study conducted by Leader and Klein (1996) indicates that FD learners are less effective when using search and find strategies within database searches. This suggests that FD individuals may be less competent in identifying underlying structures and important contents in the absence of relevant cues (Hsu & Dwyer, 2004). Students are not used to creating associations among concepts on their own. Navigational tools can guide students through the material and give FD students an overview on the topic and show relationships among concepts. If navigational tools are not provided, FD users may have problems extracting the structure or organization of the domain presented.

Supporting the use of such navigational tools, Dee-Lucas (1996) emphasizes that in order to alleviate the user’s disorientation and reduce cognitive load, hypermedia learning environments should embed navigational tools because they provide the user overview structures. Overview structures can guide the readers through which how to browse in hypermedia environments and draw their attention to the relationship between the concepts as well as help them focus on the learning goal. Bera and Liu (2006) argue that simply navigating through hypermedia is not the purpose of learning and claim that exploring the environment, gathering information, testing hypotheses, and generating solutions are the goals of learning. Navigational tools are suggested as effective tools to assist students attaining their learning goals.

**Purpose of the Study**

The purpose of this study was to examine the effects of instructional aids and FDI on students’ structural knowledge performance and attitude toward the program design
during the course of studying a hypermedia environment. Did students with different
cognitive styles react differently to the use of navigational tools when they explore in a
hypermedia environment? More specifically, the following questions were investigated:

*Research Questions*

This study addressed the following questions:

1. Is there a significant interaction between FDI and instructional aids in the
   Structural Knowledge Posttest in a hypermedia environment, after controlling
   for the Structural Knowledge Pretest?
2. Are there significant mean differences for the Structural Knowledge Posttest
   among FD, FM, and FI students in a hypermedia environment, after controlling
   for the Structural Knowledge Pretest?
3. Are there significant mean differences in the Structural Knowledge Posttest
   between students in the navigational map group and the content list group in a
   hypermedia environment, after controlling for the Structural Knowledge Pretest?
4. Is there a significant interaction between FDI and instructional aids in the
   Attitude towards the Program Design Questionnaire in a hypermedia
   environment, after controlling for the Web Attitude Scale Questionnaire?
5. Are there significant mean differences in the Attitude towards the Program
   Design Questionnaire among FD, FM, and FI students in a hypermedia
   environment, after controlling for the Web Attitude Scale Questionnaire?
6. Are there significant mean differences in the Attitude towards the Program
   Design Questionnaire between students in the navigational map group and the
content list group in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

**Significance of the Study**

It is theorized that hypermedia, with attributes of non-linearity and rich in information formats, has great potential to accommodate learners with different cognitive styles, specifically for FDI. Studies that examined hypermedia learning environments and FDI have shown that FDI plays an important role in how learners engage with and learn from computer based instruction (Carrier, Davidson, Higson, & Williams, 1984; Packard, Holmes, Viveiros, & Fortune, 1997). Due to their perceptual and processing characteristics, compared to FI individuals, FD individuals may encounter disorientation problems when navigating hypermedia environments (Lee, 2000). Witkin et al. (1977) theorize that FD learners and FI learners may perform equally well when learning materials are highly organized. In designing hypermedia material, instructional designers must take into account the aspect of FDI so as to minimize individual differences among potential users. One of the important design issues for instructional designers is how to represent the information in a hypermedia system in a meaningful way and how to access information in order to alleviate learners’ disorientation (Beasley & Waugh, 1995). Riding and Rayner (1998) suggest that identifying students’ FDI could help educators understand how people organize and represent information. In addition, the instructional aids, coupled with the complexity of information presentation modes in hypermedia lessons, may also contribute to the information and cognitive overload phenomena widely reported in the hypermedia literature. Unfortunately, research on the efficacy and effectiveness of navigational aids on FDI in a hypermedia environment have had mixed
results. So far, there is no conclusive research to support this theory. Researchers (Archer, 2003; Daniels, 1996; Hall, 2000; Lee, 2000; Umar, 1999) call for more studies to be conducted. The findings of the present study will contribute significantly to design guidelines for hypermedia designers and developers.

Limitations of the Study

The limitations of the study are described as follows:

1. The subjects in this study were limited to undergraduate students at Ohio University. Thus, the results of the study might not be generalized beyond the population sampled.

2. This study were limited by only examining students’ cognitive style of FDI.

3. The treatments were limited to around 20 minutes on a single day.

4. The subjects in this study were mainly female undergraduate students. They were in the field of Early Childhood Education, Middle Childhood Education, Special Education, Science, Adolescent to Young Adult and Art Education. The results of the study might not be generalized to male undergraduate students and students from other majors.

5. The concept map and content list in this study were developed by the researcher.

Scope of the Study

The scope of this study included undergraduates enrolled in the Technology Applications in Education course (EDCT 203) at Ohio University during winter quarter, 2007. They were from College of Education. The study was conducted at the main campus in Athens, Ohio. This study primarily focused on text-based hypertext package
and did not include additional media such as audio, video, or animation. There were two sessions of the study. The first session was carried out at the beginning of winter quarter, 2007, whereas the second session was conducted one week after the first session.

**Definition of Terms**

- **Concept**: “A regularity in events or objects designed by some label” (Novak & Gowin, 1984, p. 4).
- **Concept Map**: “[A] schematic device for representing a set of concept meanings embedded in a framework of propositions” (Novak & Gowin, 1984, p. 15).
- **Cognitive Overload**: “an excessive level of mental effort required during the processing of too many simultaneous events” (Kim, 2004, p. 2).
- **Content List**: A content list is like a table of contents in printed text as a means of assisting users to gain an overview of the breadth of material covered in the document, and to find specific information within the text (McDonald & Stevenson, 1998).
- **Declarative Knowledge**: is the factual or propositional knowledge (West, Farmer, & Wolff, 1991).
- **Disorientation**: “The tendency to lose one’s sense of location and direction in a nonlinear document” (Conklin, 1987, p. 40).
- **Field Dependent**: Pole of the cognitive style that involves the tendency to perceive visual situations globally or holistically, viewing the organization as a field (Witkin, Oltman, Rashkin & Karp, 1971). In this study, a score that is below one half standard deviation of the Group Embedded Figures Test mean score classifies a subject as field dependent.
Field Independent: Pole of the cognitive style that involves the tendency to perceive visual situations and ‘disassemble’ discrete parts of the world field (Witkin et al., 1971). In this study, a score above one half standard deviation of the Group Embedded Figures Test mean score classifies a subject as field independent.

Field Mixed: A range within the continuum of the field dependence cognitive style in which there is no dominance in either direction, toward organization or discriminations of items in the surrounding field. For the purpose of the study, a score that fell within one half standard deviation of the Group Embedded Figures Test mean score classifies a subject as field mixed.

Group Embedded Figures Test: A group administered version of the Embedded Figures Test; used to determine a learners cognitive style, typically characterized as field dependent or field independent (Witkin et al., 1971).

Hypermedia: A system that integrates text, sound, graphics, and video to present the knowledge within the network of ideas or use nodes and links to organize structure (Spiro & Jehng, 1990).

Navigation: “Navigation in hypertext involves the use of a graphic aid, such as a browser or map, to show an overview representation of the nodes and links and thus facilitate browsing” (Smith & Wilson, 1993, p. 272).

Navigational Aids: “tools or structures to aid in the movement from one component of a hypertext structure to another” (Archer, 2003, p. 11).

Procedural Knowledge: Procedural knowledge describes how learners access and interrelate relevant object, event, or idea and extract the relevant attributes to solve
the problems. This type of knowledge is the application of declarative knowledge (Jonassen, Beissner, & Yacci, 1993).

Structural Knowledge: Knowledge representing the relationships of concepts within a content domain. It is also known as cognitive structure. (Roshan, 1997, p. 10)

Organization of the Study

This study is organized into five chapters:

Chapter one includes an introduction, the statement of the problem, purpose of the study, research questions, significance of the study, limitations of the study, scope of the study, definition of terms, and organization of the study.

Chapter two provides a review and critique of the literature relevant to this study.

Chapter three describes the design of the study, including population and sample selection, instrumentation, procedure, and statistical analyses employed.

Chapter four includes the data analysis and presents the results in relation to the hypotheses tested.

Chapter five summarizes and interprets the findings, and proposes recommendations and suggestions for further research and practice.
Chapter Two: Literature Review

Introduction

The goal of this chapter is to examine the factors influencing the creation of a hypermedia environment. First, a discussion of the influence of meaningful learning on instructional design and techniques for facilitating the acquisition of knowledge is presented. Next, this examination is guided by a discussion of the cognitive psychology view of human learning, knowledge structure, and acquisition. Finally, it is imperative for teachers and administrators to understand how the structuring of hypermedia can foster a variety of student learning skills. It is equally important to reveal information about the effects of the cognitive style of FDI on the learning performance in a hypermedia that foster effective use of the hypermedia systems, so that teachers can match and accommodate these to the proper learning environment.

Meaningful Learning

Meaningful learning, according to Ausubel’s theory of meaningful, reception learning (1963a), refers to the fact that the learning material (task) to be learned is potentially meaningful to the learner. New knowledge, if it is to be meaningful, would need to be incorporated, or subsumed, into existing knowledge structures (Ausubel, 1963a, 1968). Meaning occurs when new knowledge is tied to relevant concepts and propositions in the learner’s cognitive structure. It is from this relationship, or linking, with pre-existing concepts that a new concept is understood. If more meaningful materials are anchored to the existing cognitive structure, they are better learned and better retained. By contrast, rote learning, the opposite of meaningful learning, takes
place when new information fails to connect to existing knowledge structures. Since there is no connection created, learning will not occur.

Three essential conditions are identified as being necessary for meaningful learning (Driscoll, 2005). First, the learner must employ a meaningful learning set to any learning task. Learning set, according to Ausubel (1963a), is defined as the learner’s current disposition to learn in a rote or meaningful way. If the learner intends to learn in a rote way, then meaningful learning will not occur. In Ausubel’s words:

In meaningful learning the learner has a set to relate substantive (as opposed to verbatim) aspects of new concepts, information, or situations to relevant components of an existing cognitive structure in various ways that make possible the incorporation of derivative, elaborative, correlative, supportive qualifying or representational relationships. (Ausubel, 1963a, p. 22)

Second, the material to be learned must be potentially meaningful. This means that in order to succeed in meaningful learning, the learning tasks should be presented in an organized, readable, and relevant way rather than in an arbitrary, nonsensical, and verbatim fashion. Finally, the most important fact for meaningful learning is what learners already know. As Ausubel advises (Ausubel, Navak, & Hanesian, 1978), “If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly” (p. iv). Since prior knowledge is regarded as the critical factor influencing learning, then how is it organized in the learner’s memory structure?
Ausubel (1963b) proposes a model of cognitive organization for learning and retention of meaningful materials that assumes the cognitive structure in the learner’s memory is made up of sets of ideas that are organized hierarchically and by theme. Within any given hierarchy, the general ideas higher in the hierarchy would be more stable and therefore more easily remembered than specific ideas lower in the hierarchy (Driscoll, 2005). Ausubel (1963a) presents two factors that affect how learners acquire the cognitive structure:

(a) using for organizational and integrative purposes those substantive concepts and principles in a given discipline that have the widest explanatory power, inclusiveness, generalizability, and relatability to the subject-matter content of that discipline; and (b) employing those programmatic methods of presenting and ordering the sequence of subject matter that best enhance the clarity, stability, and integratedness of cognitive structure for purpose of new leaning and problem-solving. (p. 27)

The cognitive structure provides memory structure within which new knowledge will be integrated. In order to describe how specific linkages occur, Ausubel (1963b) proposes the notion of anchoring ideas. Anchoring ideas are defined as “the specific, relevant ideas in the learner’s cognitive structure that provide the entry points for new information to be connected” (Driscoll, 2005, p. 117). Cognitive structure and anchoring ideas are prerequisites for meaningful learning.

**Information Process Theory**

Although Ausubel’s theory provides an overall framework for the organization of human knowledge, Wedge (1994) argues that he had little to say about how that
information transforms into a stable form and how it can be used for retrieval. Wedge suggests that information processing theory offers a framework in which new information can be incorporated to existing knowledge and it describes how learners acquire knowledge. The Atkinson and Shiffrin (1968) memory model is regarded as the most influential model among models of information processing (Byrnes, 2001; Driscoll, 2005). This model, according to Atkinson and Shiffrin (1968), divides the memory system into two classifications: one is the memory structure and the other is the control processes based on their different features.

**Memory Structure**

The permanent feature of memory structure makes it the same in different situations. The memory structure consists of three structural components: the sensory register, the short-term store, and the long-term store. Information is said to be received in the form of some physical energy such as light, sound, and touch by receptors (Gagne, 1985). After information is transferred first from the sensory register (SR), it then passes through the short term store (STS), and finally ends up in the long term store (LTS) (Atkinson & Shiffrin, 1968).

*The sensory register.*

The most important characteristic of the sensory register is the extremely brief time it holds information. The sensory register does not hold information for a long time and it is easy for information to decay and be lost (Atkinson & Shiffrin, 1968). According to Sperling (1960), stimuli are displayed in the sensory register around one-fourth of a second (as cited in Gagne, 1985). In addition, the sensory register possesses an infinite
capacity. The information is presented as an exact visual image within the sensory memory (Tarpy & Mayer, 1978).

**Short-term store.**

The short-term store, refers to the working memory (WM) (Atkinson & Shiffrin, 1968). One distinct characteristic of the working memory is that it keeps information for a limited amount of time. If information is not rehearsed, it will be lost in the working memory in around 15 to 30 seconds (Siegle, 1998). The control process of rehearsal plays a very important role in increasing the duration of information in the working memory.

In addition, the working memory has a limited capacity to hold seven plus or minus two items for processing information (Miller, 1956). Subjects usually cannot distinguish more than about seven alternatives for a unidimensional variable, nor can they remember more than about seven items from an input list in their immediate memory (Mandler, 1967). Given these limitations, some mechanism must be responsible for extending human judgment and memory, since we obviously do remember more than seven items and can process a wider range items at the same time (Mandler, 1967). Miller’s solution to this puzzle was, in the case of human memory, the unitization hypothesis.

Miller (1956) hypothesizes that memory capacity of the working memory may be measured by “a fixed number of chunks” (p. 93) and each chunk is arranged in one slot (Driscoll, 2005). A word or a letter is an example of a chunk. Miller (1956) suggests that a strategy for maximizing the limited capacity of the working memory is through “building larger and larger chunks, each chunk containing more information than before” (p. 93). The meaningfulness of the material determines how many items can be packed
into a chunk (Craik & Lockhart, 1972). In order to use the limited capacity of the working memory effectively and efficiently, bits of information should be grouped or organized into meaningful units or chunks, rather than presenting them in a random and arbitrary way.

*Long-term store.*

Like the sensory register, the long-term store has an infinite capacity (Tarpy & Mayer, 1978). In contrast to the sensory register and the short-term store, the long-term store can hold the information permanently (Atkinson & Shiffrin, 1968). Additionally, information in the long-term store is meaningful, organized and abstract (Tarpy & Mayer, 1978). Tarpy and Mayer (1978) claim that the subject forgets the information when he or she is interrupted or fails to retrieve the information from the long-term store. In order to learn and retain information for longer periods of time, information needs to be transferred from the short-term store to the long-term store.

Tulving (1972) divides the long-term store into two components: episodic and semantic memory (Figure 2.1). In Tulving’s conception, the episodic memory is used to store specific events, whereas the semantic memory is used to store general information (Driscoll, 2005).
The best known semantic memory model was proposed by Quillian in 1968 (Ayersman, 1993). In this model, Quillian (1968) assumes that “The memory model consists basically of a mass of nodes interconnected by different kinds of associative links” (p. 223). Nodes and links are two essential components in this memory model. Nodes may be represented by objects, events, ideas, concepts, rules, principles, generalizations, skills, and metacognitive skills (Phye & Andre, 1986). A node, as a unit of information is also referred to as a schema, which consists of a set of attributes or slots.
in which relationships to other schemas are embedded (Jonassen, 1988). Relationships among schemas have also been called links, connections, associations, and branches (Ayersman, 1993). It is the interrelationships between schemas that give them meaning (Jonassen, 1988). A basic premise of this model is that the form of a knowledge structure is organized as semantic networks (Ayersman, 1993; Byrnes, 2001; Phye & Andre, 1986).

Control Process

As mentioned previously, one classification for the memory system is the memory structure, which consists of the sensory register, the short-term store, and the long-term store. The memory structure possesses permanent features, which the subject cannot change. Control process, another classification of the memory system, on the other hand, possesses temporary features in which the subject controls the process of information processing that can be changed in different situations. It can be readily modified or reprogrammed according to the will of the subject. Attentional process, encoding procedures, rehearsal strategies, and retrieval processes are examples of control process (Atkinson & Shiffrin, 1968). The following sections will describe these examples in detail.

Selective attention in sensory register.

Attention plays a key role in controlling how information will be transferred from the sensory register to the working memory. It results in the information going through the sensory register and entering the working memory. If the subject fails to focus their attention, the information will decay (Tarpy & Mayer, 1978). How the particular information is scanned for transfer from the sensory register to the working memory is a function of selective attention. Selective attention is the basic process involved in
transferring information from the sensory register to the working memory (Mayer, 1984). Driscoll (2005) defines it as “the learner’s ability to select and process certain information while simultaneously ignoring other information” (p. 79). Three factors are identified that influence selective attention.

1. Meaningful information. If the information is highly related to the subject, it will be easy to get the subject’s attention.

2. Similarity between competing tasks. It will be difficult to catch the subject’s attention on one specific task if two similar tasks are presented to the subject simultaneously.

3. Task complexity or difficulty. Compared to simple tasks, which require little attention, difficult tasks demand more attention (Driscoll, 2005).

If the subject is not able to focus attention, learning will not occur. Hodes (1994) suggests that cognitive strategies such as relevant visual cues, repetition, and organizational aids play an important role during selective attention. With the repetition strategy, the stimuli are just repeated over and over. Organizational strategies are described as information reorganized in meaningful ways such as in a concept map. Structural knowledge learning strategies such as advance organizers, structured overviews, spider maps, concept maps, and cognitive maps can be considered organizational strategies to increase selective attention (Jonassen et al., 1993). The information attended by the subject is transferred from sensory register to working memory for rehearsal and encoding.
Rehearsal.

When information passes from the working memory, if it is not rehearsed, it will be lost or will decay. According to Baine (1986), rehearsal is the review of previously learned skills that are components of or prerequisite to the skill to be taught in the acquisition or generalization phases of instruction. This phase of instruction acts as a transition from previous activity, establishes readiness skills, and functions as a refresher, bringing skills up to an acceptable level of fluency. (p. 248)

It is in the duration-lengthening repetition process with the main purposes of prolonging the duration time that information stays in the working memory and increasing the strength of the information built in the long-term store (Atkinson & Shiffrin, 1968). Rehearsal increases the possibilities of information passing from the working memory to the long-term store. The longer the information is retained in the working memory, the greater the probability it will be transferred to the long-term store and stored. Thus, whether rehearsal strengthens the trace or merely postpones forgetting depends on what the subject is doing with the rehearsal.

Encoding.

Although rehearsal provides a better chance to hold information in the working memory, it is not sufficient and does not guarantee information is fully processed into the long-term store. If information is only retained in the working memory, no durable memory will take place. Encoding has been identified as the necessary control process for transferring information from the working memory into the long-term store (Driscoll, 2005). Through encoding, information can be processed and transferred to the long-term
Encoding is defined as “a select alteration and/or addition to the information in the short-term store as the result of a search of the long-term store” (Atkinson & Shiffrin, 1968, p.115). It is “the process of relating incoming information to concepts and ideas already in memory in such a way that the new material is more memorable” (Driscoll, 2005, p. 89). Tulving (1983) believes that the key for learning and remembering is encoding. Driscoll (2005) claims that encoding will lead to an increase in recall.

Researchers have been interested in how information is transferred from the short-term store to the long-term store. Craik and Lockhart (1972) postulate that depth of processing may inform how information is encoded into the long-term store. They describe elaboration as an example of the depth of processing, which determines the rate of decay. They claim that the deeper information is encoded or reconstructed, the greater the chance it will be retained and remembered. In other words, retention relies on how deeply the information is analyzed. Compared to shallow and superficial processing, which leads to a relatively short duration fir stimuli processing; thus, information is easily lost. Deeper levels of processing produce a somewhat more persistent memory trace and cause more durable learning. In addition, Craik and Lockhart (1972) suggest that the subject will spend less time processing highly familiar, meaningful stimuli at a deep level than he or she does for less familiar and less meaningful stimuli.

Retrieval.

According to information processing theorists, learning is related to recall and retrieval (i.e., getting information out of long term store). Once information has been stored in long-term store, it needs to be retrieved for later use. The feeling of forgetting something shows that the subject is having a problem finding a good retrieval cue rather
than losing information from long-term store. Retrieved information provides the essence of response generation (Gagne, 1985). The purpose of retrieval is to understand incoming information and to use it in a new context (Driscoll, 2005).

**Organization**

Organization is a memory strategy that a subject may use to lead to an improvement in performance (Atkinson & Shiffrin, 1968; Byrnes, 2001). Some researchers use the terms ‘organization’ and ‘structure’ interchangeably. According to Mandler (1979) “A cognitive structure is an organized set of concepts and procedures. Vice versa, a genitive organization is a structured set of concepts and procedures” (p. 260). Organizational theorists assert that organization plays a central role in learning. As Sommerfeld and Sobik (1994) state, once the cognitive system receives information, in order for this information to be processed, it is necessary to produce an internal representation of the information. This internal representation of information is considered as a cognitive structure. If the subject is not able to organize the information into a coherent, logical system, then meaningful learning will not occur (Mayer, 1984). A similar statement is also emphasized by Mandler (1967), who claims that “organization is a necessary condition for memory” (p. 330). Organization is defined by Mandler (1967):

> A set of objects or events are said to be organized when a consistent relation among the members of the set can be specified and, specifically, when membership of the objects or events in subsets (groups, concepts, categories, chunks) is stable and identifiable. (p. 330)

Pellegrino and Ingram (1979) argue that Mandler’s (1967) definition of organization only focuses on the characteristics of some external factors and ignores the
internal process of organization. They define organization as “the process(es) whereby
the organism attempts systematically to store and retrieve the information presented so as
to maximize performance” (Pellegrino & Ingram, p. 23). This definition emphasizes that
the organism is actively involved in the process of organization. The organism acts as “an
internal executive monitor” (Bower, 1972, p. 110) performing two tasks in the learning
process:

(a) tries to find a function or relation between what is known and the new material
to be learned, and (b) if such a function is discovered, it is then used, together
with supporting material, to generate the new material. (Bower, 1972, p. 101)

In the words of Battig and Bellezza (1979), organizational operations are processes that
incorporate relationships between two or more items or events during and following
encoding. Organizational processes are not limited to the formation of new direct
relationships between individual items, also include integrating new organized units into
the organized structures in the memory. In this way, new information gets assimilated
with the old information. Figure 2.2 illustrates this process.
Figure 2.2. Schema illustrating the functional relation or mapping between known and unknown material.


Sommerfeld and Sobik (1994) interpret organizational processes as formation and transformation of internal representations. Internal representations refer to structures, which include external representative elements and features and relations between elements and features. External representations are input information such as texts or pictures, or a specified cognitive problem. When the cognitive system receives external representations, for example a text or a picture, in order for information to be understood, the subject must play an active role in processing the information. In other words, the subject needs to create an internal representation of the information.

Formation and transformation of internal representations are related to not only processes of selection, structuring, and inference of information, but also the processes of integration of external and inferred information into knowledge structures. Processes of formation and transformation of internal representations may result in a reduction or an enlargement of information. A reduction of information is regarded as a process of
selection of information. This means that a subject only selects a part of external information rather than all the information. The integration of inferred information and its internal representation into existing knowledge results in an enlargement of information (Sommerfeld & Sobik, 1994). When assisting learners, outlines (Glynn & Divesta, 1977), hierarchies (Bower, Clark, Lesgold, & Winzenz, 1969), and concept trees (Tessmer & Driscoll, 1986) have all proven to be effective ways to organize materials meaningfully (as cited in Driscoll, 2005).

**Structural Knowledge**

Knowledge is the foundation for learning; it is the goal of the learning process (Jonassen, Hernandez-Serrano, & Choi, 2000). Then what is knowledge? According to Jonassen et al. (1993), there are three types of knowledge: declarative, procedural, and structural. Declarative knowledge simply means knowing an object, event, or idea. Jonassen et al. (1993) claim that declarative knowledge is the foundation of understanding; however only having declarative knowledge is not sufficient since it does not mean that you understand an object, event, or idea. Using or applying concepts in performing tasks such as inquiry and problem solving is the goal of learning. Procedural knowledge is knowledge that describes how learners access and interrelate relevant objects, events, or ideas and how learners extract the relevant attributes that apply to the task performance. Procedural knowledge is the application of declarative knowledge. Structural knowledge is a type of knowledge that “mediates the translation of declarative into procedural knowledge and facilitates the translation of declarative into procedural knowledge” (Jonassen et al., 1993, p. 4). In comparison, procedural knowledge is about know how, while structural knowledge is about knowing why.
Definition of Structural Knowledge

There are many ways to interpret structural knowledge. In general, Koubek (1991) defines structural knowledge as “the structure of inter-relationships between concepts and procedures (elements) in a particular domain, organized into a unified body of knowledge” (as cited in Lee, 2000, p. 43). Murphy and Suen (1999) suggest that the basic concept of structural knowledge consists of three components: (1) relevant domain concepts, (2) the presence and/or nature of relationships among the concepts, and (3) the strength of those interrelationships (as cited in Kim, 2004).

Conceptual knowledge (Tennyson & Cocciarella, 1986), cognitive organization (Mandler, 1979), cognitive structures (Preece, 1976), conceptual network (Goldsmith, Johnson, & Acton, 1991), and structural knowledge (Jonassen et al., 1993) are other terms scholars use to refer to what Jonassen’s et al. (1993) term “structural knowledge” (p. 4). Basically, perceived as part of declarative knowledge, structural knowledge has two dimensions: one is conceived as cognitive structure; the other as structure of content (Mitchell & Chi, 1984).

When structural knowledge is regarded as a cognitive structure, human memory is emphasized as the area where knowledge is formed and stored. As Tennyson and Corchiarella (1986) propose, “Conceptual knowledge is formed in memory by the integrated storage of meaningful dimensions selected from known examples and the connecting of this entity in a given domain of information” (p. 41). Similarly, Shavelson (1974) describes a cognitive structure as “a hypothetical construct referring to the organization (relationships) of concepts in memory” (p. 232). It is “an organized set of concepts and procedures” (Mandler, 1979, p. 260), “an individual’s organization, stability,
and clarity of knowledge in a particular subject matter field at any given time” (Ausubel, 1963b, p. 217), and “the pattern of relationships among concepts in memory” (Preece, 1976, p.1). Other definitions are described by Champagne, Klopfer, Desena, and Squires (1981) as “organized networks of information stored in semantic or long-term memory” (p. 97), and by Champagne and Klopfer (1980) as “related pieces of information…stored together in structured units (called) knowledge structures” (p.5). At this point, cognitive structure is not only the place where declarative knowledge is stored, but also an understanding of a concept's operational structure within itself and between associated concepts (Tennyson & Corrchiarella, 1986). As we can see, cognitive structure and memory correlate because cognitive structure stems from memory theory, particularly schema theory and semantic networks theory (Jonassen et al., 1993).

Structural knowledge refers to content structure when structural knowledge places “the web of facts (words, concepts) and their interrelations in a body of instructional material” (Shavelson, 1974, p. 230). Content structure reflects the interrelationships among concepts in a domain (Diekoff, 1983). Two essential components should be considered when designing content structure: (1) the content structure of a given domain of information and (2) the organization of instructional design variables related to the use of specific content structures (Tennyson & Corrchiarella, 1986). Content structure used in instructional materials can help the learner in two ways: (1) by integrating the new information with existing knowledge structures in the long-term memory to create internal connections, and (2) by organizing information in the short-term memory to develop internal connections among new information (Meyer & Rice, 1984).
Reasons for Studying Structural Knowledge

Jonassen et al. (1993) suggest the following reasons for studying structural knowledge:

1. “Structure is inherent in all knowledge” (Jonassen et al., 1993, p. 8). According to structural learning theory, all knowledge is represented in terms of rules (Stevens & Scandura, 1987). Rules are the specific relationships among a set of elements. Structure is defined by Garner (1962) as:

…the totality of the relations between events. When we say that a picture composed of randomly located dots is meaningless, we imply that we see no relations between the dots and that, therefore, the picture has no structure. If the same total number of dots is rearranged, however, we can perceive structure and the picture becomes meaningful….Meaning…refers to the entire set of relations, not just to the significations of each individual word. A particular word may be meaningful in the sense of signification, but the entire language becomes meaningful only if some structure is perceived in the total set of symbols. I am definitely not implying that meaning as structure is simply the sum of the significations of the individual words, but rather that the structure is itself meaningful. (p. 141)

This quote implies that if concepts are perceived as single and relationships among them are ignored, meaningful learning will not occur.

2. “Structural knowledge is essential to recall and comprehension” (Jonassen et al., 1993, p. 8). Research on memory theory indicates that organized ideas are better recalled than unorganized ideas (Eylon & Reif, 1984). The organization
deals with a representation of a set of familiar items in specified locations and a set of visual-motor procedures for finding them. This process helps to encode the information and to retrieve it from memory (Mandler, 1979).

3. “Learners assimilate structural knowledge” (Jonassen et al., 1993, p. 9).
   According to Jonassen et al. (1993), learning is a process of acquiring of structural and declarative as well as procedural knowledge. During this process, teacher’s or expert’s structural knowledge can be transferred to the learner or novice during instruction.

4. “Memory structures reflect the world” (Jonassen et al., 1993, p. 9). Cognitive structure in human memory reflects the structure of the environment through a causal link (Anderson & Schooler, 1990). The process of rational analyzing of worldly knowledge leads to the formation of the memory structure, which makes the structural knowledge a construct that is much more accessible (Jonassen et al., 1993).

5. “Structural knowledge is essential to problem solving” (Jonassen et al., 1993, p. 10). Research in different domains has indicated that structural knowledge is important in problem solving (Eylon & Reif, 1984). Champagne (1987) points out that the reason why the expert performs better than the novice in problem solving is because the expert’s knowledge is highly structured in ways that facilitate finding solutions to problems. In a study, Eylon and Reif (1984) used a hierarchically organized structure to assess human performance on recall and problem-solving tasks when studying physics. They found that subjects
with hierarchical organization outperformed those with single-level organization on recall, error correction and knowledge modification.

6. “Expert’s structural knowledge differs from novices” (Jonassen et al., 1993, p. 10). As mentioned previously, the characteristics of experts’ structural knowledge are different from those of novices. One characteristic of an expert’s knowledge that it is more stable, more organized, and more interrelated than that of the novice (Beyerlein, Beyerlein & Markley, 1991; Champagne, 1987; Schvaneveldt, Durso, Goldsmith, Breen, Cooke, Tucker, & DeMaio, 1985). Another characteristic of an expert’s knowledge is problem schemata which are stored in their memories to help facilitate problem-solving (Champagne, 1987; Larkin, McDermott, Simon, & Simon, 1980). By comparing the particular problem with problem schemata, experts are able to find an appropriate method to solve the problem that already exists in their memories. In contrast, due to lack of such problem schemata, novices are not able to solve the problem effectively.

Cognitive Style of Field Dependence-Independence

A Brief History and the Characteristics of Field Dependence-Independence

Research on the cognitive style concerning FDI has been extensively explored for more than 40 years. It originated from the laboratory studies conducted by Asch and Witkin from 1948 to 1952 (Witkin & Goodenough, 1981). In Asch and Witkin’s early studies, they were interested in how people perceive the upright in space. Studies were conducted based on two standards: the upright indicated by the external visual field and the upright indicated by the body itself or the gravitational pull (Witkin et al., 1977). In
the rod-and-frame test (RFT), a subject was asked to adjust a luminous rod surrounded by a luminous tilted square frame to the upright in a completely dark room. In the body-adjustment test (BAT), a subject was seated in a tilted chair in a tilted room and was asked to adjust his or her body to the upright.

The findings of the studies (Witkin et al., 1977) showed that individual differences among people influenced their performance during the tasks. Some subjects were highly influenced by the surrounding environment (the frame or the room) and others were not; they were reliant on the internal cues (their body or the gravitational pull) and ignored the surrounding environment when performing the tasks. Witkin and Goodenough (1981) describe the former as FD individuals and the latter as FI individuals.

Unlike the studies of RFT and BAT, which test differences among people from the visual perception field, the subsequent experimental studies of the Embedded Figures Test (EFT) and the Group Embedded Figures Test (GEFT) conducted by Witkin, Ottman, Raskin, and Karp (1971) explored individual differences from the view of target detection (Cox & Gall, 1981). EFT and GEFT are paper-and-pencil tests. The EFT can be administered to one person at a time and the GEFT can be administered to several persons at a time (Witkin et al., 1971). In the EFT and GEFT, subjects were required to separate a simple geometric design within a complex organized field and the time spent on the task was recorded. The findings of the two studies indicate that people differ in solving embedded figure problems. Some people quickly identified the simple figures, while others failed to perform the task in the required time. Subjects who had difficulty in separating a part from the surrounding organized field and were easily distracted by the context were defined as FD individuals. They were reliant on the surrounding perceptual
field and had difficulty attending to, extracting, and using non-salient cues. In contrast, subjects who were able to extract the perceptual information from its background were described as FI individuals. They perceived objects as distinct from the field and could separate relevant items from non-relevant items within the field (Daniels, 1996). In this view, Witkin, Dyk, Faterson, Goodenough, and Karp (1974) suggest that people solve embedded figure problems differently, in global versus analytical ways (corresponding to field dependent and field independent, respectively). Global or FD persons are less competent in overcoming the distractions of embedded contexts in perceptual functioning, and are easily dominated by the organization of the field. They tend to accept the organization of the field as given and tend to take a passive approach in which they rely on the characteristics of the learning task (Frank, 1984). They have difficulty providing structure to ambiguous information. They also have difficulty restructuring new information and forging links with prior knowledge (Daniels, 1996).

Analytical or FI persons, on the other hand, have a higher ability to separate a part from its context in perceptual functioning and are not easily governed by the organization of the field. They have a greater ability to reorganize associate material within a relatively ill-structured stimulus field (Goodenough, 1976). Compared to the FD or global individuals, analytic or FI individuals tend to see part of the task rather than the whole task (Jonassen & Grabowski, 1993). They are actively involved in abstracting important information from the context, and display an active, hypothesis-testing approach to learning (Frank, 1984). In addition, they provide structure when it is not inherent in the presented information and reorganize information to provide a context for
prior knowledge (Daniels, 1996). The characteristics of FD and FI individuals are summarized in Table 2.1.

Table 2.1

*Characteristics of FD Individuals and FI Individuals*

<table>
<thead>
<tr>
<th>FD individuals</th>
<th>FI individuals</th>
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</thead>
<tbody>
<tr>
<td>1. Having difficulty attending to, extracting, and using non-salient cues</td>
<td>1. More competent in separating, attending to, and using all relevant cues</td>
</tr>
<tr>
<td>2. Easily dominated by the organization of the field</td>
<td>2. Not easily governed by the organization of the field</td>
</tr>
<tr>
<td>3. Having difficulty restructuring new information and forging links with prior knowledge</td>
<td>3. Have greater ability to reorganize information to provide a context for prior knowledge</td>
</tr>
<tr>
<td>4. Having difficulty providing structure to ambiguous information</td>
<td>4. Provide structure to a relatively ill-structured stimulus field</td>
</tr>
<tr>
<td>5. Take a passive approach in the learning task</td>
<td>5. Display an active, hypothesis-testing approach to learning</td>
</tr>
</tbody>
</table>
Cognitive Style Field Dependence-Independence and Cognitive Processing

Based on the characterizations of FD and FI individuals mentioned above, Witkin and Goodenough (1981) point out that the analysis and structuring skills are the factors that cause differences between field dependent and independent individuals. Bennink and Spoelstra (1979) use field articulation (FA) to assess cognitive analytic and restructuring skills. They assume that FI individuals are capable of employing restructuring skills since they have a relatively high level of FA. In contrast, FD individuals are easily controlled by the surrounding context. Studies of the functions of cognitive restructuring have been reviewed (Davis & Frank, 1979). These functions can be described as

(1) breaking up the organization of a stimulus complex so that its elements can be operated upon separately or in new combinations; (2) providing structure for an ambiguous stimulus complex; and, (3) providing a structure different from that implied by the inherent structure of the stimulus complex. (Davis & Frank, 1979, p.5)

In general, FI individuals outperform in all three functions. On the other hand, FD individuals are perceived as lacking these cognitive skills and tend to keep the structure of the field as its given to them.

Bennink and Spoelstra (1979) propose that individual differences in the functions of perceiving and organizing are correlated to information processing. Messick (1993) interprets cognitive styles as “characteristics modes of perceiving, remembering, thinking, problem solving, decision making” that are “reflective of information processing regularities that develop in congenial ways” (p. 3), and as “information-processing
habits” (Messick, 1984, p. 60). Cognitive styles reflect “individual differences in ways of
organizing and processing information and experience” (Messick, 1984, p. 61)
Specifically, Daniels (1996) postulates that the cognitive style of FDI is associated with
“attentional process in the sensory-memory stage, the encoding of information in working
memory, and the organization and retrieval processes of long-term memory” (p. 35).
Figure 2.3 graphically displays these relationships.

![Figure 2.3](image-url)

**Figure 2.3.** Relationship between cognitive processes and the cognitive style of field
dependence-independence.

From “Interaction of Cognitive Style and Learner Control of Presentation Mode in a
Hypermedia Environment,” by H. L. Daniels, 1996, p. 35. [permission Appendix U]
FI individuals, according to Daniels (1996), are more competent in separating, attending to, and using all relevant cues at the sensory memory stage. By contrast, FD individuals, on the other hand, have difficulty attending to and using non-salient cues. According to cognitive information processing theory, if information is not attended to by the subject, learning will not occur. Only when attention is given to the learning task, through a process called selective attention, can the learner concentrate on elements they perceive are critical (Kunnath, 2000). Then the selective information is transferred from the sensory register to the working memory, for rehearsal and encoding. That is, the incoming information will be linked to existing knowledge already stored in the long-term memory, and then it can be retrieved from the long-term memory. If subjects have difficulties in selective attention, they will have problems efficiently processing cognitive operations, encoding in the working memory, when storing and retrieval information from the long-term memory (Lang, 1995).

In addition, Daniels (1996) proposes that FI individuals are capable of reorganizing and efficiently encoding information in the working memory, and can provide structure and richer semantic links. Conversely, FD individuals have little reorganization abilities and inefficient encoding capabilities, and tend to accept the structure given. FD individuals can create fewer links, and have isolated storage in their long-term memory. It is said that FI individuals often play active roles in processing information, and that they are likely to spontaneously reorganize an element in the field (Goodenough, 1976; Witkin et al., 1977). In other words, FI individuals are actively involved in both creating relationships among the elements of information in the working memory and in the process of building connections between organized information and
other familiar knowledge structures, already in the memory. In contrast, FD individuals with a passive approach to learning, may have difficulties organizing operations, which results in less efficient meaningful learning (Frank, 1984).

Hypermedia

Definition of Hypermedia

With the rapid development of the world wide web (www or web) in educational environments, the use of hypermedia as a mode of information accessing is increasing. The interest in hypermedia learning has grown enormously, but it appears that many educators are confusing hypermedia with multimedia. Burton et al. (1995) summarize that the current notion of hypermedia is formed by two different fields. One is multimedia, and the other is hypertext. Multimedia, according to Mayer (2001), is the presentation of material using both words and pictures.

By words, …the material is presented in verbal form, such as using printed or spoken text. By pictures, …the material is presented in pictorial form, such as using static graphics, including illustrations, graphs, photos, or maps, or using dynamic graphics, including animation or video. (Mayer, 2001, p. 2)

In multimedia systems, one important characteristic is interactive video.

The term ‘hyper’ refers to a navigation process that allows learners to access information in a nonlinear or random manner (Thompson, Simonson, & Hargrave, 1992). Hypertext, according to Nelson (1981) are nonlinear text chunks that are interactively linked by users to form unique pathways (or navigational trails) (Burton et al., 1995). Hypertext contains databases of information, or stacks of information, in text form. Hypermedia, as an extension of hypertext, includes access not only to text forms, but also
to graphics, sound, animation, and other forms of information transfer (Marchionini, 1988). Nodes and links are two basic components of hypermedia (Marchionini, 1988). The forms of nodes for information units can be represented as text, graphics, video, audio, etc. The links represent the relationship among nodes.

**Characteristics of Hypermedia and Semantic Memory**

Bush (1945) believes that the mind works like associative networks, rather than linear single direction connections. When structured associative networks in the semantic memory are reorganized, learning occurs (Quillian, 1968). That is, the learner begins to restructure his or her knowledge by adding schemas or developing new conceptualizations for existing knowledge (Jonassen et al., 1993). Whereby, existing knowledge is the basis for learning new information (Ausubel, 1963a). For example in the sentence “The rabbit is white”, the node “rabbit” is connected to the node “white” through the link “is”. Collins and Loftus (1975) assumed that when two nodes are stimulated, activation from each spreads throughout the network until the two nodes are connected. For instance the concept “rabbit” makes us think of the animals’ characteristics such as four legs, two big ears, the shape of its mouth, and its fur. The concept “four legs” makes us think of desks and dogs. The desk makes us think of wood, chair, computer, etc. This process is illustrated by Figure 2.4.
From these explanations of knowledge structures, we can infer that learning occurs by expanding the learner’s semantic network. Cognitive operations are processed by the activation of nodes and the links among these nodes (Martindale, 1991). Learning, therefore, activates existing knowledge nodes, builds new knowledge nodes, and then spreads activation among nodes.

If learning occurs as mentioned above, it is reasonable to say that as a computerized technology, hypertext/hypermedia possesses key characteristics that are often said to model human associative memory and achieve similar organizational structures (Marchionini, 1988; Nelson & Palumbo, 1992). As Liu and Reed (1994)
suggest, nonlinear, associative, and flexible characteristics of hypermedia offer the potential of providing a computerized tool for representing human knowledge acquisition when applied to learning. Fiderio (1988) claims that “Hypertext products mimic the brain’s ability to store and retrieve information by referential links for quick and intuitive access” (p. 237). In the same respect, Jonassen (1988) suggests that hypermedia technology can be used as a tool to assess the cognitive structure of human memory, to depict and display appropriate knowledge structures, and to map that new structure into the learner’s existing knowledge structure. Likewise, Nelson and Palumbo (1992) point out that “Hypermedia systems which focus on knowledge representation may readily parallel the theoretical organization of human memory” (p. 294).

The architectures of Hypermedia resemble the schema-based structure of knowledge because in hypermedia the various nodes of information are connected by links to form a large network of information, thereby mirroring the structure of human memory (Jonassen et al., 1993; Nelson & Palumbo, 1992). There are three similarities between human memory and hypermedia (Ayersman, 1993; Conklin, 1987; Nelson & Palumbo, 1992). First, as a computer-based medium for thinking and communication, Hypermedia-Assisted Instruction (HAI) provides a nonlinear method of establishing relationships which are expected to eliminate the linear, arbitrary sequencing of traditional text, and which are more meaningful to the individual learner (Ayersman, 1993; Conklin, 1987; Nelson & Palumbo, 1992). Nonlinearity is defined as “any feature whereby readers can follow their own paths of discovery in a document, navigating in patterns presumably different than those imposed on readers by the constraints of more traditional forms of publication” (Horney, 1993, p. 67). Nelson (1981) does not believe
that the thinking process follows a strict linear sequence (Burton et al., 1995). Roshan (1997) argues that the interrelationships among ideas cannot be presented by the strict traditional text simultaneously. Second, similar to human memory systems, the associativity of the relationships among concepts or ideas, is also the essence of hypertext/hypermedia. Hypermedia is an associative database in which information can be represented in a variety of media formats such as text format, graphics, audio, and video; these are interactively linked by users to build new relationships between them. Hypermedia utilizes a computerized technology to achieve organizational structures similar to the human memory. Finally, the fundamental aspect of human memory is that when new associations are developed, new organizational interconnections are established. It is not necessary for existing knowledge to be completely reorganized within the newly acquired structure. A hypermedia environment also provides such flexibility; new information and relationships can be easily integrated into previously stored information, without having to reorganize the network structure. In addition, hypermedia with flexible feature allows authors to create documents that explicitly delineate their knowledge structures for semantically and logically connecting ideas and establishing links among nodes (Marchionini, 1988).

Researchers believe that people will learn better when the information learned is structured similarly to the way knowledge is stored in the brain (Jonassen, 1988; Nelson & Palurnbo, 1992). As a result, Marchionini (1988) argues that hypermedia can be used as “powerful cognitive amplifiers” p. 8). Marsh and Kumar (1992) suggest

Hypertext and hypermedia are seen as having great potential [to improve learning] because they offer a convenient way to represent subject matter knowledge and to
model the structure of knowledge. If learning occurs when new knowledge is integrated into a preexisting web of knowledge, then it stands to reason that teaching should incorporate this concept in presentation of material. (p. 27)

Along with cognitive psychology, learning may also be perceived as a process when the learner assimilates or maps the teacher’s or expert’s knowledge structure in a particular subject matter. Jonassen and Wang (1993) suggest that hypermedia has the potential to represent the semantic network of a domain expert’s knowledge and to then be used for instruction that assists learners in gaining not only knowledge, but also the expert’s knowledge structures.

From the user’s point of view, in order to accommodate the teacher’s or expert’s knowledge, the learner needs to reorganize his or her own knowledge structure (Jonassen, 1988). In addition, nonlinear, associative, and flexible features of hypermedia allow the user to interact directly with specific pieces of information and to form unique pathways. Ayersman (1993) makes an argument that traditional forms of computer instruction have utilized linear relationships between and among ideas, which restrain the learner to narrower understandings of related subject matter in often unrelated ways. Nonlinear, associative, and flexible features of hypermedia systems permit users from accessing the information based on their interests, experience, information needs, and task demands. A hypermedia system offers the users a higher level of learner control (Marchionini, 1988). The users can make their own decisions about what information to pursue by choosing specific links. The users can control the learning speed, amount, and path based on their abilities and needs, which in turn, will result in an individualized environment (Umar, 1999).
Problems in Hypermedia

As mentioned above, research has theorized that a hypermedia learning environment that mimics human memory can facilitate learning. Hypertext reading is said to allow more random access, tends to be more interactive, and offers overt ways of reading (Tierney, 1994). However, Halpin (2005) argues that having a nonlinear, associative, and flexible learning environment does not guarantee that learners will receive information appropriately. As Halpin (2005) states, “The question is whether an arrangement of the learning environment that is similar to the way information is processed in the brain can facilitate learning. Just because the brain organizes information in this manner does not mean that it wants to receive information in this manner” (p. 8).

Schroeder (1994) claims that hypermedia environments may introduce problems for learners when they trace the overall structure of information and when they relate it to their prior knowledge. Research shows that learner control or the shift in control of access of information from author to learner may make the learner experience disorientation and cognitive overload when exploring information in a hypermedia environment (Conklin, 1987; Hammond & Allinson, 1989; Marchionini, 1988).

Elm and Woods (1985) describe disorientation as “getting lost in a display network”; whereby, “the user does not have a clear conception of the relationships within the system, does not know his present location in the system relative to the display structure, and the user finds it difficult to decide where to look next within the system” (p. 927). Researchers (Anderson & Pearson, 1984; Altun, 2000; Chen & Macredie, 2002; Schroeder, 1994) have indicated that poor interface design and the learners’ degree of prior knowledge may contribute to disorientation. In addition, Schroeder (1994) suggests
that learners with low prior knowledge in content areas may easily get disoriented and lost. Elm and Woods (1985) claim that the lack of a “clear conception of the relationships within the system” may cause disorientation (p. 927). Studies by Rouet and Levonen (1996) and Leader and Klein (1996) reveal that novice users of hypermedia/hypertext may easily experience disorientation and navigation problems in hypermedia settings; whereas, for the experienced users, Altun’s (2000) qualitative study suggests that their prior knowledge and epistemic beliefs can minimize their disorientation. Similarly, Marchionini (1988) argues that the likelihood of disorientation is reduced if the user gains experience with the system.

Another potential constraint is cognitive overload. Most educational hypermedia systems provide learners with explorative environments. Since the hypermedia system allows more learner control and cognitive flexibility, it places additional cognitive requirements on learners. They have to spend their cognitive resources on choosing what to read next and deciding the sequence of their learning. Making these decisions may increase a learner's cognitive burden; and therefore, they may decrease their resources learners have to process information (Jonassen, 1988). Explorative activities can involve searching and comprehending information to acquire domain knowledge. The comprehension and acquisition of information in these activities require integrating the information from different resources, and integrating new information into existing knowledge. Gordon, Gustavet, Moore, and Hankey’s (1988) study indicates that using hypertext required more mental effort than linear texts. Wenger and Payne’s (1996) study provides evidence that hypertext materials demanded additional cognitive effort when learners made sequencing and navigation decisions. To a greater extent, the learner must
monitor (1) whether he or she understands what has been read, (2) determine whether information must be sought to close information gaps, (3) and decide to look for that information in the text. It seems evident from the findings that when too much freedom or not enough freedom is given to early adolescent students in the hypermedia system, performance may suffer (Paolucci, 1998). In addition, Jonassen (1988) points out that disorientation might increase cognitive overload.

Decreasing disorientation is an important issue in hypermedia because, as disorientation increases, learning suffers (Lee, 2000; Tripp & Roby, 1990). To address disorientation and cognitive overload, various types of solutions have been proposed to help learners to alleviate their problems when using instructional aids. Navigational aids such as concept maps (Su & Klein, 2006), advanced organizers (Umar, 1999), navigational maps (Kim, 2004), indices (Ford & Chen, 2000), menus (Billingsley, 1982), concept maps and content outlines (Archer, 2003), hotwords, spider maps, and hierarchical maps (Beasley & Waugh, 1995) have been used to reduce disorientation and to enhance learning in hypermedia environments. Other researchers have used graphical overviews (Muller-Kalthoff & Moller, 2003), hierarchical associative links (Lee, 2000), and overviews, outlines and maps (Dee-Lucas & Larkin, 1995). Because concept maps are the focus of this study, the literature relevant to concept maps is discussed in the following section.

Concept Maps

One technique for representing knowledge structure is concept maps. Concept maps were developed by Joseph Novak in the 1960s (Novak, 1993). Concept maps have been defined by different researchers. In general, Jonassen, Reeves, Hong, Harvey, and
Peters (1997) define concept maps as “spatial representations of concepts and their interrelationships that are intended to represent the knowledge structures that humans store in their minds” (p. 290). Plotnick (1997) suggests that a concept map is a “graphical representation where nodes (points or vertices) represent concepts, and links (arcs or lines) represent the relationships between concepts” (p. 3). Novak and Gowin (1984) describe a concept map as “a schematic device for representing a set of concept meanings embedded in a framework of propositions” (p. 15). Novak and Gowin (1984) define concepts as “a regularity in events or objects designated by some label” (p. 4) and as “the idea modules from which propositional thought is created” (Green, 2003, p. 58). Propositions represent the relationships between concepts and reflect the extent of their differentiation. That is, the more concepts to which a given concept is linked (more propositions found with the concept), the better defined or explicated that concept is (Jonassen et al., 1997). Trochim proposes a concept map “is a pictorial representation of the group's thinking which displays all of the ideas of the group relative to the topic …, shows how these ideas are related to each other and, optionally, shows which ideas are more relevant, important, or appropriate” (Trochim, The concept mapping process section, ¶ 1). Trochim’s concept map was developed through group brainstorming and multivariate statistical analysis techniques.

Although researchers define concept maps differently, all of these definitions emphasize the complexity of concepts and how their relationships can be visually presented. Concept maps have been called by other names such as flowcharts, organizational charts, graphical organizers, and image maps, and navigational maps. These are all visual tools that can reflect the characteristics of concept maps. The purpose
of this study was to determine the effectiveness of concept maps for web navigation. The concept map serves as a navigation tool, and it is included in the hypertext as a visual overview with clickable areas. The term navigational map will be used in this study to refer to navigational tools. Maps developed using multivariate statistical analysis are beyond the scope of this study.

The rationale for concept maps stemmed from Ausubel’s (1968) meaningful learning theory (Novak & Gowin, 1984; Novak, 1993). New knowledge, according to Ausubel (1963a, 1968), if it is to be meaningful, needs to be incorporated or subsumed into existing knowledge structures. In a study investigating how children’s concepts of the particle nature of matter changed over twelve years of schooling, Novak (1993) identifies the following three factors influencing students’ meaningful learning.

1. Meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures;
2. Knowledge is organized hierarchically in cognitive structure; and most new learning involves subsumption of concepts and propositions into existing hierarchies; and
3. Knowledge acquired by rote learning will not be assimilated into existing knowledge structures (p. 51-52).

Concept maps, according to Novak and Gowin (1984), share the same features as cognitive structure, in which concepts and propositions are fundamental components, and are the techniques that externalize human’s cognitive structure. Concept maps are suggested by Novak (1993) as effective tools that may help students' increase thinking skills for organizing knowledge and forming mental scaffolds because when knowledge
is organized, it occupies less space and “can be searched more quickly, resulting in the retrieval and remembering of the information learned” (Roshan, 1997, p. 111).

Gupta (2000) suggests that there are several educational benefits for using concept maps. They are the following: (1) concept maps bring out clarity in the logical development of themes; (2) concept maps visually depict the interrelationships among concepts and, thus, are said to aid in identifying important steps for understanding themes; (3) concept maps present domain knowledge information hierarchically and allow learners to gain an overview of the topic they are learning; (4) concept maps could be used to identify missing links among the concepts in any body of knowledge; (5) concept maps could be used to develop learner-oriented educational material.

Although concept maps can be used as effective tools to visually present abstract knowledge structures from multiple views and to highlight relevant characteristics of a representation (Puntambekar et al., 2003), Wandersee (1990) argues that this representation may sometimes distort reality. Cortese (2005) proposes that concept maps given by novices may represent only part of the knowledge structure and may contain errors. Jonassen et al. (1993) believe that expert’s concept maps are more close to “subject-matter structure” than students” (p. 14). In addition, Green (2003) points out if the learners’ learning style is not visual they may not benefit from the graphic organizers such as concept map.

**Concept Maps and Hypermedia Interface Design**

Both concept maps and hypermedia have a network of nodes and links and they have similar structures. Thus, it seems natural to use concept maps to represent the knowledge structure in the hypermedia context (Bruillard & Baron, 2000). Chang, Sung,
and Chiou (2002) suggest that combining concept maps with web environment may lead to the following benefits. First, the learner may browse web-based courses at anytime in locations outside the typical classrooms. Learning can take place according to one's own pace and preferences. Second, the course instructor may take advantage of the two-dimensional representation of concept maps in establishing the concept structure of the course material, making it easier for learners to understand the hierarchical structure of the course topics and their interrelationships. This two-dimensional representation can make learners less prone to disorientation as they browse learning material organized in a linear manner. In addition, Bruillard and Baron (2000) emphasize that, in hypermedia environments, a concept map can be used as a navigational tool to guide learners in finding an appropriate path through a lot of documents; they are particularly useful when applied in ill-structured documents. Bruillard and Baron believe that such visualization tools can help learners understand concepts. Puntambekar et al. (2003) suggest that navigational aids such as concept maps are effective tools for helping learners in the decision-making process when they are navigating in hypermedia environments, they provide flexibility and learner control as well as prevent the learner from experiencing disorientation.

The globe map has been suggested as a way to reduce a user’s disorientation (Leader & Klein, 1996). Chou and Lin (1998) argue that the complicated global map with vast amounts of information might cause the learner to become disoriented. To cope with this specific constraint, Chiu and Wang (2000) studied the disorientation of fifth-grade elementary students using navigation maps with five different scopes: global map group, map 1 group with one level above and one level below the activated page, map 2 group
with two levels above and two levels below the activated page, map 3 group with three levels above and three levels below the activated page, and a no map group. The global map showed the entire hierarchical knowledge structure. The map 1 group only presented parts of the global map, showing particular knowledge areas in the course. They focused on only the neighborhoods of activated nodes, that is, one level above (usually the super-concept) and one level below (the sub-concepts). The map 2 group, similar to the map 1 group, showed two levels above (usually the super-concept) and two levels below (the sub-concepts). The map 3 group presented three levels above (usually the super-concept) and three levels below (the sub-concepts). The no-map group had no maps to use.

It was found that students’ learning was influenced by the scope of the map. Students in the global map group outperformed students in the no map group and the map 1 group. Students in map 3 group performed significantly better than students in the no map group. Students in the map 3 and the global map groups performed equally well. This suggests that a global map can be reduced in size and still provide enough information for an efficient search mechanism (Chiu & Wang, 2000). Their findings are contradictory to Chou and Lin’s (1998) study. Chou and Lin (1998) investigated the effects of navigation maps with five different scopes of performance in searches for information. Five maps were used: (1) the global maps displaying the entire hierarchical knowledge structure; (2) the local maps displayed parts of the global map with one level above and two levels below, and the activated node was not shown to the user; (3) the local tracking maps were similar to the local maps, but always showed the activated node in the center of the map in the "You-Are-Here"; (4) a display of all maps mentioned above; (5) no-map. Chou and Lin’s study indicates that global maps provide the most
guidance in assisting learners’ search steps, search efficiency, and development of cognitive maps; whereas, a local or local tracking map was not as efficient in providing guidance to learners. They interpret that this result contributes to the fact that partial concept structures presented in the local and the local tracking maps did not provide users with sufficient relationships to finish their tasks.

Chang et al. (2002), like other researchers, hypothesized that a navigation map might assist learners by reducing the disorientation problem when searching hypermedia databases. They investigated three instructional conditions (hierarchical hyper concept map, the navigation map, and the linear method) on students’ search efficiency. Based on Chou and Lin’s (1998) global map, Chang et al. (2002) developed a three-dimensional structure courseware called the hierarchical hyper concept map (HHCM), which combined a parent navigation map, a child concept map, and a hypermedia document. They believed the design of HHCM “enables learners to gain insight into complex knowledge and concepts” (Chang et al., 2002, p. 341) and expected that it would excel beyond the navigation map courses. Analyses of the results did not indicate that students in the HHCM significantly outperformed students in the navigation map group. They interpret that the superior prior knowledge and the students lack of familiarity with the HHCM might be the reasons for these results. It was also found that students in HHCM and in the navigation map group performed significantly better in achievement posttest than students in the linear groups. These results are consistent with the finding of Chou and Lin (1998). In addition, they reported that students using HHCM spent less time reading the material than those in the linear group, or in the navigation group.
Concept maps have been found to help students focus on their goals in their navigation; navigating via the conceptual map helped students to acquire a deeper understanding of science. For example, Puntambekar et al. (2003) conducted a study to explore the use of navigable conceptual maps to help students learn from hypertexts and their relation with learning outcomes, and examined the impact of different navigation aids (navigable conceptual maps and index) on students’ navigation path patterns. In total, 36 eighth graders were required to use a hypertext-based learning package, CoMPASS, as a resource embedded with different navigational aids (network navigable conceptual maps and index) to research physics. Puntambekar et al. (2003) argue that traditional hierarchical concept maps with a single direction relationship, from the higher level to the lower level, cannot fully represent all the relations between concepts. They believe that information should be organized in a network that provides the user with various relations such as nondirectional, unidirectional, or bidirectional. The network concept maps also can give the user "the capability to quickly access additional information related to the information currently under consideration" (Duchastel, 1990, p. 136). In addition, taking Chou and Lin’s (1998) argument into account, in order to avoid making the map too complicated and causing disorientation, Puntambekar et al. (2003) designed a network similar to concept maps, which are dynamic and zoom in and out in the form of a fisheye. It was found that the group that was exposed to the maps made more transitions related to their goals than the group who used the index. Puntambekar et al. (2003) interpret that this result might be attributed to the fact that maps provided coherence between the concepts that they were learning. The study indicates that students in both groups performed equally well in terms of their factual knowledge of physics. As
learning tasks became more difficult, students in the maps groups were more successful than students in the index group. Puntambekar et al. (2003) assert that conceptual maps may provide learners clear relationships among concepts and, consequently, students can acquire a deeper understanding of the conceptual units.

A recent study conducted by Su and Klein (2006) investigated navigation tools, computer confidence, attitudes, achievement test, and navigation patterns. Three navigation tools were used: an embedded hyperlink, a content list, and a concept map. Students in the content list group did significantly better than those in the embedded hyperlink group on the achievement posttest and had more positive attitudes about the database search. They failed to find significant differences between the map group and the other groups. This result is different from the study conducted by Puntambekar et al. (2003). Su and Klein (2006) point out that the complexity of the concept map may cause the user to lose focus and suggest that only putting important items in the concept map may increase the user’s performance. In addition, their study indicates that different levels of computer confidence also predict significant differences in performance. Students with high computer confidence outperformed students with low computer confidence. No significant difference was found between high and low computer confidence in terms of their attitude the program. This may because the subject domain is about the Internet and www, which is correlated to the computer confidence and the study showed that the average computer confidence level is high.

De Jong and Van der Hulst (2002) explored the effect of the displayed structure of the domain on learning and learners’ exploration patterns. Three treatment conditions were included. In a “visual” condition, a hierarchical graphical overview was presented
as a navigational tool; in a “hint” condition, the structure of the domain was presented by highlighting relations; in a “control” condition, no domain-related visual layout was presented and also no hints on the route through the system were given. Learning was measured in three different ways: definitional knowledge (knowledge of facts), propositional knowledge (knowledge of the relations between two specific nodes), and configurable knowledge (a card sorting task). Results indicate that learners in the ‘visual’ and ‘hint’ conditions showed a more domain-related exploration pattern than participants in the ‘control’ condition. Learners in ‘visual’ condition achieved significantly higher gains on both propositional knowledge and configurable knowledge than those in the ‘control’ condition. De Jong and Van der Hulst (2002) uncovered that the graphical overview did not increase definitional knowledge.

Although there is a strong consensus that concept maps facilitate the hypertextual organization of knowledge, there are a number of studies that indicate problems associated with their use. Wedge (1994) examined acquisition and recall of information in a Computer Assisted Instruction (CAI) environment with treatment conditions that consisted of a concept map designed at the beginning of the lesson, a concept map designed at the end of the lesson, non-mapping, and enabling students to generate concept maps. Students’ achievement was measured by an immediate posttest and a delayed posttest. One of the results indicates that the control group scored significantly higher than the post system supplanted treatment (concept map given at the end of the lesson) and the generated treatment (non-mapping given and subjects generate their own mapping) groups in the immediate posttest. This implies that the concept map strategy may hinder subjects’ learning performance because it may require more cognitive
activities and cause a cognitive overload for learners (Wedge, 1994). No significant performance differences were found among treatment groups. Well-structured learning materials and simple achievement instruments may be the possible reasons for the lack of significance among treatment groups. Wedge (1994) points out one constrain of the study was due to the limited time subjects interacted with the instructional contents, which may have prevented the subjects from incorporating the new knowledge into their existing knowledge.

Roshan (1997) investigated the effects of three types of structural knowledge graphic organizers and instructional time on students’ learning performance in the text-based instruction. Realizing the question raised by Wedge (1994), that limited time spent on tasks might be the reason for students’ unfamiliarity with the structural knowledge learning strategies, Roshan (1997) used two types of time spent on task as treatments. One type required students to learn the instructional script at their own pace; a second type required students to study the instructional script within 30 minutes. Students were provided with four types of structural knowledge learning strategies spider maps, frame maps, semantic maps, and no maps involving both different types of treatments. In all four learning strategies, the instructional script was used. No significant differences in students’ performance were found across all the treatments. Roshan analyzed that the reason for the lack of significance was that students were not engaged in the learning task because the learning content was not related to their major. Roshan (1997) asserts that their unfamiliarity with structural knowledge strategies caused the lack of motivation on the learning task resulted in cognitive overload, which hampered students’ performance. This is similarly noted by Wedge (1994). Furthermore, Roshan (1997) points out that
increasing the time for interacting with structural knowledge learning strategies will not sufficiently to improve students’ performance. Roshan poses the question of how to make real meaningful information processing occur challenges future researchers. Roshan suggests that instructional materials integrated with graphic organizers in a hypermedia environment may force students to interact with the material at a deeper level. Students’ performance may then improve significantly.

Field Dependence/Independence and Hypermedia

Hypermedia can be used as an instructional tool for addressing individual learning style differences. Ayersman and Minden (1995) suggest that hypermedia technology holds promise that can accommodate the needs of learners with different cognitive styles because of its flexibility and its potentially high level of learner control. In addition, hypermedia offers a multimedia information environment. The information in a hypermedia environment can be simultaneously represented in any combination of media formats, such as text, graphic, sound, and animation rather than merely text form. Researchers (Chen & Macredie, 2002; Liu & Reed, 1994) believe that such rich environments offer multiple tools for learners and thus can meet the needs of learners with different cognitive styles. After a comprehensive literature review, Chen and Macredie (2002) developed a learning model, as shown in Figure 2.5, which illustrates FD and FI students’ characteristics and their learning patterns in hypermedia systems. In this model, hypermedia learning systems are emphasized under three themes: non-linear learning, learner control, and multiple tools.
Figure 2.5. Hypermedia learning systems model.


Nonlinear Learning

Hypermedia presents information in a nonlinear way in structure, and can be considered more appropriate for FI individuals as they display an active, hypothesis-testing approach to learning (Frank, 1984). FD individuals, in contrast, since are hypothesized to prefer the linear navigation mode rather than their FI learners, they take a passive approach, in which they tend to accept and encode information as given and
likely have difficulty reorganizing or restructuring information. Since FI individuals are more competent in separating, attending to, and using all relevant cues, they are not easily disoriented when studying in hypermedia environments. FD individuals, who have difficulty attending to, extracting, and using non salient cues, are easily disoriented (Chen & Macredie, 2002).

**Learner Control**

Hypermedia with a nonlinear feature is considered to allow a greater amount of learner control (Reed & Oughton, 1998). Learner control is described as a design feature that allows a learner to make instructional decisions while interacting with a computer-delivered lesson (Shin, Schallert, & Savenye, 1994). Based on the studies they reviewed, Chen and Macredie (2002) assume that FI learners are likely more capable of studying in nonlinear hypermedia settings where learners have more control than their FD counterparts. In comparison, FI individuals are more reliant on internal frames of references (Witkin et al., 1971). Hence, they can make their own decisions to meet their own needs at their own pace and in accordance with their existing knowledge and learning goals, while skipping material they already know and concentrating on the material they deem relevant (Lin & Hsieh, 2001). They feel comfortable when jumping from one point to another because they are more competent in separating, attending to, and using all relevant cues. In contrast, FD individuals are more reliant on external frames of references and prefer externally directed and guided learning in terms of program control. Program control, which is the opposite of learner control, is referred to as a hypermedia environment that is designed as a linear path of information (Halpin, 2005). FD individuals, who use a passive approach in which they tend to accept and
encode information as given, likely have difficulty reorganizing or restructuring the information they are hypothesized. Conversely, they will probably prefer the linear navigation mode rather than the non-linear navigation modes.

**Multiple Tools**

As mentioned in previous sections, FI individuals process information in an analytical way. That it, they have a greater ability to reorganize materials associated with other materials on a relatively ill-structured stimulus field (Goodenough, 1976). They prefer to index and tend to use search engines, the find option, and URLs to pursue the learning goals (Chen & Macredie, 2002). In contrast, FD individuals, process information in a global way. They are less competent in overcoming the distractions of embedded contexts in perceptual functioning and they are easily overwhelmed by the organization of the field as well as have difficulty understanding ambiguous information (Witkin et al., 1971). They prefer a map. FD and FI learners’ characteristics and their learning patterns in hypermedia systems are summarized in Table 2.2 and 2.3.
Table 2.2

*FD Individuals in a Hypermedia Learning Environment with Non-Linear, Learner Control, Multiple Tools*

<table>
<thead>
<tr>
<th>FD individuals’ characteristics</th>
<th>Learning performance features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Taking a passive approach in the learning task</td>
<td>1. Prefer guided navigation in term of non-linear learning</td>
</tr>
<tr>
<td>2. More reliant on external frames of references</td>
<td>2. Prefer externally directed in term of learner control</td>
</tr>
<tr>
<td>3. Prefer global fashion</td>
<td>3. Prefer maps in term of multiple tools</td>
</tr>
<tr>
<td>4. Having difficulty attending to, extracting, and using non salient cues</td>
<td>4. Easily disoriented</td>
</tr>
<tr>
<td>5. Easily dominated by the organization of the field, accept the structure provided by the system</td>
<td>5. Tended to follow links prescribed by the authors of web pages; tended to follow the sequence from the beginning to the end, home or back/forward keys more frequently</td>
</tr>
<tr>
<td>6. Having difficulty providing structure to ambiguous information</td>
<td>6. Preferred a well-structured set of Stimuli. The system should provide them with authoritative guidance or present the context with well structured tools such as maps, menus, etc.</td>
</tr>
</tbody>
</table>
Table 2.3

*FI Individuals in a Hypermedia Learning Environment with Non-Linear, Learner Control, Multiple Tools*

<table>
<thead>
<tr>
<th>FI individuals’ characteristics</th>
<th>Learning performance features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Display an active, hypothesis-testing approach to learning</td>
<td>1. Prefer Free Navigation in terms of Non-linear Learning</td>
</tr>
<tr>
<td>2. More reliant on internal frames of references</td>
<td>2. Independent Learning in terms of learner control</td>
</tr>
<tr>
<td>3. More active and prefer analytic fashion</td>
<td>3. Prefer Index in terms of multiple tools. Tended to use search engines, the find option, and URLs more frequently to reach the desired information web sites</td>
</tr>
<tr>
<td>4. More competent in separating, attending to, and using all relevant cues</td>
<td>4. Not easily disoriented</td>
</tr>
<tr>
<td>5. Provide structure to a relatively ill-structured stimulus field</td>
<td>5. Feel comfortable when jumping from one point to another in pursuit of their goal</td>
</tr>
</tbody>
</table>

*Instructional Aids for FD Individuals in a Hypermedia Environment*

From the aforementioned studies, although in nonlinear hypermedia the integrating of aural, visual, and textual elements accommodates various cognitive styles,
most findings show that field independent individuals perform more efficient searches in a shorter time and are more comfortable navigating in a hypermedia environment (Dwyer & Moore, 1991; Weller, Repman, & Rooze, 1994). This may be because FI individuals have greater an ability to reorganize materials associated with other materials in a relatively ill-structured stimulus field; and because they employ more active hypothesis-testing approaches to learning (Frank, 1984; Goodenough, 1976). In contrast, FD individuals more often report feeling disoriented or lost, navigate more linearly (frequently using Back or Home keys), and tend to follow sequences instead of jumping around, accepting the environment as presented (Lee, 2000). Frank (1984) explains this phenomenon as FD learners tend to accept the organization of the field as given and to take a passive approach in which they rely on the characteristics of the learning task. They have difficulty understanding ambiguous information as well as restructuring new information and forging links with prior knowledge (Daniels, 1996).

Based on the characterizations of FD and FI learners in hypermedia environments, Mayer (1984) postulates that structural support may stimulate the learner to be actively involved when processing information during learning. Frank (1984) proposes that in order to help FD learners organize material meaningfully and improve their learning performance, external structural supports such as concept maps might supplement their passive approach to learning, and assist them in comprehending and recalling information.

Recognizing cognitive style factors in the use of hypermedia systems, Leader and Klein (1996) examined performances between four different search tools and FDI in a hypermedia database. The four types of search tool were the following: (1) a browser to navigate between any contiguous screens at the same level and up or down the content
hierarchy, (2) an index including a list of the descriptive names of every screen and a find function that allows the user typing text strings to search the database, (3) maps hierarchically arranging the content and allowing for searching by section, subsection, and individual screen topic, (4) an all-tools treatment that includes the above mentioned tools. They hypothesized that FD learners with tendencies to use "more intuitive spectator approaches" to learning (Goodenough, 1976, p. 676) should perform as well as FI individuals when providing them with external structured support such as browser and maps because they believe that these two tools represent information in a structured manner and hence provide FD individuals with more consistently structured user-content. On the other hand, FI individuals, due to the fact that they are more competent in terms of extracting important concepts from more ambiguous contexts and applying this information to the new contexts, they were expected to benefit more from an index/find tool, which involved disembedding words and concepts from their contexts. Three main results were reported. First, their results reveal that FDI significantly interacted with different search tools. FI learners were successful with the index/find tool, which confirmed this expectation. FD learners performed as well as FI subjects when given a more structured user-content and intuitive browser tool. These results are consistent with the hypothesis. The study’s findings indicated that the map did not give FD learners structural support. FI individuals performed significantly better than their FD counterparts, which is contrary to the stated expectation. Leader and Klein (1996) interpret that this result might be attributed to the study’s design limitations, since maps were not available on every screen. Second, it was found that cognitive style predicted tool use. FI students were reported to assess significantly more screens than their FD
counterparts. Finally, the study provides evidence that FI students feel more positive about database searches than FD students.

Not having maps on every screen was one of the limitations of Leader and Klein’s (1996) study. Taking that limitation into account, Chou and Lin (1998) developed a navigation map refining upon Leader and Klein’s (1996) map. The navigation maps were designed like a tree and persistently located at the left side of the screen. In addition, their study focused on the effects of navigation maps with five different scopes of performance in searches for information, on cognitive map development, and on attitudes with different field-dependences. No significant interaction was found between different search tools and FDI on performance. This result is contrary to Leader and Klein’s (1996) study. Similar to Leader and Klein’s (1996) study, Chou and Lin (1998) report that the global map did not provide FD structural support. Unlike Leader and Klein’s study, Chou and Lin’s study indicates that FD learners performed as well as FI learners under global map treatments. In addition, the study reveals that FI learners outperformed FD learners in terms of cognitive map development. This result supports Witkin’s et al. (1977) theory that FI individuals are more capable of constructing their own information structures than their FD counterparts.

Based on Chou and Lin’s (1998) research, Chang et al. (2002) investigated FD and FI students randomly assigned to three instructional conditions (HHCM, the navigation map, and the linear method). No interaction was found between FDI and performance by treatment, which is congruent with the finding of Chou and Lin (1998) and contradicts the finding of Leader and Klein’s (1996) study. FI students scored significantly better in the posttest achievement test than their FD counterparts.
Similarly, Lee (2000) argues that the fundamental problem of hypermedia is that “it provides too few structural cues for some users” (p. 20). Lee claims that “With the help of an more explicit approach [concept map] to provide an overview of the information structure, field dependent learners might perform just as well as field independent learners in the construction of structural knowledge” (p. 10). He investigated the effect of information conveying approaches (hierarchical-associative hyperlink approach and concept map) and learners’ FDI on learners’ performance in terms of structural knowledge and perceived disorientation in web navigation. His findings indicated that FDI significantly interacted with the type of hypermedia information conveying approaches in acquiring structural knowledge and disorientation feelings. The concept map significantly improved FD learners structural ability compared to the FD learners who used the associative hyperlink approach. FD students’ feeling of disorientation in the concept map group was more significantly reduced than those in the hierarchical-associative hyperlink group. These results support Frank’s (1984) assumption that external structural supports such as concept maps may help FD learners organize materials in meaningful ways and may help learners improve their learning performance. No significant difference was found between FD students and FI students in the concept map group. This result confirms Witkin et al.’s (1977) assumption that FD and FI learners may perform equally well when learning materials are highly organized. Finally, the study indicated that FI students scored significantly higher than FD students when given a hierarchical-associative hyperlink approach. This finding suggests that FI individuals prefer to construct information in ill-structured environments whereas FD
individuals have difficulty providing structure when information is ambiguous (Jonassen & Grabowski, 1993).

To address the navigation problems, Korthauer and Koubek (1994) assume that “field independence may act as a gateway from the knowledge structure of the user to the structural organization of the hypertext document” (p. 379). They argue that previous research only focused on partial portions of these three dimensions. Their study uncovered that experienced FI learners in an explicit approach performed at more accurate levels than experienced FD learners. In addition, significant interaction among level of knowledge, FDI, and question organization was found to effect task completion time. Experienced FD subjects took longer task-completion times and performed at less accurate levels than their FI counterparts when given explicit structures. Korthauer and Koubek (1994) suggest that FD learners might not be able to employ the external structure as effectively as FI learners. They also point out that when the explicit structure is conflicted with the internal knowledge of FD learners, their learning might suffer. The naïve FI learners in the inherent group spent less time finishing tasks than those in the explicit group. For naïve FD learners, no significant differences were found between two the types of questions. This suggests that naïve FI learners are more capable of using the inherent structure than naïve FD learners.

Umar (1999) examined the impact between the FDI and learning strategies on pre-college students’ achievement in learning information technology when using a hypermedia instructional system. Three types of learning strategies were used as the treatments: an advance organizer, a concept map, and an outline. An immediate posttest and a delayed posttest were used to measure students’ achievement. Contrary to Leader
and Klein’s (1996) study, FDI did not interact with the learning strategies. However, the study did show that FI students performed significantly better than FD students across all treatments. This finding is congruent with the general expectation that FI individuals will outperform their FD counterparts no matter what medium of instruction is used. In addition, Umar’s (1999) study indicates that learning strategies such as advance organizers, concept maps, and outlines do not predict learning performance, either the immediate recall or the delayed recall. The findings of the study indicate that none of the strategies are universally superior to the other. Umar (1999) proposes that students’ lack of experience with computers may contribute to the non-significant relationship between FDI and learning strategies.

Theorizing that instructional aids may offer FD individuals useful structures and therefore reduce their disorientation when navigating hypermedia databases, Archer (2003) explored FD, field neutral, and FI students randomly assigned to three instructional treatments (a content outline, a concept map, and no learning aid), using the hypertext software of Election of 1912. No interaction was found between the level of FDI and different instructional aids. FDI was also unrelated to learning performance and feelings of disorientation. Archer’s (2003) study confirms the general expectation that FI individuals will outperform FD individuals regardless of the treatment type. Low prior knowledge in domain subjects and the complexity of concept maps may be attributed to the lack of significance between FDI and instructional strategies. When students are not familiar with the content knowledge, they may not be engaged in it. The complexity of concept maps may cause cognitive overload. These findings are also reported by Wedge (1994), Roshan (1997), and Casteli et al. (1998). In addition, in Archer’s (2003) study,
not having concept maps on every screen may also result in the inefficiency of concept map treatment, which is similarly noted by Leader and Klein (1996).

A dissertation conducted by Kim (2004) examined the effects of an interactive navigational map as an instructional aid on the learner’s cognitive load and learning performance. The effectiveness of the map on learners with different spatial abilities was also investigated. The primary results revealed that the interactive map significantly improved the recall of students with low spatial abilities. Similarly, other research (Leader & Klein, 1996; Lee, 2000) indicates the instructional aids can increase the FD learners’ structuring ability compared to FD learners who do not have aids. The study also suggests that the interactive map could hinder learners’ with higher spatial abilities recall performance. The characteristic of subjects’ high and low spatial abilities is related to FDI (Korthauer & Koubek, 1994).

Daniels (1996) explored the relationship between FDI and selection of presentation modes (single channel and multiple channels) in hypermedia environments among high school students. The findings indicate that learner control of presentation mode did not offer any significant benefit to users of hypermedia, nor did it accommodate the perceptive and cognitive differences associated with FDI. However, the study does show that FD learners and FI learners perform equally well on simple learning tasks. As learning tasks became more difficult, however, FI learners were more successful than FD learners.

Moore and Dwyer (1991) examined performance between two presentation modes and FDI. Providing learners with black and white illustrations, and seven different colored illustrations, they report that FI learners outperformed FD learners across all the
treatments on the drawing test. FD learners performed as well as FI subjects when given the color-coded treatment on the identification test. Moore and Dwyer support the idea that the use of colors may decrease common performance differences between FD and FI students. The research provides an example of an instructional design option that may aid FD learners using color cues.

Using Moore and Dwyer’s (1991) color cues as a basis for adding interactive elements into hypermedia and developing an organizational aid, Hall (2000) examined students’ performance in learning geography using an organizational aid and FDI. Although the study placed FDI as a central element in designing hypermedia instruction, Hall’s findings do not support the idea that disembedding assistance and organizational structures may improve the performance of FD learners. Similar to Daniels’s (1996) study, Hall verified that FD and FI individuals performed equally on simple learning tasks.

**Summary**

This literature review explores the interrelationship among meaningful learning, information processing theory, organization, structural knowledge, the cognitive style of FDI, and hypermedia.

New knowledge, if it is to be meaningful, needs to be incorporated into existing knowledge structures (Ausubel, 1963, 1968). Thus, existing knowledge is the most important factor in a student’s success. Information processing theory offers a framework in which new information can be incorporated to existing knowledge. Organization is a memory strategy that a subject may use to lead to an improvement in performance. If the subject is not able to organize the information into a coherent, logical system, then
meaningful learning will not occur (Mayer, 1984). The notion of ‘organization’ is sometimes used interchangeably with ‘structure’ by some researchers. When structural knowledge is regarded as cognitive structure, human memory is emphasized as the area where knowledge is formed and stored.

The cognitive style of FDI was examined. Research on the effects of FDI showed that FDI is associated with “attentional process in the sensory-memory stage, the encoding of information in working memory, and the organization and retrieval processes of long-term memory” (Daniels, 1996, p. 35).

Hypertext/hypermedia is often said to model human associative memory and achieve similar organizational structures (Marchionini, 1988; Nelson & Palumbo, 1992). Nonlinear, associative, and flexible characteristics of hypermedia potentially provide a computerized tool for representing human knowledge acquisition when applied to learning (Liu & Reed, 1994). The features of hypermedia are said to accommodate the needs of learners with different cognitive styles because of their flexibility and potentially high level of learner control.

Disorientation and cognitive overload are often problems associated with the learning in a hypermedia learning environment. Especially, FD learners, who have difficulty attending to, extracting, and using non salient cues, are easily disoriented (Chen & Marcedie, 2002). Instructional aids such as concept maps may help them reduce these problems.
Chapter Three: Methods

This was an experimental study that used two 3X2 analyses of a covariance design. It investigated the effects of an interactive navigational map and a content outline on learners’ attitude and learning performance in a hypermedia environment. In this chapter, the design and procedure of the study are presented in the following order: (1) research questions (2) null hypotheses, (3) participants, (4) course materials, (5) instrumentation (6) independent variables, (7) dependent variables, (8) research design, (9) pilot study, (10) the validity and reliability of the instruments, (11) main experiment procedures, and (12) data analysis procedures

Research Questions

This study addressed the following questions:

1. Is there a significant interaction between FDI and instructional aids in the Structural Knowledge Posttest in a hypermedia environment, after controlling for the Structural Knowledge Pretest?

2. Are there significant mean differences for the Structural Knowledge Posttest among FD, FM, and FI students in a hypermedia environment, after controlling for the Structural Knowledge Pretest?

3. Are there significant mean differences in the Structural Knowledge Posttest between students in the navigational map group and the content list group in a hypermedia environment, after controlling for the Structural Knowledge Pretest?

4. Is there a significant interaction between FDI and instructional aids in the Attitude towards the Program Design Questionnaire in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?
5. Are there significant mean differences in the Attitude towards the Program Design Questionnaire among FD, FM, and FI students in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

6. Are there significant mean differences in the Attitude towards the Program Design Questionnaire between students in the navigational map group and the content list group in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

Null Hypotheses

The preceding research questions were explored by conducting an experimental research study that examined the use of two different navigational aids in a hypermedia environment. For the purpose of this study, six hypotheses were stated in the null form as follows:

1. H₀₁: The interaction between FDI and instructional aids in the Structural Knowledge Posttest will not differ in a hypermedia environment, after controlling for the Structural Knowledge Pretest.

2. H₀₂: Structural Knowledge Posttest will not differ among FD, FM, and FI students in a hypermedia environment, after controlling for Structural Knowledge Pretest.

3. H₀₃: Structural Knowledge Posttest will not differ by instructional aids in a hypermedia environment, after controlling for the Structural Knowledge Pretest.

4. H₀₄: The interaction between FDI and instructional aids in the Attitude Toward the Program Design will not differ in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire.
5. H$_{05}$: The mean of the Attitude towards the Program Design Questionnaire will not differ among FD, FM, and FI students in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire.

6. H$_{06}$: The mean of the Attitude Toward the Program Design Questionnaire will not differ through instructional aids in a hypermedia environment, after controlling for Web Attitude Scale Questionnaire.

**Participants**

The study participants were undergraduate students at Ohio University, who enrolled in the Technology Applications in Education course (EDCT 203) during winter quarter, 2007. Because this study involved two 3X2 analyses of a covariance design, in order to get enough power 0.8-0.9, the researcher used the software SamplePower (Borenstein, Rothstein, Cohen, Schoenfeld, & Berlin, 2000) to estimate that between 90 and 120 participants were necessary to allow an adequate distribution within each of the treatment groups. Once the sample size, power, $\alpha$ level (.05), and statistical test (this study is two-way ANCOVA) were decided, the researcher used the Table in Steven’s (1999) book to estimate the effect size. Cohen (1988) considers an effect size of .20 as small, an effect size of .50 as medium, and an effect size of .80 as large. The estimated effect size in this study was between .40 and .50.

**Course Materials**

The experimental course materials for undergraduate students “Communications, Networks, the Internet, and the World Wide Web”, were adapted from the textbook “Integrating Technology and Digital Media in the Classroom” (Shelly, Cashman, Gunter, & Gunter, 2006). Basic computer network topics were delivered via the Blackboard
course management system, including communications process, applications of communications networks, the history of the Internet, security, service, access providers, connecting to the Internet, how the Internet works, netiquette, web page components, web browser software, and searching for information on the web. The adapted course material was presented using two methods: a navigational map method (Appendix A), and a content list method (Appendix C). The lessons were developed using the DreamWeaver 8 web authoring software, Fireworks 8, and Inspiration 8; Windows XP was the operating system for all the software programs.

Instrumentation

The instrumentation of the study is described as follows.

Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) was administered to assess each subject’s degree of FDI. The GEFT is a group administered 25-item test that requires subjects to locate and trace a simple, known geometric figure embedded within a more complex one. It is a timed test that consists of three sections. The first section is a practice section that contains seven simple embedded figures; and it is not scored. The time limit on the first section is two minutes. The second and third sections, containing nine embedded figures each, are the graded test. The standardized testing times is five minutes for each of the second and third sections (Witkin et al., 1971). In this study, the time limit on the second and third sections of the GEFT was reduced to four minutes each. Such changes are recommended by Witkin et al. (1971) “It seems reasonable that, without changing the format of the test, adjustment of time limits and directions will
make possible a flexible instrument for use with groups widely diversified in age and background" (p. 28).

The score on the GEFT is the number of figures correctly traced and ranges from 0 to 18. Participants, who were scored in the range of the grand mean plus and minus one-half standard deviation were classified as field mixed (FM); those who score above this range are considered FI; and those who score below the range are regarded as FD (Moore & Dwyer, 1991; Dwyer & Moore, 1999; Dwyer & Moore, 2001). The test is reliable \( r = .82 \) (Witkin et al., 1971).

The Original Web Attitude Scale Questionnaire

The Original Web Attitude Scale Questionnaire was adapted from Liaw’s (2002) study (Appendix E). Demographic information was added by the researcher in this questionnaire. The purpose of the demographic information and Web Attitude Scale Questionnaire is to identify whether participants' demographic characteristics and prior www/internet experience may impact learning and navigation in the hypermedia environment. Each participant was required to report their background information (age, gender, academic background, and ethnicity). A seven-point Likert scale questionnaire was used to measure the students’ attitude WWW/Internet. Sixteen items were included (Appendix E). A pilot study was conducted using the original structural knowledge pretest. The results of the pilot study will be described later in this chapter.

The Revision of Web Attitude Scale Questionnaire

Reasons of making changes.

The Original Web Attitude Scale Questionnaire’s content and construction were evaluated by four judges who were a professor in the Research and Evaluation program
and three professors in the Instructional Technology program. Based on the results of the pilot study and the suggestions from the four judges, the Original Web Attitude Scale Questionnaire was revised (Appendix H). The reasons for making these changes are as follows.

1. Although the reliability of the Original Web Attitude Scale Questionnaire were high with the value of .957, the variance did not spread respondents out, and thus contributed little to the validity. After checking the raw data, the researcher found that the participants chose one particular scale intensively on different questions. The researcher doubted that the participants might only settle for merely satisfactory answers, instead of generating the most accurate ones.

2. All 16 items in the Original Web Attitude Scale Questionnaire were positive, which caused the acquiescence response rather than the opinions regarding the content of test items. Acquiescence is a “tendency to acquiesce --to agree --carries over to test-taking” behavior (Mueller, 1986, p. 72). When acquiescence occurs, the validity is reduced (Mueller, 1986). About half positive and half negative items is the proportion usually recommended by Mueller (1986) in order to control the effect of acquiescence. Based on this recommendation, the original Web Attitude Scale Questionnaire was modified. Table 3.1 presents the changes in Liaw’s (2002) Web Attitude Scale Questionnaire.
Table 3.1

Changes in Liaw’s Web Attitude Scale Questionnaire

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Original</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>I feel confident using E-mail.</td>
<td>I feel more confident using E-mail than any other communications tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(such as Instant Message, cell phone).</td>
</tr>
<tr>
<td>4</td>
<td>I feel confident using search engines (e.g.</td>
<td>I lack confidence using search</td>
</tr>
<tr>
<td></td>
<td>Yahoo, Excite, and Lycos).</td>
<td>engines (e.g. Yahoo, Excite, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lycos).</td>
</tr>
<tr>
<td>5</td>
<td>I like to use E-mail to communicate with</td>
<td>I do not like to use E-mail to</td>
</tr>
<tr>
<td></td>
<td>others.</td>
<td>communicate with others.</td>
</tr>
<tr>
<td>8</td>
<td>I like to use the Internet from home.</td>
<td>I don’t have any use for the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internet/WWW on a day-to-day basis.</td>
</tr>
<tr>
<td>11</td>
<td>I believe the Internet makes</td>
<td>I doubt the Internet makes</td>
</tr>
<tr>
<td></td>
<td>communication easier.</td>
<td>communication easier.</td>
</tr>
<tr>
<td>13</td>
<td>I believe the Internet/WWW has potential</td>
<td>I believe the Internet/WWW has little</td>
</tr>
<tr>
<td></td>
<td>as a learning tool.</td>
<td>potential as a learning tool.</td>
</tr>
<tr>
<td>14</td>
<td>I believe that the Internet/WWW is able to</td>
<td>I don’t think that the Internet/WWW is able to offer online learning</td>
</tr>
<tr>
<td></td>
<td>offer online learning activities.</td>
<td>activities.</td>
</tr>
<tr>
<td>16</td>
<td>Learning the Internet/WWW skills can</td>
<td>I don’t think that learning the</td>
</tr>
<tr>
<td></td>
<td>enhance my academic performance.</td>
<td>Internet/WWW skills can enhance my academic performance.</td>
</tr>
</tbody>
</table>
3. The points on the Likert scale in the original Web Attitude Scale Questionnaire were labeled as follows (1 = SD = Strongly Disagree, 7 = SA = Strongly Agree).

<table>
<thead>
<tr>
<th>SD</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Krosnick and Berent (1993) recommend if all points on the scale are labeled with words, the reliability and validity can be significantly improved because they clarify the meanings of the scale points. Based on this suggestion and a review of literature, the researcher labeled the points below.

(1) strongly disagree
(2) disagree
(3) somewhat disagree
(4) neutral
(5) somewhat agree
(6) agree
(7) strongly agree

4. The 16 items in the Original Web Attitude Scale Questionnaire were arranged based on the following four categories: web self-efficacy, web enjoyment, web usefulness, and behavioral intention to use the web. There were four items under each category. The problem with this arrangement is that some respondents chose their answers to an item according to how they responded to another item (Converse & Presser, 1986). In order to avoid this problem, the researcher randomly assigned the 16 items in the questionnaire (Appendix H).
**Scoring procedure.**

The questionnaire consisted of 16 Likert-type items, and had 8 positive and 8 negative statements. The positive items were 1, 3, 5, 7, 8, 12, 14, and 16. The negative items were 2, 4, 6, 9, 10, 11, 13, and 15. The responses for all positive statements were recorded so that “strongly agree” = 7, “agree” = 6, “somewhat agree” = 5, “neutral” = 4, “somewhat disagree” = 3, “disagree” = 2, “strongly disagree” = 1. The responses for all negative statements were recorded so that “strongly agree” = 1, “agree” = 2, “somewhat agree” = 3, “neutral” = 4, “somewhat disagree” = 5, “disagree” = 6, “strongly disagree” = 7.

The Original Structural Knowledge Pretest

Because the students in the two treatment groups may have different prior knowledge, the Structural Knowledge Pretest served as a covariate. Students score one point for each correct question on the test. The development of the structural knowledge pretest has gone through a revision. The original pretest presented in Appendix E contains 30 multiple-choice questions. These questions were adopted from the CD of “Integrating Technology and Digital Media in the Classroom” (Shelly et al., 2006), but some items were modified to meet the needs of this study. A pilot study was conducted using the original structural knowledge pretest. The results of the pilot study will be described later in this chapter.

The Revision of Structural Knowledge Pretest

The Original Structural Knowledge Pretest’s content and construction were evaluated by four judges who are one professor in the Research and Evaluation program and other three professors in the Instructional Technology program. Based on the results
of the pilot study and the suggestions from the four judges, the Original Structural Knowledge Pretest was not kept and the Structural Knowledge Posttest was used as the Structural Knowledge Pretest (Appendix G). This change was made to reduce confounding effects that might arise from using different outcome measures. Structural Knowledge Pretest and Posttest included Structural Knowledge Part A and B. Part A included 15 True/False questions and Part B included 15 multiple-choice questions. The only difference was the arrangement of the questions in each test (Appendix K). Students were given one point for each correct answer, thus a maximum score of thirty points was possible. The Structural Knowledge Posttest will be discussed in details in the following section.

The Original Structural Knowledge Posttest Part A

Structural Knowledge Posttest consists of two parts: part A and part B. The Original Structural Knowledge Posttest Part A framework (Appendix F) was adapted from Antico’s (1995) dissertation and the content was changed based on the nature of this study. This test intended to assess how well the students learn the relationships among concepts in a given domain during the experiment. Fifteen pairs were included in the part A. Each question consists of two concepts and was arranged on the left and right, respectively. The participants were asked to choose one answer from the three options to indicate the relationship between these concepts. Lee (2000) gives the reason for using this approach as it provides a way that through which the learners’ structural knowledge can be drawn out. A pilot study was conducted using the Original Structural Knowledge Posttest Part A. The results of the pilot study will be described later in this chapter.
The results of a pilot study indicated that the reliability of the Original Structural Knowledge Posttest Part A was low with the value of .202. From the participants’ feedback, the researcher knew that the subjects were not familiar with the original testing format and that they felt confused by the way the information was presented. The results of the study might not reflect their true understanding. Therefore, based on the results of the pilot study and the suggestions from the four judges, the format of Original Structural Knowledge Posttest Part A was changed to True/False (Appendix H).

Structural Knowledge Posttest Part B

Structural Knowledge Posttest Part B consisted of fifteen multiple-choice questions (Appendix H). These questions were intended to test students' mastery of the concepts taught in the hypermedia program.

Attitude towards the Program Design Questionnaire

An Attitude towards the Program Design Questionnaire was constructed for students in all treatment groups to investigate students' opinions about the two methods (Appendix I). The questionnaire measured participants' general feelings toward the program design, whether participants feel lost in the program, their perception of learning efficiency, and their perception of efficiency of instructional aids.

The questionnaire identified eight positive and eight negative beliefs and attitudes about the program design. In addition, there was a general statement: “Overall, I like the program” because the researcher would like the respondents to define their general attitude toward program design. The items were randomly arranged in order to avoid bias. The positive items were 1, 3, 4, 5, 6, 9, 13, 15 and the negative items were 2, 7, 8, 10, 11,
12, 14, and 16. A 5-point Likert scale with the following choices was used: strongly agree, agree, neutral, disagree, and strongly disagree. Participants were asked to select one of these five choices, indicating their reaction to the statement. The responses for all positive statements were recorded so that “strongly agree” = 5, “agree” = 4, “neutral” = 3, “disagree” = 2, and “strongly disagree” = 1. The responses for all negative statements were recorded so that “strongly agree” = 1, “agree” = 2, “neutral” = 3, “disagree” = 4, “strongly disagree” = 5. Obviously, the more positive the mean score obtained, the more strongly that subjects agreed with the statement, and vice versa for negative scores. In addition, at the end of the questionnaire, there was an open-ended question “Do you feel that the concept maps helped you to navigate the text? Explain why.”

**Independent Variables**

There are two independent variables (IV) in this study. The first IV is instructional aids, which includes a navigational map and a content list in this study. The second IV is the students’ cognitive style of FDI that was identified by the GEFT.

**Instructional Aids**

In this study, two instructional aids were used: a navigational map and a content list.

**Navigational map.**

The navigational map had a hierarchical structure that illustrates the links of all the web pages (Appendix A). Each small rectangle represented a section in the lesson and they were clickable. A small rectangle with light blue color indicated that it had subtitles. At any time, students could access the map by clicking any small rectangle and a small window shows up. For example, when students click the small
rectangle, a small new window named “Communications, Networks, the Internet, and the World Wide Web” pops up (Appendix B), which covers a proportion of the large map window. If the students want to go through the next content, they can just close the small window and click another small rectangle.

The navigational map was designed based on a literature review of the benefits of using hierarchical concept maps (Gupta, 2000). The map has the following potential educational benefits.

1. It brings out clarity in logical development of the themes.
2. The map has a hierarchical structure where the general concepts appear highest in the hierarchy and detailed concepts are the lowest. It gives the user an overview of Communications Networks.
3. It aids the user in reducing the feeling of disorientation in hypermedia learning environments.
4. The navigational map was designed in a way that it would persistently occupy the full screen, while the content disciplines are presented in a smaller new window that covers a proportion of the large map window. This design was intended to be convenient, to encourage participants to use it.

Content list.

Traditional printed text forms often uses a hierarchical content list as a navigation tool for helping users acquire the structure of the content. A content list is like a table of contents in a printed text. This aid is also used as a means of assisting hypermedia users in their search for information. Compared to the navigational map treatment, a content list does not present an overview of the information structure. Instead, it only shows
particular knowledge areas in the course. Similar to the navigational map, it had a hierarchical structure.

In the content list treatment, students received a navigation tool consisting of a hierarchical structure of the hypertext document located on the left of the screen, and each unit title has a hypertext link. Students moved through the program by clicking on the content list navigation tool (Appendix C). When the user clicked on the links, the corresponding hypermedia document is displayed on the right of the screen (Appendix D).

*Cognitive Style of Field dependence/independence*

The second independent variable is the students’ cognitive style of field dependence-independence which is measured by the GEFT in three categories:

*Field dependent individuals.*

Students are the individuals who score in the GEFT below the grand mean minus half of the standard deviation (Moore & Dwyer, 1991; Dwyer & Moore, 1999; Dwyer & Moore, 2001).

*Field independent individuals.*

Students are the individuals who score in the GEFT above the grand mean plus half of the standard deviation (Moore & Dwyer, 1991; Dwyer & Moore, 1999; Dwyer & Moore, 2001).

*Field mixed individuals.*

Students are the individuals who score in the GEFT between the grand mean plus/minus half of the standard deviation (Moore & Dwyer, 1991; Dwyer & Moore, 1999; Dwyer & Moore, 2001).
Dependent Variables

There are two dependent variables (DV) in this study: learners’ Structural Knowledge Posttest and learners’ Attitude towards the Program Design Questionnaire.

Structural Knowledge Posttest

The purpose of the Structural Knowledge Posttest was to determine whether students were impacted by the treatments.

Attitude towards the Program Design Questionnaire

An Attitude towards the Program Design Questionnaire was constructed to investigate students' opinions about the two different instructional aids. The questionnaire consists of five components: Value of Program Design, Learning Efficiency, Disorientation, Benefit of Instructional Aids, and Overall Attitude towards Program Design. The items associated with each component are presented in Appendix L.

Research Design

Two 3 X 2 (FDI X instructional aids) factorial, pretest and posttest experimental design was used in this study. There were two factors that were analyzed. These factors included the treatments (navigational map and content list) and the degree of field dependence (FD, FM, and FI). GEFT was administered to assess each subject’s degree of FDI. The subjects were classified as FD, FM, and FI individuals. Participants were then randomly assigned into one of the two treatment groups: navigational map and content list.
Table 3.2

3X2 Analysis of Covariance Design

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>Instructional Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Navigational Map Group</td>
</tr>
<tr>
<td>FD</td>
<td>x</td>
</tr>
<tr>
<td>FM</td>
<td>x</td>
</tr>
<tr>
<td>FI</td>
<td>x</td>
</tr>
</tbody>
</table>

Pilot Study

Prior to the formal experiment, a pilot study was conducted within the targeted population. The purpose of the pilot study was to identify the potential problems with the administration of the GEFT, the design of the treatments (navigational map and content list), Web Attitude Scale Questionnaire, Structural Knowledge Pretest, Structural Knowledge Posttest, and Attitude towards the Program Design Questionnaire. Adjustments were made to these instruments to achieve the study’s purpose, to determine the time required for students to complete all experimental procedures, and to evaluate whether the study procedures are reliable.

The pilot study was conducted in the same computer lab that was used for the formal experiment. There were two sessions of the first pilot study. The first session was carried out on September 14, 2006. Twenty-four volunteers from the current students enrolled in EDCT 203 class in the College of Education at Ohio University. At the
beginning of the first session, participants were required to sign a consent form. Then the GEFT was administered to determine the extent to which participants were FD, FM, or FI. After finishing the GEFT, the participants were asked to complete a paper-based Web Attitude Scale Questionnaire and Structural Knowledge Pretest, during the same session. The first session took approximately 30 minutes. Twenty-three students completed the questionnaire and the pretest.

Prior to the second session, subjects were randomly assigned to the two treatment groups (navigational map group and content list group) based on their scores of GEFT. The courseware with the navigation tools of the navigational map and the content list were uploaded to Blackboard (course management software) just before the second session started.

The second session of the pilot study was conducted on September 28, 2006, and it was carried out in the same class. Twenty-one volunteers participated in this session. Participants were asked to log into Blackboard to read the courseware according to their assigned group. After they finished the reading, they were required to take an online Structural Knowledge Posttest and Attitude towards the Program Design Questionnaire. In the pilot study, in order to identify the potential problems with the design of courseware and assess the time required for students to complete reading the courseware, participants were asked to complete three open-ended questions about the courseware design (Appendix J). The average time the subjects spent on the reading was around 20 minutes.

Data gathered from the pilot group was evaluated to determine if any changes were necessary. Based on the results of the pilot study and the suggestions from
committee members, one professor from the Research and Evaluation and other three professors from the Instructional Technology, several changes were made as discussed in the previous sections.

The second pilot study was conducted on September 29, 2006, for the revised Web Attitude Scale Questionnaire. It was an online-based questionnaire with 16 participants. The samples were different from the original Web Attitudes Questionnaire and used by convenience. They are mainly doctoral students from the College of Education.

**Validity and Reliability of the Instruments**

Mueller (1986) points out that reliability and validity are the benchmark criteria for assessing the quality of all measurement devices and procedures. Reliability is often used to evaluate instruments in terms of consistency and accuracy of measurement devices and procedures (Mueller, 1986). Reliability reflects whether an instrument measures the same thing if measured repeatedly. If an instrument lacks reliability, it means it does not consistently measure the same thing.

Validity is extent to which an instrument measures what it is supposed to measure (Light, Singer, & Willett, 1990; Mueller, 1986). Reliability is a precondition for validity (Mueller, 1986). In other words, reliability is necessary but not sufficient for validity. Just measuring the same thing does ensure validity. High reliability is not guarantee for high validity. A highly reliable measure can have a validity of .00.
Reliability

The reliability of this pilot data was conducted by using Cronbach’s alpha coefficient for internal consistency. Table 3.3 summarizes the values for Cronbach’s Alpha coefficient from the pilot studies. Although the reliability of the revised Web Attitude Scale Questionnaire was lower with a value of .733 as compared to the original value of .957, but its variance spread out and the validity increased due to the changes that were made to the questionnaire.

Table 3.3
Internal Consistency of the Instruments

<table>
<thead>
<tr>
<th>Category</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Web Attitude Scale Questionnaire</td>
<td>.957</td>
</tr>
<tr>
<td>Revised Web Attitude Scale Questionnaire</td>
<td>.733</td>
</tr>
<tr>
<td>Structural Knowledge Pretest</td>
<td>.508</td>
</tr>
<tr>
<td>Structural Knowledge Posttest Part A</td>
<td>.202</td>
</tr>
<tr>
<td>Structural Knowledge Posttest Part B</td>
<td>.601</td>
</tr>
<tr>
<td>Attitude towards the Program Design Questionnaire</td>
<td>.933</td>
</tr>
</tbody>
</table>
Validity

Three approaches were used to establish the content validity of the instruments. First, the Web Attitude Scale Questionnaire was adopted from Liaw (2002) and was revised based on the needs of this study (Appendix H). An Attitude towards the Program Design Questionnaire was constructed based on a comprehensive review of literature (Appendix I). Second, face validity was applied to examine the measure of the instruments. Four dissertation committee members were involved in examining the instruments. Among them, three professors were from the Instructional Technology program and a professor was from the Research Evaluation program. Their comments and suggestions were used to revise the instruments.

Procedures

The study was conducted in the college’s computer laboratory and carried out in two sessions. In the first session, the researcher briefly explained the purpose of the study. Then the participants were asked to sign an informed consent form. The GEFT was administered to measure the subjects’ level of FDI. Following the GEFT session, participants were required to log into a URL to complete the online-based Web Attitude Scale Questionnaire and the Structural Knowledge Pretest to detect whether their prior knowledge on the content influenced the dependent variables. The first session took approximately 30 minutes.

Prior to the second session which was held the following week, the GEFT was administered to assess each subject’s degree of FDI. The subjects were classified as FD, FM, and FI individuals. Participants were then randomly assigned into one of the two treatment groups: navigational map and content list.
One week later, the second session was conducted in the same computer laboratory as the first session. Each participant was assigned to an Intel Pentium D Duo Core processors Personal computer with a 19 inch LCD display. Internet Explorer was used as the web browser. Before starting the program, students were notified that they would use a self-directed online program to learn about the Internet and the World Wide Web. They were told that they would be given 20 minutes to browse through the learning material on the computers. The participants were instructed on how to navigate through the courseware and on how to try to learn as much from the materials as possible. After finishing the hypermedia program, students were directed to log into Blackboard to complete the online Structural Knowledge Posttest and an Attitude towards Program Design Questionnaire. The second session took approximately 30 minutes.

Data Analysis Procedures

The data from this study was organized for analysis using the Statistical Package for Social Science (SPSS 14) computer software package. Two 3 (FDI) X 2 (instructional aids) analysis of a covariance (ANCOVA) were conducted to determine the effect of field dependence/independence and instructional strategies on the Structural Knowledge Posttest and Attitude towards Program Design Questionnaire in this study (Table 3.2). The level of statistical significance for all procedures was set at $\alpha \leq .05$. 
Chapter Four: Analysis of Data and Results

Introduction

This study examined the interaction effects of instructional aids and FDI on students’ structural knowledge and attitude towards program design in a hypermedia learning environment. Data analysis consisted of a 3 X 2 ANCOVA to examine interaction between FDI and instructional aids on the Structural Knowledge Posttest. The Structural Knowledge Pretest was the covariate. A secondary analysis examined interactions between FDI and instructional aids on the Attitude towards the Program Design Questionnaire utilizing a 3 X 2 ANCOVA. The Web Attitude Scale Questionnaire was the covariate.

This chapter used the data collected to answer the following questions:

1. Is there a significant interaction between FDI and instructional aids in the Structural Knowledge Posttest in a hypermedia environment, after controlling for the Structural Knowledge Pretest?

2. Are there significant mean differences for the Structural Knowledge Posttest among FD, FM, and FI students in a hypermedia environment, after controlling for the Structural Knowledge Pretest?

3. Are there significant mean differences in the Structural Knowledge Posttest between students in the navigational map group and the content list group in a hypermedia environment, after controlling for the Structural Knowledge Pretest?
4. Is there a significant interaction between FDI and instructional aids in the Attitude towards the Program Design Questionnaire in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

5. Are there significant mean differences in the Attitude towards the Program Design Questionnaire among FD, FM, and FI students in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

6. Are there significant mean differences in the Attitude towards the Program Design Questionnaire between students in the navigational map group and the content list group in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

The research questions were divided into two parts. The first three questions centered on the Structural Knowledge Posttest, while the last three questions focused on the Attitude towards the Program Design Questionnaire.

Demographic Data

A total of 104 undergraduates enrolled in the Technology Applications in Education course (EDCT 203) at Ohio University participated in this study during winter quarter, 2007. Data from 29 participants was discarded and not used in analysis due to unusable participant response. A final total of 75 participants finished the study. Demographic information included age, gender, major, participating group, and ethnicity. The sample consisted of 53 females and 22 males between the ages of 18 and 24. They were mainly students in Early Childhood Education (12), Education (11), Middle Childhood Education (10), Special Education (7), and Science (7) disciplines. Most of the
participants were juniors (45) and seniors (20). The majority of participants, 72, were white. Appendix M presents a summary of the demographic information.

*Group Embedded Figures Test Results*

The GEFT scores were administered to classify the 75 participants’ level of field dependence. The mean GEFT score for college students in the USA was 11.4 with a standard deviation of 4.2 (Witkin et al., 1971). For the participants in the current study, the mean of GEFT score was 9.43 with a standard deviation of 4.51. Participants whose scores were in the range of the grand mean plus and minus one-half of the standard deviation were classified as field mixed (FM) (7.18 - 11.68). When a score fell below the grand mean minus one-half of the standard deviation of the GEFT (7.18) was classified as FD; whereas a score that fell above grand mean plus one-half of the standard deviation of the GEFT (11.68) was classified as FI. In this study 23 participants were identified as FD, 21 were identified as FM, and 31 were identified as FI. Table 4.1 presents the means and standard deviations achieved by students identified as FD, FM, and FI on the GEFT test.

These 75 participants were randomly assigned to two groups, the navigational map group and the content list group. In the navigational map group, 10 participants were FD individuals, 10 participants were FM individuals, and 14 participants were FI individuals. In the content list group, 13 participants were FD individuals, 11 participants were FM individuals, and 17 participants were FI individuals. Table 4.2 presents the number of subjects in 3 X 2 Analysis of Covariance for different treatment groups.
Table 4.1

Means for GEFT Scores

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>23</td>
<td>3.61</td>
<td>1.75</td>
<td>.365</td>
</tr>
<tr>
<td>FM</td>
<td>21</td>
<td>9.43</td>
<td>.98</td>
<td>.213</td>
</tr>
<tr>
<td>FI</td>
<td>31</td>
<td>13.74</td>
<td>1.44</td>
<td>.258</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>9.43</td>
<td>4.51</td>
<td>.521</td>
</tr>
</tbody>
</table>

Table 4.2

Numbers of Subjects in 3 X 2 Analysis of Covariance

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>Instructional Aids</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Navigational Map</td>
<td>Content List</td>
<td></td>
</tr>
<tr>
<td>FD</td>
<td>10</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>FM</td>
<td>10</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>FI</td>
<td>14</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>
Reliability

The reliability of the instruments was conducted by using Cronbach’s alpha coefficient for internal consistency. Table 4.3 summarizes the values for Cronbach’s Alpha coefficient.

Table 4.3

<table>
<thead>
<tr>
<th>Category</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Knowledge Pretest</td>
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<tr>
<td>Structural Knowledge Posttest</td>
<td>.624</td>
</tr>
<tr>
<td>Web Attitude Scale Questionnaire</td>
<td>.699</td>
</tr>
<tr>
<td>Attitude towards the Program Design</td>
<td>.926</td>
</tr>
<tr>
<td>Questionnaire</td>
<td></td>
</tr>
</tbody>
</table>

Analysis of Structural Knowledge Posttest

One of the learning outcomes in this study, Structural Knowledge Posttest, was analyzed according to research questions 1-3. An ANCOVA was designed to address the effects of different instructional aids and FDI in terms of students’ Structural Knowledge Posttest. The Structural Knowledge Pretest was the covariate. The DV was the Structural
Knowledge Posttest. The IVs were cognitive styles (FD, FM, and FI) and treatments (navigational map and content list).

Screening Data and Detecting Missing Data and Outliers

There are four purposes for screening data prior to conducting an analysis. The first purpose regards the accuracy of the data that has been collected. The second purpose deals with missing data and makes an effort to examine the effect and ways to deal with incomplete data. The third purpose deals with assessing the effects of extreme values (i.e., outliers) on the analysis. The fourth purpose for screening data is to assess the adequacy of fit between the data and the assumptions of specific data (Mertler & Vannatta, 2005). The missing data and outliers were examined using explore procedure in SPSS. Among 75 participants, all data was found to be valid and there was not a problem with missing data.

The Assumptions of ANCOVA

ANCOVA design requires meeting six assumptions, which are:

(1) The observations within each sample size must be randomly sampled and must be independent of one another.

(2) The distributions of scores on the dependent variable must be normal in the population from which the data were sampled.

(3) The distributions of scores on the dependent variable must have equal variances.

(4) A linear relationship exists between the dependent variable and the covariate(s).
(5) The regression slopes for a covariate are homogeneous (i.e., the slope for the regression line is the same for each group).

(6) The covariate is reliable and is measured without error (Mertler & Vannatta, 2005, p. 97).

The first assumption, which is the independence of observations, is mainly a design issue. According to Mertler and Vannatta (2005), if the study is randomly sampled and subjects are randomly assigned to treatments, this assumption is met. The participants in this study were randomly assigned to the treatments. In addition, they finished the tests and questionnaire independently, without influencing each others, and this assumption was met.

The second assumption, which is the normality of the dependent variable within each group, was examined by using Kolmogorov-Smirnov test. All Kolmogorov-Smirnov tests indicated no significant differences except for the hypothesis of normality of Structural Knowledge Posttest for the FD individuals. Non-significance meant that there was a normal distribution. Although this study slightly violated the normality assumption, according to Kennedy and Bush (1985), slight violations of the normality for an analysis of covariance will have little effect on the outcome of the analysis.

The third assumption, which is the homogeneity of variance, was evaluated by conducting custom ANCOVA. Levene’s test was used to test this assumption. The F-test from Levene’s test indicated no significance, $F(5, 69) = 1.023, p=.411$. The null hypothesis failed to be rejected and the assumption of homogeneity was met.

The fourth assumption, which is a linear relationship between the covariate(s) and the dependent variable, was inspected by using the bivariate scatterplots between the
covariate and the dependent variable. There is a seemingly linear relationship trend indicated in the scatter diagram. The assumption of a linear relationship between the covariate and the dependent variable was tenable.

The fifth assumption of homogeneity of regression is that the slopes of the regression of the DV on the covariates(s) are the same for all cells of a design. This assumption means that the interaction between the covariate (Structural Knowledge Pretest) and the IVs (FDI and instructional aids) should be non-significant. This assumption was tested by using SPSS MANOVA program. The syntax was adapted from the book “Using Multivariate Statistics” (Tabachnick & Fidell, 1996). There was no significant difference for the interaction between preABmean (the Mean of Structural Knowledge Pretest) and FDI, \( F(2, 69) = .93, p = .398 \).

Moreover, no significant difference was found for the interaction between preABmean and instructional aids (as named by instruction), \( F(1, 71) = 3.21, p = .077 \). The homogeneity of regression slopes assumption was met.

The sixth assumption is the reliability of covariate(s), which means that the covariate is reliable and is measured without error. This assumption is an issue of research design.

The Structural Knowledge Posttest Results

A 3 X 2 ANCOVA was used to test the first three research questions.

Research Question 1. Is there a significant interaction between FDI and instructional aids in the Structural Knowledge Posttest in a hypermedia environment, after controlling for the Structural Knowledge Pretest?
Null Hypothesis 1:

$H_{01}$: The interaction between FDI and instructional aids in the Structural Knowledge Posttest will not differ in a hypermedia environment, after controlling for the Structural Knowledge Pretest.

A 3 X 2 analysis of covariance was conducted to determine the effect of instructional aids and FDI in the Structural Knowledge Posttest after controlling for the Structural Knowledge Pretest. ANCOVA results (Table 4.4) indicated that the covariate of preABmean (the mean of Structural Knowledge Pretest) significantly influenced the dependent variable of postABmean (the mean of Structural Knowledge Posttest), $F (1, 68) = 11.944, p = .001$, partial $\eta^2 = .149$.

After the influence of the covariate of preABmean score was excluded, ANCOVA results (Table 4.4) indicated that interaction between instructional aids and FDI was not significant, $F (2, 68) = .127, p = .881$, partial $\eta^2 = .081$, which meant that the difference between different instructional aids groups did not result from the difference in cognitive styles. The instructional aids did not differently influence students with different cognitive styles. Therefore, the null hypothesis was kept at the .05 level of significance.
Table 4.4

*Analysis of Covariance for Structural Knowledge Posttest*

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>partial $\eta^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariate (preABmean)</td>
<td>1</td>
<td>11.944</td>
<td>.149</td>
<td>.001</td>
</tr>
<tr>
<td>FDI</td>
<td>2</td>
<td>.104</td>
<td>.003</td>
<td>.901</td>
</tr>
<tr>
<td>instruction</td>
<td>1</td>
<td>2.662</td>
<td>.038</td>
<td>.107</td>
</tr>
<tr>
<td>FDI * instruction</td>
<td>2</td>
<td>.127</td>
<td>.004</td>
<td>.881</td>
</tr>
<tr>
<td>Error</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Research Question 2. Are there significant mean differences for the Structural Knowledge Posttest among FD, FM, and FI students in a hypermedia environment, after controlling for the Structural Knowledge Pretest?

Null Hypothesis 2:

$H_{02}$: The Structural Knowledge Posttest will not differ among FD, FM, and FI students in a hypermedia environment, after controlling for Structural Knowledge Pretest.

After removing the effect of the covariate of preABmean, the results of ANCOVA indicated that there was no significant main effect of FDI in the Structural
Knowledge Posttest, F (2, 68) = .104, \( p = .901 \), partial \( \eta^2 = .003 \) (Table 4.4). FD, FM, and FI students did not exhibit significant differences in Structural Knowledge Posttest when studying in a hypermedia environment. Students in the FD, FM, and FI groups performed equally well in the Structural Knowledge Posttest. Therefore, the null hypothesis was retained at the .05 level of significance. The descriptive statistics for these three levels of field dependence are presented in Table 4.5.

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>N</th>
<th>Adjusted Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>23</td>
<td>.58</td>
<td>.13</td>
</tr>
<tr>
<td>FM</td>
<td>21</td>
<td>.61</td>
<td>.11</td>
</tr>
<tr>
<td>FI</td>
<td>31</td>
<td>.61</td>
<td>.14</td>
</tr>
</tbody>
</table>

Research Question 3. Are there significant mean differences in the Structural Knowledge Posttest between students in the navigational map group and the content list group in a hypermedia environment, after controlling for the Structural Knowledge Pretest?
Null Hypothesis 3:

$H_{03}$: The Structural Knowledge Posttest will not differ by instructional aids in a hypermedia environment, after controlling for the Structural Knowledge Pretest.

ANCOVA was again used to analyze the Structural Knowledge Posttest scores for the two types of instructional aids: the instructional map and the content list, with the Structural Knowledge Pretest as the covariate. After removing the effect of the covariate of $\text{preAB} mean$, results revealed that there was not a significant main effect for instructional aids, $F (1, 68) = 2.662, p = .107$, partial $\eta^2 = .038$ (Table 4.4), which meant the students in the navigational map and the content list groups achieved the same scores in the Structural Knowledge Posttest. The null hypothesis was kept at the .05 level of significance. Table 4.6 presents descriptive statistics for the two instructional aids.

Table 4.6

*Descriptive Statistics of Means and Standard Deviation for Structural Knowledge Posttest by Instructional Aids*

<table>
<thead>
<tr>
<th>Instructional Aids</th>
<th>N</th>
<th>Adjusted Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigational Map</td>
<td>34</td>
<td>.58</td>
<td>.13</td>
</tr>
<tr>
<td>Content List</td>
<td>41</td>
<td>.62</td>
<td>.13</td>
</tr>
</tbody>
</table>
Analysis of the Attitude towards the Program Design Questionnaire

The second learning outcome in this study, the Attitude towards the Program Design Questionnaire, was examined according to research questions 4-6. A 3X2 ANCOVA design was applied to answer these research questions. The Web Attitude Scale Questionnaire (preatimean) was the covariate. DV was the score of Attitude towards the Program Design Questionnaire (postatimean). The IVs were cognitive style of FDI (FD, FM, and FI) and instructional aids (navigational map and content list).

Detecting Missing Data and Outliers

The missing data and outliers were examined using explore procedure in SPSS. Among the 75 participants, all the data was valid and there was not a problem with missing data.

The Assumptions of ANCOVA for Attitude towards the Program Design Questionnaire

Since a 3X2 ANCOVA was used in this study, it is very important to test the following assumptions: (1) independence of observations, (2) normality of the dependent variable within each group, (3) homogeneity of variance, (4) a linear relationship between the covariate(s) and the dependent variable, (5) homogeneity of regression, and (6) the covariates are reliable and are measured without error (Mertler & Vannatta, 2005).

The first assumption of the independence of observations was met because the participants in this study were randomly assigned to the treatments. In addition, they finished the questionnaire independently without influencing each other.

The assumption of the normality of the dependent variable within each group was evaluated by using the Kolmogorov-Smirnov test. All Kolmogorov-Smirnov tests indicated that there were not significant differences, except for in the navigational map.
group. Non-significance means a normal distribution. Although this study slightly violated the normality assumption, according to Kennedy and Bush (1985), slight violations of the normality for an analysis of covariance will have little effect on the outcomes of the analysis.

The assumption of homogeneity of variance was examined by conducting custom ANCOVA. Levene’s test was used to test this assumption. The F-test from Levene’s test indicated no significance, $F(5, 69) = .901, p = .486$, and the assumption of the homogeneity was met.

The fourth assumption, which is a linear relationship between the covariate and the dependent variable, was inspected by using bivariate scatterplots. There is a seemingly linear relationship trend indicated in the scatter diagram. Hence, the assumption of a linear relationship between the covariate and the dependent variable was tenable.

The fifth assumption of the homogeneity of regression slope was tested by using the SPSS MANOVA program. There was not a significant difference for the interaction between preatimean (the mean of Web Attitude Scale Questionnaire) and FDI, $F(2, 69)=.02, p=.983$. Therefore, the homogeneity of regression slopes assumption was met.

No significant difference was found for the interaction between preatimean and instruction, $F(1, 71)=.07, p=.799$. Therefore, the homogeneity of regression slopes assumption was met.

The sixth assumption is the reliability of covariate, which means that the covariate is reliable and is measured without error. This assumption is an issue of research design.
Attitude towards the Program Design Questionnaire Results

A 3 X 2 analysis of covariance was conducted to determine the effect of instructional aids and FDI on Attitude towards the Program Design Questionnaire when controlling for Web Attitude Scale Questionnaire. The Attitude towards the Program Design Questionnaire was used to measure participants' general feelings about the navigation map and content list and whether they were helpful. The questionnaire consisted of 17 Likert-type items and one open-ended question that asked students whether the concept map could help them navigate the text.

Since the custom ANCOVA test showed that the factor-covariate interaction was not significant, the full ANCOVA was conducted to determine the effect of FDI and instructional aids on students’ Attitude towards the Program Design Questionnaire. Research questions 4-6 were designed to examine this question.

Research Question 4. Is there a significant interaction between FDI and instructional aids in the Attitude towards the Program Design Questionnaire in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

Null Hypothesis:
H₀₄: The interaction between FDI and instructional aids in the Attitude towards the Program Design Questionnaire will not differ in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire.

ANCOVA results (Table 4.7) indicated that the covariate of preatimean (Web Attitude Scale Questionnaire) did not significantly influence the dependent variable of
postatimean (Attitude towards the Program Design Questionnaire), $F(1, 68) = 2.738, p = .103$, partial $\eta^2 = .039$.

The interaction between instructional aids and FDI was not significant, $F(2, 68) = .653, p = .524$, $\eta^2 = .019$, which meant that differences among groups did not result from differences in cognitive styles. Instructional aids did not differently influence students with different cognitive styles. Therefore, the null hypothesis was kept at the .05 level of significance.

Table 4.7

*Analysis of Covariance for Attitude towards the Program Design Questionnaire*

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>$F$</th>
<th>partial $\eta^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariate (preatimean)</td>
<td>1</td>
<td>2.738</td>
<td>.039</td>
<td>.103</td>
</tr>
<tr>
<td>FDI</td>
<td>2</td>
<td>2.620</td>
<td>.072</td>
<td>.080</td>
</tr>
<tr>
<td>instruction</td>
<td>1</td>
<td>.333</td>
<td>.005</td>
<td>.566</td>
</tr>
<tr>
<td>FDI * instruction</td>
<td>2</td>
<td>.653</td>
<td>.019</td>
<td>.524</td>
</tr>
<tr>
<td>Error</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Research Question 5. Are there significant mean differences in the Attitude towards the Program Design Questionnaire among FD, FM, and FI students in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

Null hypothesis:

H₀₅: The mean of the Attitude towards the Program Design Questionnaire will not differ among FD, FM, and FI students in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire.

The results of ANCOVA indicated that there was not a significant main effect of FDI on Attitude towards the Program Design Questionnaire, F (2, 68) = 2.620, p = .080, \( \eta^2 = .072 \) (Table 4.7). FD, FM, and FI students did not exhibit significant differences in Attitude towards the Program Design Questionnaire when studying in a hypermedia environment. Perceptions of students with different cognitive styles of FD, FM, and FI groups were the same on the Attitude towards the Program Design. Therefore, the null hypothesis was retained at the .05 level of significance. The descriptive statistics for these three levels of field dependence are presented in Table 4.8.
Research Question 6. Are there significant mean differences in the Attitude towards the Program Design Questionnaire between students in the navigational map group and the content list group in a hypermedia environment, after controlling for the Web Attitude Scale Questionnaire?

Null Hypothesis:

$H_{06}$: The mean of the Attitude towards the Program Design Questionnaire will not differ through instructional aids in a hypermedia environment, after controlling for Web Attitude Scale Questionnaire.

ANCOVA was again used to analyze the Attitude towards the Program Design Questionnaire scores for the two types of instructional aids: the instructional map and content list, with the Web Attitude Scale Questionnaire as the covariate. ANCOVA results revealed no significant main effect for instructional aids, $F(1, 68) = .566, p = .005$ (Table 4.7), which means the students’ Attitude towards the Program Design
Questionnaire in the navigational map and the content list groups were the same. The null hypothesis was kept at the .05 level of significance. Table 4.9 presents descriptive statistics for the two instructional aids.

Table 4.9

*Descriptive Statistics of Means and Standard Deviation for the Attitude towards the Program Design by Instructional Aids*

<table>
<thead>
<tr>
<th>Instructional Aids</th>
<th>N</th>
<th>Adjusted Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigational Map</td>
<td>34</td>
<td>3.481</td>
<td>.676</td>
</tr>
<tr>
<td>Content List</td>
<td>41</td>
<td>3.569</td>
<td>.634</td>
</tr>
</tbody>
</table>

*Analysis of an Open-Ended Question*

The Attitude towards the Program Design Questionnaire included an open-ended question that asked participants’ opinions of whether the concept map had helped them navigate the text and explain why. The students’ responses in the navigational map and content list are presented in Table 10 and Table 11, respectively.
Table 4.10

*Students' Responses in the Navigational Map Group to an Open-Ended Question*

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>Do you feel that the concept maps helped you navigate the text? Explain why.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>1. Yes; it helped organize the information into groups and it was easier to read and establish relationships.</td>
</tr>
<tr>
<td>FD</td>
<td>2. yea...because i could tell which ones were related to which ones directly.</td>
</tr>
<tr>
<td>FD</td>
<td>3. Yes; because it provided a clear connection between the different terms.</td>
</tr>
<tr>
<td>FD</td>
<td>4. Yes; I feel that the concept map helped me to navigate the text because it was very easy to read and follow. The concept was label very clearly which made navigation much easier.</td>
</tr>
<tr>
<td>FD</td>
<td>5. Yes. It was very easy; all one had to do was click on a term and the explanation or definition popped right up.</td>
</tr>
<tr>
<td>FD</td>
<td>6. Yes; but sometimes it was hard to remember which part I was because the boxes were so close together.</td>
</tr>
<tr>
<td>FD</td>
<td>7. a little</td>
</tr>
<tr>
<td>FD</td>
<td>8. Not really; it might have if it had been more simple; but this was too complex and confusing</td>
</tr>
<tr>
<td>Cognitive Style</td>
<td>Do you feel that the concept maps helped you navigate the text? Explain why.</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>FM</td>
<td>1. yes; I'm more of a hands on; visual learner; and seeing how everything fit together helped me better understand the material.</td>
</tr>
<tr>
<td></td>
<td>2. Yes because I always knew where to go next.</td>
</tr>
<tr>
<td></td>
<td>3. Yes. I thought it did a good job of directing me. If I had a question about one of the definitions there was an extension underneath it that answered my question. Great job!</td>
</tr>
<tr>
<td></td>
<td>4. I believe that they did. It was well organized; although at first I did not realize that the information was being repeatedly presented.</td>
</tr>
<tr>
<td></td>
<td>5. I felt as though the program was designed very well. I; however; thought that there was a lot of information to memorize in a short amount of time before the test. Had I not had to rush through to get as much info as possible for the test; I would have found this program helpful.</td>
</tr>
<tr>
<td></td>
<td>6. yes....but it was way to long (too much information)</td>
</tr>
<tr>
<td></td>
<td>7. No. I don't do well with picture relationships. There were too many sub-categories confined too closely together making the relationships confused.</td>
</tr>
<tr>
<td>Cognitive Style</td>
<td>Do you feel that the concept maps helped you navigate the text? Explain why.</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>FI</td>
<td>1. Yes it helped. The time constraint from doing this while in class is the only thing that took away from the program.</td>
</tr>
<tr>
<td></td>
<td>2. They did help me to navigate the text; however; there was not enough time allotted for reading the material and there was too much information to read about. For someone who doesn't know much about networking; there was just too much to absorb and not enough time to do it in. Plus; simply reading the material is not a sufficient way to gain true understanding.</td>
</tr>
<tr>
<td></td>
<td>3. I agree. The lines connecting different concepts of the WWW provided me with a better understanding and breakdown of what certain terms meant.</td>
</tr>
<tr>
<td></td>
<td>4. Yes; I feel that they are very organized and easy to read while making it easier to understand the concepts that are being presented.</td>
</tr>
<tr>
<td></td>
<td>5. Yes. Once I figured out how the content was set up--how the different things connected together; it was easy for me to use.</td>
</tr>
<tr>
<td></td>
<td>6. It was really hard to navigate the program; I felt more lost than I felt like I learned anything. I really didn't like the organization of it either.</td>
</tr>
</tbody>
</table>
Cognitive Style | Do you feel that the concept maps helped you navigate the text? 
--- | ---
**FI** | Explain why.
7. I guess so; you could visualize and break down from the big picture of the internet to its smaller components.
8. The concept map was a good way to navigate the text because it showed relationships between the information. If I clicked on a blue square I knew immediately that there was subtext I also needed to read; which I would find below. The arrows also helped direct where to click next. Overall it presented a flow-chart like quality to the information; which I think was an effective organization for learning.
9. It was very confusing to use the web. Relationships were clearly understood; but I was not sure when I would need to click on something for more details; or if it would just have the information I needed in the one above it.
10. No I could not go back to the map and view the text without loosing the work I had accomplished on my posttest.
11. No because I kept forgetting which one I had opened; and it just repeated itself in certain spots. So I kept getting lost and got bored with reading things over and over again.
Table 4.11

*Students’ Responses in the Content List Group to an Open-Ended Question*

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>Do you feel that the content list helped you navigate the text? Explain why.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>1. Yes; I thought that it was very easy to follow since it was in a list.</td>
</tr>
<tr>
<td></td>
<td>There were the big topics and listed underneath them were all the topics</td>
</tr>
<tr>
<td></td>
<td>that went along with that specific topic. I found it very easy to find</td>
</tr>
<tr>
<td></td>
<td>where to go next; and to follow the connections between the different</td>
</tr>
<tr>
<td></td>
<td>concepts.</td>
</tr>
<tr>
<td></td>
<td>2. Not really. Viewing the information the content list provided was</td>
</tr>
<tr>
<td></td>
<td>just like reading out of a text book! There's no way I was able to get all</td>
</tr>
<tr>
<td></td>
<td>the information I needed; in 20 minutes; to answer the questions in the</td>
</tr>
<tr>
<td></td>
<td>posttest. I think I would have liked the map better.</td>
</tr>
<tr>
<td></td>
<td>3. I think the Content List helped to navigate the text because you could</td>
</tr>
<tr>
<td></td>
<td>see an outline of the topics and then go to a more in depth look at each</td>
</tr>
<tr>
<td></td>
<td>topic. It also showed which things you had already looked at which</td>
</tr>
<tr>
<td></td>
<td>helped keep your place.</td>
</tr>
<tr>
<td></td>
<td>4. I like to learn through outline (content list) form; so the concept map</td>
</tr>
<tr>
<td></td>
<td>I read was perfect for me to learn. After reading; I was able to take the</td>
</tr>
<tr>
<td></td>
<td>posttest and I had remembered a lot of what was read because of the</td>
</tr>
<tr>
<td></td>
<td>organization.</td>
</tr>
</tbody>
</table>
Cognitive Style  Do you feel that the content list helped you navigate the text? Explain why.

FD  5. Yes; because if all the information was just on one page it would be confusing i like it separated onto different links.

6. Yes; Having sep[a]erate links was helpful. It was even more helpful to see the links I had clicked as I read through. This made for a more simplified process.

7. No; I do not feel that the map helped me to navigate the text because the amount of information; at one click; was too great. I found my self reading but not comprehending the information I was presented with. There was a lot of information to read in a short amount of time; but also it was only clumped into 4 or 5 sections.

8. Yes they broke things up for me and it was easier to comprehend. When things are broken up it makes the topic at hand less intimidating.
<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>Do you feel that the content list helped you navigate the text? Explain why.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM</td>
<td>1. The content list helped me navigate the information because I knew what I would be learning about if I clicked a certain link. If I had a question about the history of the internet it would have been easy to find exactly where to get that information. The text was so dry and boring it was hard to read though.</td>
</tr>
<tr>
<td></td>
<td>2. It was fine; it could be spruced a m little bit to visually engage the reader. The content is not so interesting; one needs to draw the reader in so that they can stick with the material....</td>
</tr>
<tr>
<td></td>
<td>3. Not really because there was so much information.</td>
</tr>
<tr>
<td></td>
<td>4. Yes; because all of the related information is easily connected.</td>
</tr>
<tr>
<td></td>
<td>5. Yes; it was easy to find the information because it was in order for me to click on it. The information was put in categories which made it easy to understand.</td>
</tr>
<tr>
<td>Cognitive Style</td>
<td>Do you feel that the content list helped you navigate the text? Explain why.</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| FI              | 1. I thought that the lists of information was dull; hard to read and about put me to sleep. Interesting way of teaching but I think there needs to be an animated person in the classroom too.  
2. Yes. I knew the bolded words (content list) were important so I concentrated more on them.  
3. Yes I felt that the way my content list was set up helped. I knew which section I was under the whole time. Being able to click on a link and have it open next to the 'map' was good because I could still see where I was. Sometimes there was too much information on each link but all in all it was good.  
4. it was alright  
5. They aided in that they provided a basic outline for us to follow rather than having a bunch of information thrown at us at one time.  
6. There was too much reading involved for this survey.  
7. I used the content list though; and it was easy to navigate.  
8. I thought the concept maps were very useful in their organization. It helped me a lot to see the larger concepts and work towards the more specific. I think I learned a lot during this exercise. |
Cognitive Style Do you feel that the content list helped you navigate the text? Explain why.

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FI 9. yes. It was easy to read short snips of information at a time rather than looking down a long display of content at once. It was easy to stay on track because you are constantly clicking on the next thing to read.</td>
<td></td>
</tr>
</tbody>
</table>

Additional Analysis for the Structural Knowledge Posttest

The results of the 3X2 ANCOVA test indicated that there was not a significant interaction between instructional aids and FDI in the Structural Knowledge Posttest. The results also revealed that there was not significant main effect for instructional aids and FDI in the Structural Knowledge Posttest. The researcher suspected that the low reliability of the Structural Knowledge Pretest Part A and Posttest Part A may have been responsible for the lack of significant effects. It was decided to remove the variables, the Structural Knowledge Pretest Part A and Posttest Part A, and reanalyze ANCOVA results. The Structural Knowledge Pretest Part B was used as the covariate. The dependent variable was the Structural Knowledge Posttest Part B. The independent variables were cognitive styles (FD, FM, and FI) and treatments (navigational map and content list).

ANCOVA results (Table 4.12) indicated that the covariate of the preBmean (the mean of the Structural Knowledge Pretest Part B) significantly influenced the dependent
variable of the postBmean (the mean of Structural Knowledge Posttest Part B), $F(1, 68) = 24.395, p = .000$, partial $\eta^2 = .264$.

After the influence of the covariate of the preBmean score was excluded, ANCOVA results (Table 4.12) indicated that the interaction between instructional aids and FDI was not significant, $F(2, 68) = .350, p = .706$, partial $\eta^2 = .010$, which means that the instructional aids did not significantly influence students with different cognitive styles of FDI.

The results also indicated that there was not significant a main effect of FDI on the Structural Knowledge Posttest Part B, $F(2, 68) = .274, p = .761$, partial $\eta^2 = .008$ (Table 4.12). FD, FM, and FI students did not exhibit significant differences in the Structural Knowledge Posttest Part B when studying in a hypermedia environment. Students in the FD, FM, and FI groups performed equally well in the Structural Knowledge Posttest.

After removing the effect of the covariate of preBmean, results revealed that there was not significant a main effect for instructional aids, $F(1, 68) = 2.964, p = .090$, partial $\eta^2 = .042$ (Table 4.12), which meant the students in the navigational map and the content list groups achieved the same scores in the Structural Knowledge Posttest Part B.
Table 4.12

*Analysis of Covariance for Structural Knowledge Posttest Part B*

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>partial $\eta^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariate (preBmean)</td>
<td>1</td>
<td>24.395</td>
<td>.264</td>
<td>.000</td>
</tr>
<tr>
<td>FDI</td>
<td>2</td>
<td>.274</td>
<td>.008</td>
<td>.761</td>
</tr>
<tr>
<td>instruction</td>
<td>1</td>
<td>2.964</td>
<td>.042</td>
<td>.090</td>
</tr>
<tr>
<td>FDI * instruction</td>
<td>2</td>
<td>.350</td>
<td>.010</td>
<td>.706</td>
</tr>
<tr>
<td>Error</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Additional Analysis for the Attitude towards Program Design Questionnaire*

The results of the 3X2 ANCOVA test indicated that there was not a significant interaction between instructional aids and FDI in the Attitude towards Program Design Questionnaire. The results of ANCOVA also revealed that there was not a main effect for instructional aids and not a main effect of FDI in the Attitude towards Program Design Questionnaire. However, the researcher would like to further evaluate the differences from the five aspects (subscales) of the Attitude towards Program Design Questionnaire. In addition, initial ANCOVA analysis contained the preatimean (the mean of Web Attitude Scale Questionnaire) as a covariate. There were not significant effects involving
the preatimean for the dependent variable of the postatimean (the mean of Attitude towards the Program Design Questionnaire). Hence, the researcher removed the covariate Web Attitude Scale Questionnaire and decided to conduct a 3X2 MANOVA. The IVs were FDI and Instructional Aids. The combined DV was the Attitude towards the Program Design Questionnaire (as measured by the Value of Program Design, Learning Efficiency, Disorientation, Benefit of Instructional Aids, and overall attitude toward program design). It consisted of 17 Likert-type items and one open-ended question that asked students whether the concept map could help them navigate the text. Items 2, 4, 13, and 16 inquired about the participants' feelings on the Value of Program Design. Item 1, 6, 7, and 12 dealt with the Learning Efficiency of the program design. Item 3, 9, 10, and 14 assessed participants' feelings of Disorientation. Item 5, 8, 11, and 15 evaluated students’ perceptions about the Benefit of Instructional Aids. Item 17 tested their overall attitude about the courseware (Appendix L).

Research questions 4-6 were rephrased as follows to be answered by MANOVA.

4. Is there a significant interaction between FDI and instructional aids in the Attitude towards the Program Design Questionnaire in a hypermedia environment?

5. Are there significant mean differences in the Attitude towards the Program Design Questionnaire among FD, FM, and FI students in a hypermedia environment?

6. Are there significant mean differences in the Attitude towards the Program Design Questionnaire between students in the navigational map group and the content list group in a hypermedia environment?
The Assumptions of MANOVA

Since a 3X2 MANOVA was used in this study, it was very important to test its assumptions. This research design required meeting four assumptions, which are (1) independence of observations, (2) multivariate normality, (3) homogeneity of variance-covariance, and (4) linearity (Mertler and Vannatta, 2005).

The first assumption was met since participants were randomly assigned to the treatments and responded to the questionnaires separately. The second assumption, which is the multivariate normality, was checked using the Kolmogorov-Smirnov test. The Normality results for DVs by FDI indicated that FD and FI students were normal based on the mean Learning Efficiency, FD and FM students were normal based on the mean disorientation, and FI students were normal based on the mean aidsmean (Benefit of Instructional Aids). Others showed that nonnormal distribution on the dependent variables.

The Normality results for DVs by Instructional Aids showed that only the content list group was normal on the aidsmean (Benefit of Instructional Aids). Other groups showed nonnormal distribution on the dependent variables. According to Tabachnick and Fidell (1996), MANOVA can accept robust to moderate violations of normality. This violation will not cause a big effect on the interpretations of the results.

The third assumption, which is the homogeneity of variance-covariance, was tested by conducting a custom MANOVA. Box’s Test was used to assess this assumption. Box’s Test hypothesizes that the observed covariance matrices of the dependent variables are equal across the groups. The F-test from Box’s Test indicated no significance, F (75,
The fourth assumption, linearity, means that the relationships among all pairs of DVs for each cell in the data matrix must be linear. This assumption was assessed by creating a scatterplot matrix and calculating Pearson correlation coefficients. In order to minimize the chances of making a Type I error across the 15 correlations and have a corrected significance level, the Bonferroni approach was used to adjust alpha. In this study, a $p$ value of less than .0033 (.05/15 = .0033) was required for significance. The results of the correlational analyses presented in Appendix P showed that 10 out of the 15 correlations were statistically significant and were greater than or equal to .534, which means a linear relationship existed among those DVs. The assumption of linearity was met.

The MANOVA Results

A 3X2 MANOVA was conducted to determine the effect of FDI and instructional aids on students’ Attitude towards the Program Design Questionnaire.

Research Questionnaire 4. Is there a significant interaction between FDI and instructional aids in Attitude towards the Program Design Questionnaire in a hypermedia environment?

Null Hypothesis:

$H_{04}$: The interaction between FDI and instructional aids in Attitude Toward the Program Design Questionnaire will not differ in a hypermedia environment.

MANOVA results are presented in Table 4.13 and indicated that there not a significant interaction between FDI and instructional aids in the combination of DVs,
Wilks’ $\Lambda = .938$, $F(10, 130) = .419$, $p = .935$, $\eta^2 = .031$ ($\hat{\eta} > .05$). The null hypothesis was kept at the .05 level of significance.

Table 4.13

*Multivariate Analysis of Variance for Attitude towards the Program Design Questionnaire*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>$F$</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>partial $\eta^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>Lambda</td>
<td>.029</td>
<td>435.013</td>
<td>5.000</td>
<td>65.000</td>
<td>.971</td>
</tr>
<tr>
<td>FDI</td>
<td>Lambda</td>
<td>.802</td>
<td>1.513</td>
<td>10.000</td>
<td>130.000</td>
<td>.104</td>
</tr>
<tr>
<td>instruction</td>
<td>Lambda</td>
<td>.688</td>
<td>5.906</td>
<td>5.000</td>
<td>65.000</td>
<td>.312</td>
</tr>
<tr>
<td>FDI * instruction</td>
<td>Lambda</td>
<td>.938</td>
<td>.419</td>
<td>10.000</td>
<td>130.000</td>
<td>.031</td>
</tr>
</tbody>
</table>

Research Question 5. Are there significant mean differences on the Attitude towards the Program Design Questionnaire among FD, FM, and FI students in a hypermedia environment?
Null hypothesis:

$H_{05}$: The mean differences of the Attitude towards the Program Design Questionnaire will not differ among FD, FM, and FI students in a hypermedia environment

The main effect of FDI did not indicate a significant difference on the combined DVs at the $\alpha=.05$ level, Wilks’ $\Lambda=.802$, $F(10,130)=5.906, p=.142, \eta^2=.104$, (Table 4.13). This finding suggests that null hypothesis 5 was valid. The subjects’ different cognitive style of FDI did not cause the significant difference in Attitude towards the Program Design Questionnaire.

Research Question 6. Are there significant mean differences in the Attitude towards the Program Design Questionnaire between students in the navigational map group and the content list group in a hypermedia environment?

Null hypothesis:

$H_{06}$: The mean differences of the Attitude towards the Program Design Questionnaire will not differ between students in the navigational map group and the content list group in a hypermedia environment.

Wilks’ Lambda criteria indicated significant differences between the two instructional aids groups with respect to the Attitude towards the Program Design Questionnaire, Wilks’ $\Lambda=.688$, $F(5,64)=5.807, p=.000, \eta^2=.312$ (Table 4.13). This finding suggests that null hypothesis 6, which postulates that the Attitude towards the Program Design Questionnaire will not differ by instructional aids is rejected. Further univariate ANOVA results (Table 4.14) reveal that only disorientation mean (Disorientation) was found at the significant level for treatment with different
instructional aids, $F(1, 69)=3.871, p = .053, \eta^2 = .053$. As illustrated in Figures 8, students’ disorientation feelings were significantly reduced by using the navigational map approach (mean = 3.492) when compared with those disorientation feelings using the content list approach (mean = 3.871). Mean differences in the Value of Program Design, Learning Efficiency, Benefit of Instructional Aids, and Overall Attitude toward Program Design did not reach significant levels. A summary of the ANOVA is presented in Table 4.15.
Table 4.14

*Analysis of Variance for Attitude towards Program Design Questionnaire*

<table>
<thead>
<tr>
<th>Source</th>
<th>DV</th>
<th>df</th>
<th>F</th>
<th>Partial $\eta^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>instruction</td>
<td>programme</td>
<td>1</td>
<td>.100</td>
<td>.001</td>
<td>.753</td>
</tr>
<tr>
<td></td>
<td>learn</td>
<td>1</td>
<td>.066</td>
<td>.001</td>
<td>.798</td>
</tr>
<tr>
<td></td>
<td>disorientation</td>
<td>1</td>
<td>3.871</td>
<td>.053</td>
<td>.053</td>
</tr>
<tr>
<td></td>
<td>aids</td>
<td>1</td>
<td>1.163</td>
<td>.017</td>
<td>.285</td>
</tr>
<tr>
<td></td>
<td>overall</td>
<td>1</td>
<td>.563</td>
<td>.008</td>
<td>.465</td>
</tr>
<tr>
<td>Error</td>
<td>programme</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>learn</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>disorientation</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>aids</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>overall</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.1. Line Plot of Attitude towards the Program Design by Instructional Aids
Table 4.15

*A Summary of the ANOVA*

<table>
<thead>
<tr>
<th>DV</th>
<th>Instructional Aids</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>programmean</td>
<td>Navigational Map</td>
<td>3.579</td>
<td>.120</td>
<td>3.339 - 3.818</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content List</td>
<td>3.630</td>
<td>.110</td>
<td>3.411 - 3.849</td>
<td></td>
<td></td>
</tr>
<tr>
<td>learnmean</td>
<td>Navigational Map</td>
<td>3.276</td>
<td>.129</td>
<td>3.017 - 3.534</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content List</td>
<td>3.321</td>
<td>.118</td>
<td>3.085 - 3.557</td>
<td></td>
<td></td>
</tr>
<tr>
<td>disorientationmean</td>
<td>Navigational Map</td>
<td>3.512</td>
<td>.127</td>
<td>3.259 - 3.765</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content List</td>
<td>3.849</td>
<td>.116</td>
<td>3.619 - 4.080</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aidsmean</td>
<td>Navigational Map</td>
<td>3.779</td>
<td>.116</td>
<td>3.544 - 4.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content List</td>
<td>3.606</td>
<td>.106</td>
<td>3.394 - 3.818</td>
<td></td>
<td></td>
</tr>
<tr>
<td>overallmean</td>
<td>Navigational Map</td>
<td>3.295</td>
<td>.158</td>
<td>2.979 - 3.611</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content List</td>
<td>3.134</td>
<td>.145</td>
<td>2.845 - 3.423</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Additional Analysis for Gender and Field Dependence/Independence*

An additional 2x3 two-way contingency table analysis was conducted to examine the relationship between gender and field dependence/independence. There was not a significant difference in the GEFT scores for males and females: $X^2 (2, 75) = 4.99, p = .082$. Gender was not a major factor when investigating the students’ GEFT ranking.
Additional Analysis for the Relationship between

GEFT and Structural Knowledge Posttest

A linear regression analysis was conducted to examine whether the GEFT has an impact on Structural Knowledge Posttest. The regression results indicated that the GEFT did not significantly predict Structural Knowledge Posttest score. Two percent ($r^2 = .015$) of the variance of the Structural Knowledge Posttest achievement is associated with the GEFT.
Chapter Five: Discussion and Conclusion

Summary

A summary of the research problem is discussed in this chapter. Then, the discussion and conclusion of this study are presented followed by the limitations of this research and the researcher’s recommendations for future research.

This study examined the cognitive style of FDI and the effects of different instructional aids on the acquisition of Structural Knowledge Posttest and Attitude towards the Program Design Questionnaire during the course of studying in a hypermedia environment. The purpose of the study was to evaluate whether the instructional aids helped students with different cognitive styles of FDI acquire a richer understanding of Technology Applications in Education course content. The instructional aids used in this study were a navigational map and a content list. The cognitive style of FDI was chosen as one of the independent variables in this study. The GEFT was used to determine the subjects’ levels of field dependence. The Structural Knowledge Posttest scores were analyzed to measure the students’ learning performances. The Attitude towards the Program Design Questionnaire examined students' with different cognitive styles of FDI perceptions about the two different navigational aids.

Discussion and Conclusion

Structural Knowledge Posttest

Previous research suggested a significant association between cognitive styles and academic achievement (Dwyer and Moore, 2001). Yet, this study revealed that FDI did not significantly interact with the type of instructional aids in the Structural Knowledge Posttest. It was expected that the navigational map would significantly improve the
structural knowledge of FD students. The results of this study indicated that the scores of Structural Knowledge Posttest of FD students were equal to those of FI students, regardless of varied instructional aids, after the Structural Knowledge Pretest was controlled. The expectation was not supported by this study. The results of the current study offer conflicting views on the statement claimed by Davis (1991) that “cognitive style effects override the effects of instructional manipulations” (p. 160). The finding of the study is consistent with previous research (e.g., Archer, 2003; Chang et al., 2002; Chou & Lin, 1997; Hsu et al., 1994; Umar, 1999) and contradictory to the studies conducted by Leader and Klein (1996) and Grieve and Davis (1971). This study suggests that students’ structural knowledge is not associated with cognitive style of FDI.

With respect to the main effects of FDI, no significant difference was detected between FD, FM, and FI students in the Structural Knowledge Posttest. Hypermedia presents information in a nonlinear way in terms of their structure, and the researcher expected that FI students would perform better than their FD counterparts from the nonlinear hypermedia learning environment because they are more competent in providing structure to a relatively ill-structured stimulus field. FD students, in contrast, who have difficulty restructuring new information and providing structure to ambiguous information, are easily disoriented in these environments (Chen & Marcedie, 2002). This study provided evidence that the factor of FDI has little effect on the difference in Structural Knowledge Posttest scores and revealed that FI students did not outperform FD students as might be expected.

The research question examined concerned the idea that a more structured navigational map would positively influence the structural knowledge of individual
relationships among concepts. Concept maps visually depict the interrelationships among concepts, present information of domain knowledge hierarchically, and allow learners to gain an overview of the topic to be learned. Novak (1991) suggests that concept maps can serve as an efficient cognitive means to enhance students’ meaningful learning. Concept maps are an instructional strategy that can help learners organize information in a visual way to uncover the relationship among ideas (Novak & Gowin, 1984). The assumption of this study was that the performance of the students in the navigational map group would be higher than the students in the content list group. The data of this study did not indicate that instructional aids had a significant effect on the dependent variable. Students in the navigational map group did not outperform students in the content list group as expected. This finding is consistent with the work of Archer (2003), Chang’et al. (2002), Roshan (1997), Su and Klein (2006), and Umar (1999) and contradictory to the study of Chou and Lin (1998). This result implies that although the structure of the navigational map and content list is different, their function is identical. Students in the content list group received only partial knowledge of the structure of information.

One possible reason for this non-significance was the limited study time that was given to students. They were asked to study for only 20 minutes in a hypermedia environment and the subjects had the possibility of not going through all the material. This short study time, with a large amount of information, may have generated cognitive overload for the students. When students experience cognitive overload, their learning suffers (Martin, 1980). In addition, the limited time subjects interacted with the instructional contents, may have prevented the subjects from incorporating new knowledge into their existing knowledge.
Another possible factor that might have resulted in the non-significant finding is that the navigational map was too complex and caused confusion. There were too many sub-categories confined too closely together making the relationships confusing. This confusion might impede students from comprehending information. A study conducted by Casteli et al. (1998) indicates that when navigation mechanisms in the hypertext are complicated, the user’s attention shifts from informational features to navigational ones. As a result, the user puts more effort on mastering the navigation structure rather than on reading the informational content. Jonassen and Wang’s (1993) study suggests that structural cues will not automatically cause greater structural knowledge acquisition. Jonassen and Wang (1993) conclude that getting users to focus on structural relationships can result in an increase in structural knowledge acquisition. Chou and Lin (1998) argue that having a complicated map with vast amounts of information might cause learners to become disoriented. This implies that the concept map strategy may hinder subjects’ learning performance because it may require more cognitive activities and cause cognitive overload (Wedge, 1994). Chiu & Wang (2000) suggest that a map can be reduced in size and still provide enough information to provide an efficient search mechanism.

In addition, unlike the content list treatment, the navigational map did not provide tracks indicating to the user which section he or she had already viewed. The user might forget which one he or she had opened, and he or she might get lost and lose the motivation to continue to go through the courseware. Getting lost and lack of motivation with the navigational map that was used in this study could have impeded students’ interaction with the course materials and hindered their performance.
Initial ANCOVA analysis contained preatimean (the mean of Web Attitude Scale Questionnaire) as a covariate; however, there were no significant effects involving preatimean for the dependent variable of postatimean (the mean of Attitude towards the Program Design Questionnaire). The results of the MANOVA are discussed to evaluate the differences from the five aspects (subscales) of the Attitude Toward Program Design Questionnaire scale: Value of Program Design, Learning Efficiency, Disorientation, Benefit of Instructional Aids, and the overall attitude about the courseware. The discussion and conclusion about the Attitude Toward Program Design was based on the additional analysis of MANOVA.

Researchers have investigated the effects of instructional aids in a hypermedia environment in relation to improving students’ performance (e.g., Barba, 1993; Beasley & Waugh, 1995; Puntambekar et al., 2003). This study explored the use of a navigational map as an orienting device and examined not only the structural knowledge learning outcomes, but also students’ Attitude towards the Program Design Questionnaire in the real-world context of learning in classrooms. This study examined whether the use of instructional aids can help students with different cognitive styles interact with the content and view relationship among concepts. The interaction between FDI and instructional aids on the Attitude towards the Program Design Questionnaire (as measured by the Value of Program Design, Learning Efficiency, Disorientation, Benefit of Instructional Aids, and overall attitude toward program design) was not significant. No significant evidence was found to support the use of the navigational map; and the use of the navigational map did not cause FD students to have significantly more positive
attitudes toward the Value of Program Design, Learning Efficiency, Disorientation, Benefit of Instructional Aids, and overall attitude toward program design. FD students did not appear to favor the use of the navigational map over the content list. These results were consistent with the studies of Archer (2003), Chou and Lin (1998), and Hammond and Allison's (1989), and contradictory to Lee’s (2000) study.

With respect to the main effect, this study found significant group differences in terms of Attitude towards the Program Design Questionnaire according to the two different instructional aids groups. Further, univariate ANOVA results revealed that only Disorientation was found at the significant level for treatment with different instructional aids. Students in the navigational map treatment reported feeling significantly less disoriented than the learners in the content list treatment. The results of this study support Beasley and Waugh’s (1995) suggestion that “the inclusion of a properly constructed navigational map can indeed diminish feelings of disorientation in the learner” (p. 253). In Beasley and Waugh’s (1995) study, the subjects were asked to construct a pencil and paper representation of the organization of the main concepts in the lesson after being exposed to the hypermedia lesson. Three browsing devices were used: hotwords, spider maps, and hierarchical maps. They found that the feelings of disorientation in the subjects in the spider maps with a hierarchical structure embedded were not decreased; conversely, in some cases, their feelings of disorientation were increased. They suggested that spider maps are an inappropriate choice for inclusion in hypermedia systems that are organized hierarchically. On the contrary, subjects’ feelings of disorientation were significantly less when using the cognitive maps approach compared to students who used the hotwords approach. They concluded that cognitive maps which depict a hierarchy do seem to be an
appropriate choice for inclusion in hypermedia systems which are organized in this manner.

The main effect of FDI did not indicate a significant effect on the combined DVs. Students’ attitude toward program design did not significantly differ, regardless of the level of FD, FM, and FI.

Limitations of the Study and Recommendations for Future Research

The present study has implications for hypermedia designers and developers. With advances in computer technology, the use of hypermedia as a learning medium has prompted a lot of research. Hypermedia designers and developers call for hypermedia design guidelines. The navigational map was used to represent structural knowledge. It visually depicts interrelationships among concepts, presents information on domain knowledge hierarchically, and allows learners to gain an overview of the topic they are learning. The implication of this finding is that more research needs to be conducted before claiming that hypermedia systems can increase the efficiency and effectiveness by meeting the needs of students with different cognitive styles. The limitations of this study and future recommendations are discussed as follows:

1. Structural Knowledge Measure: The current study suffered from the low reliability of Structural Knowledge Pretest Part A and Posttest Part A with the value -.409 and .275, respectively. The content of the Structural Knowledge Pretest and Posttest Part A are identical. The only difference is the arrangement to the questions in each test. There are fifteen True/False questions intended to assess how well students learned the relationships between concepts in a given domain during the experiment. Perhaps the content of the True/False questions,
which had been modified from the multiple-choice questions, were not appropriate. The main challenge for future researchers is how to assess a student’s structural knowledge. There is a need to develop and validate the ways that researchers test learning outcomes that are visual in nature and difficult to access via verbal mode (Friedman, McNutt, Bliek, Evans, Wallsten, & Martz, 1994). The limitation of Pre/Post test may be a limitation of the study.

2. In this study, the researcher constructed the concept map rather than having the students generate it. Their interaction with the content was limited. Roshan (1997) suggests that if students construct and structure their own maps, they would have interacted with the content at a deeper level. Quality of interaction with the instructional material increases the effectiveness of the rehearsal strategies by increasing information acquisition. In an exploratory study, Kessler (1995) made an effort to investigate the effect of cognitive style of FDI and different learning environments on students’ learning performance in constructing concept mapping. Text-based and interactive hypermedia instructions were used to guide college students to construct concept maps about the study of insects. Five dimensions of concept mapping were defined to measure learning performance. They included the number of valid propositions, the number of valid hierarchies, the number of valid cross-links, the number of valid examples, and the total concept map score. The results indicated that FI students had significantly higher total map scores than FD students. He concluded that FDI influenced the total map scores and the number of valid
propositions. Concept mapping played some part in the construction of concept maps. Future research might apply this concept mapping strategy.

3. One characteristic of the current study was that most information was presented using text forms. The weakness of this approach is that it was hard to draw the learners’ attention so that they could maintain interest stick in the information. Future studies need not be confined to using only text forms to present information. Placing specific elements of video, graphics, audio, and animation within the hypermedia environment may improve the efficiency and effectiveness of hypermedia systems on learning outcomes.

4. Because the treatment session in this study was limited to around 20 minutes, it might not be sufficient for the subjects to interact with the instructional content, which may prevent them from incorporating new knowledge into existing knowledge. Future research should provide a longer period of time for interacting with the content.

5. The initial analyses for the Attitude towards Program Design contained Web Attitude Scale Questionnaire as a covariate; however, there was no significant effect involving Web Attitude Scale Questionnaire for the Attitude towards Program Design. Usually, college students have had some past experience with the internet. This previous experience might explain why they are sufficiently confident and competent when using technology (Davis & Crowther, 1995). For future research, the Web Attitude Scale Questionnaire should not be used as a covariate to test its effect on the Attitude towards Program Design.
6. In future studies, a qualitative method of inquiry is suggested to use. In this study, the researcher developed an open-ended question to ask the participants’ opinions of whether the concept map had helped them navigate the text and explain why. The analysis of the response does provide insight on students’ learning process and therefore establishes suitable strategies for the correction of any possible problems that are seen.

7. The navigational map in this was too complex and might cause confusion. How to reduce the complexity of concept maps and how to provide enough information about the relationships among concepts challenges hypermedia designers, developers, and programmers.

8. In this study, the navigational map did not provide tracks indicating to the user which section he or she has already viewed. The user might get lost and lose motivation to continue to go through the courseware. Future studies might provide tracks by using color in the navigational map.

9. Other possible limitations of this study are the small sample size of 75 subjects. Future research may consider using a minimum sample size between 90 and 120 participants in order to get enough power 0.8-0.9.
References


Wedge, K. S. (1994). Effects of sequencing supplanted concept maps and generating concept maps on recall of structural knowledge presented in a CAI lesson for nursing students (Doctoral dissertation, University of Pittsburgh) (UMI No. 9521423)


Appendices A~P
Appendix A

An Example of Course Representation with Navigational Map (1)
Appendix B

An Example of Course Representation with Navigational Map (2)
Communications, Networks, the Internet, and the World Wide Web

Communications and networks are the fastest growing areas of computer technology and digital media. Adding tremendously to this growth is the popularity of the Internet and the World Wide Web (also called the Web), which is a service of the Internet that supports graphics and multimedia. Together, the Internet and the World Wide Web represent one of today's most exciting uses of networks. Already, these networks have changed dramatically the way people gather information, conduct research, shop, take classes, and collaborate on projects.

Businesses encourage you to browse their Web-based catalogs, send them email for customer service requests, and buy their products online. The government publishes thousands of informational Web pages to provide individuals with materials such as legislative updates, tax forms, and e-mail addresses for members of Congress. Colleges give tours of their campuses on the Web, accept applications online, and offer thousands of classes on the Internet.

Today, communications media and networks are breaking down the walls of a classroom, allowing students to view the world beyond where they live and learn. The Internet is expanding student learning beyond the covers of a textbook to include interactive, up-to-date, Web-based content. Never before has any technology opened so many opportunities for learning.
Appendix C

An Example of Course Representation with Content List (1)
Communications Networks
    Applications of Communications Networks
    Communications Process

The Internet
    Internet Service
    History of the Internet
    Internet Access Providers
    Connecting to the Internet
    How the Internet Works
    Inner Structure of the Internet
    Netiquette
    Internet Security

The World Wide Web
    Web Page Components
    Web Browser Software
    Searching for Information on the Web
Appendix D

An Example of Course Representation with Content List (2)
Communications, Networks, the Internet, and the World Wide Web

Communications and networks are the fastest growing areas of computer technology and digital media. A tremendous contributor to this growth is the popularity of the Internet and the World Wide Web (also called the Web), which is a service of the Internet that supports graphics and multimedia. Together, the Internet and the World Wide Web represent one of today’s most exciting uses of networks. Already, these networks have dramatically changed the way people gather information, conduct research, shop, take classes, and collaborate on projects.

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Today, communications media and networks are breaking down the walls of a classroom, allowing students to view the world beyond where they live and learn. The Internet is expanding student learning beyond the pages of a textbook to include interactive, up-to-date, Web-based content. Never before has there been such an opportunity for learning.

The future will bring even more exciting applications of these technologies. Federal and state governments, private businesses, and organizations are investing billions of dollars in Internet-related hardware such as computers and software. K-12 schools. As a result of this substantial investment, most public schools have equipped their classrooms with multimedia computers and provide teachers and students with access to the Internet. This change in communications, networks, the Internet, and the World Wide Web, explains how they work, and how teachers and administrators can use these technologies to communicate, obtain almost unlimited access to information, and enhance student learning.
Appendix E

The Original Web Attitude Scale Questionnaire
Demographic Information

1. Your age is:__________

2. You are:
   a. Female
   b. Male

3. Currently, you are:
   a. Freshman
   b. Sophomore
   c. Junior
   d. Senior
   e. Graduate student (in a master’s program)
   f. Graduate student (in a Ph.D. program)
   g. Others:

4. What is your academic background?
   Major:
   Minor:
   Others (please specify):_______________________

5. With which of the following ethnic groups do you most identify?
   a. White
   b. Asian
   c. Black
   d. American Indian
   d. Hispanic (Mexico…Central/South America)
d. Others (Please specify): __________________________
The Original Web Attitude Scale Questionnaire

Directions: Please circle the response that best indicates your attitudes for the following questions (1 = SD = Strongly Disagree, 7 = SA = Strongly Agree).

1. I feel confident using the Internet/World Wide Web (WWW).

   SD         SA
   1 2 3 4 5 6 7

2. I feel confident using E-mail.

   SD         SA
   1 2 3 4 5 6 7

3. I feel confident using WWW browsers (e.g. Internet Explorer, Netscape Communicator).

   SD         SA
   1 2 3 4 5 6 7

4. I feel confident using search engines (e.g. Yahoo, Excite, and Lycos).

   SD         SA
   1 2 3 4 5 6 7

5. I like to use E-mail to communicate with others.

   SD         SA
   1 2 3 4 5 6 7

6. I enjoy talking with others about the Internet.

   SD         SA
   1 2 3 4 5 6 7
7. I like to work with the Internet/WWW.
   
   SD  SA
   1  2  3  4  5  6  7

8. I like to use the Internet from home.
   
   SD  SA
   1  2  3  4  5  6  7

9. I believe using the Internet/WWW is worthwhile.
   
   SD  SA
   1  2  3  4  5  6  7

10. The Internet/WWW helps me to find information.
    
    SD  SA
    1  2  3  4  5  6  7

11. I believe the Internet makes communication easier.
    
    SD  SA
    1  2  3  4  5  6  7

12. The multimedia environment of WWW (e.g. text, image) is helpful to understand online information.
    
    SD  SA
    1  2  3  4  5  6  7

13. I believe the Internet/WWW has potential as a learning tool.
    
    SD  SA
    1  2  3  4  5  6  7
14. I believe that the Internet/WWW is able to offer online learning activities.

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15. I believe that learning how to use the Internet/WWW is worthwhile.

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16. Learning the Internet/WWW skills can enhance my academic performance.

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Appendix F

The Original Structural Knowledge Pretest
Your Last Four Digits of Social Security Number: _____________________

* refers to correct answers.

Directions: There is ONLY ONE correct answer for each question. Please choose the best answer for the following questions.

1. A basic communications system consists of _________.
   a. two computers, one to send and one to receive data
   b. communications devices that send and receive data
   c. a communications channel over which data is sent
   d. communications software, which are programs that manage the transmission of data between computers.
   *e. all of the above
   f. a, b, c

2. A ________ is the path that data follows as data is transmitted.
   *a. communications channel
   b. Communications devices
   c. Digital signals
   d. all of the above

3. Communications channels are made up of transmission media, which are the physical materials or other means used to establish a communications channel. The most widely used transmission medium is _________.
   a. coaxial cable
   *b. twisted-pair cable
c. fiber-optic cable

d. microwave transmission

4. _________ signals are individual electrical pulses that a computer uses to represent data.

a. Analog

b. Bi-directional

c. Digital *c.
d. Modem

5. _________ signals are signals that are comprised of a continuous electrical wave.

a. Analog *a.
b. Bi-directional

c. Digital

d. Modem

d. Modem

6. For telephone lines to carry data, a communications device called a(n) _________ is used to convert digital signals to analog signals.

a. converter

b. conversion device

c. analog converter

d. modem *d.
7. __________ connect computers directly to a school or business network without using a modem.

*a. Network interface cards (NICs)

b. DSL

c. Cable television networks

d. Dial-up access

8. In the following items, all of them use broadband technologies, except__________.

a. Satellite modem

*b. Dial-up access

c. DSL modem

d. cable modem

9. A __________ LAN is a LAN that uses media such as radio waves rather than wires.

*a. wireless

b. wirefree

c. wired

d. wire

10. A(n) __________ covers a limited geographical region such as a school.

*a. local area network (LAN)

b. wide area network (WAN)
11. The world's largest network is called the __________.
   a. LAN
   b. WAN
   *c. Internet
   d. World Wide Web

12. A __________ is a business that provides Internet access to a specific geographic area.
   a. local ISP
   b. national ISP
   *c. regional ISP
   d. international ISP

13. __________ provides Internet connection from any home, school, or office using an electrical outlet.
   *a. Power line communication (PLC)
   b. Digital subscriber line (DLS)
   c. Public access point (PAP)
   d. Electric line communication (ELC)
14. Most Web pages contain __________, which are built-in connections to other related Web pages.

*a. hyperlinks or links
b. hypertext or text
c. hyperbonds or bonds
d. hyperties or ties

15. A(n) __________________ hyperlink links to another document on a different Internet computer that could be across the country or across the world.

a. target
b. relative
*c. absolute
d. hot

16. ____________ is an extremely high-speed network that will develop and test advanced Internet technologies for research, teaching, and learning.

a. ARPANET
*b. Internet2 or I2
c. NSFnet
d. Web browser

17. A(n) __________________ provides Internet access, but it also has members-only features that offer a variety of special content and services.

a. Internet service provider (ISP)
b. regional ISP

c. national ISP

*d. online service provider (OSP)

18. With __________________, a computer and a modem might be used to dial into an ISP or online service provider over a regular telephone line.

a. satellite modem

*b. dial-up access

c. DSL

d. power lines communication

19. A(n) ________________ is built on a circuit board that is installed inside a computer and attaches to a telephone socket using a standard telephone cord.

a. cable modem

b. DSL modem

c. satellite modems

*d. internal modem

20. Netiquette recommends that Internet users avoid sending or posting flames, which are __________.

*a. abusive or insulting messages

b. unsolicited e-mail messages or newsgroup postings sent to many recipients

c. frequently asked questions
d. messages that reveal the solution to a game or ending to a movie

21. Internet __________ allows parents, teachers, and others to block access to certain materials on the Internet.
   a. e-mail software
   *b. filtering software
   c. telephone software
   d. authoring software

22. A(n) __________ is an outline of user standards that reminds teachers, students, and parents that they are guests on the Internet.
   a. filtering software (FS)
   *b. Acceptable Use Policy (AUP)
   c. K-12 user policy
   d. Internet standard

23-25. The Internet provides a variety of services, such as the World Wide Web, e-mail, File Transfer Protocol (FTP), newsgroups, message boards, blogs, mailing lists, instant messaging, chat rooms, Internet telephony, Playing Games (RPGs), Massively Multiplayer Online Role-Playing Games (MMORGs), Facebooks, and Podcasting.

23. If the discussion in a particular newsgroup is appealing, a user can __________ to it, which means its location is saved in a newsreader so it can be accessed easily in the future.
a. post
b. upload
*c. subscribe
d. download

24. ___________ is a way for anyone to create their own syndicated radio shows.

a. Facebooks
*b. Podcasting
c. RPGs
d. MMORGs

25. A(n) ________ is a computer that allows users to upload and download files using FTP.

a. FTP site
b. FTP page
c. FTP server
*d. FTP program

26. A(n) _________________ is a high-speed network that connects regional and local networks to the Internet.

a. LAN
b. WLAN
27. __________ is a technique of breaking a message into individual packets.
   a. Packet changing
   b. TCP/IP
   c. Message switching
   *d. Packet switching

28. The protocol used to define packet switching on the Internet is a communications protocol known as __________.
   a. OSP
   b. ISP
   *c. TCP/IP
   d. FTP

29. A(n) ______________ is a type of search tool that allows users to navigate to areas of interest without having to enter keywords.
   a. search engine
   *b. subject directory
   c. Mosaic
   d. microbrowser
30. Text that is animated to scroll across the Web page screen, called a(n) ____________, can serve as a ticker to display stock updates, news, sports scores, or weather.

*a. marquee

b. animated GIF

c. streaming

d. streaming video
Appendix G

The Original Structural Knowledge Posttest Part A
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<thead>
<tr>
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<td></td>
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<tr>
<td></td>
<td>B) … is part of …</td>
</tr>
<tr>
<td></td>
<td>C) … neither includes nor is part of…</td>
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<td>2. Communications Systems</td>
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<td>3. Multimedia</td>
<td>VR (A)</td>
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<td>4. WAN</td>
<td>Network Interface Cards (B)</td>
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<td>5. Inner Structure of Internet</td>
<td>backbone (A)</td>
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<td>6. electrical outlet</td>
<td>Power Lines Communication (A)</td>
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<td>7. Communications Devices</td>
<td>Transmission Media (C)</td>
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<td>8. Internet Access Provider</td>
<td>DSL (C)</td>
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<td>9. WWW</td>
<td>Internet (B)</td>
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<td>10. Communications System Equipment</td>
<td>Modem (A)</td>
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<td>11. 56K</td>
<td>DSL (C)</td>
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<td>12. Web Page Components</td>
<td>Hotlink (C)</td>
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<td>13. Mosaic</td>
<td>Web Browser (B)</td>
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<td>14. Communications Channel</td>
<td>Microwave Transmission (A)</td>
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<td>15. Role-Playing Games (RPGs)</td>
<td>Internet Service (B)</td>
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Appendix H

Demographic Information, Web Attitude Scale Questionnaire, and
Structural Knowledge Pretest
There are 4 sections in this Part. It will take about 10 to 15 minutes.

**Instruction**

Please Type Your Last Four Digits of Social Security Number in the box

---

**Section 1: Demographic Information**

1. Your age:

   ---

2. You are:
   
   a. Female
   
   b. Male

3. Currently, you are:
   
   a. Freshman
   
   b. Sophomore
   
   c. Junior
   
   d. Senior
   
   e. Graduate student (in a master’s program)
   
   f. Graduate student (in a Ph.D. program)
   
   g. Others (please specify):

   ---

4. What is your academic background?

   Major:

   ---

   Minor:

   ---
5. With which of the following ethnic groups do you most identify?

- [ ] a. White
- [ ] b. Asian
- [ ] c. Black
- [ ] d. American Indian
- [ ] e. Hispanic (Mexico...Central/South America)
- [ ] f. Others (Please specify):

Others (please specify):
Section 2: Web Attitude Scale Questionnaire

Directions: Please choose the response that best indicates your attitudes for the following questions.

1. I believe using the Internet/WWW is worthwhile.
   - (1) strongly disagree
   - (2) disagree
   - (3) somewhat disagree
   - (4) neutral
   - (5) somewhat agree
   - (6) agree
   - (7) strongly agree

2. I do not like to use E-mail to communicate with others.
   - (1) strongly disagree
   - (2) disagree
   - (3) somewhat disagree
   - (4) neutral
   - (5) somewhat agree
   - (6) agree
   - (7) strongly agree

3. I feel more confident using E-mail than any other communications tools (such as Instant Message, cell phone).
   - (1) strongly disagree
   - (2) disagree
   - (3) somewhat disagree
   - (4) neutral
   - (5) somewhat agree
4. I doubt the Internet makes communication easier.

   - (1) strongly disagree
   - (2) disagree
   - (3) somewhat disagree
   - (4) neutral
   - (5) somewhat agree
   - (6) agree
   - (7) strongly agree

5. I believe that learning how to use the Internet/WWW is worthwhile.

   - (1) strongly disagree
   - (2) disagree
   - (3) somewhat disagree
   - (4) neutral
   - (5) somewhat agree
   - (6) agree
   - (7) strongly agree

6. I don’t think that the Internet/WWW is able to offer online learning activities.

   - (1) strongly disagree
   - (2) disagree
   - (3) somewhat disagree
   - (4) neutral
   - (5) somewhat agree
   - (6) agree
7. I feel confident using WWW browsers (e.g. Internet Explorer, Netscape Communicator).

8. The multimedia environment of WWW (e.g. text, image) is helpful to understand online information.

9. The thought of using Internet/WWW frightens me.
10. I don’t have any use for the Internet/WWW on a day-to-day basis.

- (7) strongly agree
- (1) strongly disagree
- (2) disagree
- (3) somewhat disagree
- (4) neutral
- (5) somewhat agree
- (6) agree
- (7) strongly agree

11. I lack confidence using search engines (e.g. Yahoo, Excite, and Lycos).

- (1) strongly disagree
- (2) disagree
- (3) somewhat disagree
- (4) neutral
- (5) somewhat agree
- (6) agree
- (7) strongly agree

12. The Internet/WWW always helps me to find information I need.

- (1) strongly disagree
- (2) disagree
- (3) somewhat disagree
- (4) neutral
- (5) somewhat agree
- (6) agree
- (7) strongly agree
13. I believe the Internet/WWW has little potential as a learning tool.

☐ (1) strongly disagree
☐ (2) disagree
☐ (3) somewhat disagree
☐ (4) neutral
☐ (5) somewhat agree
☐ (6) agree
☐ (7) strongly agree


☐ (1) strongly disagree
☐ (2) disagree
☐ (3) somewhat disagree
☐ (4) neutral
☐ (5) somewhat agree
☐ (6) agree
☐ (7) strongly agree

15. I don’t think that learning the Internet/WWW skills can enhance my academic performance.

☐ (1) strongly disagree
☐ (2) disagree
☐ (3) somewhat disagree
☐ (4) neutral
☐ (5) somewhat agree
☐ (6) agree
☐ (7) strongly agree

16. I enjoy talking with others about the Internet.
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<td>(7)</td>
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Section 3: Structural Knowledge Pretest Part A

True/False

1. A network interface card connects computers directly to a school or business network without using a modem.
   - a. True
   - b. False

2. A backbone is the inner structure of the Internet.
   - a. True
   - b. False

3. For telephone lines to carry data, a communications device called a transmission media converts digital signals into analog signals.
   - a. True
   - b. False

4. A Mosaic is a special type of browser that allows Web-enabled mobile devices to view Internet sites.
   - a. True
   - b. False

5. 56K modems, DSL, cable modems, and satellite modems use broadband technologies.
   - a. True
   - b. False

6. Role-Playing Games (RPGs) is one type of Internet Service.
   - a. True
   - b. False

7. VR (Virtual Reality) is part of multimedia component.
   - a. True
   - b. False
8. Communications systems include digital signals.
   
   a. True  
   b. False

9. Videoconference is one of Internet services.
   
   a. True  
   b. False

10. Communications channels are made up of one or more microwave transmission, which are the physical materials or other means used to establish a communications channel.
    
   a. True  
   b. False

11. Power line communications technology allows broadband Internet connectivity using an electrical outlet.
    
   a. True  
   b. False

12. Internet is part of WWW world.
    
   a. True  
   b. False

13. Hyperlinks include target links, relative links, absolute links, and hotlinks.
    
   a. True  
   b. False

14. An Internet Service Provider is an organization that has a permanent Internet connection and provides temporary connections to individuals and companies for a fee.
    
   a. True  
   b. False
15. Communications systems equipment includes modem.

  a. True
  b. False
Section 4: Structural Knowledge Pretest Part B

Instructions: There is ONLY ONE correct answer for each question. Please choose the best answer for the following questions.

1. A basic communications system consists of __________.
   - a. two computers, one to send and one to receive data
   - b. communications devices that send and receive data
   - c. a communications channel over which data is sent
   - d. communications software, which are programs that manage the transmission of data between computers
   - e. all of the above
   - f. a, b, c

2. A __________ is the path that data follows as data is transmitted.
   - a. communications devices
   - b. digital signals
   - c. communications channel
   - d. network backbone

3. __________ connect computers directly to a school or business network without using a modem.
   - a. DSL
   - b. Dial-up access
   - c. Cable television networks
   - d. Network interface cards (NICs)
4. A(n) __________ covers a small geographical region such as a school.
   - a. analog network
   - b. WAN
   - c. LAN
   - d. SGR

5. ______________ is an extremely high-speed network that will develop and test advanced Internet technologies for research, teaching, and learning.
   - a. ARPANET
   - b. Internet2 or I2
   - c. NSFnet
   - d. Web browser

6. A(n) __________________ provides Internet access, but it also has members-only features that offer a variety of special content and services.
   - a. Internet service provider (ISP)
   - b. regional ISP
   - c. national ISP
   - d. online service provider (OSP)

7. A(n) ________________ is built on a circuit board that is installed inside a computer and attaches to a telephone socket using a standard telephone cord.
   - a. cable modem
   - b. DSL modem
   - c. satellite modems
   - d. internal modem
8. Netiquette recommends that Internet users avoid sending or posting flames, which are ________.
   o a. abusive or insulting messages
   o b. unsolicited e-mail messages or newsgroup postings sent to many recipients
   o c. frequently asked questions
   o d. messages that reveal the solution to a game or ending to a movie

9. A(n) _________ is an outline of user standards that reminds teachers, students, and parents that they are guests on the Internet.
   o a. filtering software (FS)
   o b. Acceptable Use Policy (AUP)
   o c. K-12 user policy
   o d. Internet standard

10. If the discussion in a particular newsgroup is appealing, a user can ________ to it, which means that its location is saved in a newsreader so it can be accessed easily in the future.
    o a. post
    o b. upload
    o c. subscribe
    o d. download

11. ________ is a technique of breaking a message into individual packets.
    o a. Packet changing
    o b. TCP/IP
    o c. Message switching
    o d. Packet switching
12. A(n) __________________ is a type of search tool that allows users to navigate to areas of interest without having to enter keywords.
   - a. search engine
   - b. subject directory
   - c. Mosaic
   - d. microbrowser

13. Text that is animated to scroll across the Web page screen, called a(n) __________________, can serve as a ticker to display stock updates, news, sports scores, or weather.
   - a. marquee
   - b. animated GIF
   - c. streaming
   - d. streaming video

14. For telephone lines to carry data, a communications device called a(n) __________ is used to convert digital signals to analog signals.
   - a. converter
   - b. conversion device
   - c. analog converter
   - d. modem

15. The world's largest network is called the __________.
   - a. LAN
   - b. WAN
   - c. Internet
   - d. World Wide Web
Appendix I

Structural Knowledge Posttest and

Attitude towards the Program Design Questionnaire
There are 3 sections in this Part. It will take about 10 to 15 minutes.

Please Type Your Last Four Digits of Social Security Number in the box

Section 1: Structural Knowledge Posttest Part A

True/False

1. 56Kmodems, DSL, cable modems, and satellite modems use broadband technologies.
   - a. True
   - b. False

2. Power line communications technology allows broadband Internet connectivity using an electrical outlet.
   - a. True
   - b. False

3. Videoconference is one of Internet services.
   - a. True
   - b. False

4. A network interface card connects computers directly to a school or business network without using a modem.
   - a. True
   - b. False

5. Communications channels are made up of one or more microwave transmission, which are the physical materials or other means used to establish a communications channel.
   - a. True
   - b. False

6. Communications systems include digital signals.
   - a. True
   - b. False
7. VR (Virtual Reality) is part of multimedia component.
   a. True
   b. False

8. An Internet Service Provider is an organization that has a permanent Internet connection and provides temporary connections to individuals and companies for a fee.
   a. True
   b. False

9. Role-Playing Games (RPGs) is one type of Internet Service.
   a. True
   b. False

10. Hyperlinks include target links, relative links, absolute links, and hotlinks.
    a. True
    b. False

11. A backbone is the inner structure of the Internet.
    a. True
    b. False

12. A Mosaic is a special type of browser that allows Web-enabled mobile devices to view Internet sites.
    a. True
    b. False

13. Internet is part of WWW world.
    a. True
    b. False

14. For telephone lines to carry data, a communications device called a transmission media converts digital signals into analog signals.
    a. True
15. Communications systems equipment includes modem.

- a. True
- b. False

b. False
Section 2: Structural Knowledge Posttest Part B

There is ONLY ONE correct answer for each question. Please choose the best answer for the following questions.

1. __________ connect computers directly to a school or business network without using a modem.
   - a. DSL
   - b. Dial-up access
   - c. Cable television networks
   - d. Network interface cards (NICs)

2. A(n) ____________________ is a type of search tool that allows users to navigate to areas of interest without having to enter keywords.
   - a. search engine
   - b. subject directory
   - c. Mosaic
   - d. microbrowser

3. A(n) ____________________ provides Internet access, but it also has members-only features that offer a variety of special content and services.
   - a. Internet service provider (ISP)
   - b. regional ISP
   - c. national ISP
   - d. online service provider (OSP)

4. A(n) __________ covers a small geographical region such as a school.
   - a. analog network
   - b. WAN
   - c. LAN
   - d. SGR
5. Text that is animated to scroll across the Web page screen, called a(n) ________________, can serve as a ticker to display stock updates, news, sports scores, or weather.
   - a. marquee
   - b. animated GIF
   - c. streaming
   - d. streaming video

6. A basic communications system consists of __________.
   - a. two computers, one to send and one to receive data
   - b. communications devices that send and receive data
   - c. a communications channel over which data is sent
   - d. communications software, which are programs that manage the transmission of data between computers
   - e. all of the above
   - f. a, b, c

7. For telephone lines to carry data, a communications device called a(n) __________ is used to convert digital signals to analog signals.
   - a. converter
   - b. conversion device
   - c. analog converter
   - d. modem

8. A __________ is the path that data follows as data is transmitted.
   - a. communications devices
   - b. digital signals
   - c. communications channel
   - d. network backbone
9. ______________ is an extremely high-speed network that will develop and test advanced Internet technologies for research, teaching, and learning.
   a. ARPANET
   b. Internet2 or I2
   c. NSFnet
   d. Web browser

10. A(n) __________________ is built on a circuit board that is installed inside a computer and attaches to a telephone socket using a standard telephone cord.
   a. cable modem
   b. DSL modem
   c. satellite modems
   d. internal modem

11. __________ is a technique of breaking a message into individual packets.
   a. Packet changing
   b. TCP/IP
   c. Message switching
   d. Packet switching

12. The world’s largest network is called the __________
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   b. WAN
   c. Internet
   d. World Wide Web

13. Netiquette recommends that Internet users avoid sending or posting flames, which are ___________
   a. abusive or insulting messages
   b. unsolicited e-mail messages or newsgroup postings sent to many recipients
c. frequently asked questions
d. messages that reveal the solution to a game or ending to a movie

14. A(n) _________ is an outline of user standards that reminds teachers, students, and parents that they are guests on the Internet.
   a. filtering software (FS)
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   c. K-12 user policy
   c. Internet standard

15. If the discussion in a particular newsgroup is appealing, a user can _________ to it, which means that its location is saved in a newsreader so it can be accessed easily in the future.
   a. post
   b. upload
   c. subscribe
   d. download
Section 3: Attitude towards the Program Design Questionnaire

Please choose the response that best indicates your attitude of this hypermedia-based instruction.

1. The courseware helped me acquiring a deeper understanding of the content knowledge.
   - (1) strongly disagree
   - (2) disagree
   - (3) neutral
   - (4) agree
   - (5) strongly agree

2. It was difficult to find the information I need from this courseware.
   - (1) strongly disagree
   - (2) disagree
   - (3) neutral
   - (4) agree
   - (5) strongly agree

3. I always knew where to go next when using this courseware.
   - (1) strongly disagree
   - (2) disagree
   - (3) neutral
   - (4) agree
   - (5) strongly agree

4. The design of the program is good.
   - (1) strongly disagree
(2) disagree
(3) neutral
(4) agree
(5) strongly agree

5. The navigational tool (content list or navigational map) helped me quickly access additional information related to the information currently under consideration.

(1) strongly disagree
(2) disagree
(3) neutral
(4) agree
(5) strongly agree

6. I learn a lot from this program.

(1) strongly disagree
(2) disagree
(3) neutral
(4) agree
(5) strongly agree

7. Learning from this courseware is difficult for me.

(1) strongly disagree
(2) disagree
(3) neutral
(4) agree
8. The navigational tool (content list or navigational map) is too complicated to master.

☐ (5) strongly agree
☐ (1) strongly disagree
☐ (2) disagree
☐ (3) neutral
☐ (4) agree
☐ (5) strongly agree

9. I always knew where I was when using this program.

☐ (1) strongly disagree
☐ (2) disagree
☐ (3) neutral
☐ (4) agree
☐ (5) strongly agree

10. The design of the courseware caused confusion in me.

☐ (1) strongly disagree
☐ (2) disagree
☐ (3) neutral
☐ (4) agree
☐ (5) strongly agree

11. The navigational tool (content list or navigational map) did not provide sufficient relationships among concepts.

☐ (1) strongly disagree
12. It is hard for me to find the information related to the questions.

(1) strongly disagree
(2) disagree
(3) neutral
(4) agree
(5) strongly agree

13. The program was well organized.

(1) strongly disagree
(2) disagree
(3) neutral
(4) agree
(5) strongly agree

14. I more often felt lost when browsing the courseware.

(1) strongly disagree
(2) disagree
(3) neutral
(4) agree
(5) strongly agree
15. The navigational tool (content list or navigational map) clearly presented the relationships among concepts.

○ (1) strongly disagree
○ (2) disagree
○ (3) neutral
○ (4) agree
○ (5) strongly agree

16. The design of the course does not make any sense to me.

○ (1) strongly disagree
○ (2) disagree
○ (3) neutral
○ (4) agree
○ (5) strongly agree

17. Overall, I like the program.

○ (1) strongly disagree
○ (2) disagree
○ (3) neutral
○ (4) agree
○ (5) strongly agree
18. Open-Ended Question:

“Do you feel that the concept maps helped you to navigate the text? Explain why.”
Appendix J

Pilot Questions
1. How long did you take to navigate through the web-based program?

2. Do you have any problems or confusions in navigating the courseware?

3. Do you have any suggestions to change the courseware design?
Appendix K

Comparison Tables of Structural Knowledge Pretest and Posttest Part A and B
### Table of Structural Knowledge Pretest and Posttest Part A

**True/False**

<table>
<thead>
<tr>
<th>Items</th>
<th>Order in Pretest</th>
<th>Order in Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>A network interface card connects computers directly to a school or business network without using a modem. (T)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>A backbone is the inner structure of the Internet. (T)</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>For telephone lines to carry data, a communications device called a transmission media converts digital signals into analog signals. (F)</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>A Mosaic is a special type of browser that allows Web-enabled mobile devices to view Internet sites. (F)</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>56Kmodems, DSL, cable modems, and satellite modems use broadband technologies. (F)</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Role-Playing Games (RPGs) is one type of Internet Service. (T)</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>VR (Virtual Reality) is part of multimedia component. (T)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Communications systems include digital signals. (F)</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Videoconference is one of Internet services. (F)</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Communications channels are made up of one or more microwave transmission, which are the physical materials or other means used to establish a communications channel. (F)</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Items</td>
<td>Order in Pretest</td>
<td>Order in Posttest</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Power line communications technology allows broadband</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Internet connectivity using an electrical outlet. (T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet is part of WWW world. (F).</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Hyperlinks include target links, relative links, absolute links, and</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>hotlinks. (F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>An Internet Service Provider is an organization that has a</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>permanent Internet connection and provides temporary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>connections to individuals and companies for a fee. (T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communications systems equipment includes modem. (T)</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Items</td>
<td>Order in Pretest</td>
<td>Order in Posttest</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>A basic communications system consists of __________.</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>A __________ is the path that data follows as data is transmitted.</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>__________ connect computers directly to a school or business network without using a modem.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>A(n) __________ covers a small geographical region such as a school.</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>__________ is an extremely high-speed network that will develop and test advanced Internet technologies for research, teaching, and learning.</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>A(n) ____________________ provides Internet access, but it also has members-only features that offer a variety of special content and services.</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>A(n) ____________________ is built on a circuit board that is installed inside a computer and attaches to a telephone socket using a standard telephone cord.</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Netiquette recommends that Internet users avoid sending or posting flames, which are __________.</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------------</td>
<td>---</td>
</tr>
</tbody>
</table>
| A(n) _______ is an outline of user standards that reminds teachers, students, and parents that they are guests on the Internet. | 9 | 14
| If the discussion in a particular newsgroup is appealing, a user can _______ to it, which means that its location is saved in a newsreader so it can be accessed easily in the future. | 10 | 15
| _______ is a technique of breaking a message into individual packets. | 11 | 11
| A(n) ____________________ is a type of search tool that allows users to navigate to areas of interest without having to enter keywords. | 12 | 2
| Text that is animated to scroll across the Web page screen, called a(n) _______ , can serve as a ticker to display stock updates, news, sports scores, or weather. | 13 | 5
| For telephone lines to carry data, a communications device called a(n) _______ is used to convert digital signals to analog signals. | 14 | 7
| The world's largest network is called the _______. | 15 | 12
Appendix L

Table of Components of an Attitude towards the Program Design Questionnaire
<table>
<thead>
<tr>
<th>Component</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Program Design</td>
<td>2. It was difficult to find the information I need from this courseware.</td>
</tr>
<tr>
<td></td>
<td>4. The design of the program is good.</td>
</tr>
<tr>
<td></td>
<td>13. The program was well organized.</td>
</tr>
<tr>
<td></td>
<td>16. The design of the course does not make any sense to me.</td>
</tr>
<tr>
<td>Learning Efficiency</td>
<td>1. The courseware helped me acquiring a deeper understanding of the content knowledge.</td>
</tr>
<tr>
<td></td>
<td>6. I learn a lot from this program.</td>
</tr>
<tr>
<td></td>
<td>7. Learning from this courseware is difficult for me.</td>
</tr>
<tr>
<td></td>
<td>12. It is hard for me to find the information related to the questions.</td>
</tr>
<tr>
<td>Disorientation</td>
<td>3. I always knew where to go next when using this courseware.</td>
</tr>
<tr>
<td></td>
<td>9. I always knew where I was when using this program.</td>
</tr>
<tr>
<td></td>
<td>10. The design of the courseware caused confusion in me.</td>
</tr>
<tr>
<td></td>
<td>14. I more often felt lost when browsing the courseware.</td>
</tr>
<tr>
<td>Component</td>
<td>Item</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Benefit of Instructional Aids</td>
<td>5. The navigational tool (content list or navigational map) helped me quickly access additional information related to the information currently under consideration.</td>
</tr>
<tr>
<td></td>
<td>8. The navigational tool (content list or navigational map) is too complicated to master.</td>
</tr>
<tr>
<td></td>
<td>11. The navigational tool (content list or navigational map) did not provide sufficient relationships among concepts.</td>
</tr>
<tr>
<td></td>
<td>15. The navigational tool (content list or navigational map) clearly presented the relationships among concepts.</td>
</tr>
<tr>
<td>Overall Attitude</td>
<td>17. Overall, I like the program</td>
</tr>
</tbody>
</table>
Appendix M

A Summary of Demographic Information
<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-Categories</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>4</td>
</tr>
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<td></td>
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<td></td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>22</td>
</tr>
<tr>
<td>Participating Group</td>
<td>Sophomore</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Junior</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Senior</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>1</td>
</tr>
<tr>
<td>Major</td>
<td>Early Childhood Education</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Middle Childhood Education</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Integrated Language Arts</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Special Education</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Adolescent to Young Adult Art Education</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Integrated Social Studies Education</td>
<td>5</td>
</tr>
</tbody>
</table>
## Table

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-Categories</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish Education</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>White</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>3</td>
</tr>
</tbody>
</table>
Appendix N

Consent Form
Title of Research Project: The Effects of Varied Instructional Aids and Field Dependence-Independence on Learners’ Structural Knowledge in a Hypermedia Environment

Researcher(s): Aifang Wang

Purpose of Research
The purpose of this research study is to examine the effects of varied instructional aids (content list and navigational map) and the level field dependence-independence on learners’ structural knowledge in a hypermedia environment.

Risks and Discomforts
This study will not pose any risk or discomfort to participants.

Benefits of this Project
Participants in the study will be exposed to a self-directed web-based lesson about the Internet and World Wide Web. This study will help the participants understand the basic concepts such as communications networks, the Internet history, how the Internet works, and World Wide Web, etc. In addition, from this research, we hope to provide valuable information of understanding of appropriate instructional design for learners with different level of field dependence-independence in a hypermedia environment.

Extent of Anonymity and Confidentiality
Participants will be identified only by their last four digits of social security numbers. All data will only be accessed by the researcher and the faculty advisor. The data obtained from this study will be used only to present the results, and no individual scores will be reported. At no time will participants’ real names or other identifying numbers be able to be identified and released.

Compensation
The participants will have 10% chance to get a 256 M USB flash drive when they complete the study. Students who choose not to participate will not be penalized in any way.

Freedom to Withdraw
Participants are free to withdraw from this study at any time without any penalty.

Subjects’ Permission
I certify that I have read and understand this consent form and agree to participate as a subject in this research. I agree that known risks to me have been explained to my satisfaction and I understand that no compensation is available from Ohio University and its employees for any injury resulting from my participation in this research. I certify that I am 18 years of age or order. I acknowledge the above and give my voluntary consent for participation in this study. I understand that I may withdraw at any time without
penalty. I agree to abide by the rules of this study. I certify that I have been given a copy of this consent form to take with me.

Signature___________________________________Date_____________________
Printed Name____________________________________________________

Contact Information
Aifang Wang (researcher) Dr. Teresa Franklin (advisor)
740-593-6414 (aw652101@ohio.edu) 740-593-4561 (franklit@ohio.edu)
Appendix O

Letter from the Institutional Review Board (IRB)
A determination has been made that the following research study is exempt from IRB review because it involves:

Category 1 - research conducted in established or commonly accepted educational settings, involving normal educational practices.

Project Title: The Effects of Varied Instructional Aids and Field Dependence - Independence on Learners' Structural Knowledge in a Hypermedia Environment

Project Director: Aifang Wang

Department: Educational Studies

Advisor: Teresa Franklin

Rebecca Care, Associate Director, Research Compliance
Institutional Review Board

Date 10/23/06

The approval remains in effect provided the study is conducted exactly as described in your application for review. Any additions or modifications to the project must be approved by the IRB (as an amendment) prior to implementation.
Appendix P

Permissions
Dear Aifang Wang:

Technically Academic Press is the copyright holder. I give you my permission to use it, but you probably should get Dr. Phye's and release from Academic Press as well. I am copying Dr. Phye. He actually edits for AP and may be able to tell you how to obtain copyright release. My permission to use the figure is contingent on your citing the original source.

Tom Andre

Thomas Andre
Associate Dean for Research and Graduate Education
Director, Center for Excellence in Science and Mathematics Education
College of Human Sciences
E262 Lagomarcino Hall
Ames, IA, 50011-3191
voice 515-294-7804
fax 515-294-7802

-----Original Message-----
From: aifang wang [mailto:aw652101@ohio.edu]
Sent: Tuesday, November 28, 2006 9:36 AM
To: tandre@iastate.edu
Subject: ask for permission

Hello Dr. Andre Thomas,

I am Aifang Wang and current a doctoral candidate in Instructional Technology at Ohio University. I am working on my dissertation and my topic is The Effect of Varied Instructional Aids and Field Dependence/Independence on Learners' Structural Knowledge in a Hypermedia Environment. The study will examine impacts of two types of web interface designs (one is content list, and the other is the navigational map) and field dependence/independence on students' achievement.

I am very excited about reading your book:

I am very interested in the Figure "A model of the cognitive system"
(p. 4) and I found that this figure is appropriate to analyze two components of long-term memory: episodic and semantic memory. I hope that I can get your permission to use it in my dissertation.

I appreciate your help.

I am going to be very excited if I could get the response from you.

Best regards,

Aifang Wang
Aifang,

Yes you have my permission to reproduce the requested figure.
Your best bet is to e-mail

Barbara Makinster at Academic Press
Senior Development Editor
525 B Street Suite 1900
San Diego, CA 92101
Phone 619.699-6269
b.makinster@elsevier.com

Cheers,

GP

At 02:46 PM 11/28/2006, you wrote:
>Hello Dr. Gary Phye,
>From Dr. Andre Thomas I know your email address. I am Aifang Wang
>and current a doctoral candidate in Instructional Technology at
>Ohio University. I am working on my dissertation and my topic is
>The Effect of Varied Instructional Aids and Field
>Dependence/Independence on Learners' Structural Knowledge in a
>Hypermedia Environment. The study will examine impacts of two types
>of web interface designs (one is content list, and the other is the
>navigational map) and field dependence/independence on students' achievement.
>
>I am very excited about reading your book:
>In G. D. Phye & T. Andre (Eds.), Cognitive classroom learning:
>Understanding, thinking, and problem solving (pp. 1-19). New York:
>Academic Press.
>
>I am very interested in the Figure "A model of the cognitive
>system" (p. 4) and I found that this figure is appropriate to
>analyze the components of long-term memory: episodic and semantic
>memory. I got the permission from Dr. Andre Thomas. I hope that I
>can get your permission to use it in my dissertation.
>
>Except the permissions from the authors, do I need to get the
>permission from the Academic Press? Could you please tell me how to
>get the permission from the Academic Press?
>
>Thanks.
>
>Best regards,
>
>Aifang Wang
>
>---On Tuesday, November 28, 2006 1:18 PM -0600 "Andre, Thomas [C I]"
><tandre@iastate.edu> wrote:
>
>>Dear Aifang Wang:
Technically Academic Press is the copyright holder. I give you my permission to use it, but you probably should get Dr. Phye's and release from Academic Press as well. I am copying Dr. Phye. He actually edits for AP and may be able to tell you how to obtain copyright release. My permission to use the figure is contingent on your citing the original source.

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of long-term memory: episodic and semantic memory. I hope that I can get your permission to use it in my dissertation.

I appreciate your help.

I am going to be very excited if I could get the response from you.

Best regards,

Aifang Wang

Gary Phye                             Ph: (515) 294-1962
Curriculum & Instruction             Fax: (515) 294-6206
N164 Lagomarcino                      gdphye@iastate.edu
Iowa State University
Ames, Iowa   50011-3190
Dear Ms Wang,

Thank you for your kind words about my chapter in the Tulving & Donaldson book. Yes, you have my permission to use this "Schema..." figure in your dissertation.

Sincerely,
Gordon Bower

On Nov 28, 2006, at 8:35 AM, aifang wang wrote:

> Hello Dr. Gordon H. Bower
> I am Aifang Wang and current a doctoral candidate in Instructional Technology at Ohio University. I am working on my dissertation and my topic is The Effect of Varied Instructional Aids and Field Dependence/Independence on Learners' Structural Knowledge in a Hypermedia Environment. The study will examine impacts of two types of web interface designs (one is content list, and the other is the navigational map) and field dependence/independence on students' achievement.
> I am very excited about reading your book:
> I am very interested in the Figure "Schema illustrating the functional relation or mapping between known and unknown material" (p. 101) and I found that this figure is appropriate to analyze organizational processes.
> I hope that I can get your permission to use it in my dissertation.
> I appreciate your help.
> I am going to be very excited if I could get the response from you.
> Best regards,
> Aifang Wang
Permission for the Figure 2.3 “Relationship between Cognitive Processes and the
Cognitive Style of Field Dependence-Independence”

Please use anything you like Mr. Wang. Best of luck to you.

--

Lee Daniels, Ph. D.
Associate Professor and Graduate Coordinator
Educational Media and Educational Technology
Box 70684
East Tennessee State University
Johnson City, TN 37614

(423) 439-7843
(423) 439-8362 (fax)
danielsh@mail.etsu.edu

> From: aifang wang <aw652101@ohio.edu>
> Date: Fri, 01 Dec 2006 02:36:19 -0500
> To: <danielsh@mail.etsu.edu>
> Subject: ask for permission
>
> Hello Dr. Harold Lee Daniels,
> I am Aifang Wang and current a doctoral candidate in Instructional
> Technology at Ohio University. I am working on my dissertation and my
> topic is The Effect of Varied Instructional Aids and Field
> Dependence/Independence on Learners' Structural Knowledge in a
> Hypermedia
> Environment. The study will examine impacts of two types of web
> interface
designs (one is content list, and the other is the navigational map)
and
field dependence/independence on students' achievement.
>
> I am very excited about reading your dissertation "Interaction of
Cognitive
Style and Learner Control of Presentation Mode in a Hypermedia
Environment".
>
> I am very interested in the Figure 5 "Relationship Between Cognitive
Processes and Cognitive Style FDI"(p. 35) and I found that this
figure is
appropriate to analyze the relationship between field
dependence/independence and information processing. I hope that I can
get
your permission to use it in my dissertation.
>
> I appreciate your help.
Dear Aifang

Thank you for your mail. There is no problem with using our figure in your doctoral dissertation assuming that the dissertation remains unpublished (which is the norm for PhDs) and that you correctly attribute the figure (following your normal citation/referencing convention).

I hope that this helps and both Sherry and I wish you all the best with your doctoral thesis.

Regards

Robert Macredie

******************************************************
Professor Robert Macredie
Pro-Vice-Chancellor and Professor of Interactive Systems
School of Information Systems, Computing and Mathematics
Brunel University
Uxbridge UB8 3PH, UK

Tel: 44 1895 266053
Fax: 44 1895 269800
email: Robert.Macredie@brunel.ac.uk
Permission for the Web Attitude Scale Questionnaire

Hello, Wang,

Yes, you have my permission to use and modify the questionnaire survey. According to the 7-point Likert scales, it could have more significantly statistical results.

I am glad to know that you are studying at Ohio University. Hope this paper can help you.

Sincerely,
Shu-Sheng Liaw<ssliaw@mail.cmu.edu.tw>

---------- Original Message ----------
From: "Aifang Wang" <aifangw2001@hotmail.com>
To: ssliaw@mail.cmu.edu.tw
Sent: Sat, 09 Sep 2006 04:42:58 +0000
Subject: ask for permissions

> Hello, Dr. Liaw,
>
> I am Aifang Wang and current a doctoral candidate in Instructional Technology at Ohio University. I am working on my dissertation and my initial topic is "The effect of navigational map and field dependence on students' learning performance". The study will examine impacts of two types of web interface designs (one is content list, and the other is the concept map) and field dependence-independence on students' achievement.
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> I was very excited about reading your article:
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> I am very interested in the "Web attitude scale" and I found that it is the most appropriate survey that can be used to test students' prior knowledge on the WWW in my study. I hope that I could get your permission to use it and allow me modifying it based on my context. In addition, the article only showed 7-point Likert scales (from 'strongly disagree' to 'strongly
> agree'). Could you please give me specific information
> about what the 7-point Likert scales was used in this
> survey?
>
> >From your web site, I know that you also graduated
> from Ohio University. I am going to be very excited if
> I could get the response from you, the alumni of Ohio
> University.
>
> > Best regards,
>
> > Aifang Wang