INTERACTION OF COGNITIVE STYLE AND LEARNER CONTROL OF PRESENTATION MODE IN A HYPERMEDIA ENVIRONMENT

by

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Abstract

      Educational hypermedia has been heralded as providing instruction that accommodates learners' individual differences, allowing them to learn in accordance with their unique needs, desires, and preferences. Advocates of hypermedia point to learner control, multimedia capability, and parallels to theories of human memory as evidence for educational hypermedia's efficacy. While intuitively appealing, empirical research has not confirmed (or rejected) this assumption. Nor is there compelling evidence to suggest that learners who posses different cognitive styles benefit equally from educational hypermedia environments.

      This study reports on an examination of cognitive style field dependence/independence and learner control of presentation mode within an educational hypermedia environment. Participants were 122 high school juniors and seniors enrolled in classes whose curricula dealt with the political process. The experimental sites were three high schools located in North Carolina, Virginia, and West Virginia. Learners classified as field dependent and field independent were asked to explore a commercial hypermedia program concerning the presidential primary election process. Participants were randomly assigned to one of two versions of the program, a control group which utilized the commercially designed multimedia presentations and a treatment group that offered the choice of single-channel presentations in addition to the multiple-channel presentations.

      After interacting with the program participants completed a ten item post test consisting of five recall and five problem-solving questions. Their actions within the hypermedia environment were automatically tracked by the computer. Data analysis consisted of a 3 x 2 ANOVA to examine interaction between field dependency and learner control of presentation mode as measured by the post test. Field dependency was

correlated with frequency of multiple-channel selections. A secondary analysis examined main effects and interactions on the recall and problem-solving questions separately utilizing a 3 x 2 ANOVA.

Data analysis revealed no correlation between field dependency and frequency of multimedia selections. The study found no significant interaction between field dependency and control (program or learner) of presentation mode as measured by the ten item post test. Separate analysis of the recall and problem-solving questions also revealed no significant interaction.

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CHAPTER I

Introduction

Background

From Skinner's teaching machines to drill and practice computer-based instruction, technology has played an important role in the quest to provide learners with instruction that accommodates their unique abilities, interests, and needs. Although it is one of the newest forms of educational technology, hypermedia has quickly become very popular among educators seeking to provide instruction according to the individual differences that learners possess.

Hypermedia consists of information databases or nodes arranged non-linearly and linked so that the learner may access information from any node at any time. The information contained in these nodes may be presented in various combinations of media formats such as text, graphics, still pictures, motion video, and sound. In addition, the structure of hypermedia closely resembles semantic network theory (Harmon, 1993; Jonassen, 1989) which contends that individuals store information via nodes that are linked by unique associations (Dede & Palumbo, 1991).

A major claim of hypermedia advocates is that it can adapt to the individual differences of learners and provide instruction to accommodate these differences. Indeed, educators have enthusiastically embraced commercial hypermedia programs, and thanks to the plethora of user-friendly authoring programs, have begun to design their own hypermedia lessons. However, the excitement over hypermedia technology is tempered by the research (or lack thereof) on hypermedia in education.

Need for the Study

The bulk of hypermedia literature consists of descriptive and advocacy pieces, while the experimental studies that do exist are conflicting. Since many of the early hypermedia reports were comparison studies, researchers have called for studies that concentrate on the specific features of hypermedia and their relationship to learner characteristics (Jonassen, 1991; Park, 1991). Although Jonassen (1991) noted that there was no empirical evidence to support or reject the use of hypermedia in education, the development and implementation of educational hypermedia systems has continued to increase rapidly. Unfortunately, research on its efficacy and effectiveness has not kept pace (Harmon, 1993; Harmon & Dinsmore, 1994).

The advent of hypermedia provides learners with an unheralded opportunity to explore, discover, and learn according to their own unique needs. However, this freedom may come with a price and as Marchionini's (1988) aptly titled article *Hypermedia and Learning: Freedom and Chaos* suggests, hypermedia instruction may be a two-edged sword. One problem regularly reported in hypermedia research is that learners often get "lost in hyperspace". This disorientation appears to be a common problem in the non-linear hypermedia environment and may result from cognitive "overload" of information or the structural features of the hypermedia program (Jonassen, 1991).

Differing cognitive styles have been shown to influence achievement and attitude in learning tasks (Witkin & Goodenough, 1981). The cognitive style field dependence/independence (FDI) is a measure of a learner's perceptual and processing characteristics which influence the preferences and strategies learners use to perceive, process, store, and recall information (Chinien & Boutin, 1993). Field dependents find it more difficult to reorganize information, attend to salient cues, and impose structure on information when there is none present than field independents (Witkin & Goodenough, 1981).

Studies examining computer-based instruction and FDI have shown field dependency to be a significant individual characteristic influencing how an individual interacts, and performs within a computer-mediated environment (Carrier, Davidson, Higson, & Williams, 1984; Hannafin, 1984). Although only a handful of studies have examined the relationship between hypermedia and FDI, they suggest that FDI is an important individual characteristic related to information sequencing, choice of content, metacognitive strategies, and navigation patterns in educational hypermedia lessons (Hsu, 1994; Lui, & Reed, 1994; Weller, Repman, & Rooze, 1994). Considering hypermedia's potential for individualized instruction, there is a surprisingly small amount of research that examines the relationship between hypermedia's effectiveness and field dependency. (Ayersman, 1994; Weller, et al., 1994).

Hypermedia lessons typically offer the learner control over sequence, content, and feedback options (Milheim & Martin, 1991). What is usually controlled by the hypermedia program itself are the delivery channels used to present the information. While well-designed multichannel presentations appear to improve recall and transfer of information (Hsia, 1971; Park & Hannafin, 1993), evidence suggests that all learners do not benefit from multiple channels of information delivery in the same way (Hsia, 1971; Lee, Hunt, & Pellegrino, 1991; Park, 1991). Several researchers suggest that individuals' cognitive processing capacity can be "overloaded" by excessive stimuli or dissonant cues contained in multiple channel messages (Grimes, 1991; Hsia, 1971).

The navigational demands, coupled with the complexity of multichannel presentation modes in hypermedia lessons, may contribute to the information and cognitive overload phenomena widely reported in the hypermedia literature. Due to their perceptual and processing characteristics, field dependents may benefit by having the option to select a single-channel message when they experience cognitive overload. In his review of research on hypermedia features, Park (1991) urged researchers to examine different types

of information presentation. He suggested that a dynamic process of selecting forms of information presentation may benefit learners in hypermedia environments.

Purpose of the Study

As hypermedia becomes more popular it is prudent for educational researchers to provide the users and designers of hypermedia with sound advice on the effectiveness of hypermedia in educational settings. Exploring the relationship between hypermedia's formal features and the individual characteristics of learners is needed so that educators can determine what features are most appropriate for individual learners. Hypermedia advocates contend that hypermedia provides instruction that accommodates individual differences such as cognitive style. However, these claims are not yet supported by empirical research. Heeding Park's advice, this study attempts to examine the relationships that may exist between cognitive style field dependence/independence and the option for learners to select single- or multiple-channel message presentations in a hypermedia environment.

CHAPTER II

Literature Review

Multiple-Channel Communication

As noted earlier, hypermedia is able to present information in a variety of ways either as single channels or more often in a multimedia format. According to Heinich, Molenda, and Russell (1993) a multimedia system is a "combination of audio and visual media integrated into a *structured* (emphasis added), systematic presentation" (p. 447). Although this definition of multimedia would include such technologies as slide-tape presentations and multi-image slide shows, it is more commonly thought of as a computer environment that *interacts* with the user (Moore, Burton, & Myers, in press). The efficacy of multimedia instruction is based on the assumption that adding an additional channel of media to transmit a message will effectively increase the amount communication (Dwyer, 1978). This notion is primarily based on two theories that support multiple-channel communication: the cue-summation theory and the dual-code theory.

Cue-summation theory contends that learning increases as the number of available cues or stimuli are increased. Severin (1967a) extends the cue-summation theory when he states that "multiple channel communications appear to be superior to single channel communications when *relevant* (italics added) cues are summated across channels" (p. 397). Severin also contends that when cross-channel cues are irrelevant, interference will occur and result in an inferior communication method.

There is an abundance of research that supports the effectiveness of multi-channel learning (Moore, et al., in press). In their literature review of text and visual illustrations Levie and Lentz (1982) contend that the attributes and information across the two channels reinforce each other and enhance both recall and comprehension. Mayer (1989) and Mayer and Gallini (1990) found that illustrations with text labels improved problem solving and

transfer for learners with low prior knowledge of the subject matter. Hsia (1971) claims that redundant information presented across channels increases the dimensionality of the information, and the stimuli in one channel provides reinforcement for the other which "results in more effective communication" (p. 66). The words redundant and related are used interchangeably in the literature although there are differences. Hartman (1961) defined redundancy as having four levels: redundant, related, unrelated, and contradictory.

As one might expect, the majority of multi-channel research has been conducted in the area of television and film. Studies by both Reese (1984) and Findahl (1971) examined recall and retention of information in television segments with treatment conditions that consisted of separate audio or video presentations, multiple channel presentations, and varying levels of redundancy between channels. In both studies the presentation of redundant audio-visual communication was superior. Other studies (Drew & Caldwell, 1985; Drew & Grimes, 1987; Grimes, 1990) found redundant audio and visual communication more effective for comprehension and problem solving than single channel presentations.

Paivio's (1971) dual-code theory also supports the effectiveness of multiple-channel communications. Paivio (1971, 1991) contends that concrete stimuli termed *imagens* are coded twice, both as images and corresponding verbal labels. Abstractions termed *logogens* are more difficult to image and are coded only as verbal information (Figure 2.1). Paivio points out that imagens, while most often thought of as images in the modal sense, refer to *any* concrete stimuli. Logogens are abstract stimuli that could include nebulous visuals as well as verbal information. According to the dual-code hypothesis, since visual images are usually coded by two referential systems, information that is presented in both the aural and visual modes should increase recall and retention.

For nearly thirty years a large body of research has supported this theory of cognition (Paivio, 1991). Most recently Mayer and others (Mayer,1989; Mayer &

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Anderson, 1991; Mayer & Gallini, 1990) have extended the dual-code theory to include both representational and referential connections (Figure 1). Studies by Mayer and his colleagues have upheld Paivio's contention that visual information helps one to process and remember verbal information and vice versa. Mayer and Anderson found that narration connected to a visual increased recall, problem solving, and transfer. Not surprisingly, they report that a treatment with unconnected verbals and visuals resulted in learning practically equivalent to no instruction at all. Baggett and Ehrenfeucht (1983) reported similar results using an instructional film. When narration preceded the visual component, learning was inferior to synchronous audio and video, while spoken narration was superior to text narrative. The dual-code theory is also assumed to contribute to the visual superiority effect noted by many researchers (Barron & Atkins, 1994; Basil, 1992; Hodes, 1994; Moore, et al., in press; Rolandelli, 1989).

Figure 1   Dual Code Theory of Perception and Encoding (from Mayer)

Verbal Stimuli   Visual Stimuli

Sensory Systems

Representational
Connections

Verbal System   Visual System

Propositions   Images

Referential
Connections

Responses
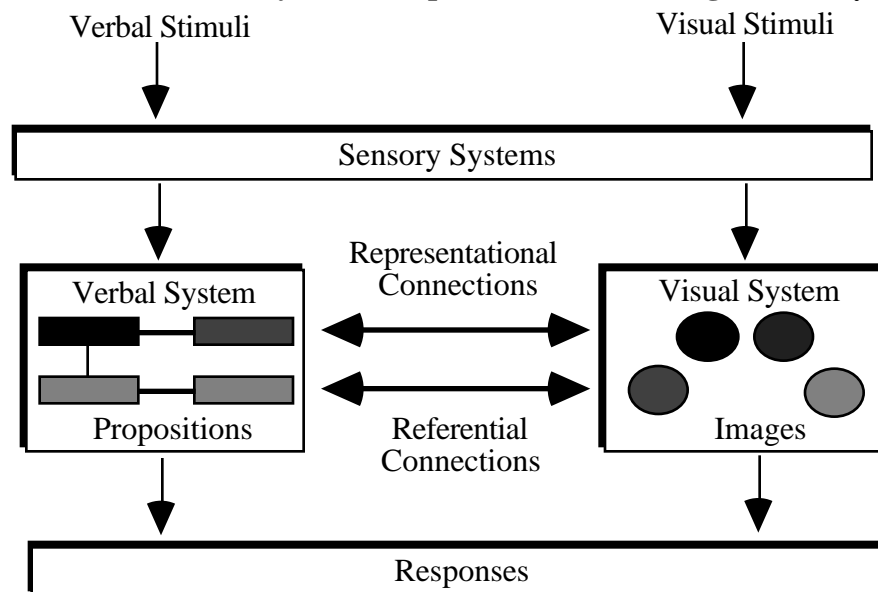
An opposing theory of multiple-channel communication is based on an assumption by Broadbent (cited in Ashcraft, 1989) that there is but one channel linking the senses to

the central nervous system. He conceptualized a filter in the sensory stage that switched between modalities in order to combine information from two channels into a single path to the central nervous system. Travers (1964) hypothesized that if this were the case little advantage would be gained by employing two channels of communication. In fact, Travers reported that multiple-channel communication resulted in "jamming" of the system and a reduction of communication (Severin, 1964).

There is a body of research that would seem to support the single channel theory. Flemming (1970) concluded that overloading the senses through multiple channels of information could result in less efficient learning and communication. Dwyer (1972), summarizing the results of nearly 50 studies on visual-verbal presentations, notes that the addition of cues in a second channel (or even excessive cues within the same channel) can be distracting and detrimental to learning.

There are several possible explanations for the discrepant findings on the effectiveness of multi-channel communication. Much of the early research was plagued by poor methodology, sampling error, faulty analysis, and test channel bias (Barron & Kysilka, 1993; Dwyer, 1978). Many of Travers' studies presented verbal information across two modalities (i.e., text and speech). According to the dual-code hypothesis this should not necessarily result in dual-coding and improved memory. In a 1994 study that examined the redundancy of text and speech, Barron and Atkins concluded that since the redundant channels were between two linguistic formats no reinforcement of information occurred.

This would support other research findings concerning redundant text and audio. Barton and Dwyer (1987) reported mixed results from redundant audio and text. Muraida and Spector (1992) found no significant advantage for visually and aurally presented text. Research by Nugent (1982) found increased achievement for combinations of audio and

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images, but not for audio and text. It would appear that dual coding does not occur when the information sources are coded by the same mechanism.
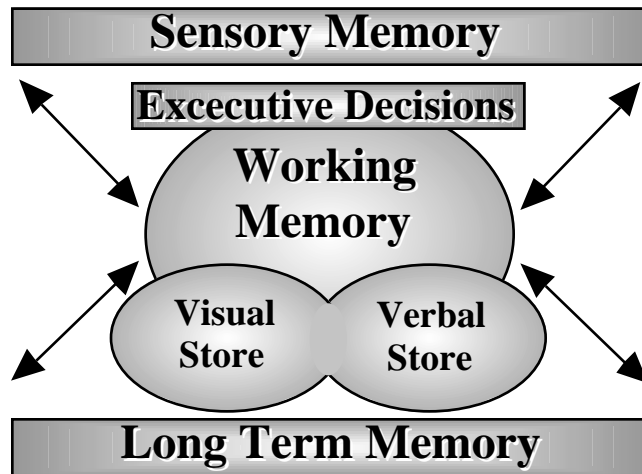
As noted earlier, multi-channel learning is effective when cues presented across channels are related or redundant. Severin (1967) notes that many communication researchers incorporated as many cues as possible within channels without regard to their meaning. Other studies consisted of nonsense syllables and unrelated visuals. One would expect that unrelated or contradictory stimuli would have a detrimental effect on learning.

Perhaps the most reasonable explanation for the inconsistent results of multiple channel communication research pertains to the capacity of the central nervous system. In his exhaustive review of the literature concerning the processing capacity of modalities, Hsia (1971) found that while well designed multiple-channel presentations are more effective, they can exceed the processing capacity of the central nervous system faster than single-channel presentations. According to Hsia, the central nervous system operates as a multiple channel mechanism until processing capacity is exceeded. At this point "jamming" the system may attenuate to a single channel system, the result being equivocation and loss of information. Hsia further suggests that capacity is taxed not only by the number of cues but also by the complexity and difficulty of the information.

Hsia's findings are in agreement with the multiple-resource theory proposed by Wickens (1984). According to this theory, finite cognitive processing resources are allocated as needed for various mental tasks (Figure 2). Extending this notion, Lange (1995) contends that when the information processing system operates at or above capacity cognitive resources must be shared among the three stages of cognitive processing. A reduction in the resources available to these stages causes incomplete and inefficient processing. Due to the temporal nature of encoding stimuli and the reflexive attentional features of novel stimuli (especially vivid visuals and modal combinations), Lange theorizes that resources are shifted to the attentional and encoding tasks in the sense register

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at the expense of the processing and storage stages. The result is that stimuli can be
attended to (although attentional resources may also be reduced) but inefficiently coded and
stored, hindering both comprehension and retrieval (Figure 3). Lange's theory would
account for many of the apparent differences in the memory for individual channels of
information in multi-channel presentations reported in the literature (Basil, 1992; Findahl,
1971; Graber, 1990; Hanson, 1989), and lend credence to the visual superiority effect.

Figure 2   Limited Resource Capacity of Cognition and Memory

Sensory Memory

Exceutive Decisions

Working Memory

Visual Store   **Verbal Store**

Long Term Memory

Figure 3   Depletion of Cognitive Resources

Sensory Memory

Exceutive Decisions

Working Memory

Visual   **Verbal**

Long Term Memory
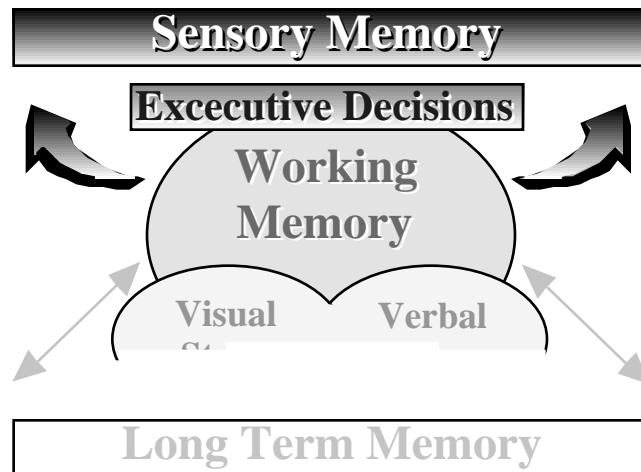
This theory is supported by neurophysiological research examining media stimuli and brain activity. Newhagen (1990) found a significant decrease for memory of material presented immediately before and after violent images. This is similar to the work of Walsh (1981) who found that novel stimuli elicited a significant increase in transient electrical activity within the brain, indicating an increase in short term memory demands.

Although the literature on multiple channel communication is inconsistent one can make some general observations:

- Regardless of how or why, excessive cues (information) can exceed the processing capacity of the human system.

- When across channel redundancy or relevance is high, and processing capacity demands are not exceeded, multiple-channel communication appears to be superior to single-channel communication.

- Cue-summation theory, dual-code theory, and the concept of a limited capacity model of processing contribute to the visual superiority effect.

These generalizations have important implications for designers of hypermedia (and multimedia). How information is presented to the learner is a critical factor in how it is encoded, elaborated, stored, and retrieved. Educators and designers also must be aware of the cognitive load that message complexity and media type place on the processing demands of the learner. In addition to these concerns, hypermedia has other attributes which influence the learning process.

Hypermedia

A Brief History

Multimedia instruction traditionally has adapted technological innovations to implement various educational strategies. It is primarily a linear system in which a designer determines the structure, path, and content of information. On the other hand, hypermedia

is based on notions of how the mind works. Rather than adapting instructional theories to function within technology, hypermedia can be thought of as a theory of memory that is served by technology (Spiro, Jacobsen, and Jeng, 1988).

The roots of hypermedia are usually traced back to Vannevar Bush's 1945 article in *Atlantic Monthly* entitled "As We May Think" (Frasse,1989). As president Roosevelt's scientific advisor Bush was overwhelmed by the amount of information he was charged to oversee and organize. He theorized a machine that would store information in nodes connected by links. Bush's machine would allow users to instantly access information nodes as they deemed necessary, moving from one segment to another in a non-linear fashion. His description of this machine (dubbed "Memex") reflected his notion of how human memory organized and assimilated information: concepts were related by associations in a non-linear manner (Frasse, 1989).

Although Bush's dream machine could not be realized by the technology of his day, the notion that people thought in a non-linear, associative manner was influential (Frasse, 1989). Both Englebart and Nelson (who coined the term "hypertext") based their "hyper" information systems on Bush's concept of link-node relationships. Although functional, these systems were too unwieldy for widespread use. As computers became more powerful and affordable in the 1980's, Bush's "Memex" became feasible. In addition to text, information representation via visuals and sound also became possible. Nelson's hypertext became hypermedia.

The event that brought hypermedia to the masses was the development of HyperCard™ by Apple in 1987. HyperCard™ is an authoring system based on non-linear links with multimedia capability. With an intuitive interface and an easy to understand topology, HyperCard™ was quickly embraced by educators as a tool for learning (Ambrose, 1991). More important perhaps is the fact that HyperCard™ developer Bill

Atkinson insisted that the program be provided free with all new Apple computers (Frasse, 1989).

Although a formal definition is not agreed upon, certain characteristics of hypermedia systems are prevalent in the literature (Conklin, 1987; Dede & Palumbo, 1991; Jonassen, 1989; Kearsley, 1988; Marchionini, 1988; Nelson & Palumbo, 1992; Park, 1991):

- Essentially a database of information, information "nodes" are connected by "links" to other nodes.
- These links are associative in nature and instantly accessible.
- Navigation through the database is accomplished with a browse tool, menu bars, buttons or "hot" text.
- Information can be presented in a variety of media.
- The system offers a high degree of learner control of instructional options such as sequence, media, assessment, review, and content.
- A high degree of interactivity is provided not only by learner control, but also by annotation and the creation of new links.

From these features one can consider hypermedia to be a non-linear database, with instant access to multimedia information. It not only presents information, it can represent, and actually assist in constructing knowledge (Nelson & Palumbo, 1992).

Hypermedia and Human Memory

Support for educational hypermedia stems from two broad bases. One concerns the multimedia capability of the technology and is based on the theories related to multiple-channel learning discussed earlier. The other is related to how people organize information in long-term memory, specifically, semantic-network theory (Quillian, 1968). Quillian proposed a model of long-term memory that is composed of interrelated concepts (nodes)

connected by numerous semantic relationships (links) which form a network. These links are ultimately unique to each individual (Ayersman, 1993). For instance in the sentence "The car is blue", the node "car" is connected to the node "blue" through the link "is". Alternative nodes might be linked according to the individual, context, or stimulus features (e.g., the car is "Bill's, broken, fast, or loud"). When a node is activated (e.g., car) it spreads to other related nodes in what is known as spreading activation theory (Collins, cited in Anderson, 1983). This concept can be demonstrated by the game of "What is the first thing that comes to mind when I say... blue" (Figure 4).

Figure 4   Model of Spreading Activation
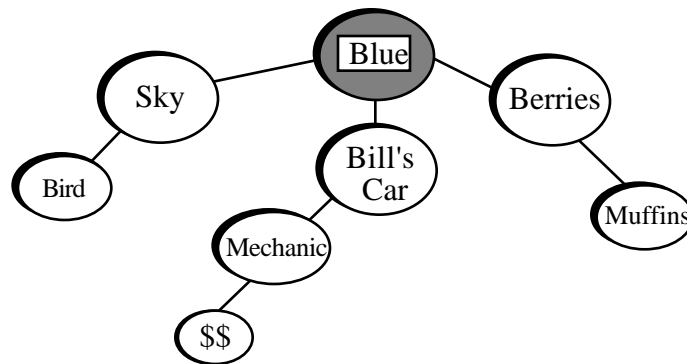
Semantic network models imply that a key to learning new information is associating it to existing knowledge by a semantically related link. According to Norman (1976), the more complex the links between existing knowledge and new information, the more likely that new information will be learned. Current notions on learning propose that meaningful learning is accomplished when new information is linked to existing knowledge or node structures (Caudhill & Butler, 1990; Jonassen, 1988; Mayer, 1987; Whitrock, 1974).

Even though it was not originally intended for instruction, hypermedia's formal features and structure so closely resemble theories of memory and cognition that a number

of authors suggest that it will become a powerful educational tool. Nelson and Palumbo (1992) note that hypermedia parallel theories of human memory. Park (1991) cites the argument that "hypermedia is a mechanism to externally represent the active structural network of human cognition" (p. 28). According to Kearsley (1988) hypermedia "should improve learning because it focuses attention on the relationships between ideas rather than isolated facts" (p. 23). Conklin (1987) describes hypermedia as "...a computer-based medium for thinking and communication" (p. 32).

Another recurring theme in the literature is the ability of hypermedia to accommodate the differences, preferences, and interests that are unique to individuals. Marchionini (1988) contends that this freedom allows users to learn "according to their individual abilities and objectives" (p. 9). Jonassen (1988) suggests that hypermedia encourages the learner "to explore information and even alter it in ways that make sense to the learner" (p. 14). Although hypermedia is a relatively new concept, a considerable amount of literature has been devoted to the subject (Nelson & Palumbo, 1992). Unfortunately the overwhelming majority of the literature consists of opinion pieces and descriptive articles. Experimental or qualitative studies are rare. Not surprisingly, the research that does exist is inconsistent.

While tentative, some studies have reported positive results with educational hypermedia. Swan (1994) reported gains in problem solving and transfer with a hypermedia program about the civil rights movement of the 1960's. Lin, Newby, and Foster (1994) reported increased transfer with a hypermedia program concerning light, moisture, and animal behavior. Gill and Wright (1994) used hypermedia to teach Newtonian physics and reported gains in transfer and problem solving. McCoy (1994) found hypermedia to be an effective way of improving statistics knowledge for graduate students. Several studies have reported that hypermedia increased efficiency (Higgins & Boone, 1992; Hardiman & Williams, 1990). Positive attitudes toward hypermedia

technology have also been consistent (Ambrose, 1991; Becker & Dwyer, 1994).

Hypermedia is not without its critics however. There is understandable concern about

hypermedia's lack of structure and the learner's ability to control and monitor learning.

Both of these concerns are related to hypermedia's provision of a high degree of learner

control over instructional options.

Learner Control

Advocates claim that providing control of pace, sequence, content, and other

elements to the learner individualizes instruction. Accommodating the learner, as opposed

to the learner having to accommodate the instruction is expected to result in higher

achievement and improved attitudes (Friend & Cole, 1990).

From a cognitive theory framework learner control is assumed to promote

elaboration since decisions made about instruction require deeper processing and reflection

on the learning process. This decision making process is assumed to promote elaboration,

and allows learners to adjust the rate of encoding and processing to their level (Merrill,

1984; Williams, 1993). Reigeluth and Stein (1983) advocate "...*informed* learner control

by *motivated* learners" (emphasis added). The term "informed" implies both cognitive

(processes) and metacognitive (knowledge of those processes) skills.

However, the research literature concerning learner control and achievement does

not bear out these expectations. While there are studies that both support and reject learner

control as an effective instructional strategy, the vast majority report no significant

difference (Chung & Reigeluth, 1992; Steinberg, 1977; Steinberg, 1989; Williams, 1993).

Carrier and Williams (1988) summarize the research on learner control with the statement

"...as a whole these findings present a montage of inconsistencies, contradictions, and

caveats" (p. 286). In a meta-analysis of computer-based-instruction (CBI) learner control

studies Parsons (1993) concluded that achievement under learner control was practically

equivalent to program control. Two reasons are usually cited (outside of research flaws) to explain why learner control failed to improve achievement: students did not use appropriate learning and review strategies; and students were unable to manage their time and monitor their progress (Clark, 1985; Merrill, 1984; Steinberg, 1989).

Other findings from the research indicate that students with high ability and those with high levels of prior knowledge appear to benefit more than other types of students (Friend & Cole, 1990; Williams, 1993). Subject matter also appears to influence the effectiveness of learner control treatments. Social oriented subjects with less specific rules and procedures usually showed more positive results under learner control. Domains that are more rule driven and require precise application of declarative knowledge such as math consistently resulted in less achievement for learner control treatments (Parsons, 1993; Steinberg, 1989; Williams, 1993).

Learner control is assumed to be a beneficial feature of hypermedia. Indeed, it is explicit in the definition offered by most researchers of hypermedia (Jonassen, 1989; Marchionini, 1988; Moore, et al., in press; Park, 1991). However, hypermedia has the potential of creating even more cognitive and metacognitive problems than other systems that use learner control. The most often reported negative effects are "getting lost in hyperspace" and cognitive overload due to navigation decisions and trying to make sense of the database (Chung & Reigeluth, 1992; Jonassen, 1988; Jonassen, 1991; Marchionini, 1988; Park, 1991).

When learners are faced with navigation decisions in a huge data base the cognitive demand can consume mental resources that should be available for learning (Gray, 1987; Park, 1991; Tripp & Roby, 1990). Many hypermedia links are either tangential or irrelevant which causes more confusion (Nelson & Palumbo, 1992). In addition, many programs do not provide navigation trails or exit paths when they are needed (Cates, 1992). A study by Harmon (1993) found that some students moved to topics as quickly as

possible because they did not want to forget the associations they were forming. Harmon also noted that learners' thought processes were interrupted when viewing content and making links, and they could not remember what associations they were developing or why.

Harmon and Dinsmore (1994) examined linking patterns by learners in a hypermedia program on Middle Eastern history. They found that the multiple-channel video segments seemed to thwart purposeful linking by the learners. The authors reported that after watching the video segments many learners became disoriented and confused. When given the option of choosing video segments only seven of the twenty-four participants chose video more than once. In a study by Lin (1994) students became confused when they could not remember which icon or menu item to use. In larger, more complex, and unstructured systems, getting lost or stranded is not uncommon for novices (Jonassen, 1991). The lack of effective and intuitive navigational tools and browsers also contributes to this situation (Park, 1991).

Several studies of hypermedia instruction have noted the absence of metacognitive ability in learners to monitor and assess their learning and take proper action to remedy their deficiencies (Jonassen, 1991; Lin, 1994; Weller et al., 1994). It is suggested that the lack of ability to assess their state of learning and take action to remedy their deficiencies leads to students missing important information, frustration, and incorrect conceptual links (Clark, 1983; Merrill,1984; Park, 1991; Recker & Pirolli, 1992). As a result, researchers have recently began to investigate not only the functional features of hypermedia but how these features interact with individual learners' characteristics.

Cognitive Style Field Dependence/Independence

A Brief History

Educators and researchers have long recognized the unique differences among individuals and the impact these differences can have on learning. Concern for these differences led to research on the cognitive variables or *cognitive style* that individuals posses (Tamaoka, 1985). Green (1985) defines cognitive style as consistencies in the ways in which people perceive, think, respond to others, and react to their environment. According to Green cognitive styles consist of four attributes. He contends that cognitive styles are: Bi-polar, value neutral, consistent across domains, stable over time.

With nearly 4,000 references in the literature, field dependence/independence (FDI) has received the most attention by researchers of all the cognitive styles (Chinien & Boutin, 1993; Entwistle, 1981; Kent-Davis & Cochran, 1989; Greene, 1985; Witkin & Goodenough, 1981). The cognitive style, field dependence/independence, has been recognized as having widespread implications for education (Bertini, 1986; Witkin, Moore, Goodenough, & Cox, 1977). Field dependence/independence has a valid and reliable measure which is not a measure of intelligence or ability (Linn & Kyllonen, 1981).

Field Dependency came out of the "New Look Movement" in perceptual research proposed by Klien and Schlesinger in a paper entitled "Where is the Perceiver in Perception Research" presented at the 1949 annual meeting of the American Psychological Association (Witkin & Goodenough, 1981). It seemed inadequate to the "New Look" psychologists to only examine a given act of perceiving across individuals. They argued that the act of perceiving in an individual should be examined in relation to that individual's unique aptitudes, needs, and personality.

Witkin and others conducted studies in the late 1940's to determine how individuals locate and orient themselves to the upright position (Goodenough, 1986). The results of

these studies indicated a consistent pattern in the strategies used by individuals to perform an upright task (Witkin & Goodenough, 1981). Some people tended to use the cues of the visual field while others appeared to rely on internal gravitational referents.

In the body adjustment task (BAT) participants were seated in a small room that was tilted to the right or left. The participants' chair could also be tilted and they were asked to correct the tilt of the chair to the upright position. It was found that some individuals oriented themselves to the tilt of the room while others correctly oriented themselves to the true upright position.

The rod-and -frame test (RFT) eliminated the gravitational cue inherent in the BAT but still required the participants to rely on external or internal referents. While seated in a dark room, the participants viewed a tilted illuminated square frame. A luminous rod was suspended within the frame, pivoting from the same center point as the frame. The participants were instructed to move the tilted rod to the upright position within the tilted frame. Consistent with findings from the BAT, some people used the frame to define the upright while others used their bodies.

Based upon these findings, Witkin theorized that individuals were either dependent on the external field or independent of the field for their perception of the upright. In a further test of this hypothesis the rotating-room (RRT) test was designed. In the RRT external field was the true marker of the upright. While the subject was seated in a tilting chair both the chair and the room swung around a circular track, imposing centrifugal as well as gravitational forces on the body. Individuals who relied on the external field were more successful in the RRT, while those who relied on internal cues were less adept at locating the upright position. Individuals were consistent across all three tests, that is, an individual's success on the BAT and RFT was inversely related to the RRT and vice versa.

On the RRT dependence on the visual field of reference was the most appropriate method for determining the upright position. As Witkin and Goodenough (1981) have

noted, where a person lies on the continuum of field dependence/independence does not imply a best or worst scenario. Either method may be appropriate depending on the task at hand. Another distinction to be made is in the meaning ascribed to the two ends of the continuum. The terms "field dependent" (FD) and "field independent" (FI) were designated to refer the mode in which an individual located the upright: reliance on the external field or independence on the external field. Over the years the F-D-I construct has been used erroneously to categorize individuals in an "either-or" dimension. As Witkin, Moore, Goodenough and Cox (1977) assert:

"Because scores from any test of field dependence/independence form a continuous distribution, these labels reflect a tendency in varying degrees of strength, towards one mode of perception or the other. There is no implication that there exist two distinct types of human beings." (p. 7)

The results of these early tests had two important implications. Individuals were consistent in their strategy for certain perceptual tasks, and depending on the situation, either strategy might be the most effective. In other words, the degree to which one was field independent was both a bi-polar and value-neutral dimension (Goodenough, 1986).

Witkin and his associates theorized that the upright tasks of the earlier measures could also be conceived as a perceptual task that required one to separate an item (e.g., a rod) from a background (e.g., a frame). This notion was confirmed using the Eembedded Figures Test (EFT) that required an individual to extract a simple geometric shape embedded in a more complex shape. The EFT is a paper and pencil test that does not involve the internal versus external field perception of earlier tests. The EFT requires individuals to separate or break up the organized patterns of the complex Figure in order to disembed the simple shape from its background.

The results of the EFT correlated highly with the BAT and the RFT. Field dependents found the task to be difficult while field independents found it relatively easy to overcome the influence of the organized complex figure and locate the simple figure within it. In 1971 Witkin and his colleagues developed the group embedded Figures test (GEFT) which can be administered to several persons at once. The EFT and GEFT results suggested that the field dependency dimension had a more general application than just spatial orientation. This assumption led to research that focused on the relationship between disembedding or restructuring ability in perception and the same ability in cognition.

This line of research is founded upon the premise that separating a part from its embedded context is as much a cognitive operation, where a person deals with symbolic representation, as it is a perceptual function of locating the upright (Witkin, et al., 1977). This view of field dependency contends that learners deal with information in an active (FI) or passive (FD) manner. One would either accept the information in its presented form or dissect the structure and extract the embedded information. It was hypothesized that field independents would act on the information and impose a new structure while field dependents would perceive the information as a whole and not reorganize the structural context (Witkin, et al., 1977).

Indicative of the research that supported this hypothesis are the results of Dickstein (1969). Dickstein found that field dependents tended to ignore cues that were not dominant in the information field, whereas field independents sampled more cues regardless of their saliency. Flemming (1968) used a set of word lists that were presented in either a super ordinate hierarchy or a subordinate hierarchy. In recall tasks, field dependents had difficulty when words were presented in a subordinate fashion. In the superordinate treatment there was no statistically significant difference between field dependents and field independents.

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These and similar studies expanded the concept of the field-dependence construct to include not only a perceptual dimension but also cognitive restructuring ability (Witkin & Goodenough, 1981). Originally Witkin had considered field dependence/independence to be a specific perceptual construct. As research revealed the relationship between field independence and cognitive restructuring abilities, the larger construct of global versus articulated field approach was incorporated to unify the correlation between the cognitive dimension of restructuring ability to its perceptual origins (Goodenough, 1986). As noted by Linn (1980) research indicated the EFT and RFT, though highly correlated, appeared to reflect different processes. Witkin and Goodenough concluded that the EFT and GEFT reflected cognitive restructuring ability which was highly related (but not identical) to the perceptual tendencies that generated cognitive strategies and methods of problems solving (Witkin & Goodenough, 1981).

A large body of research also developed that related personality differences such as interpersonal relations (DeWitt & Averill, 1976; Greene, 1979) and social interaction (Quinlan & Blatt, 1972; Witkin, et al., 1977; Witkin, Moore, Oltman, Goodenough, Friedman, Owen, & Raskin, 1977) to field dependency. As the relationships among cognitive restructuring, social functioning, and interpersonal traits became clear, the original construct of field dependence/independence was modified to reflect the new data (Witkin & Goodenough, 1981). Research found educational and vocational choices, cultural influences, and child-rearing practices correlated highly with the cognitive style field dependence/independence (Messick, 1970; Witkin et al., 1977; Witkin & Goodenough, 1981). Witkin and Goodenough came to believe that one's level of field dependency is, in part, related to a variety of cultural and social experiences early in life.

The most recent view postulated by Witkin is that field dependency reflects a broad dimension of self/non-self separation that is manifested by perception of the upright, cognitive restructuring strategies, and social functioning (Goodenough, 1986). Witkin

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developed the psychological differentiation theory to explain the interrelationship of the various dimensions within the field dependent/independent cognitive style (Rush, 1990).

The field dependent/independent construct reflects how individuals function within their environment. Field independents tend to have a more articulated self concept with clear boundaries between internal attributes, feelings, and needs and the external social environment (Witkin & Goodenough, 1981). Field dependents are more global or undifferentiated while field independents tend to be more articulated or differentiated (Saracho, 1989). Of interest to educators is how this level of autonomy from the environment (self/non-self segregation) is reflected in perception, cognitive processes, and memory.

In their reviews of the field dependence/independence literature Goodenough (1976) and Witkin, et al. (1977) drew several conclusions about the strategies and approaches taken by field dependents and field independents in learning situations. They contend that field independents tend to adopt an analytical approach to problem solving, sample more cues inherent in the field, and are able to extract the relevant cues necessary for completion of a task. Field dependents take a passive approach, are less discriminating, and attend to the most salient cues regardless of their relevancy. Goodenough (1976) suggested a cue salience hypothesis to explain field independents consistently higher performance on concept-attainment tasks. Goodenough contends that field-dependent learners attend to the most vivid or salient features of a stimulus, tending to overlook other features that may be more relevant to task performance.
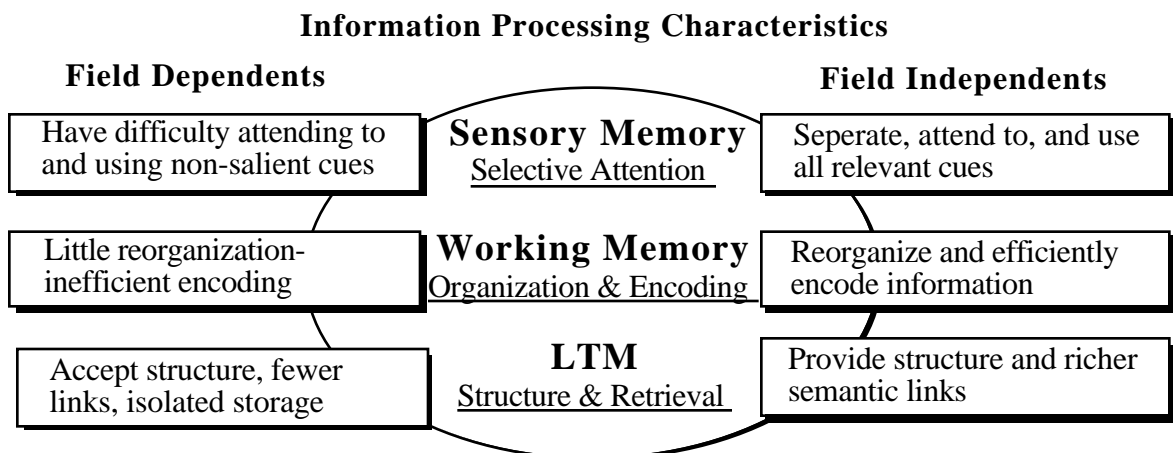
Field Dependency and Cognitive Processing

Messick (1970) has described cognitive styles as "information processing habits" (p. 190) suggesting that the cognitive characteristics of field dependency are associated with the three general stages of the information processing model of cognition and

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memory. Research indicates that field dependency is related to attentional processes in the sensory-memory stage, the encoding of information in working memory, and the organization and retrieval processes of long-term memory (Figure 5).

Witkin and Goodenough (1981) postulate that due to differences in disembedding and cognitive restructuring abilities, field independents are more likely to provide organization for ambiguous information and to restructure new information. This would result in more efficient processing in working memory as well as better storage in long-term memory. Lange (1995) theorized that when formal features of a particular stimulus elicit reflexive attention, mental resources are allocated to the sensory stage depleting the resources available for processing and storage. At high cognitive loads this would result in shallow and incomplete processing of the information with only the most salient and vivid features being encoded, exacerbating a tendency of field dependents' cognitive style. This in turn would provide only a few (and perhaps incorrect) associations to prior knowledge and inhibit the storage/retrieval process.

Figure 5   Relationship Between Cognitive Processes and Cognitive Style FDI

Information Processing Characteristics

Field Dependents		**Field Independents**
Have difficulty attending to and using non-salient cues	**Sensory Memory** Selective Attention	Seperate, attend to, and use all relevant cues
Little reorganization- inefficient encoding	**Working Memory** Organization & Encoding	Reorganize and efficiently encode information
Accept structure, fewer links, isolated storage	**LTM** Structure & Retrieval	Provide structure and richer semantic links

Goodenough's (1976) cue-salience hypothesis contends that attentional processes are different among field dependents and field independents. Several studies support Goodenough's hypothesis. Forbes and Barrett (1978) reported that in a visual detection task field dependency was positively related to task efficiency and that the differences between field dependents and field independents increased with more demanding tasks. In a study using both visual and auditory modes Avolio, Alexander, Barrett, and Sterns (1981) found that field dependents made more errors than field independents in both sensory modes. Jolly and Reardon (1985) studied the learning of automatized sequences and found that as more interruptions were introduced, field dependents focused on more irrelevant stimuli than field independents. Shinar, McDowell, Rackoff, and Rockwell (1978) employed a driving simulation to study eye movement and field dependency. Results confirmed that field dependents required more time to process the visual information and were less effective in their visual search patterns.

These studies are consistent with Goodenough's hypothesis and demonstrate a difference in selective attention according to levels of field dependency. Field dependents appear to have more difficulty selectively attending to salient cues and are less flexible in their visual search strategies. These differences become more pronounced when irrelevant cues are presented and as the demand on cognitive resources increase.

According to Lange (1995) difficulties with selective attention would result in less efficient short-term memory processes such as encoding, chunking, rehearsal, and less effective long-term memory searches, especially when cognitive load is high. Frank (1983) studied encoding on a recall task and reported that when recall cues were the same as those presented during acquisition there was no difference in field-dependent and field-independent individuals. However, when recall cues where different, field independents performed better than field dependents. Berger and Goldberger (1979) found no difference among levels of field dependency on simple digit span tasks while field independents did

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significantly better on more difficult interference tasks. Niaz and Logie (1993) found field dependents less likely to use appropriate strategies for problem solving in science lessons. They state "...when a task incorporates information that is distracting or irrelevant to successful performance, a field independent will more readily pick out the information that is relevant to the task at hand" (p. 513). These studies indicate that when a limited amount of information is presented for processing there is little difference between field dependent and field independent individuals. When larger amounts of information are to be processed however, field independents are more accurate and efficient in their performance.

While Goodenough (1976) did not find convincing evidence that field dependence was related to long-term memory and associative learning tasks, later research does indicate memory differences among field-dependent and field-independent learners in some long-term memory storage, organizational, and retrieval processes. Spiro and Tirre (1980) found that field independents were more likely to use previous information during recall than field dependents. Durso, Reardon, and Jolly (1985) reported that field independents were more proficient than field dependents at discriminating between externally and internally generated memory traces. They further suggested that the results could be due to differences in the information used for retrieval and the process of encoding information into long-term memory. Both Adejumo (1983) and Strawitz (1984) found field dependence to be related to information recall from long term-memory.

In most studies that include field dependency as an independent variable, differences in information processing between field independents and field dependents is used as a post hoc explanation for differences in experimental results. Examining field dependence/independence from an information processing framework at the outset would appear to have implications for designers of multimedia and hypermedia (Messick, 1970; Kent-Davis & Cochran, 1989; Shipman & Shipman, 1985).

Over forty years of research reveals that the construct of field dependency can be considered a cognitive style according to Green's (1985) definition. It is bi-polar, value neutral, consistent across domains, and stable over time (Goodenough, 1986; Messick, 1986; Witkin, et al., 1977; Witkin & Goodenough, 1981). From the research, one can identify several cognitive tendencies that are more or less typical of field-dependent or field-independent individuals.

Field-dependents:

- Rely on the surrounding perceptual field.
- Have difficulty attending to, extracting, and using non salient cues.
- Have difficulty providing structure to ambiguous information.
- Have difficulty restructuring new information and forging links with prior knowledge.
- Have difficulty retrieving information from long-term memory.

Conversely, field-independents:

- Perceive objects as separate from the field.
- Can disembed relevant items from non-relevant items within the field.
- Provide structure when it is not inherent in the presented information.
- Reorganize information to provide a context for prior knowledge.
- Tend to be more efficient at retrieving items from memory.

Field Dependency and Hypermedia

One of hypermedia's most promising features is the flexibility it provides for accommodating individual differences such as field dependency. Several studies suggest that individual differences influence the effectiveness of hypermedia and learner control (Chung & Reigeluth, 1992; Steinberg, 1989; Weller et al., 1994; Williams, 1993). Martin (1993) found that field dependents preferred a deductive method of sequencing,

while field independents preferred an inductive approach. More importantly, the study revealed that field dependents and field independents had diverse reasons for their selections.

Other studies that examined field dependency and various types of hypermedia structures have been inconclusive as to how the individuals differ and what type of design strategies are effective for different populations (Hsu, 1994; Lin & Davidson, 1994). Carrier, et al. (1984) hypothesized that field independents, due to their ability to restructure information, would select more options under learner control than field dependents. This hypothesis was not confirmed as field dependents were equal with field independents in the level of control exercised. Both Yoon (1994) and Martin (1993) found significant interactions between field dependency and navigation patterns, but reported contradictory results on recall and problem-solving questions. Hsu (1994) found that while field dependents monitored their instruction and used guiding questions more often than field independents, they did not perform as well on a post test.

Two recent studies examined cognitive style and media selection in educational hypermedia programs. Liu and Reed (1994) used a hypermedia program to teach English to international students in which learners could choose different presentation formats for supporting information about vocabulary words they were instructed to learn. They found that field dependents utilized the video vignettes more often than field independents, who preferred text-based presentations. It is important to note that in this study the media presentation type was determined by the type of supporting information (glossary, definition, contextual, etc.). Although the navigation and information presentation selections differed, field dependents and field independents did equally well on the post test. Similar results were reported by Frey and Simonson (1994) who used a hypermedia lesson to examine the choice of media by home economics and education undergraduates in a hypermedia lesson on historic costume. They examined nine learning styles from the

National Association of Secondary School Principals Learning Style Profile (NASP LSP) as learner variables. They found statistically significant correlations between media choice and analytical ability and spatial skill. As with the study by Lui and Reed, there were no significant interactions between cognitive styles, media choices, and performance on a post test. Although the NASP LSP is suspect in its validity (Bonham, 1988), and the program was a poor example of hypermedia's features, the results seem to indicate that individual differences do influence the selection of media in learner-controlled instruction. While research on cognitive style and presentation mode is still evolving and incomplete, hypermedia's potential to accommodate the individual difference of field dependence/independence is promising.

Summary

One of hypermedia's most captivating features is the provision of information presentations in a variety of ways including both single- and multiple-channel formats. Increasing relevant cues across channels can improve learning but can also overwhelm the cognitive processing of learners. As Grimes (1991) notes, even a mild discrepancy between channel cues can result in inferior attention and comprehension. The added demand of navigation and orientation decisions in a hypermedia environment make it even more likely that an overabundance of multi-channel information would overload the cognitive resources of the learner. Although educators and designers do not *intend* to produce ineffective media, the final verdict lies with the learner.

Cognitive overload has been cited as a major problem for hypermedia users contributing to disorientation, missed information, and other problems. Providing different structures and navigational aids, while helpful, may not address all of the issues that lead to poor performance in hypermedia programs (Weller, et al., 1994). Message complexity, stimulus features, and the additional cognitive demands inherent in an unstructured

computer mediated environment such as hypermedia, may combine to exceed the cognitive resources of the field-dependent learner more easily and quickly than the designer realizes. Allowing the learner to choose the media delivery format as either a single- or multiple-channel presentation may be one way to alleviate the cognitive overload and result in more efficient learning for both field-dependent and field-independent learners.

Research Questions

Several questions arise from the review of the literature concerning hypermedia and field dependency. One question of specific interest for this study is, what type of relationships exist between field dependency and the provision of learner control over presentation mode in hypermedia environments? This study seeks to answer four sub-questions concerning the relationship between learner control of selecting single- or multiple-channel messages and cognitive style field dependence/independence in a hypermedia environment:

1) Is there a relationship between the cognitive style FDI and frequency of selection of single-channel messages in a hypermedia lesson?

2) Is there an interaction between the cognitive style FDI and learner control of presentation mode in a hypermedia environment?

3) Does learner control over presentation mode lead to better performance on tests of recall and problem-solving in a hypermedia environment?

4) Do field dependents perform better on tests of recall and problem-solving in a hypermedia environment when they are able to select single-channel or multiple-channel messages?

Hypotheses

        The author hypothesized that an experimental research study examining the research questions stated above, would produce the following results:

1) Field dependence-independence will be correlated to the frequency of selection of multiple-channel messages, with field dependents choosing single-channel presentations more often than field independents.

2) There will be a significant difference between experimental groups (control, treatment) using the total mean scores (five recall scores and five problem-solving scores) as the dependent measure, with the treatment group scoring higher.

3) There will be a significant disordinal interaction between experimental groups (control, treatment) as a function of field dependency using the total mean scores (recall and problem-solving) as the dependent measure, with field dependents in the treatment group scoring higher than field dependents in the control group.

Secondary Hypothesis

4) There will be a significant disordinal interaction using the mean scores of the five problem-solving questions and the five recall questions in separate analyses as the dependent variable and the level of field dependency and experimental groups (control, treatment) as independent variables, with field dependents in the treatment group scoring significantly higher than those in the control group.

This study examined the relationship between the cognitive style FDI and learner control of presentation mode in a hypermedia environment. Recall and problem-solving test performance of participants were measured, as was the percentage of multiple-channel messages selected by individuals in the learner control treatment group. In both cases, levels of field dependency were also assessed and measured to ascertain their interaction with the option of learner control or program control over the mode of presentation (single- or multiple-channel).

Chapter III

Methodology

Introduction

This study examined the relationship between cognitive style and the provision of learner control of presentation mode in an educational hypermedia environment. The researcher included high school students as participants because of the paucity of this population's representation in the hypermedia research literature and also because of the number of hypermedia products that are aimed at high school populations. "The '88 Vote" was chosen as the source hypermedia program. "The '88 Vote", published by ABC News Interactive, is used by many educational institutions and is easily available to other researchers.

Reeves (1992) contends that an optimal scenario for answering experimental research questions would be to conduct an experiment in an environment and context that is meaningful and relevant to the sample population. Reeves also questions the lack of orientation and training for participants involved in studies that examine complex issues, such as learner control and non-linear computer environments. He points out that the participants' lack of knowledge and understanding of the technological medium that delivers the instruction presents a confounding variable that is rarely addressed. In this study the sample groups were drawn from courses whose content was explicitly related to the material in "The '88 Vote". As a part of the experimental sequence, participants were instructed on the features and functions of the technology involved in the study.

Participants

The sample for this study was drawn from three high schools. The high schools, located in southwest Virginia, northwest North Carolina and southeast West Virginia, each had an enrollment of approximately 1,000 students. School district superintendents of each

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school system approved the request to conduct the study in their school system and forwarded the request to the individual school principals. The high school principals approved the request and allowed the researcher to contact high school faculty who taught civics, social-studies, or government courses that included the United States political system in their curricula. Classroom teachers announced the request for research participants to their classes and posted a sign up sheet for volunteers to enroll in the study. Informed consent forms were given to each participant for parental or legal guardian approval. Arrangements were also made with the schools computer lab directors for the use of the computer labs for the experimental sessions. Sixteen subjects were not included in the statistical analysis due to malfunctioning technology or unusable student input .

Materials and Apparatus

Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) was administered in order to assess each participants' level of field dependency. The GEFT requires one to locate simple geometric figures embedded in more complex designs within specified time limits (Figure 3.2). The estimate of reliability of the GEFT is .82 (Witkin, Oltman, Raskin, & Karp, 1971). Participants who scored one-half of a standard deviation above the mean on the GEFT were classified as field independent. Those who scored one-half of a standard deviation below the mean were classified as field dependent. Individuals who scored within one-half of a standard deviation of the mean were considered field neutral for this experiment.

Criterion Measures

In order to assess the information learned by the participants the researcher designed a ten-item post test based on the curriculum guide provided by ABC News Interactive. Five of the questions concerned recall of factual data. Five problem-solving questions measured how well participants applied factual information to novel situations and utilized that information to arrive at satisfactory solutions to a defined problem goal. These questions consisted of determining the impact of primaries on the convention and how the structure of primaries affected the various campaigns (see Appendix A). The program also contained a survey to gather demographic information (see Appendix B).

"The '88 Vote"

The hypermedia program used in this study, "The '88 Vote", is published by ABC News Interactive and addresses various aspects of presidential elections using the 1988 presidential election as a backdrop for the concepts involved. The program consists of a HyperCard™ computer program which contains text and graphics and controls a videodisc which contains the multimedia resources for the program. The multimedia examples consist of motion video with sound, static visuals with text, and static visuals with sound. The parts of the program concerning the Democratic party primary, Democratic primary candidates, and the Democratic party convention were selected for use in this study.

"The 88 'Vote" was designed by ABC News Interactive and produced jointly by ABC News Interactive and Sunriver Associates. The product was evaluated and tested with high school students, college students, and educators. It has been well received and is in use at many high schools, colleges, and universities world wide (S. Cheiten, personal communication, December, 1996). "The '88 Vote" has also been utilized in several research studies over the past several years (e.g., Harmon, 1993; Small & Grabowski,

1992). Permission to use "The '88 Vote" for this study was received by the researcher

from ABC News Interactive (T. Chaffardet, personal communication, December, 1996).

In order to provide two versions of the hypermedia program necessary for this

study, "The '88 Vote" was re-configured to contain all the necessary multimedia resources

from the videodisc as a part of the HyperCard™ stack. The program control version of

"The '88 Vote" contained the original multimedia presentations from the videodisc and the

multiple-channel presentations originally contained in the HyperCard™ stack. The

multimedia presentations in the learner control version were broken down into separate

single-channel messages and stored along with the multiple-channel messages. In the

treatment version of "The '88 Vote" the user was able to select a single- or multiple-channel

message presentation whenever he or she clicked on a topic button. Samples of the

treatment and control versions are illustrated in Appendix C.

Procedures

Participants volunteered for the study and received no compensation for

participation. The experimental sequence consisted of two consecutive sessions conducted

three to five times at each site. During the first session The GEFT was administered and a

training session was provided to the participants on utilizing the features in the hypermedia

program . During the second session, participants interacted with the treatment or control

versions of "The '88 Vote" for 40 minutes.

Participants at each site reported to a computer lab where the computers had been

set up for the study. The computer laboratory at each school site provided the experimental

setting. In order to avoid possible threats to validity by variables such as ability, previous

knowledge, and novelty effect, participants were randomly assigned to either the control

group (program control of presentation mode) or the treatment group (learner control of

presentation mode). As they entered the room, participants drew random numbers out of

an envelope which they used as their identification for both the Group Embedded Figures Test (GEFT) and the hypermedia lesson. The participants then took their seats at one of six computer stations with that corresponding number, which was taped to the top of the computer. Three of the computers delivered the treatment version of "The '88 Vote" while the other three presented the control version of the hypermedia program.

Participants were given a brief explanation of the purpose of the experiment. They were told that the experiment was to determine if certain features in an educational computer program would be beneficial to different types of learners. The administrator explained that the GEFT was a measure of cognitive style, commonly called learning style, and *not* an assessment of their IQ or previous knowledge in any subject matter. Participants were told that they would be asked questions at the end of the hypermedia program about the program content (see Appendix D). Each participant was given an informed consent form ahead of time (which was read aloud by the administrator) to sign before beginning the study (see Appendix E).

Participants were given sharpened pencils and test booklets and received instructions on taking the GEFT as outlined in the GEFT manual. Extra time was allotted for questions and explanations after each of the two practice items and at the end of the first section of the test (which is not used in scoring the GEFT). Administering the GEFT took approximately 19 minutes.

The first session included a training and orientation on using the features of the hypermedia programs. This orientation period immediately followed the administration of the GEFT. The orientation session utilized information and multimedia resources from the help section of "The '88 Vote" and a hypercard stack designed by the author to explain the features and the purpose of the hypermedia program. The orientation session was designed to ensure that all students were familiar and comfortable with the features and uses of the hypermedia program. The training stack provided a "guided tour" of the program that

explained the navigation and topic buttons, how to type in answers, and the feature that let them select the type of presentation mode. Participants at the computers that delivered the control version did not have the control of presentation mode feature in the training stack.

After eight minutes, participants were asked if they had any questions concerning the features, operation, or purpose of the program. When all questions were answered the first session was completed. The orientation session lasted approximately ten minutes. A five-minute break followed the first session, where participants were free to get water, visit the rest room, and ask any further questions about using the program.

Control and treatment versions of "The '88 Vote" were used for data collection during the second session. The participants were requested to complete as much of the program as possible and to navigate through the program in any way they wished. They were instructed to respond to all questions and to type "I don't know" if they did not know the answer to a particular question. Using a stopwatch for time keeping, the researcher instructed the participants to begin the program. Participants were allowed to interact with "The '88 Vote" for 35 minutes. After 35 minutes, participants who had not began the test section were asked to click the test button on the screen and complete each of the questions. After they had answered the last question, they were instructed to click on the "Quit" button which stored the data to a text file and database. The participants returned to their classes after the second experimental session was concluded. The entire time of the two experimental sessions lasted 90 minutes.

Media selections and responses to post test and survey questions were collected via a background script in the HyperCard™ stack of both versions of "The '88 Vote" and written to a text file with the corresponding ID number for that participant. Data from the text files were copied into separate files for scoring by two judges. Two educational research graduate students were recruited as judges and received instructions from the researcher on the nature of the questions and the words and phrases that were considered

correct for each post test item. Each judge was provided with a checklist of correct answers (see Appendix A) and scored all test responses. The resulting post test scores were subjected to a statistical analysis to determine inter-judge agreement. Inter-judge agreement for the questions was .95 for the recall questions and .93 for the problem-solving questions. The scores for each participant and other quantitative data collected by the HyperCard™ script were entered by hand into a statistical package to perform analyses.

The treatment and control versions of "The '88 Vote" were delivered on Macintosh computers at each experimental site. The types of computers used for this study were Macintosh 660AV, PowerPC 7200, Color Macintosh II, and Performa 575 models. Each computer was equipped with a set of headphones used for personal monitoring of the sound and video with sound presentations.

Pilot Study

A pilot study of this experiment was carried out in February of 1996. The pilot study used the same treatment and control versions of "The '88 Vote" as described in this study. The participants in the pilot study were 24 high school juniors and seniors from a rural high school in North Carolina. During the pilot study a classroom teacher acted as an observer to assist the researcher in identifying problems with the design and procedures of the experiment. Participants were randomly assigned to either the control or treatment versions of the hypermedia program by selecting numbers from an envelope. These numbers were also used to identify the participants for both the Group Embedded Figures Test and their interaction with the hypermedia program.

Several adjustments were made to the study based upon feedback from the observer and interviews with twelve of the participants. It was decided that one experimental session did not allow sufficient time for the completion of the GEFT, the training segment,

and the full use of the hypermedia program. Accordingly, the experiment was changed to include two consecutive sessions of 45 minutes each.

Another problem that was identified concerned the instructions for the GEFT. It was determined that additional time for reviewing instructions should be added after each of the two practice examples and after the first section of the GEFT (which is not used for scoring). Technological "bugs" were also identified which included slow access time for large graphic and video files, a failure of some programs to capture and write audit trails, and failure to log answers to some of the test and survey questions. The graphic and video files in question were digitized again with more compression to reduce file size. While fidelity was reduced somewhat, it was the researcher's opinion that this process did not affect the results of the study in any way. It was determined that some of the bugs were incompatibility conflicts related to other software programs housed on the computers and to a corrupt version of one of the treatment versions. These technological matters were corrected and tested before beginning the current study.

The test results (n = 18) from the pilot study were analyzed for their reliability. This was done by utilizing two judges trained by the researcher who used a list of key words and phrases that could be considered as correct answers (see Appendix A). For the pilot study, the inter-judge reliability coefficient on the recall questions was .90 and .87 on the problem-solving questions. After revising two of the recall questions and three of the problem-solving questions, inter-judge agreement for the current study was improved to .95 and .93 respectively.

Method of Analysis

A correlation of GEFT scores and the percentage of multiple-channel messages selected by the participants in the treatment group was performed to test the first hypothesis. A 3 X 2 factorial Analysis of Variance (ANOVA) statistical analysis for main

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effects and interactions to test hypotheses two and three. Field dependency and experimental group (learner control or program control of presentation mode) were the independent measures. The dependent measure was the mean combined score on the recall and problem-solving test items.

The five recall questions and five problem-solving questions were analyzed separately for the secondary analyses via a 3 X 2 factorial ANOVA to test for main effects and interactions. The dependent measure was the mean scores of the recall items and the mean scores of the problem solving questions. Independent measures were level of field dependency and experimental group. The level of significance for all analyses was set at .05.

CHAPTER IV

Results

Introduction

The research experiment which provided the data for this study was conducted at three rural high schools in the Southeastern United States. The high schools, located in southwest Virginia, northwest North Carolina and southeast West Virginia, each had an enrollment of approximately 1,000 students. Experimental sessions were conducted once at one school and twice at two of the schools in the spring of 1996. The following sections show the results of the statistical analyses and the research hypotheses.

Description of Participants

A total of 136 juniors and seniors from three rural high schools volunteered to participate in the study. The sample consisted of 63 males and 59 females with an average age of 17 years. Data from fourteen participants was discarded and not used in analysis due to unusable participant responses, with a resulting n of 122.

Group Embedded Figures Test Scores

The mean GEFT score was 10, with a standard deviation of 4.7. Scores ranged from 1 to 18 and the median score was 10.5. In this study 41 participants were identified as field dependent, 40 were identified as field neutral, and 41 were identified as field independent. Table 1 presents the mean GEFT scores of the participants.

Table 1   **Means Table for Group Embedded Figures Test Scores**

	n	Mean	SD	SE
Field Dependent	41	4.44	1.84	.29
Field Neutral	40	10.60	1.72	.27
Field Independent	41	15.23	1.67	.26
Total	122	10.05	4.757	.43

Primary Analysis

Hypothesis One

Level of field dependency will be correlated to selection of presentation mode, with field dependents choosing single-channel presentations more often than field independents.

The first hypothesis was rejected as the correlation between the percentage of multimedia choices of the participants in the treatment group and GEFT scores, $r = -.297$, was not statistically significant. The participants in the treatment group identified as field dependent did not significantly choose single-channel presentations more often than multiple channel presentations. The means table in Appendix F presents the complete descriptive statistics concerning the percentages of multimedia choices selected by the participants in the treatment group (learner control of presentation mode).

Hypothesis Two

There will be a significant difference between experimental groups (control, treatment) using the total mean scores (five recall scores and five problem-solving scores) as the dependent measure, with the treatment group scoring higher.

Total scores from the five recall questions and the five problem-solving questions were subjected to an analysis of variance. For the main effect of treatment group versus control group the resulting F statistic was not significant between the two groups with $F (1, 122) = .997$ $p > .05$. Table 2 shows the count, mean, standard deviation, and standard error of responses to the ten test questions as a function of field dependency level and experimental group.

Table 2   Mean Total Score as a Function of Group and Field Dependency

FDI, Group	n	Mean	SD	SE
FD, Treatment	18	6.05	2.18	.51
FN, Treatment	23	6.09	2.04	.43
FI, Treatment	24	6.37	1.61	.33
FD, Control	16	5.87	2.60	.65
FN, Control	19	7.56	2.77	.64
FI, Control	22	6.77	2.22	.47
Total	122	6.46	2.25	.20

The second hypothesis was rejected at the .05 level. There was no significant difference in total mean scores between experimental groups. Total mean scores in the treatment group were not significantly higher than those in the control group. The ANOVA table for total test scores in Appendix G illustrates the total test score as a function of field dependency experimental group (control, treatment).

Hypothesis Three

There will be a significant disordinal interaction using the total mean scores (five recall questions and five problem-solving questions) as the dependent variable and the level of field dependency and experimental group (control, treatment) as independent variables, with field dependents in the treatment group scoring significantly higher than those in the control group.

The total mean scores (five recall questions and five recall questions) were analyzed using a three way ANOVA to examine main effects and interactions. The result of the interaction of field dependency and experimental group on total mean scores was $F (2, 122) = .327$ $p > .05$. Hypothesis three was rejected at the .05 level. No significant disordinal interaction was discovered. The difference in mean scores on the ten test items between field dependents in the treatment group and field dependents in the control was not statistically significant.

Table 2 shows the count, mean, standard deviation, and standard error of responses to the ten test questions as a function of field dependency level and group. The ANOVA table for total test scores in Appendix G illustrates the mean total test score as a function of field dependency and experimental group (control, treatment).

Secondary Analysis

Recall and problem-solving scores were analyzed separately via a 3-way ANOVA for main effects and interactions. For the five recall scores the statistical result $F_{(2, 122)} = 1.630$ $p > .05$ revealed no significant interactions or differences among treatment groups. Table 3 shows the count, mean, standard deviation, and standard error of responses to the five recall questions as a function of field dependency level and group. The ANOVA table in Appendix H illustrates the mean scores as a function of field dependency, and treatment (learner control of presentation mode) or control (program control of presentation mode) group.

Table 3   Mean Recall Scores as a Function of Group and Field Dependency

FDI, Group	n	M	SD	SE
FD, Treatment	18	4.22	.88	.21
FD, Control	23	4.17	.89	.18
FN, Treatment	24	4.45	.72	.15
FN, Control	16	3.62	1.41	.35
FI, Treatment	19	4.21	1.42	.33
FI, Control	22	4.09	1.02	.22
Total	122	4.16	1.07	.10

Analysis of the five problem-solving scores revealed no significant interactions and no significant difference in mean problem-solving scores between experimental groups with $F_{(2, 122)} = 1.088$ $p > .05$. The only significant effect that was demonstrated in the

study was the effect of field dependency on mean problem-solving scores with $F_{(2, 122)}$ = 6.276 $p < .05$. Mean problem-solving scores of the participants identified as field independent were significantly higher than field dependent participants. Table 4 shows the count, mean, standard deviation, and standard error of responses to the five problem-solving questions as a function of field dependency level and group. The ANOVA table in Appendix I for problem-solving scores illustrates the mean scores as a function of field dependency experimental group (control, treatment).

Table 4 **Mean Problem-Solving Scores as a Function of Group and Field Dependency**

FDI, Group	n	M	SD	SE
FD, Treatment	18	1.83	1.42	.34
FD, Control	23	1.91	1.50	.31
FN, Treatment	24	1.92	1.50	.31
FN, Control	16	2.25	1.57	.39
FI, Treatment	19	3.32	1.42	.32
FI, Control	22	2.68	1.67	.36
Total	122	2.30	1.58	.14

CHAPTER V

Discussion

Introduction

Hypermedia features such as multimedia presentation, learner control, and associative information structure are intuitively appealing to educators. Indeed, hypermedia technology has been embraced by educators and technologists with an enthusiasm that rivals the introduction of the personal computer. Developers have rushed to market educational hypermedia programs, with new products appearing everyday. However, the small body of empirical research on the educational benefits of hypermedia does not warrant such uncritical acceptance. Many researchers have lamented the fact that hypermedia research has not kept pace with the development of educational hypermedia systems (Harmon, 1992; Heller, 1990; Jonassen & Grabinger, 1990; Tsai, 1988).

The provision of information in a variety of presentation formats is touted as a benefit of hypermedia. Multiple-channel presentations are often used to present information in hypermedia environments. Based on the research of multiple-channel communication it is clear that multimedia presentations with a high degree of relevant cross-channel cues improve comprehension and recall (Dwyer, 1976; Mayer & Anderson, 1991; Paivio, 1971). It is also evident that the capacity to process multi-channel messages varies among individuals and that even mildly dissonant cues can negatively affect the learning process (Dwyer, 1987; Grimes, 1990, 1991; Hsia, 1971; Lange, 1995).

Advocates of hypermedia contend that it can accommodate individual differences by allowing learners to access and organize information according to their cognitive needs (Park, 1991). The cognitive style field dependence/independence is manifested by individuals' perceptual and cognitive restructuring differences. Field dependents typically attend to only the most salient cues, accept the structure of information presentations, and

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have difficulty in imposing their own organization to unstructured information. Research on field dependency indicates that multiple-channel messages that direct attention to important cues are helpful for field dependents, while distracting and unrelated cues introduce interference and place added demands on the limited pool of cognitive resources.

The high degree of learner control inherent in hypermedia has also been shown to increase the cognitive load of learners (Harmon, 1992; Jonassen, 1991; Marchionini, 1988). The demands of navigation, orientation, and searching often result in cognitive overload and the feeling of being "lost in hyperspace". Due to the disorientation often reported by users of hypermedia, many researchers have called for studies that examine ways to lessen the cognitive demand inherent in such open-ended environments (Hannifin, Hall, Land, & Hill, 1994; Jonassen, 1990; Park, 1991). Park (1991) urged researchers to explore strategies for "dynamically selecting information representation forms during the ongoing process of instruction" (p. 29). In this study it was hypothesized that learners interacting with educational hypermedia would benefit by having the option to select single-channel presentations. Field dependents in particular would be able to reduce the cognitive demands of processing multiple-channel messages, allowing them to focus on learning tasks and other decision making processes.

This study examined learning outcomes of participants who interacted with one of two versions of the hypermedia program "The '88 Vote". In the control version, only the original multimedia presentations were available. In the treatment version learners were provided with the option of selecting multimedia presentations or a single-channel version of the same information. This study also investigated the relationship between learner control of presentation mode and the cognitive style field dependence/independence. It was expected that field dependency and learner control of presentation mode would interact to produce differences in recall and problem-solving scores and there would be a strong relationship between field dependence level and the selection of presentation mode options.

Conclusions

In the first hypothesis it was assumed that as GEFT scores rose, so too would the frequency of multiple-channel selections (i.e., field independents would select more multiple-channel messages than field dependents). This study reveals no relationship between GEFT scores and the frequency of selecting multiple-channel or single-channel presentations. When further analyzed by omitting the field neutral participants, the correlation is even less apparent (r = -.08).

The absence of a correlation between field dependency and the selection of media presentation options contradicts the findings of Lui and Reed (1994) who utilized a hypermedia program to teach English as a second language. In their experiment, field dependency was highly correlated with the type of media learners selected for vocabulary instruction. In their study field dependents chose more video information while field independents tended to select the option of text-based presentations. However, the media type (text, video) was a part of the classification of information requested. Information based on contextual settings was presented through video clips while vocabulary examples that were relational in nature were presented as text.

A similar study conducted by Frey and Simonson (1993) found significant correlations between learning styles and media selection in an educational hypermedia program on historic costume. In their study, analytical skill correlated highly with the selection of text-based information, and the selection of audio presentation mode was negatively correlated with both analytic and spatial skills. These findings are somewhat suspect due to the visual nature of the instructional material (historic costume). Frey and Simonson admit that the nature of the material may have biased learners towards visual presentations.

The second hypothesis predicted that participants who had control of presentation mode would score higher on a post test of recall and problem-solving questions. This

hypothesis was rejected as there was no significant difference in the total mean scores between participants using the learner control version and those who interacted with the program control version of the hypermedia program.   Many researchers (Basil, 1992; Dwyer, 1978; Grimes, 1990) have pointed out that the relationship between cross-channel cues determine the effectiveness of multiple-channel messages. Perhaps the multimedia presentations used in "The '88 Vote" possess a high degree of relevancy across channels and did not unnecessarily tax the cognitive resources of the participants. According to cue-summation theory and the tenants of the Dual-Code theory, such well designed messages should increase comprehension.

The author questions this assumption however, as most of the multimedia presentations used for "The '88 Vote" were ABC News video clips with descriptive audio narration over the live sound. Memory and comprehension for television news programs has proven to be consistently low, as visual and verbal cues rarely contain a high degree of agreement (Brosius, 1993; Grimes, 1991; Reeves & Thorson, 1986). Television news research, coupled with the lack of correlation between GEFT scores and frequency of multimedia selections, suggests that the variable of learner control was an important factor in the results of the study.

Although many studies can be found that support learner controlled instruction, the majority of learner control research reports no significant benefit for learners with a high degree of control over their instruction. According to Merrill (1984) and Clark (1983) many learners do not possess the metacognitive skills necessary to monitor and adjust their learning when given control over instruction. In his review of Aptitude-Treatment-Interaction studies, Clark (1982) contends that learners often select instructional options they prefer but which are not the most appropriate. Snow (1980) suggests that ability is often a confounding variable that influences success in learner controlled instruction. In her meta-analysis of learner control studies, Parsons (1993) determined that a myriad of

methodological, learner, and instructional variables have led to the largely non-significant findings from learner control studies. The results of the current study reflect Parsons conclusion that "achievement under learner control was practically equivalent to program control" (p. 162).

In hypothesis number three it was expected that field dependents, due to perceptual and cognitive restructuring characteristics, would benefit from having a choice of single- or multiple-channel message presentation modes. The expected scenario did not take place, as there were no significant interactions and no significant differences in mean test scores among field dependents in the experimental groups. Separate analyses of the five recall and five problem-solving test scores also revealed no significant differences in mean scores or interactions between field dependency levels and experimental group.

The results of the current study are similar to those of Kini (1994) who utilized a multimedia program on concept attainment. Kini reports no significant differences on a recall test between treatment groups presented with text only, static visuals with text, and animations with text, as a function of field dependency. As in the Kini study, the current experiment failed to show any significant interaction between field dependency and presentation mode as measured by a post test.

Two recent studies offer conflicting views on the benefits of various media presentations to field dependents. Although these studies did not provide the learner with control of the presentation mode, they did find significant differences in post test scores between field dependents and field independents who were randomly assigned to various media treatments. Wey and Waugh (1993) report that field independents scored higher than field dependents using text only presentations while multiple-channel presentations were equally effective for both groups. They concluded that a combination of visuals and verbals helped field dependents isolate and extract important cues in the field. Packard (1996) reports that field dependents scored higher on immediate and delayed recall tests

when instruction was presented as text only. The field independent participants scored higher when presented with animation. It would seem that the field dependents in Packard's study learned best from a single-channel (text) presentation mode. The results of the current study reflect the inconsistent findings of the few studies attempting to examine the relationship between field dependency, presentation modes, and hypermedia and multimedia instructional environments.

Other Findings

Although it was not an initial component of the current study, the effect of field dependence level as a function of problem-solving test score proved to be significant. An analysis of the data ($F (2, 122) = 6.276$, $p < .05$) indicated that field independents scored significantly higher on the five problem-solving questions than the field dependent participants in both experimental groups (Appendix H). This outcome is consistent with the research on the cognitive style field dependence/independence, which shows that field independents are more successful at learning tasks that involve higher order skills (e.g. restructuring information) for successful completion (Messick, 1976; Witkin & Goodenough, 1981).

Research has shown that field dependents and field independents perform equally on simple learning tasks . As learning tasks become more difficult, however, field independents are more successful than field dependent learners (Kent-Davis & Cochran, 1989; Niaz & Logie, 1993; Witkin, et al, 1976). The current study supports this premise, finding no significant difference between field dependent and field independent learners on the questions of simple recall in the current study. However, on the more difficult problem-solving questions field dependents scored significantly lower than field independents.

Summary

This experiment revealed no causal relationship between field dependency and the provision of control over presentation mode in hypermedia environments, nor a predictive relationship between field dependency and selection of presentation mode. Fortunately, there does not appear to be a significant detriment in allowing learners, including field dependents, to choose single- or multiple-channel messages. Field dependents in the treatment and control groups performed equally on tests of recall and problem-solving. However "no harm" is not a compelling reason to recommend this option be implemented by designers of multimedia and hypermedia. It would appear that learner control of presentation mode does not offer any significant benefit to users of hypermedia, nor does it accommodate the perceptive and cognitive differences associated with the cognitive style field dependence/independence.

Suggestions for Future Research

Consistent with previous research on learner controlled and hypermedia instruction this study found no significant differences in post test achievement between learners with control of instructional presentations and those without such control. There is insufficient evidence to compel further examination of the superiority of program or learner control of instructional elements within educational hypermedia environments. The considerable body of learner control literature, as well as the emerging hypermedia research indicates that there is not a significant advantadge for either format.

Likewise, the variable of controlling presentation mode in hypermedia does not appear to offer answers to the problems of cognitive overload and differences in achievement related to field dependency. A study by Leider and Klein (1996) sought to lessen the cognitive load of field dependents in hypermedia environments by utilizing different search tools. They found no significant advantadge for field dependents in any of

the four treatments. It would appear that field dependents using educational hypermedia encounter the same difficulties noted in other learner control research studies. Specifically, unstructured learning environments present a dilema for field dependents who tend to perform better within organized instructional settings.

Future studies need not be confined to strict quantitative methods of inquiry. In this study, learners with control over media presentation fared no better or worse in a post test than those who interacted with the program control version of the hypermedia program. Nor did learners with different levels of field dependency exhibit tendencies to suggest that cognitive style may be a factor in their selections of presentation mode. What this study did not address are the various decisions made by participants as they interacted with the hypermedia program and why they were made. What cognitive processes led to their decisions? What metacognitive strategies were employed? What affective and motivational factors were involved in the decision making process?

A recent study by Young (1996) examined the use of self regulated learning strategies (SRLS) reported by learners and their performance in CBI instructional treatments. Young found no difference between learner control or program control groups on a post test. Young also reports no interaction between SRLS level and time on task or amount of instruction selected. The learner control treatment was more beneficial only to the learners in the high SRLS group, that is, those who were most able (or willing) to employ appropriate strategies in determining their learning needs and monitor their learning progress.

This author contends that more research is needed that examines the moment-by-moment actions of individuals within hypermedia environments. That is, asking "why " as well as "what". Examining the cognitive, metacognitive, and affective variables that influence how learners interact in hypermedia environments may be more illuminating than post test measures of how much they learned.

Recent studies employing qualitative methods have begun to shed some light on the ways that different groups of learners interact with educational hypermedia programs. Reckor and Pirrelli (1992) have examined information seeking strategies and the importance of prior knowledge. Harmon (1993) and Harmon and Dinsmore (1995) have begun to identify the linking patterns of novices and experts. Research that examines the *process* of learning as well as learning outcomes in hypermedia environments appears to hold promise for the elusive individualized instruction that has beguiled educators for so long.

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Appendix A

Post Text Questions Presented in "The '88 Vote"

Recall Questions

1- How many candidates ran for the Democratic presidential nomination in 1988?

2- Why are the "Super Tuesday" primaries so important to the nomination process?

3- When does the campaign season begin?

4- What is the central difference between a primary and a caucus?

5- What are the central duties of the party delegates at the party convention?

Problem-Solving Questions

1- Party conventions often feature defeated candidates in addition to the party's nominee (for instance Jesse Jackson at the democratic convention in 1988) as speakers. What factors influence the selection of the former candidates to address the convention?

2- Suppose each state had the same number of delegate votes. How would the campaign for the presidential nomination be different?

3- What methods do candidates use to get their message and positions out to the voters?

4- Under what circumstances might the candidate with most popular votes *not* be nominated as the party's presidential candidate?

5- Why is it important for candidates to win or do well in the early primary contests (such as New Hampshire)?

Scoring

Two judges, instructed by the researcher, scored the test items in the study. Participants were given one point for each correct answer on each question. In scoring the items, judges referred to a checklist of keywords for correct responses for the recall questions and correct associations and analyses for the problem-solving questions.

The checklists for correct answers to the recall and problem-solving questions are presented below:

Recall Questions

1- Seven

2- Because of the large numbers of delegates won on one day in the heavily populated Southern states. Key terms are population, delegates, and southern states

3- When the candidates(s) announce their intention to run, or seek the nomination. Key terms are announce(ment) and nomination.

4- Primaries are determined by popular vote, while caucuses are determined by party member delegates (also activists or workers). Key terms are popular vote versus activists, delegates, or workers.

5- To cast votes for the candidate they are pledged to or, for their state's choice of candidate(s). Key terms are vote, candidate, and pledge or state.

Problem-Solving Questions

6- The defeated candidate was popular and or influential in some way (such as delegates won, or national prominence).

7- Candidates could not place an emphasis on any particular state or region, or that all states would be equally important.

8- Debates, advertising (print or electronic), public appearances, and "grass roots" campaigning (or face to face meetings with voters).

9-   A candidate could win the most delegates from heavily populated states, while not gaining a majority of the popular votes was an acceptable response. An alternative answer is that a candidate with fewer delegates could "gain support" or delegates pledged to other candidates at the convention.

10-   As candidates gain victories and/or delegates they receive more media attention and/or campaign money from donors.

Treatment group identity, field dependency scores, gender, and age of the participants were unknown to the two judges at the time of scoring. Inter-judge agreement on the five recall questions was .95 (forced agreement on 5%) and .93 (forced agreement on 7%) for the five problem solving questions. Reliability for the test questions in the hypermedia program were assessed through a pilot study and from information provided by the instructional designers of the "The '88 Vote".

APPENDIX B

Demographic Survey

Demographic Survey

1-   How old are you?

2-   Are you male or female?

3-   About how many times per week do you use a computer?

        0-4   5-9   10-14   15 or more

4-   About how many times per week do you play video/computer games?

        0-4   5-9   10-14   15 or more

APPENDIX C

Examples of "The '88 Vote"

The hypercard stack that controls the hypermedia program "The '88 Vote" was manipulated through the scripting language "Hypertalk" in order to carry out this experimental study. The background script kept track of actions such as mouse clicks, media selections, time spent on individual cards, and other interactions without interfering with the operation of "The '88 Vote". Both the treatment and control versions of "The '88 Vote" were modified in this way.

In the treatment version of "The '88 Vote" the media resources were presented as either multiple-channel single-channel messages. The user selected presentation mode via a "pop up" menu button. If the original presentation was video with audio, the choices would be "Video" (original multimedia presentation), "Audio" (audio only), or "Text" (text only). If the original presentation was a static visual with text, the participants could choose "Picture" (visual only), "Text" (text only), or "Graphic" (original multiple-channel message). As with the control version of "the '88 Vote", clicking one of these choices took the user to a new card that presented the information.

In both the control and treatment versions of "The '88 Vote", presentation screens contained navigational buttons and a "Repeat" button for replaying temporal messages such as audio or video. The program's interface was kept essentially the same as the original HyperCard™ stack. Certain buttons related to topics that were not used (such as the Republican primary, convention, etc.) were deleted. Other features that were not related to this experiment included the "Documentary Maker", the note taking function, and the video disc remote control function.

The '88 Uote copy1

Please type in your ID number in the space below, then click on the "Continue" button at the bottom of the screen.

Remember your answers are confidential and you cannot be identified.

Thanks!

What is your ID number?
(Click in the blank field to type)

Click Here To Continue

DEMOCRATIC CANDIDATES

Bruce Babbitt

Michael Dukakis

Richard Gephardt

Albert Gore

Jesse Jackson

Paul Simon

Gary Hart

Peter Jennings on the Democratic Candidates

ABC News

Topic Menu

Atlanta

Test?

The '88 Uote copy1

DEMOCRATIC CANDIDATES

Bruce Babbitt

Michael Dukakis

Richard Gephardt

Albert Gore

Jesse Jackson

Audio
Video
Text

Paul Simon

Gary Hart

Peter Jennings on the
ABC News
Democratic
Candidates

Topic Menu

Atlanta

Test?

?

91

The '88 Uote copy1

Michael Dukakis

Repeat Movie

The '88 Uote copy1

Repeat Audio

Back to card

The '88 Vote copy1

Delegates and Electoral Votes

ALABAMA

Montgomery

The Vote

REPUBLICAN DELEGATES	38
DEMOCRATIC DELEGATES	65
ELECTORAL VOTES	9

Step Backward

Step Forward

Use the "STEP FORWARD" and "STEP BACKWARD" buttons to step through the following series of U.S. states to find out how many convention delegates and electoral votes each one has. States are listed alphabetically.

The '88 Vote copy1

PRIMARY & CAUCUS STATES

Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
D. C.
Florida

Click Here for
Super Tuesday
States! ◄

The '88 Vote copy1

Scroll through the following series of U.S. states to find out how many convention delegates and electoral votes each one has. States are listed alphabetically.

Alabama

Republican Delagates 65
Democratic Delagates 65
Electoral Votes 9

APPENDIX D

Script for Informing Participants of the Nature of the Study

Script

Thank you for participating in this study. This study seeks to determine if certain features in an educational computer program is beneficial to certain types of learners. In order to determine this, you will be asked to take a pencil and paper test, use a computer program, and answer questions about the program and yourself. Remember, your answers are anonymous and you cannot be identified.

The first test is an assessment of cognitive style, commonly called learning style, and not an assessment of IQ, previous knowledge, or what you have learned in class. The questions in the computer program are related to the content of the program. It concerns the 1988 Democratic presidential campaign. You will be asked about the campaigns, the purpose and structure of the primaries and caucuses, and the party convention. You will also be asked for some demographic information about yourself.

APPENDIX E

Informed Consent for Study Participants

Consent Form

Title of Research Project: Interaction of Cognitive Style and Learner Control of Presentation Mode in a Hypermedia Environment

Researcher(s): Lee Daniels

Purpose of Research

The purpose of this research study is to determine if allowing learners to control the presentation of information in a hypermedia computer lesson will benefit them in recall and problem-solving tasks. The study also seeks to determine if this type of control is of particular benefit to learners who possess a certain cognitive style. Additionally, the study asks if there is a relationship between cognitive styles and presentation mode selections.

Procedures

Participants in the study will be asked to complete the Group Embedded Figures Test (GEFT) to determine the participant's cognitive style. It is expected that administration of the GEFT will last twenty minutes.

Participants in the research study will be asked to view and interact with an educational hypermedia program produced by ABC News Interactive, on the presidential primary system. This program will be used for the experimental session and to acquire data for the research study.

At the end of the session participants will be asked to complete the test section in the computer program. Participants will also be asked to provide demographic information (age, gender, etc.) for research purposes only. Answers will be recorded via the software and stored in a text file. Each student's unique numerical ID will be used to code their answers, selections, and navigation within the computer program.

Risks

There are no known mental or physical risks involved in this study.

Benefits

Participants in the study will benefit by being exposed to an informative and engaging lesson about the political process in America. In addition, the software environment provides exposure and familiarity with the emerging technology known as hypermedia. The study itself asks some very important questions regarding the efficacy and efficiency of hypermedia technology. There are no personal or group rewards for participating and no penalties for not participating.

Anonymity and Confidentiality

All participants in the study will remain anonymous. Participants will be identified only by a randomly drawn number. Only the researcher will have access to experimental data and the ID numbers. The data obtained from this study will be used only to present the results, and at no time will the participants' real names or other identifying information be revealed. Summary results of the study will be released to the school officials, participants, and their legal guardians or parents upon request .

Compensation
There will be no compensation (such as extra credit, money, or other valuable items) for participating in this study. Likewise, there will be no penalties for not participating in this study.

Freedom To Withdraw
Participants who wish to withdraw from the study are free to do so at any time without explanation or penalty. Participants may also refuse to answer any questions or refuse to participate in any part of the study at any time without penalty or explanation.
Questions or requests for information about this research project before, during, and after the study can addressed to:

Lee Daniels (researcher)   Dr. Norm Dodl (faculty advisor)
4621-C Hope Valley Rd   220 War Memorial Hall
Durham, NC 27707   Virginia Tech
(919)419-6286   Blacksburg, VA 24060
                                                      (540)231-5587

Participant Approval

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project. If you agree to participate in this study please sign the bottom section, detach, and return to the researcher.

Signature of participant:

_____   Date: _____

   An equivalent form was provided for the parents or legal guardians of the participants.

APPENDIX F

Multiple-Channel Selections as a Percentage of All Selections

(Treatment Version Only)

Group	n	M	SD	SE
		(percentage)		
Field Dependent	18	40.39	31.35	7.39
Field Neutral	23	19.48	20.48	4.27
Field Independent	19	35.63	30.44	6.98
Total	61	31.47	28.58	3.66

APPENDIX G

ANOVA Table for Total Test Scores as a

Function of Field Dependency and Group

	df	Sum of Squares	Mean Square	F-Value	P-Value
FDI	2	29.800	14.900	2.997	.0538
Group	1	4.958	4.958	.997	.3201
FDI, Group	2	3.248	1.624	.327	.7220
Residual	116	576.746	4.972		

APPENDIX H

ANOVA Table for Recall Scores as a

Function of Field Dependency and Group

	df	Sum of Squares	Mean Square	F-Value	P-Value
FDI	2	.504	.252	.223	.8005
Group	1	3.327	3.327	2.944	.0889
FDI, Group	2	3.684	1.842	1.630	.2004
Residual	116	131.100	1.130		

APPENDIX I

ANOVA Table for Problem-Solving Scores as
a Function of Field Dependency and Group

	df	Sum of Squares	Mean Square	F-Value	P-Value
FDI	2	29.002	14.501	6.276	.0026*
Group	1	.162	.162	.070	.7916
FDI, Group	2	5.026	2.513	1.088	.3404
Residual	116	268.037	2.311		

*Significant at $p < .05$

APPENDIX J

Frequency of Technology Use by Participants

Times Used Per Week	Percentage of Participant Response	
	Computer	Video Game
0-4	18	11
5-9	29	33
10-14	44	39
Over 15	11	27

Harold Lee Daniels
━━━━━━━━━━━━━━━━━━ *Curriculum Vita* ━━━━━━━━━━━━━━━

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EDUCATIONAL BACKGROUND

Doctor of Philosophy in Instructional Systems Development
Virginia Tech
June 1996
Current GPA: 4.0
Dissertation title: Interaction of Cognitive Style and Learner Control of Presentation
Mode in a Hypermedia Environment.

Master of Arts in Educational Media (Concentration in Media Production)
Appalachian State University
May 1993
GPA: 3.84

Bachelor of Arts in Music Education (Concentration in Percussion)
Appalachian State University
May 1983
GPA: 3.2

ACADEMIC HONORS

Phi Kappa Phi National Honor Society, 1995.

Tuition and Fee Scholarship, College of Education, Department of Curriculum and
Instruction, Virginia Tech, 1993-1995.

Reich College of Education Outstanding Graduate Student Award, College of
Education, Department of Curriculum and Instruction, Appalachian State University,
1991.

Talent Award Scholarship, College of Fine and Applied Arts, Department of Music,
Appalachian State University, 1979-1983.

TEACHING EXPERIENCE

Instructor, Department of Curriculum and Instruction, Virginia Tech, 1995.
  Supervisor: Dr. Glen Holmes.

- Audio Processing in Multimedia. Graduate course in the design and production of audio for multimedia. Responsibilities included instructional design, delivery, and evaluation of course content and lab supervision.

Instructor, Department of Curriculum and Instruction, Virginia Tech, 1995.
  Supervisor: Dr. John Burton.

- Seminar: Multimedia Integration and Hypermedia Instruction. Instructional module for Hypermedia on the Macintosh, a graduate course in hypermedia design and development. Responsibilities included the design and delivery of instruction on integrating multimedia presentations within hypermedia environments.

Instructor/Faculty Development, Learning Resources Center, Virginia Tech, 1994-1995.
  Supervisor: Dr. Tom Head.

- Faculty Development Initiative, a campus-wide program to integrate technology into curriculum, classroom, and research endeavors. Responsibilities included Designing and conducting workshops, consultation with faculty participants on utilizing instructional technology, and training faculty in software applications.

Instructor, Department of Curriculum and Instruction, Virginia Tech, 1994.
  Supervisor: Dr. Glen Holmes.

- Workshop: Incorporating Audio in Multimedia. Instructional module for Cross Platform Multimedia Authoring and Development, a graduate course on the design, development, and production of multimedia instruction. Responsibilities included design and delivery of instruction on the use of audio in multimedia programs.

Instructor, Broyhill School of Music, Appalachian State University, 1989-1993.
  Supervisor: Dr. Arthur Unsworth, Dean.

- Music Production and Recording. Introductory course in recording techniques and the operation of the modern recording studio. Responsibilities included supervising student recordings in the school of music and recording sessions at a professional recording facility.

Instructor, Broyhill School of Music, Appalachian State University, 1991-1993.
  Supervisor: Dr. Arthur Unsworth, Dean.

- Recording Engineering and Production. Intermediate course in operational techniques for the modern recording studio. Responsibilities included supervision of student recordings in the school of music and recording sessions at a professional recording facility.

Instructor, Department of Communication Arts, Appalachian State University, 1986-1992.
Supervisor: Dr. Terry Cole, Chair.

- Radio Production. Production course that covered radio broadcast procedures. Responsibilities included supervision of student broadcasting at WASU-FM and laboratory production facilities.

Teaching Honors

Nominated as Outstanding Teacher of The Year, School of Music, Appalachian State University, 1993.

RESEARCH EXPERIENCE

Research Assistant, Educational Technology Lab, Virginia Tech, 1994-1995.
Supervisor: Dr. Norm Dodl

- Responsibilities included: assisting students and faculty in the Educational Technology Lab, a cross platform computer lab utilizing high end multimedia development workstations, internet and desktop publishing services.

Research Assistant, School of Mechanical Engineering, Virginia Tech, 1994.
Supervisor: Dr. Arvid Mycklebust

- Responsibilities included: the design and development of computer-aided instructional materials for self-paced multimedia instructional modules for engineering students; design and development of multimedia instructional presentations for classroom instruction.

Research Assistant, Department of Music, Virginia Tech, 1993-1994.
Supervisor: John Husser

- Responsibilities included assisting with management and maintenance of the department's digital recording, developing instructional software for the Department of Music, and assisting faculty, staff, and students with the Computer Assisted Learning and Composition Laboratory.

Research Assistant, Department of Curriculum and Instruction, Appalachian State University, 1990-1992.
Supervisor: Dr. Jeff Fletcher

- Responsibilities included the instruction of education majors in the of audio-visual equipment, production of audio-visual materials for the College of Education, provision of service to faculty and students, and maintenance of equipment.

Research Assistant, Educational Media Services, Department of Curriculum and Instruction, Appalachian State University, 1989-1990.
> Supervisor: Joseph Murphy

- Responsibilities included assisting university faculty in the production of instructional film and video, instruction of graduate and undergraduate students in film and video production and maintenance of equipment.

PROFESSIONAL EXPERIENCE

Technical Director, Broyhill School of Music, Appalachian State University, Boone, NC. 1990-1993.
> Supervisor: Dr. William Harbinson, Assistant Dean.

- Responsible for the operation of 650 seat, multiple venue, performance and production facilities in the School of Music including audio, video, and lighting production, maintenance, budgeting, and purchasing. Also responsible for supervising work study employees, acting as liaison with faculty and visiting artists, and pursuing external funding.

Recording Engineer/Producer, The Loft Recording Studio, Boone, NC. 1991-1993.
> Supervisor: Tim Greene, owner/head engineer.

- Staff engineer/producer. Credits include: Benson Recording Company, ACA Recording, and Myrrh/Word Records.

Recording Engineer/Producer, "Broyhill School of Music Faculty Recital Series". Appalachian State University, Boone, NC. 1992-1993.
> Supervisors: Dr. Arthur Unsworth, Dean
> Josh Graves, NCPR Artistic Supervisor

- Responsible for recording faculty and visiting artist performances, broadcast on southeastern National Public Radio affiliates.

Recording Engineer/Sound Design, "An Appalachian Summer", summer arts festival, Boone, NC. 1991-1993.
> Supervisor: Gil Morgenstern, Artistic Director.

- Responsibilities included sound and light design, sound reinforcement, and recording the performances of the Broyhill Chamber Ensemble and the North Carolina Symphony for broadcast on National Public Radio's "Performance Today" series.

Owner, HLD Sound Productions, Boone, NC. 1987-1992.

- Contracted services for music production, engineering, and recording in a variety of media. Clients include:

ABC Sports	South Carolina Educational TV
Maryland Sound, Inc.	Turner Sports & Entertainment
CBS Records	Jefferson/RayCom Sports
National Public Radio	North Carolina Public TV
ESPN	Mammoth Records
Corporation for Public Broadcasting	Home Team Sports
Carowinds, Inc.	Flying Fish Records

(Demo reel available upon request)

Sound Reinforcement Engineer, High Country Sound and Light, Hickory, NC. 1985-1987.
Supervisor: John R. Greene, owner.

- Staff engineer (FOH/Monitor). Credits include: South Carolina State Fair, North Carolina State Fair, Randy Travis, Reba McIntyre, Stevie Ray Vaughn, Huey Lewis, and Peabo Bryson.

Recording Engineer/Producer, NorthStar Productions, Todd, NC. 1984-1988.
Supervisor: Carl Rudisill, owner/head engineer.

- Staff engineer/producer. Credits include Sugar Hill Records (2 Grammy nominated albums), Folkways Records, and Flying Fish Records.

PUBLICATIONS

Daniels H. L. (in press). How much is too much? Issues of visual/verbal options in hypermedia. In R. Griffin (Ed.), <u>Eyes On the Future: Converging Images, Ideas, and Instruction.</u> The International Visual Literacy Association.

Daniels, H. L. (1994). Sound and vision: Incorporating psycho-acoustic principles in multimedia design and production. In R Braden, D. Beachamp, & R. Griffin (Eds.), <u>Imagery and Visual Literacy,</u> 57-63. The International Visual Literacy Association.

Daniels, H. L. (1991). A professional guide for recording high school instrumental and choral groups. <u>Journal of the North Carolina Music Educators National Conference, 46</u>(8), 22-25.

PROFESSIONAL PRESENTATIONS & ACTIVITES

Daniels, H. L., Lockee, B. B., & Roussell, J., H. (in press). <u>On-line dissertations: A new media for research dissemination</u>. Paper accepted for presentation at the conference of the International Visual Literacy Association, Laramie, Wyoming.

Daniels, H. L. (1996, February). <u>Cognitive style and presentation mode: Learner control issues in hypermedia.</u> Paper presented at the conference of the Eastern Educational Research Association National Conference, Boston, MA.

Daniels, H. L. (1996, February). <u>Adapting to individual differences: The promise of hypermedia and the reality of the research.</u> Paper presented at the conference of the Association for Educational Communications and Technology, Indianapolis, IN.

Daniels, H. L. (1995, October). <u>How much is too much? Issues of visual/verbal options in hypermedia</u>. Paper presented at the conference of the International Visual Literacy Association, Chicago, IL.

Daniels, H. L. (1995, November). <u>Integrating multimedia technology into the classroom: Hits and misses</u>. Paper and workshop presented at the conference of the Virginia Educational Media Association, Richmond, VA.

Daniels, H. L. (1995, May). <u>Learner control of channel delivery in multimedia: A theoretical framework for research.</u> Paper presented at the conference of the Eastern Educational Research Association, Hilton Head, SC.

Daniels, H. L. (1995, February). <u>Getting the most out of your stacks: Desktop audio and hypercard</u>. Paper presented at the conference of the Association for Educational Communications and Technology, Anaheim, CA.

Daniels, H. L. (1994, November). <u>Utilizing multimedia in the classroon: Theory and practice</u>. Paper and workshop presented at the conference of the   Virginia Educational Media Association, Richmond, VA.

Daniels, H. L. (1994, October). <u>Sound and vision: Incorporating psycho-acoustic principles in multimedia design and production</u>. Paper presented at the conference of the International Visual Literacy Association, Tempe, AZ.

RESEARCH INTERESTS

Learner control issues in hypermedia instruction

Cognitive style interactions with computer-mediated instruction

Technology Diffusion

PROFESSIONAL AFFILIATION

Association for Educational Communications and Technology

International Visual Literacy Association

Eastern Educational Research Association

American Educational Research Association

Society of Professional Audio Recording Services

SOFTWARE EXPERIENCE

Premier	SoundEdit 16
Photoshop	Performer
Hypercard/Appletalk	SuperCard
Authorware	QuickTime
Director	Desktop Publishing
MS Excel	Presentation Software
Media 100	Web Browsers & HTML
Pro Tools	3-D Graphics

ACADEMIC REFERENCES

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PROFESSIONAL REFERENCES

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(800) 366-4811

Wes Lachot
Owner, Overdub Recording
300 East Main Street
Carrboro, NC 27510
(919) 942-9434

Mike Edwards
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1018 Central Avenue
Charlotte, NC 28204
(704) 375-1053

Tim Greene
Owner, Loft Recording
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Boone, NC 28607
(704) 262-1169