CUSTOMIZING ONLINE INFORMATION: HOW LEARNING STYLE, CONTENT DELIVERY AND PRE-INSTRUCTIONAL STRATEGY AFFECT RECALL AND SATISFACTION

DISSERTATION

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ABSTRACT

How people understand and learn information is changing due to an increased reliance on technology. The Internet is creating a complex environment where the lines between media and information are blurring. This switch can be seen in mass media, classroom learning applications and the work environment. Along with this reliance on technology comes access to an almost unlimited amount of information presented in a multitude of ways. This presentation can be overwhelming to information seekers and online learners alike. By taking advantage of the inherent properties of new media, namely the ability to present content in different forms to a variety of learners, online learning can be structured to improve recall and satisfaction for multimedia learners.

This research presents the results of an experimentally designed research study that examines the effects of learning style, content delivery method, and pre-instructional strategy on recall and satisfaction in an online learning environment. Two hundred and forty-two participants were tested on their individual learning styles and online learning self efficacy and then randomly assigned to one of six conditions. The three independent variables consisted of 1) two learning styles: concrete and abstract; 2) two content delivery methods: linear and nonlinear; and 3) three pre-instructional strategies: control, elaborative interrogation and factual questioning. Online learning self-efficacy, or one's belief in their ability to learn using the web, was used as a covariate in all analyses.

This research indicated a strong relationship between learning style, recall and satisfaction. Abstract learners had higher recall scores and were more satisfied in the online learning environment than concrete learners. Online learning self-efficacy was found to play an important role with recall and satisfaction in the online learning environment. Content delivery method also affected content satisfaction. Future research is needed to examine the role of learning style and online learning self efficacy in both educational and mass media contexts.

For Christina

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CHAPTER 1

INTRODUCTION

How people understand and learn information is changing due to an increased reliance on technology. The Internet is creating a complex environment where the lines between media and information are blurring. This switch can be seen in mass media, classroom learning applications and the work environment. Media consumers download information without the filter of traditional media (Sundar, Kalyanaraman, & Brown, 2003). In education, the development of the computer, Internet, and hyperlinked multimedia is quickly becoming the norm (Dijkstra, 2001; Schmidt & Brown, 2003). In the work place, employers are switching to a team-based and interactive approach to problem-solving (Reigeluth, 1996; Stacey, Smith & Barty, 2004), where negotiating information online is considered a critical skill (Heinssen, Glass & Knight, 1987; Miura, 1987). These approaches require media consumers, students and employees alike to be able to think for themselves, solve problems in teams, take initiative and bring their own unique ideas and problem-solving skills to bear on the multitudes of problems facing an information-based economy (Reigeluth, 1996). To further understand the relationship between information and the reliance on technology, the research presented here will focus on how new media technology combined with instructional methodologies show potential for creating learning environments that allow for the electronic delivery of information tailored to individual learners.

Learning Online

Research indicates that students are satisfied with electronic information environments, and obtain similar achievement levels between traditional types of learning and online learning (Hiltz, 1994; Hoskins & van Hooff, 2005; Moore & Thompson, 1990; Newman, Webb, & Cochrane, 1995; Ruberg, Taylor, & Moore, 1996; Swan, Shea, Fredericksen, Pickett, Pelz, & Maher, 2000). In today's electronic classroom, however, contextualizing learning experiences can be more difficult than ever. The Internet provides access to unlimited amounts of information in an overwhelming learning environment (Mayer & Moreno, 2003; Nielsen, 1995). This continuing shift in education to computer-based teaching resources in-and-out of the classroom includes course-specific websites that take advantage of both multimedia and traditional instructional methods. Adding to these developments is the use of hypermedia, collaborative course websites, and connected learning environments that allow educators and students to structure learning to fit both their needs (McCain & Maxwell, 2003). Information is available to students who can log onto course websites at any time of the day or night to view subject-related documents, listen to audio lectures, watch video demonstrations, and view images associated with the course subject (Dijkstra, 2001).

Who Learns Online?

The increased number of students using technology in higher learning institutions nationwide reflects this instructional change (Goldstein & Ford, 2002). In U.S. K-12 public schools, for example, computer access is at an all-time high with an average of one computer for every five students. This number has changed considerably since 1998 when computer access was reported as twelve to one (NCES, 2002). This means that computer access in the classroom doubled in just five short years, and that number does not account for student computer use at home. Further, according to the NCES (2002), 87 percent of all public schools had Internet access in instructional classrooms, with 85 percent of those classrooms utilizing broadband access. Compared to just eight years ago when classroom access to the Internet was around three percent (NCES, 2002), this rapid increase in access to information clearly indicates a growing reliance on classroom technologies.

This trend continues in higher education as well. According to the Cooperative Institutional Research Program, more than 78 percent of new college freshmen in 2000 frequently used personal computers prior to entry into college, reflecting a ten percent increase from the year before and more than doubling since 1985 (Sax, Astin, Korn, & Mahoney, 2000). In the 2001-2002 school year, there were more than 127,000 distant education courses with more than three million students enrolled (Waits & Lewis, 2003).

Difficulties Learning Online

This reliance on technology for learning does not come without complications. Alongside the hype and promise surrounding online learning, basic difficulties encountered by online learners include inexperience, disorientation, cognitive overload, and lack of motivation (Papanikolaoua, Grigoriadoua, Magoulasb, & Kornilakisa, 2002). Another problem facing online learners is access to an overwhelming amount of information combined with novice web-design by instructors (Hoskins & van Hooff, 2005). Fortunately, these associated problems can be compensated for, and some of the disadvantages of online learning can be controlled. For example, to maximize the payoffs of online learning, it is important to examine characteristics of the learner combined with the appropriate learning solutions that create successful online leaning (Hoskins & van Hooff, 2005). Further, since people learn and process information at different rates based on experiences that vary widely from person to person (Dijkstra, 2001; Reigeluth, 1996; Schmidt & Brown, 2004), an information delivery system that takes advantage of technology involves customizing learning based on personal preference and prior experience (Banathy, 1991; Papanikolaoua, et. al., 2004; Reigeluth, 1996, 1996). One way to accomplish this is to structure information based on characteristics of different learning styles (2004Dijkstra, 2001; Reiguluth, 1996; Stacey, Smith & Barty, 2004).

Current instructional design theories such as constructivism also show potential for creating tailored online content delivered to overcome the disadvantages of learning online while considering the individual needs of information seekers (Papanikolaoua, et. al., 2002). By combining elements of message design and personal preference with multimedia presentation, the lingering difficulties facing online learning can be overcome. The current study begins this investigation by examining the relationships among learning style (Koob & Funk, 2002), content delivery method (Mayer & Moreno, 2003), pre-instructional strategy (Sarasin, 1999), recall, and satisfaction.

Based on this framework, the central themes of this research are to examine what happens to recall and satisfaction when the inherent advantages of new media—namely content presentation and pre-instructional strategies—are exploited using multimedia and interactive presentations of electronic information tailored for various learning styles.

By examining the relationship between information delivery methods among different types of learners, it is predicted that those who find information delivery matches the way they prefer to learn should have increased recall and satisfaction with online learning.

CHAPTER 2

REVIEW OF THE LITERATURE

New Communication Technology and Education

The recent push in academia to computer-based resources in-and-out of the classroom for teaching includes technologies such as chat, list serves, course-specific web sites and a multitude of course-enhancing online learning environments. Some students attend classes online from home, while others participate in web-enhanced courses—part online, part in a traditional "brick and mortar" university. Oblinger and Verille (1999) identified four major trends in technological development that have helped facilitate this change in informational resources. The first, *digitizing of information,* has made it possible to capture text, audio, video and still photos in a digital environment. Second, s*torage capacity* has evolved by more than 60 percent every year to allow for enormous amounts of information on small, compact C.D. ROMs that previously required dozens of volumes of bulky books on stacks in the library. Encyclopedias can be published in CD ROM format and made interactive with hypermedia links that relate topics with audio files. Streamlined video also allows access to important visual documentation of certain key historical events, and still photos provide further resources for research interests.

A third innovation is *processing power*. Processing power provides high-speed access to the digitized information available in large volumes of stored information. Computers that process high volumes of information two to three years ago seem slow by today's standards. Finally, the *networked world* has created a link between families, friends, neighbors, businesses, governments, and learning institutions around the world.

Computers and information networks are also becoming less expensive, increasing the numbers of classrooms and information environments available online. Digitized courses and instructional material is shared through networks, providing learners with access to original source documentation and the ability to augment course materials through online searches (Oblinger & Verille, 1999). "The sharing of authentic or original information brings learners closer to the level of scholarship that faculty experience. It is through working with authentic material, coupled with learning the 'way of thinking' of a particular scholarly community, that students enhance learning" (Oblinger & Verille, 1999, p. 52).

The shift in technological dependence is already being felt in instructional settings on campuses everywhere. Collaborative learning environments—where learners display research findings and projects—are adding to a growing body of existing knowledge. Additionally, online learning environments provide direct access to experts, other communities, cultures and alternative ideas on the same topics.

Learning from New Media

With increased use of online learning in classrooms coupled with advanced medium capabilities, the computer has been used for learning in a wide variety of subjects including writing (Wolf, 1985), math (Henderson, Landesman, & Kachuck, 1985; Carrier, Post, & Heck, 1985), science (Hale, 1986; Kracjik, Simmons, & Lunetta, 1986), communication studies (Phillips & Santoro, 1989; Premkumar, Ramamuthy, & King, 1993), statistics and classroom management (Skinner, 1990). Research has also explored computer use for media studies (Dutton, Rodgers & Jun, 1987; Palmgreen, Wenner, & Rosengreen, 1985; Schamp, 1991; Williams, 1991; Wiliams, Rice & Rogers, 1988), organizational communication (Rice, 1987), group communication (Lea & Spears, 1991) and interpersonal communication (Rice & Love, 1987; Walther & Burgoon, 1992; Walther, 1992). The diverse uses for this medium have created a growing need for deeper understanding of technological development in the form of systematically based theoretical research. Can new media be effectively incorporated into the classroom as a teaching device? It is clear that students need to be proficient using media, but can they learn from it?

Comparisons of learning from traditional and new media have resulted in mixed findings. The majority of studies comparing the two have found learning from print is more effective than the web (Eveland & Dunwoody, 2001; Sundar, Narayan, Obregon, & Uppal, 1998; Tewksbury & Alhaus, 2000). However, studies have also found that students are satisfied online and find similar achievement levels between traditional and online learning environments (Swan, et al., 2000; Hiltz, 1994; Kearsley, 2000; Moore & Thompson, 1990; Newman Webb & Cochrane, 1995; Ruberg, Taylor, & Moore, 1996).

Researchers are also divided. Clark (1983) argued that media do not, in fact, influence learning any more than the "truck that delivers our groceries causes changes in our nutrition" (p. 445). On the other hand, Kozma (1994) wrote more than ten years ago that if a relationship between learning and media was not created, this new technology would primarily be used for online shopping and the distribution of entertainment. He further explained that an understanding of different media attributes and their effect on instructional variables is not where the relationship between media and learning occurs. The relationship between media and learning occurs on a deeper level involving both cognitive and social relationships to information, which is further reinforced when internal and external resources like media, ability and preference fit together (Kozma, 1994).

Exploring these relationships requires understanding the underlying structure that supports technological, social and psychological factors of learning (Kozma, 1991, 1994). *Technology* refers to the attributes and navigational categories that help a medium's classification such as a television, radio or computer. *Symbol systems* are the ways content for each of these technologies are communicated (Kozma, 1991, p.11). For example, spoken word on the radio, pictures and images on television, or three-dimensional spatial navigation in video games are symbol systems. Finally, *processing capabilities* are the ways in which information is "displayed, received, stored, retrieved, organized, translated, transformed, and evaluated" for each medium (Kozma, 1991, p. 11). Central to this discussion is establishing how these attributes are used to create and build knowledge through social and psychological constructs that match the way learners acquire, process, create and link knowledge. When the attributes of the medium match the social and psychological ways we process information, a relationship between learning and media can be created.

Clarke (1983) believes that these factors (technology, symbol systems and processing capabilities) are not necessarily unique to individual media and therefore do not establish a relationship between media and learning. The counter-argument presented here, however, is that establishing a match between content delivery and the way we process information will create more successful learning experiences, thus reinforcing and strengthening learning (Kozma, 1991, 1994). This means when taking multiple sources of media and their individual properties into consideration, there should be a number of ways to exploit medium attributes in the form of content delivery.

Characteristics of the learner also need consideration because they have a wide variety of reasons for seeking and creating new knowledge. They vary by ability, content delivery preference, experience, and motivation. All of these factors directly affect the types of information connections stored in long-term memory. When content delivery mimics these connections and takes advantage of the natural ways the learner navigates through information, the relationship between learning and media begins to emerge, and a clearer picture of how these concepts are related can be developed (Kalyuga, Chandler, & Sweller, 1998, Kotovsky, Hayes, & Simon, 1985, Schneider & Shiffrin, 1977). Of primary concern is the difference between seeking information and actively building structures of related and increasingly complicated pieces of inter-related information.

> "…learning is viewed as an active, constructive process whereby the learner strategically manages the available cognitive resources to create new knowledge by extracting information from the environment and integrating it with information already stored in memory. This process is constrained by such cognitive factors as the duration and amount of information in short-term memory, the structure of the information, (and) the procedures that are activated to operate on it …" (Kozma, 1991, p. 179).

This matching between the individual and preferred presentation of information allows the learner to develop models which are used to process new information in a way that is more significant and personalized by building on previously connected knowledge already stored in long-term memory (Mayer & Moreno, 2000; Bransford, Brown & Cocking, 1999; Lambert & McCombs, 1998).

Multimedia and Interactivity

Not all attributes of a medium are necessarily an advantage to every learner. One thing to remember is that the capabilities of the medium are different from the variability of its use. Accordingly, a distinction must be made between the medium's abilities (which are always present) and how best to use them to facilitate learning (Kozma, 1994). The Internet offers the user the ability to go virtually anywhere and to find information on just about any topic, but can easily lead to disorientation and information overload. The potential strengths of *structured* online learning through instructor control, however, offers the possibility of increasing the learner's ability to understand and process complex information in a safe environment. Within this structure, online learning using multimedia seems like a perfect platform for developing simple to complex relationships of information thanks in part to hyperlinking.

Mayer & Moreno (2003) define multimedia as the use of different senses (i.e. audio, visual) to process or transmit a message. Hyperlinking is defined as multimedia information that has been divided and sorted into major "chunks" of information that can be selected dynamically (McKnight, Dillon, & Richardson, 1991), and the "non-sequential, nonlinear method for organizing and displaying text that was designed to enable readers to access information from a text in ways that are most meaningful for them" (Jonassen, 1986). Hyperlinking allows learners with differing learning styles and information needs to order the presentation of information in ways that suit individual requirements. In this manner, hyperlinked presentations of information can be structured in either a linear or non-linear presentation of information (Lee & Lehman, 1992). A presentation using hyperlinked multimedia can also foster learning through ease of access and learner control of the environment (Dillon & Gabbard, 1998). It also gives instructors the opportunity to link different course resources together into an interactive learning environment using video, print, audio and still photographs. When combined with interactivity, hyperlinking, and multimedia promote and foster information structures that closely resemble the structure of the cognitive process (Jonnasen & Wang, 1993).

Interactivity is also important to successful navigation of online information. As information is connected through hyperlinking, different layers and connections to that information are created through interactivity. "By interacting with networked media, users do not simply dictate reception of information, they become veritable gatekeepers of it, thus transferring agency from senders to receivers" (Sundar, 2004). Successful interactivity among different layers of information does not have to be complicated to be perceived as interactive as much as they need to remain usable. Successful navigation of a simple environment will be perceived by the user as more interactive compared to the failed navigation of very complex systems. Interactivity is related to usability through *perceptual interactivity*, or the learner's sensitivity to the different levels of information (Sundar, 2004).

Multimedia presentations allow learners to process different representations of information using different parts of the cognitive process, which can be important when processing information, especially among different learner types. Information processed using both visual and auditory channels reduce short-term cognitive load and increase the shift of information to long-term memory in the form of schemas, thereby reducing the load on cognitive processes. By creating single learning schemas with interactive visual and auditory cues, cognitive load can be reduced thereby increasing learning from multimedia environments (Sweller, et al., 1998). When examining the effects of multimedia processing and perception of online news, Sundar (2000) examined the relationship between photos, audio, and video downloads of online news, and found that images and audio are particularly powerful cues for recall of story content (Sundar, 2000).

Schema, Cognitive Overload and Learner Disorientation

Inherent in multimedia and interactive presentations of information is the danger of cognitive overload, especially for novice learners. Cognitive overload is created by the natural limitations on human ability to learn new information which is stored in working memory. Working memory is only able to processes relatively small amounts of information before overloading (Kalyuga, Chandler, and Sweller, 1998; Baddeley, 1992; Miller, 1956), but long-term memory has an unlimited capacity to store information in the form of complex and simple schemas (Kalyuga, Chandler, and Sweller, 1998; Sweller, et al., 1998; Larkin, et al., 1980). According to Kalyuga, et al. (1998), these schemas are used to store complex information in long-term memory that can be readily accessible and understood in short term memory automatically, with little cognitive load.

Navigating through hyperlinked information closely resembles natural representations of information stored in long-term memory in complex schemas (Delany & Gilbert, 1991). If the process of creating schema can be automated, or improved, allowing for instant access to both short and long-term memory in an unconscious form, demands on working memory decrease (Kalyuga, Chandler, and Sweller, 1998). This is a substantial benefit to learning because compared to new complex associations of information, automatic recall can be processed almost unconsciously, freeing up short-term cognitive resources (Kalyuga, Chandler, and Sweller, 1998, Kotovsky, Hayes, and Simon, 1985; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). Multimedia presentations of information increases both visual and auditory channels and reduces short-term cognitive load further, increasing the shift of information to long-term memory, thereby reducing the load on cognitive processes. By creating single learning schemas with interactive visual and auditory cues, cognitive load can be reduced thereby increasing learning from multimedia environments (Sweller, et al., 1998).

There is a fine line here, however. Higher levels of interactivity can also increase cognitive load by placing more demands on short-term memory, so cognitive overload should be one of the main concerns when constructing online learning environments (Sweller, et al., 1998; Kalyuga, Chandler, and Sweller, 1998).

> "Both interactive features and interactively transmitted content compete for allocation of processing resources in the human brain, which means interactivity, especially when combined with other interface features, may result in cognitive overload, resulting in disorientation and better encoding but lower storage of information" (Sweller, et al., 1998, p. 388).

Remember, in addition to navigational overload, novice learners are also prone to different cognitive task loads than more experienced learners, which can cause differing instructional needs across groups (Sloan, 1997; Sweller, et al., 1998; Sweller, 1998;

Kalyuga, Chandler, and Sweller, 1998). Since the amount of information available on-line can be overwhelming, it often causes difficulties for learners attempting to make decisions about what is and is not important. In some cases, the tributary information is often more interesting than the information being presented in the environment being used for coursework (Sloane, 1997). This factor is magnified because online media is a user-controlled medium (Collier, 1987), providing extensive control to the user sometimes without the experience or frames of reference to understand where to go and how to interpret those decisions once made (Mayer & Moreno, 2003).

Limited learning experience, overwhelming amounts of information, lack of information interpretation, and disorientation in online learning environments can all contribute to the lack of knowledge gained. The learner also has more control over the interpretation of the assignment which can contribute to cognitive overload. When using the broad-range of the World Wide Web for information seeking, the learner is able to look at almost a limitless amount of information but doesn't know enough about the topic to pull-off a concentrated search effort that will reflect an educated understanding of the subject. "The role of researcher using a multimedia database is wonderful for the expert scholar, but not for the learner" (Laurillard, 1998, p. 242).

Obviously novice users are at a bigger disadvantage because they have an increased potential for disorientation while learning using the Internet. Often they lack both the sophistication required to conduct a thorough scan of content or the ability to make decisions about the credibility and source of information they do find. Even expert users can lack the content expertise needed to construct a fulfilling learning experience while online (Laurillard, 1998). And while expert users may be able to construct a comprehensive search of information, they sometimes lack the ability to contextualize information to the learning task at hand. Simply stated, an unorganized information search on the Internet by seasoned and novice learners alike present problems for both.

So, in effect, the greatest advantage of new media education—hypermedia and interactivity combined with unlimited access and multiple presentations of information—can also serve as a great distraction. If novice learners are not furnished with clear learning objectives when there is a specific point to be learned, time spent using new media is wasted and the advantages negligible. This is where the role of the instructor comes into play. The narrative structure can still be achieved through the technological advancement of today's new media, but the instructor has to provide interpretation, guidance and instructional goals (Mayer & Moreno, 2003). It would be ideal if the learner were able to adopt actual information delivery to match cognitive information storage and develop strategies that reflect the best combination of the two for learning, but that probably can not happen without some sort of structured learning to begin with. Further, to enhance the development of these relationships requires stepping outside the bounds of the traditional classroom to evaluate how learning with new media can be different from traditional education.

Constructivism

The development of schemas has, in part, helped create constructivist-based online learning, so it should be an excellent model for taking advantage of multimedia and interactive information while allowing for customized content delivery that matches individual learners. In constructivist-based learning, learners are presented with alternative presentations of information that allow for construction of their own educational experience based on prior knowledge and beliefs, or values (Good & Brophy, 1990; Mergel, 1998). This sounds familiar because it is similar to the method of schema construction, which has already been linked to interactive multimedia presentations of information.

Constructivism also provides an understanding of not only what we know, but how we come to know it (Mayer, 1999a; Savery & Duffy, 1995). This relationship between knowledge and how we acquire it usually happens when a connection is reinforced or created between recently acquired knowledge stored in short-term memory and the knowledge stored in long-term memory (Mayer, 1999a). Since fundamental learning goals or stimulus are provided to the learner based on prior experience, cognition and goals (Savery & Duffy, 1995), once the learner has made an interpretation of that knowledge, it evolves through the individual's social and cognitive process resulting in an individualized understanding (Mayer, 1999a).

This seems like a good match for individual learners, but most classrooms range in size from 12 to 400 students, so there is difficulty constructing a shared educational experience tailored to different learners where everyone involved can benefit from this type of instruction (Jonassen, 1990). There are some guidelines, however, that can facilitate this process on a mass scale. Three main constructivist principles that outline the instructional design of learning and aid in the creation of a shared experience that benefits *most* learners include; 1) the relationship between knowledge and motivation; 2) learning that is motivated by the learner's common experience through a larger task or problem; and 3) associating the learning task with the learner's experience, thereby providing ownership to the student, and increasing motivation and desire to learn the task at hand (Savery & Duffy, 1995).

To begin this process, instruction starts with a problem or question that allows learners to cognitively engage content that helps them learn domain-specific information in the process of finding solutions to problems (Jonassen, 1990). By motivating learners to use knowledge that builds on their prior experiences through real-world tasks, instructional designers provide learners with ownership of not only the information being learned, but the learning and solution process as well (Savery & Duffy, 1995). The learning environment should also support and challenge the learner's thinking by pushing them to the edge of their thought process while encouraging them to test their ideas against alternative ideas and concepts (Savery & Duffy, 1995).

Learners make the most out of information when they can select information and organize it into representations that make sense to them (Jonassen, 1990; Mayer & Moreno, 2000; Mayer, 1996; Mayer, 1999b; Wittrock, 1990). "For meaningful learning to occur, the learner must carry out each of these cognitive processes, i.e. selecting relevant words and images, organizing them into coherent verbal and visual representations, and integrating corresponding verbal and visual representations" (Mayer and Moreno, 2000). Mayer & Moreno, (2000) found that students learn better when their visual and/or verbal memories are not full. Learning has a better chance of occurring when "learner's needs have corresponding visual and verbal representations in working memory at the same time" (Mayer & Moreno, 2000, p. 10).

Instructional Design

The constructivist model seems like a natural fit with schema building and interactive presentation of multimedia information, but how can it be delivered to multitudes of learners at the same time? Obviously there is no way to deliver individualized instructions to each learner on a personal basis, but since the current model of learning typically only caters to one type of learner without allowing for much variety between different learning styles, the inherent advantages of new media can at least offer some alternatives.

One solution to this dilemma is to take cognitivism into consideration when designing learning environments. This allows the development of instructional design that fosters effective learning and matches environments where learners already interact with information to individual specifications. In this design, the instructor still plays a significant role since neither novice nor expert Internet users are likely to have enough content expertise to pull-off a concentrated search of general Internet sites that allow for significant online learner. Having said that, the first decision component of any instructional design is deciding what information to teach, and how to teach it. This decision should not be confused with curriculum and pedagogy, because this decision entails attempting to understand how students learn, set goals, and base their understanding of new and current information on prior experience and knowledge stored in the form of long-term memory; all the while weighing those considerations against the development constraints and instructional goals.

Deciding what to teach, is more difficult than it sounds. To begin with, instructional designers sort through their resources based on a particular subject, and compare that to the total amount of information available about a particular subject based on their own knowledge and experience (Merrill, 2001). These decisions are often based on the instructor's area of expertise, level of comfort with the subject matter and established departmental guidelines. The second part, deciding how to teach the subject, or the design of the learning space, is based on the type of information that is to be covered, the learning objectives/goals set by the student and the instructor, and the way in which new knowledge will be assessed (Merrill, 2001). To help answer these questions, designers evaluate the conditions in which the learning will take place and then evaluate the desired instructional outcome (Reigeluth, 1996). Included in these considerations are

- What is going to be learned?
- What are the learners ability levels?
- Where is the learning going to take place?
- And finally, what are the development constraints (money, time, location, knowledge, etc.).

An important point to consider is that not every instructional design will work across all four of these considerations for every learner. The same can be said for the second aspect of instructional situations: the desired outcome. When considering the desired outcome, designers weigh it against the level of effectiveness, or how well the method works (Reigeluth, 1996). One method used to measure how well the learners reach (or do not reach) their learning goals is weighing the desired outcome against the developmental constraints (Reigeluth, 1996). For example, is the amount of learning gained from the instructional method worth the time, effort and money put into constructing the learning environment? And finally, the level of appeal refers to the learner's interest in the learning content. The time invested in constructing a learning environment might not pay off if learners are not interested in the course content. An ideal constructivist-based learning environment that cost thousands of dollars and takes hundreds of hours to develop is still a failure if learners do not successfully use it or care about the content.

On a more basic level, any learning situation can take advantage of constructivist-based learning. One example is selection, organizing and integrating, or SOI (Mayer, 1999a). This three-part guideline can transform most learning tasks into constructivist-based learning design (Mayer, 1999a). The three key components of SOI learning are selection, organizing and integrating. *Selecting* refers to the process of selecting the relevant information; *organizing* refers to processing the incoming information; and *integrating* refers to the process of connecting new information with old (Mayer, 1999a). Selection helps learners decide which information is important to them and allows for greater transfer from short-term memory to long-term memory (Mayer, 1999a). Once the relevant information has been selected; it is organized and grouped into coherent chunks of information the learner can process more easily (Mayer, 1999a). Finally, integrating the information helps create and bond connections between the new knowledge and previous knowledge (Mayer, 1999a). Using this process, instructional designers can help students learn by designing learning activities that help the learners select, organize and process information (Mayer, 1999a).

These steps can be applied to a multitude of learning environments from simply reading a passage, to more complex task-oriented learning environments (Mayer, 1999a). Instructional methods that foster information selection include any device that sets information apart from other information (i.e. bullet points, bold, underlining) (Mayer, 1999a). To help organize information, designers use simple techniques like outlines, page headers and illustrations (Mayer, 1999a). Finally, to help integrate new knowledge into old knowledge, instructional designers provide examples and learner-specific questions (Mayer, 1999a) including pre-instructional strategies (Sarasin, 1999).

Another way to root out the core problems hindering the barriers to online learning is to design learning spaces with the learner in mind. Constructivist-based learning defines how effective learning can occur among large groups of learners by taking into account variables like instructional delivery method, previous experience, learner goals and preferred learning style. The nature of hypermedia-based learning environments seems like a natural fit with constructivism because of the multitude of information presentation possibilities (Delany & Filbert, 1992). Fundamental learning goals or stimuli are provided to the learner based on prior experience, cognition and goals (Savery & Duffy, 1995). Once the learner has made an interpretation of that knowledge, it evolves through the individual's social and cognitive process resulting in an individualized understanding (Mayer, 1999b).

This acquisition of knowledge is measured and can be demonstrated through application, or recall (Dijkstra, 2001). "Design rules and principles are derived from studies of acquiring and mastering the content of such elements in various circumstances and under different conditions. While this approach is legitimate, the knowledge and skill of a specific subject is not typically the ultimate goal of an educational program." (Dijkstra, 2001, p. 281). According to Dijkstra (2001), that goal should be adapting the knowledge gained from specific learning situations into the more complex realities of social systems. Information is interpreted, categorized and then presented using a design method that allows learners to achieve measurable learning.

One of the primary constructivist principles is the relationship between knowledge and motivation (Savery & Duffy, 1995). It is not enough to simply assign a task to learners; the task should be motivated by common experience through a larger task or problem (Savery & Duffy, 1995). By associating the learning task with the learner's experience, it should provide ownership to the student, increasing motivation and desire to learn the task at hand (Savery & Duffy, 1995). These tasks should be authentic tasks that learners would experience in situations outside of the classroom (Savery & Duffy, 1995).

Constructivist learning begins with a problem that challenges learners to cognitively engage content while helping them learn domain-specific information in the process of finding solutions to problems (Jonassen, 1990). By motivating learners to use knowledge that builds on their prior experiences through real-world tasks, they are given a sense of ownership—not only the information being learned, but the learning and solution process as well (Savery & Duffy, 1995). The learning environment should also support and challenge the learner's thinking by pushing the student to the edge of his or her thought process while encouraging learners to test their ideas against alternative ideas and concepts (Savery & Duffy, 1995).

Psychological Methods of Information and Knowledge Construction

Self Efficacy

Combining constructivist-based delivery of information in an interactive, hyper-linked online learning environment that matches the development of complex and connected schemas is one way to understanding the relationship between media and learning. Another way to deepen this understanding is to examine how self efficacy affects learners in this type of environment. Self efficacy is a person's belief that they can perform a given task, and the level of success they will achieve when they attempt that task (Bandura, 1999).

Bandura's (1977) Social Cognitive Theory offers a broader understanding of the cognitive process in the form of outcome expectations, self-efficacy and the factors that drive motivation. This relationship is explained through a triadic relationship of behavior, personal factors (cognitive) and environment (Bandura, 1977). Bandura's (1986) social cognitive theory posits a causal relationship used to explain human behavior by the interaction of outside influences through an internal intermediary influence. This view presents people as self-organizing, proactive and self-regulating individuals that are shaped by events influencing their lives (Bandura, 1999). This relationship is cyclical in nature where each part influences the other in an uninterrupted loop (Bandura, 1999).

Another conceptual outcome is forethought, or ones ability to predict certain behavior based on past experiences and self-efficacy (Bandura, 1999). While events that occur in the future cannot necessarily represent current motivations for performing certain behaviors, through symbolic cognitive process, those *anticipated* actions can be transformed into motivational factors that influence behavior in the here and now (Bandura, 1999). Through forethought, people are able to model their current behavior and make progress towards long-term goals (Bandura, 1999).

There are four sources for self-efficacy (Bandura, 1999). The first one, "mastery experiences," refers to overcoming experiences through mastering each step involved with little failure (Bandura, 1999). Failure at early stages can cause non-participation, but failure at later stages can also be discouraging; therefore, it is a combination of overcoming obstacles and the repeated success of overcoming these obstacles that build mastery experience self-efficacy (Bandura, 1999). Second is vicarious experience, or strengthening of efficacy beliefs through watching other succeed (Bandura, 1999). Third is social persuasion, or persuading people to believe they have what it takes to succeed (Bandura, 1999). And finally, people make efficacy decisions based on their physical and emotional states (Bandura, 1999). For example, fatigue, depression, and anxiety might all be factors to reduce personal self-efficacy (Bandura, 1999).

Students who lack previous computer experience often encounter frustration when working with computer-mediated communication (Sturgill, Martin, & Gay, 1999). Previous Internet experience has been shown to predict Internet self efficacy (Eastin and LaRose, 2000), and computer experience has been directly associated with success in online learning (Swan, et al., 2000; Martinez & Sweger, 1996; & Sturgill, Martin and Gay, 1999). Hong (2002) found that experienced computer users were more satisfied with web-based learning. Additionally, Wang and Newlin (2002) found that students who took courses because they enjoyed web-based courses had higher self efficacy and higher recall scores than students who took course for convenience.

Learning Styles

Another characteristic that can determine individual differences in learning are learning styles. Learning styles can broadly be defined as “the characteristic behaviors of learners that serve as relatively stable indicators of how they perceive, interact with, and respond to the learning environment” (Keefe, 1970). Manipulating the flexibility of hyper-media makes it a prime candidate for customizing content in online learning environments by individual learning styles (Dillon & Gabbard, 1998). Learning theories have developed from a range of learning theorist. Dewey (1938) called for learning based in experience; Lewin (1935) emphasized active learning, while Piaget (1972) argued for intelligence based on an interaction of environment and the individual. Essentially, learning styles categorize people into dichotomous groups (modalities) according to specific learning characteristics that are meant to maximize learning (Barber & Milone, 1980; Carbo, 1997). Inherent in any type of dichotomous classification is the narrow categories learners are placed in (Smith, 2002), but generally individuals fit in one category more than the others (Dillon & Gabbard, 1998). Learning styles are determined by measuring learner perceptions in the form of habit, preferences and orientation towards learning and studying (Messick, 1994; Reiff, 1992). Typically, surveys that measure reasoning, perceived abilities and preferences that correlate with ability to learn using these constructs are used to evaluate learners (Barber & Milone, 1980; Dunn, Dunn & Price, 1989; Paivio & Harshman, 1983). In some cases, learning styles are compared to the learner's cognitive style in the form of memory, reasoning, and experience as well (Kolb, 1984; Messick, 1994; Riding & Rayner, 1998; Yates, 2000).

According to Dillon and Watson (1996) and Dillon and Gabbard (1998), meta-analysis of learner levels and hypermedia use indicate learning styles are excellent predictors of individual differences among learners. Previous research regarding hypermedia and learning styles includes Witkin, Moore, Goodenough, and Cox's (1977) theory of field dependence/independence; Svensson's (1997) holisitic/Sequential approach; auditory and visual learners (Sarasin, 1999); and Kolb's (1984) Learning Style

Inventory. Among learning styles, there are common themes that classify learner types. For example, a division between information that is presented in it's final form for the learner, and information that has to be constructed, or pieced together for the learner.

This division is apparent in the classifications of visual learners and verbal learners (Richardson, 1977; Specht & Martin, 1998). Verbal learners tend to be more structured in their learning, using lectures, textbooks and memorization as keys to understanding (Sarasin, 1999). Visual learners tend to utilize visual information in the form of flow charts and diagrams and can understand information better through demonstrations and experience (Sarasin, 1999).

One of the earliest cognitive-based measures of learning style is Witkin, Moore, Goodenough, and Cox's (1977) theory of field dependence/independence. By examining the methods in which learners use context to understand new information, learners are put into one of two categories: field dependence or field independence (Smith, 2002). Within this learning style, field dependent learners prefer a formal approach to learning through the use of lecture and guidance, while field independent learners tend to favor impersonal subjects that require cognitive skills (Smith, 2002).

Holistic/sequential learning is a learning style based on right-brain/left-brain learning theory (Smith, 2002; Svensson, 1997). With the right-brain approach, learners tend to tackle entire tasks at one time. They are more intuitive and subjective in their thinking and often approach learning in a random method, similar to visual learners. Left-brain thinkers tend to follow logical, sequential steps and look to solving the parts of a problem in some methodical fashion, similar to verbal learners.

In addition to learning styles that measure cognitive preferences, work on student approaches to learning has produced interesting results as well. For example, student approaches to learning can be divided into deep and surface learning (Marton, Hounsell, & Entwistle, 1984). Through the deep learning approach, learners tend to fully understand and internalize knowledge and ideas (Smith, 2002). The surface approach to learning is based more on memorization of facts and figures (Smith, 2002).

Strategic Learners

In some cases learners are able to mix deep and surface approaches depending on the context of the learning situation. Smith (2002) calls these learners strategic learners. Mixing methods and approaches to learning provides learners with more educational options (Smith, 2002). A deep learning approach gives learners the knowledge and understanding they need to explore complex topics in confidence while allowing them to create a learning environment that is well-suited to them (Smith, 2002). But learning style is deeper than just visual or verbal. Those two distinctions are used to categorize learners based on the result of learning style assessments.

The importance of learning styles is recognizing that learners have a preference, and instructional designers should take steps to ensure that those modes of learning are included in instructional design (Smith, 2002). Currently emphasis is placed on one type of learning in standardized education (typically verbal, or concrete, learning) and all learners, regardless of learning type, are missing out on the creative and exploratory nature of visual, or abstract, learning (Smith, 2002). Furthermore, student instruction is typically based on one type of learning style and is so systematically engrained in the education system that learners might have difficulty performing well in a new learning environment, even when it matches their own learning style (Smith, 2002).

Not that matching learning styles with instructional delivery is an easy task (Keri, 2002). As early as 1969, researchers (Cronbach & Snow, 1969) hypothesized that matching learning styles with teaching methods would vastly improve student classroom satisfaction and achievement. Past research has produced mixed results. According to Simon (2000), when learning style is matched to the corresponding training method, learners tend to be more successful in reaching their goals, obtaining satisfaction and increasing their level of computer use as an information source (Barber & Milone, 1980, 1981; Carbo, 1997; Jenkins, 1988; Sarasin, 1999; Whyte, Karolick, Nielsen, Elder, & Hawley, 1995). Karuppan (2001) found that learning styles affected recall and satisfaction in an online learning environment. In contrast, however, other research has failed to produce a significant relationship between learning style and effectiveness and satisfaction with computer based instruction (Gunawarden & Boverie, 1993; Larsen, 1992; Sein & Robey, 1991).

Kolb's Learning Style Inventory

In a meta-analysis of online learning, Dillon and Gabbard (1998) found that one of the most promising areas was in the exploration of learning styles and online delivery of information. Support for Kolb's (1984) Learning Style Inventory (LSI) based on experience, behavior and performance was found (Dillon and Gabbard 1998) over other types of learning styles. The LSI presents a four stage cycle that makes up understanding of the experiential learning process. In this model, concepts and observations are formed into new ideas that guide our interactions with the world (Kolb, 1994; Wang, et al, 2001).

These four dimensions consist of 1) Concrete Experience (CE) (affective or feeling); 2) Abstract Conceptualization (AC) (symbolic or cognitive/thinking skills); 3) Active Experimentation (AE) (behavioral or doing); and finally, 4) Reflective Observation (RO) (perceptual/observation) (Kolb, 1976, 1984; Koob & Funk, 2002).

Concrete Experience (affective or feeling)	Learning by experiences	o Learning from specific experience o Relating to people o Being sensitive to feelings and people
Active Experimentation (behavioral or doing)	Learning by doing	o Showing ability to get things done o Taking risks o Influencing people and events through action
Reflective Observation (perceptual/ observation)	Learning by reflecting	o Careful observing before making judgments o Viewing issues from different perspectives o Looking for the meaning of things
Abstract Conceptualization (symbolic or cognitive)	Learning by thinking	o Logically analyzing ideas o Planning systematically o Acting on an intellectual understanding of a situation

Table 1:

Four Types of Learners by the Kolb Learning Style Inventory (Kolb, 1976, 1984).

Within this model there are two main components which are direct opposites: concrete experience-abstract conceptualization (CE-AC, or feeling and thinking—an analytical method of learning), and active experimentation-reflective observations (AE-RO, or behavior and perception—experience-based method of learning). When combined, these preferences create four different learning styles that are used to process information (Koob & Funk, 2002). The four learning styles are: the accommodator, the diverger, the assimilator and the converger. According to Kolb, learners have a preferred learning style that falls somewhere on this model, but it is likely that all learners experience elements of each learning phase depending on the learning context (Kolb, 1976).

Accommodators (CE-AE)	Combine active experimentation with concrete experience and learn primarily from hands-on experience (Kolb, 1984). Accommodators tend to take action and problem solve through intuition or experience gained through trial and error (Hong, 2002). Accommodators enjoy other people and new experiences and are considered risk takers and problem solvers (Koob & Funk, 2002; Smith & Kolb, 1996).
Divergers (CE-RO)	Use reflective observation with concrete experience (Kolb, 1984). Divergers typically look at problems from multiple perspectives and are usually able to find a number of solutions for a single problem (Hong, 2002). These learners tend to be imaginative and able to generate ideas (Koob & Funk, 2002; Kolb, 1976, 1984).
Assimilators (RO-AC)	Combine reflective observations with abstract conceptualization and are good at taking complex and large amounts of information and putting it into logical order (Kolb, 1984). They tend to use reasoning to create theoretical models to find explanations to problem solve (Hong, 2002). These learners are more interested in logic and placing ideas in order than relating to people (Koob & Funk, 2002; Kolb, 1976, 1984).
Convergers (AC-AE)	Use active experimentation and abstract conceptualization to find practical uses for new ideas and theories (Kolb, 1984). Convergers are best at finding practical, single answers to problems (Hong, 2002). These learners prefer things over people, tend to be less emotional, and are able to make logical deductions when problem-solving (Koob & Funk, 2002; Kolb, 1976, 1984).

Table 2:

Four Dimensions of Learner Types (Kolb, 1976, 1984).

Accommodators combine active experimentation with concrete experience and learn primarily from hands-on experience (Kolb, 1984). Divergers use reflective observation with concrete experience and view experiences through a multitude of perspectives (Kolb, 1984). Assimilators combine reflective observations with abstract conceptualization and are good at taking complex and large amounts of information and putting it into logical order (Kolb, 1984). Convergers use active experimentation and abstract conceptualization to find practical uses for new ideas and theories (Kolb, 1984).

Most learners fit into at least one of these categories and often two or more. Learners who can switch from one learning style to another are usually better learners (Smith, 2002), but just by making learners aware of their learning preference, learners are able to develop an understanding of how they learn and expand learning styles which in turn makes them better learners (Smith, 2002). One of the benefits of the Kolb's model is that it is experience-based; therefore it takes experience into consideration of the level of the learner (Kolb, 1984; Smith, 2002).

Considering the Learner and Instructional Environment

There are several methods used to match learning style with instructional method including a "direct match" of learning style and instructional delivery method; "negotiated self-direction," where learners are presented with several choices and must pick one based on their learning style; "special scheduling," in which students learn instructional content in one learning style, and then switch to a review discussion using another learning style, and finally, there is the "holistic" method, in which the instructor presents the same course content in a variety of ways and the learner selects the most appropriate method (Klien, 2003).

All three of these options fit with the design of constructivist-based online learning. Adopting learning styles to meet learner's need is important for instructional designers, but part of the problem, however, is that it is not always possible to plan and adopt different teaching modalities to reach all types of learners at once. Economy of scale, time, and money drastically impact one’s ability to program different types of learning activities into daily or even weekly activities. This is dependent on the type of content and task. Using the holistic method as an example, the time an instructional designer spends developing multiple versions of the same content to deliver to learners with multiple learning styles is prohibitive. Perhaps a better approach is to start with special scheduling—in this way the designer develops only two different content delivery methods the first time a course is taught, and then two more the next time the course is taught. Over time, the instructor develops a “library” of instructional content and is able to move to a “holistic” teaching approach. On the other hand, a research or case study based course allows the instructor to offer several options to learners at once. The nature of the content is the same, the method in which the student’s attempt to understand it is different, therefore the front-end work an instructional designer has contributed is minimal. Essentially the instructor must decide what types of assignments he or she will accept (for example, a poster board, a term paper, a project, etc.), and learners can pick the method that matches their learning style.

Assuming it is possible to match learning style with instructional technique using one of the methods just described; instructional designers can make sure they offer the best fit. Researchers have attempted to identify the relationship between online learning and online communication, technical support and instructional design (Everett, 1998; Hara & Kling, 2000; Jegede, Fraser, & Curtin, 1995; Mory, Gambill & Browning, 1998), but a broader understanding of the relationship between learning styles and student motivation in the form of instructional goals is needed. This need goes beyond a simple matching of instructional concepts as alternative learning environments that fit changing student learning styles. What is needed is a fit between proven instructional strategies coupled with a true understanding of student's goals and motivations while considering natural limits placed on designers by money, time and the point of diminishing returns. As stated above, student learning styles are modulated by the context of what is to be learned through their direct experiences—learners often switch from one learning style to another depending on their interests, motivations and ability (Klien, 2003; Geddis & Wood, 1997; Lampert, 1985).

Simon (2000) found that matching the Kolbe LSI to training methods increased success in training outcomes and improved participant sense of satisfaction in the learning environment. Based on prior divisions of other learning styles, Kolb's LSI can also be divided into dichotomous groups along lines similar to field dependant/independent learners, auditory/visual learners, and holistic/sequential learners. Simon (2000) divided the four Kolb learner styles into two dichotomous learning categories that were matched to training method through exploration training and instruction training. *Exploration training* has been defined as providing the learner with the "freedom to impose their own structures on learning" (Simon, 2000, p. 44). *Instruction training* is defined as "the situation when the entire content of what is to be learned is presented to the learner in final form" (Simon, 2000, p. 43). The first, exploration training, or abstract learning, is similar to visual, field independent and the right-brain approach to learning. This group consisted of accommodators and convergers. The second group, instruction training, or concrete learning, is similar to verbal, field dependent and the left-brain approach to learning. This groups consisted of diverges and assimilators.

Multimedia capability is able to provide instructors with opportunities to teach educational content by matching a variety of presentation formats with particular learning styles (Dillon & Gabbard, 1998). Computer-mediated communication in the form of computer-assisted instruction is common in education from grade school through graduate school and has been a popular method of instruction for some time (Wang, Hinn, & Kanfer, 2001). There are a number of studies that examine the relationship between learning styles and traditional instructional delivery methods, but understanding the relationship between information design, presentation, and learning styles, however, is a relatively new idea (Wang, et. al., 2001).

Pre-Instructional Strategy

Another aspect contributing to the constructivist-based design of instruction is integrating information into existing schemas. Research supports goal-setting strategies that include assigning questions to learners before a learning task as an effective way to increase recall of information (Andre, 1979; Reder, 1985). This means deciding how to select, organize and integrate information that will reducing cognitive load in the multimedia and interactive learning environment—essentially priming learners to their default learning mode based on their learning style. An effective method for motivating learners and preparing them for instruction is through the use of pre-instructional strategies (Sarasin, 1999). Pre-instructional strategies help learners focus on the goals and objectives of each lesson, and, when matched with learning style, provide an important tool to foster successful learning (Sarasin, 1999).

There are three pre-instructional strategies that can help facilitate learning, two of which correspond to abstract and concrete types of learners. One method is to provide learners with a list of factual questions they consider while viewing the learning module (answers are found in the learning module) which should promote understanding of content-specific information (Dornisch & Sperling, 2004). A second approach consists of questions based on elaborative interrogation (answers are inferences based on information presented in the learning module), and geared towards developing a deeper understanding of course content by building on previous knowledge (Dornisch & Sperling, 2004). Finally, a straight recall option asks respondents to write down everything they can remember about the learning modules after viewing them (do your best) (Dornisch & Sperling, 2004). Each of these pre-instructional strategies can be matched with specific learning styles for optimal learning effect. Pre-instructional strategies for abstract learners include using focusing questions to engage learners to think critically about concepts, issues and information (Sarasin, 1999). Pre-instructional strategies for concrete learners include direct questions with specific answers (Sarasin, 1999).

Summary of the Literature

Improvements in web-delivered information have sparked an interest in understanding how hypermedia and interactivity affect content presentation and the recall of information. Convenience, access to an unlimited amount of information and the growing popularity of personal home computers hooked into the World Wide Web combined with the growing reliance of the Internet for information seeking and delivery has further energized this research. The majority of studies to date examined the relationship between the properties of various media and the effects those properties have on learning. Fewer studies have examined the relationship between customizing information presentation based on inherent learner qualities.

Learning from new media has been studied in a number of contexts with mixed results. What has been missing from this research, however, is the notion that individual learners have a preference in the way they learn new information based on previous experience and learning style. Factors that contribute to a lack of learning can be attributed in part to learner disorientation and cognitive overload. These factors are compounded by learners seeking complex information with limited, or no experience with a particular environment.

That said, when electronic delivery of online information is matched to inherent learner qualities, there is potential for strengthening existing cognitive structures in the form of schemas that fit into short and long term memory. Schemas allow learners to automate the recall and understanding of complex strands of information buried deep in long-term memory. The recall of these strands, or schemas, is automatic and requires limited cognitive load on short-term memory. It is believed that further automating the information delivery process to match the way these complex pieces of information are stored in long-term memory will reduce cognitive load, freeing essential short-term memory and thus allowing for the construction of new knowledge.

To help reduce disorientation and cognitive overload, there are some basic guidelines that can be used when designing the presentation of online information. The type of learning that best matches the advantages of online information presentation is constructivist-based learning environments. Constructivist-based learning takes previous experience and learner preference into consideration in the delivery and evaluation of information and knowledge gained, and typically offers different types of learning environments and evaluation to learners with different needs. One method for constructivist-based online learning is SOI, where information is selected, organized and integrated into presentations that help reduce disorientation and cognitive load for novice learners. This type of design also helps experienced learners sort out and process complex information as well.

Matching constructivist-based information presentation with the cognitive process of different learner types should further reduce disorientation and cognitive load while increasing recall and satisfaction through the automation or improvement of schema building. Online learning self-efficacy, or one’s belief in their ability to learn online, has shown a propensity for increased recall and satisfaction with online learning. Combined with learning styles, which essentially describes the most appropriate method for individual learners to interact with information for knowledge construction, self efficacy can help predict success or failure in online learning environments. Since satisfaction is tied directly to the likeliness of adopting a particular learning strategy, and learning styles tend to affect one’s perceived satisfaction, learning styles should also help determine success in online learning environments.

Purpose of the Study

Simon (2000) found that matching learning style to training methods increased success in training outcomes (recall) and improved participant sense of satisfaction in the learning environment. He divided the four Kolb learner styles into two dichotomous learning categories that matched training method using exploration training and instruction training. Exploration training has been defined as providing the learner with the “freedom to impose their own structures on learning” (Simon, 2000, p. 44). Instruction-based learning is defined as “the situation when the entire content of what is to be learned is presented to the learner in final form” (Simon, 2000,p. 43). The first, exploration training, or abstract learning, consisted of accommodators and convergers. The second group, instruction training, or concrete learning, consisted of diverges and assimilators. As cited in Simon (2000), abstract learning shows promise when learning personal computing (Brynda, 1992). Therefore, abstract learners should score higher and be more satisfied in a computer-based environment than concrete learners. According to Simon (2000), when learning style is matched to the corresponding content delivery method, learners tend to be more successful in reaching their goals, obtaining satisfaction and increasing their level of computer use as an information source (Barber & Milone, 1980, 1981; Carbo, 1997; Jenkins, 1988; Sarasin, 1999; Whyte, Karolick, Nielsen, Elder, & Hawley, 1995).

This research uses two interactivity levels as defined by Sundar, Kalyanaraman and Brown (2003)[1]. The first, linear, is a medium interactivity website (a single layer of hyperlinks). The second, non-linear, is a high interactivity website (two hierarchical layers of related links) (Sundar et. al., 2003). To help learners organize information, designers can use simple techniques like outlines, page headers and illustrations (Mayer, 1999a). Finally, to help learners integrate new knowledge into old knowledge, instructional designers can provide examples and learner-specific questions (Mayer, 1999a).

[1] See appendix D and E for a visual representation of the learning environments.

An effective method for motivating learners and preparing them for instruction in constructivist learning environments is through the use of pre-instructional strategies (Sarasin, 1999). Pre-instructional strategies help learners focus on the goals and objectives of each lesson, and, when matched with the learning style, provide an important tool to foster successful learning (Sarasin, 1999). There are three pre-instructional strategies that can help facilitate learning. First, providing learners with a list of factual questions to consider while viewing the learning module (factual questions—answers are found in the learning module) should promote understanding of content-specific information (Dornisch & Sperling, 2004). Second, suggests priming with questions based on elaborative interrogation (answers are inferences based on information presented in the learning module) that are geared towards developing a deeper understanding of course content by building on previous knowledge (Dornisch & Sperling, 2004). Third, asks respondents to simply do their best. This strategy acts as a control to the previous instructional strategies previously outlined. (Dornisch & Sperling, 2004).

Each of these pre-instructional strategies can be matched with specific learning styles for an optimal learning effect. Pre-instructional strategies for visual abstract learners include using focusing questions to engage learners to think critically about concepts, issues and information (Sarasin, 1999). Pre-instructional strategies for concrete learners include direct questions with specific answers (Sarasin, 1999). Furthermore, abstract learners tend to use a cognitive process that is inductive in nature and requires specific tasks or examples (Simon, 2000), therefore, when learning style and pre-instructional strategy match, there should be an increase in recall and satisfaction.

Based on this framework, the following are hypothesized:

Recall

Research H1: Learning style will significantly influence recall of instructional module content. Abstract learners will have higher recall than concrete learners.

Research H2: The interaction between learning style and content delivery method will significantly influence recall. Abstract learners will have higher recall scores in the non-linear condition and concrete learners will have higher recall scores in the linear condition.

Research H3: The interaction between learning style and pre-instructional strategy will significantly influence recall. Abstract learners will have higher recall scores in the elaborative interrogation condition, followed by the factual questioning condition and then the pre-instructional strategy (PIS) control condition. Concrete learners will have higher recall scores in the (PIS) control condition, followed by the factual questioning condition, and then elaborative interrogation.

Overall Satisfaction

Research H4a: Learning style will significantly influence overall satisfaction with the learning module. Abstract learners will be more satisfied with the instructional model than concrete learners.

Research H4b: The interaction between learning style and content delivery method will significantly influence overall satisfaction. Abstract learners will be more satisfied in the non-linear condition and concrete learners will be more satisfied in the linear condition.

Research H4c: The interaction between learning style and pre-instructional strategy will significantly influence overall satisfaction. Abstract learners will be more satisfied in the elaborative interrogation condition, followed by the factual questioning condition and then the (PIS) control condition. Concrete learners will be more satisfied in the (PIS) control condition, followed by the factual questioning condition, and then elaborative interrogation.

<u>Satisfaction with Information Needs Fulfilled</u>

Research H5a: Learning style will significantly influence satisfaction with information needs fulfilled with the learning module. Abstract learners will be more satisfied than concrete learners.

Research H5b: The interaction between learning style and content delivery method will significantly influence satisfaction with information needs fulfilled. Abstract learners will be more satisfied in the non-linear condition and concrete learners will be more satisfied in the linear condition.

Research H5c: The interaction between learning style and pre-instructional strategy will significantly influence satisfaction with information needs fulfilled. Abstract learners will be more satisfied in the elaborative interrogation condition, followed by the factual questioning condition and then the (PIS) control condition. Concrete learners will be more satisfied in the (PIS) control condition, followed by the factual questioning condition, and then elaborative interrogation.

<u>Satisfaction with Content</u>

Research H6a: The interaction between learning style and content delivery method will significantly influence content satisfaction. Abstract learners will be more satisfied in the non-linear condition and concrete learners will be more satisfied in the linear condition.

Research H6b: The interaction between learning style and content delivery method will significantly influence content satisfaction. Abstract learners will be more satisfied in the non-linear condition and concrete learners will be more satisfied in the linear condition.

Research H6c: The interaction between learning style and pre-instructional strategy will significantly influence content satisfaction. Abstract learners will be more satisfied in the elaborative interrogation condition, followed by the factual questioning condition and then the (PIS) control condition. Concrete learners will be more satisfied in the (PIS) control condition, followed by the factual questioning condition, and then elaborative interrogation.

CHAPTER 3

METHODS

Introduction

This research presents the results of an experimentally designed research study that examines the effects of learning style, content delivery method, and pre-instructional strategy on short-term recall and learner satisfaction of electronically delivered information.

Sample

The sample for this research consists of 242 students enrolled in communication classes at a large Midwestern university. Sixty-seven percent of participants were female and 32 percent were male. Ages ranged from 19 to 51 (M = 21.18, SD = 2.61). Eighty percent were Caucasian, five percent were African American, five percent were Asian, three percent were Latino, and the remaining six percent were Native American or other. Twenty-three percent were seniors, 21 percent juniors, 32 percent sophomores, and the remaining 24 percent were first year students. Eighty percent of participants indicated they were taking the course as a required course. Reported grade point average ranged from 1.58 to 4.00 on a four-point scale (M = 3.13, SD = .49).

Four percent of participants reported an estimated family income under $20,000. Six percent estimated their family income between $20,000 and $34, 999. Another ten percent estimated family income between \$35,000 and \$49,999. Twenty five percent estimated family income in the \$50,000 to \$74,999 range and fifty two percent said their family income was more than \$75,000. Twelve percent of participants said their hometown was urban, 70 percent said suburban, and 18 percent indicated rural.

Internet and Computer Use

Personal computer and Internet use is high among this sample. The number of years participants have been using a computer ranged from zero to 25 (M = 9.55, SD = 4.56). Ninety-three percent of participants said they had a computer in their home when growing up, with 87 percent of those reporting that they had Internet access while growing up. Ninety-seven percent of participants reported owning a personal computer outside of their family or home computer.

Participants reported using the Internet between one and 15 years (M = 5.89, SD = 3.26). Seventy-eight percent of participants reported using the Internet daily (M = 6.59, SD = .97). Daily Internet use among participants started about 10 years ago (M = 4.22, SD = 2.24), and ranges from 17 minutes to eight and a half hours a day (M = 3.11, SD = 1.91). Time spent on the Internet yesterday ranged from zero to 11 hours (M = 2.24, SD = 1.87). Of that, average web use broke down into about 30 minutes web browsing (M = 32.63, SD = 33.196), 50 minutes using email/chat or newsgroups (M = 48.06, SD = 66.55), 26 minutes seeking information (M = 26.04, SD = 33.32), eight minutes playing online games (M = 8.46, SD = 27.42) and 17 minutes using the Internet for other reasons (M = 17.03, SD = 29.73).

Seventy percent of participants said they used the Internet for education; 49 percent use it for shopping/gathering product information; 62 percent use it for entertainment; 25

percent use it for business; 72 percent use it for communication with others (not including email); 60 percent use it to gather information for personal needs; and 59 percent admitted to using it for wasting time. Thirteen percent of participants said they launched their browsers for a specific task or activity more than nine times a day. Thirty percent said they launched a browser five to eight times a day, 40 percent said one to four times a day, 13 percent said a few times a week, with three percent opening a new browser once a month or less.

Procedure

Participants were initially contacted through an in-class solicitation. Students were offered extra credit to participate in this research with an alternative non-research extra credit opportunity assigned by their instructors. Pre-test data measuring the Kolb Learning Style Inventory and descriptive participant data was collected through an online survey. Each participant was given a URL where the assigned pre-survey was located and the pre-test survey was completed from the participant's personal computer or one of several on-campus public computer labs. After the pre-test, participants signed up for 30 minutes of research participation in a campus computer lab. Since Learning Style is a naturally occurring independent variable, participants were not randomly assigned to conditions based on their preferred style. Participants were, however, randomly assigned to one of six conditions consisting of all possible combinations of the remaining independent variables to test the hypotheses. Following random assignment, participants were given 30 minutes to interact with the instructional material. Immediately following the experimental session, participants were given an electronic post-test survey measuring satisfaction with the online modules and short-term recall of instructional content.

Content for the instructional modules consisted of information students in a typical undergraduate communication course would be exposed to. The subject matter was divided into three distinct content modules consisting of *digitizing a signal*, *transmission media*, and *high definition television*. The first content module contained information about digitizing a signal and covered topics such as the digitizing process, the four steps of converting a signal from analog to digital, and multiplexing.[2] The second content module consisted of information on transmission media and covered topics such as guided and unguided media; types of satellites; and the last mile.[3] Finally, the third content module covered high definition television including content consisting of types of HDTV, aspect ratios, components, and production.[4] All instructional content was presented in audio and video (Flash 7.0) format consisting of a combination of lecture and visual aids similar to a Power Point presentation.[5] Each content module was controlled using a play button, a stop button, a rewind button and a fast forward button. The rewind button and fast forward buttons either advanced or reversed the content by 10 seconds.

<u>Learning Style</u>

Learning style is assessed through 12, four-item scales where participants rank items that best represent their preferred learning style in a specific learning context which displays the four learning dimensions. Four learning styles were measured using Kolb's

[2] For a full transcription of the digitizing content module, see appendix A.
[3] For a full transcription of the transmission media module, see appendix B.
[4] For a full transcription of the HDTV module, see appendix C.
[5] See appendix D and E for examples of the content module.

Learning Style Inventory and then combined into two different learning types (*alpha* = .82). As cited in Simon (2000), accommodators and convergers were combined to create the abstract learning style and divergers and assimilators were combined to create the concrete learning style. There were 93 abstract learners and 145 concrete learners.

Content Delivery Method

Two types of content delivery methods were used. The first method consisted of non-linear delivery. Each of the three content modules was divided into two separate parts creating a total of six smaller presentation modules. Participants were then able to choose which content module they wanted to watch first, second, third etc. The second type of content presentation was linear presentation. Once the participant pushed play on the content module, the information was presented to them in one stream. Participants in both conditions were able to stop, rewind or fast forward content as needed.

Pre-Instructional Strategies

The third manipulated condition consisted of three pre-instructional strategies. The first condition, or control, reminded participants at the beginning of every content module that they would be asked some questions about the content after they were finished viewing all of the material.[6] The second condition, elaborative interrogation, asked questions about information that was implied in the content, but not specifically listed or presented.[7] The third condition, factual questioning, prompted participants to think about answers to specific questions about content present during the content module.[8]

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[6] Condition one: Remember, you will be asked some questions after you view all thee content modules.
[7] Condition two: Elaborative Interrogation questions 1) Why are live reports from the other side of the world delayed in time (tm)? 2) How do satellites move around the Earth (tm)? 3) How is multiplexing used in creating a signal for HDTV (das)? 4) Why are ID codes important (das)? 5) What happens when the FCC

Outcome Variables

Satisfaction

An electronic post-test survey was used to measure the dependent variables. Satisfaction is defined as one's belief in their ability to achieve success and the feeling associated with that outcome (Keller, 1983). Three measure of satisfaction were assessed—overall, information needs met and content. Overall satisfaction was measured using a modified version of Doll & Torkzadeh (1988) satisfaction scale (*alpha* = .91, *M* = 3.42, *SD* = .48). The overall satisfaction scale consists of 14 items measured on a seven-point Likert type scale ranging from strongly disagree (1) to strongly agree (7).

Satisfaction with information needs fulfilled is assessed through one's belief that the content modules contained all of the information they needed. Satisfaction with information needs fulfilled was measured using a modified version of Doll & Torkzadeh (1988) satisfaction scale (*alpha* = .81, *M* = 3.61, *SD* = .84) and consisted of a three-item scale measured on a seven-point Likert type scale ranging from strongly disagree (1) to strongly agree (7).

Content satisfaction is one's belief that the content modules contained all of the necessary content. Content satisfaction was measured using a modified version of Doll & Torkzadeh (1988) satisfaction scale (*alpha* = .83, *M* = 3.74, *SD* = .76) and consisted of a three-item scale measured on a seven-point Likert type scale ranging from strongly disagree (1) to strongly agree (7).

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revokes additional bandwidth after conversion (hdtv)? 6) Why is HDTV more expensive than regular TV (hdtv)?

[8] Condition three: Factual Questions 1) Which satellite has the largest footprint (tm)? 2) What is the difference between a single hop and a multi hop (tm)? 3) What are discreet values (das)? 4) Why is multiplexing important (das)? 5) What are the HDTV growing conditions (hdtv)? 6) How are signals for HDTV compressed (hdtv)?

Recall

Short-term recall was measured by summing the final score on a recall-type test at the end of the experimental session. One point was awarded for every question answered correctly. Participants were asked a total of twelve questions.[9] Four questions worth one point each about digitizing a signal, four questions worth one point each about transmission media, and four questions worth one point each about high definition television. Questions for the recall test have been developed over a period of eight quarters during the actual teaching of the content areas. After summing all questions, overall recall scores ranged from zero to 18 (*alpha* = .80, *M* = 11.35, *SD* = 3.75).[10]

Control Variable

Social Cognitive Theory offers a broader understanding of the cognitive process in the form of self-efficacy and the factors that drive motivation. Since self efficacy has been directly associated with success in online learning (Swan, et al., 2000; Martinez & Sweger, 1996; & Sturgill, Martin and Gay, 1999), one way to deepen the understanding of how people learn using multimedia is by understanding how self efficacy affects them in this type of environment. Bandura's (1977). Thus, the current study used self efficacy with online learning as a control variable. Online learning self-efficacy was measured during the pre-test using a modified version of Thompson, Higgins, and Howell (1994) self efficacy scale (*alpha* = .91, *M* = 3.63, *SD* = 1.31) and consisted of five questions on a seven-point Likert type scale ranging from strongly disagree (1) to strongly agree (7).

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[9] See appendix (G), part five for the recall questionnaire.

[10] An ANOVA comparison of scores by content and the independent variables showed no significant differences between the three content types, suggesting the absence of an order effect.

Data Analysis

All analyses were conducted using the Statistical Package for Social Science, version 12. To assess each of the hypothesized relationships a general linear model was used to measure the two dependent variables.

CHAPTER 4

RESULTS

This research presents the results of an experimentally designed research study that examines the effects of learning style, content delivery method, and pre-instructional strategy on recall and satisfaction in an online learning environment. The three independent variables consisted of 1) two learning styles: concrete and abstract; 2) two content delivery methods: linear and nonlinear; and 3) three pre-instructional strategies: control, elaborative interrogation and factual questioning. The 244 participants were tested on their individual learning styles and then randomly assigned to one of six conditions, which consisted of all the possible variations of the remaining independent variables. Online learning self-efficacy was used as a covariate in all analyses.

Descriptive Statistics

Since self efficacy was used as a covariate, estimated marginal means will be presented in the results section. Table 3 presents the raw means and standard deviations for the dependent measure of recall and the three dependant measures of satisfaction[11] *(overall satisfaction, satisfaction with information needs fulfilled and content satisfaction)* by the three independent variables including *learning style*, *content delivery method*, and pre-*instructional strategy*.

[11] Mean scores for the satisfaction variables are presented as sum of scale items (1=strongly disagree; 7=strongly agree).

		Mean	Variance	Std. Dev.
Recall				
By Learning Style:	abstract	12.21	9.56	3.09
	concrete	10.84	15.76	3.97
By Content Delivery Method:	non-linear	11.19	13.38	3.66
	linear	11.58	12.00	3.76
By Pre-Instructional Strategy:	control	11.98	11.23	3.35
	elaborative interrogation	11.25	14.26	3.78
	factual questioning	10.97	15.24	3.90
Overall Satisfaction				
By Learning Style:	abstract	3.52	.22	.47
	concrete	3.41	.18	.43
By Content Delivery Method:	non-linear	3.41	.22	.47
	linear	3.50	.19	.42
By Pre-Instructional Strategy:	control	3.44	.17	.41
	elaborative interrogation	3.31	.22	.47
	factual questioning	3.50	.20	.45
Satisfaction with Information Needs Fulfilled				
By Learning Style:	abstract	3.62	.63	.79
	concrete	3.57	.65	.80
By Content Delivery Method:	non-linear	3.55	.63	.79
	linear	3.76	.65	.80
By Pre-Instructional Strategy:	control	3.71	.61	.78
	elaborative interrogation	3.56	.67	.82
	factual questioning	3.70	.66	.81
Content Satisfaction				
By Learning Style:	abstract	3.91	.48	.68
	concrete	3.71	.51	.72
By Content Delivery Method:	non-linear	3.66	.57	.76
	linear	3.88	.49	.70
By Pre-Instructional Strategy:	control	3.83	.44	.66
	elaborative interrogation	3.73	.50	.71
	factual questioning	3.81	.58	.76

Table 3

Descriptive Statistics for Recall and Satisfaction by Learning Style, Content Delivery Method and Pre-Instructional Strategy.

Interpretation of Results

To test hypotheses 1 through 6, a two (learning styles) by two (content delivery method) by three (pre-instructional strategy) factorial design was used. Self efficacy as a covariate failed to interact with any of the independent variables on the dependent measures, and thus, results will represent a test of the full factorial model.[12]

Summary Table—Recall

Table 4 presents the estimated marginal means, standard error and summary statistics for *recall*. After co-varying out the main effects of self-efficacy, $F_{(1,224)} = 2.810$, $p = .095$, *PES* = .01, hypothesis 1 was supported. There was a main effect for learning style on recall, $F_{(1, 224)} = 9.021$, $p < .05$, Partial Eta Squared (*PES*) = .04. As predicted, recall for abstract learners ($M = 12.21$) was significantly higher than concrete learners ($M = 10.74$). There was no support for hypotheses 2 and 3. Data did not indicate a significant interaction between learning style and content delivery method on recall, $F_{(1, 224)} = .033$, $p = .855$, *PES* = .00, or between learning style and pre-instructional strategy on recall, $F_{(1, 224)} = .799$, $p = .451$, *PES* = .01.

[12] According to Keppel (1991), measures of covariance should be taken before the actual experiment to ensure the covariate is not contaminated by exposure to the independent variables. In this case, self efficacy was measured during the pre-test prior to exposure to the independent variables.

	Estimated Marginal Mean	Std. Error	F	Sig.	Partial Eta Squared
Covariate					
Self efficacy			2.810	.095	.012
Combined					
Learning Style			9.021*	.003	.038
Abstract	12.21(b)	.38			
Concrete	10.74(a)	.31			
Content Delivery Method			.109	.742	.000
Non-Linear	11.39(a)	.35			
Linear	11.56(a)	.35			
Pre-Instructional Strategy			1.896	.153	.016
Control	12.19(a)	.47			
Elaborative Interrogation	11.21(a)	.40			
Factual Questioning	11.03(a)	.42			
*Learning Style * Content Delivery*			.033	.855	.000
Abstract * Non-linear	12.09	.55			
Abstract * Linear	12.34	.54			
Concrete * Non-linear	10.71	.42			
Concrete * Linear	10.78	.44			
*Learning Style * Pre-Instructional Strategy*			.799	.451	.007
Abstract * Control	12.51	.78			
Abstract * Elaborative Interrogation	12.29	.58			
Abstract * Factual Questioning	11.84	.63			
Concrete * Control	11.88	.50			
Concrete * Elaborative Interrogation	10.13	.55			
Concrete * Factual Questioning	10.22	.54			
*Content Delivery * Pre-Instructional Strategy*			1.012	.365	.009
Non-Linear * Control	12.07	.67			
Non-Linear * Elaborative Interrogation	11.56	.57			
Non-Linear * Factual Questioning	10.57	.57			
Linear * Control	12.31	.64			
Linear * Elaborative Interrogation	10.87	.57			
Linear * Factual Questioning	11.50	.61			
*Learning Style * Content Delivery * Pre-Instructional Strategy*			.377	.686	.003

*p<.05, R Squared = .079 (Adjusted R Squared = .030); Covariates appearing in the model are evaluated at the following values: SE = 26.066. *Note*. Within each independent variable, means with a different subscript are significantly different at p < .05 by Bonferroni pairwise comparison among estimated marginal means.

Table 4

Estimated Marginal Means, Standard Error and Summary of Three-Way ANOVA for Overall Recall.

Summary Table—Overall Satisfaction

Table 5 presents the estimated marginal means, standard error and summary statistics for *overall satisfaction* after co-varying out the main effect of self efficacy, $F_{(1, 225)} = 137.375$, $p < .05$, $PES = .38$. Hypothesis 4a was supported. There was a main effect for learning style on satisfaction, $F_{(1, 224)} = 4.580$, $p < .05$, Partial Eta Squared (PES) = .02. As predicted, overall satisfaction for abstract learners ($M = 3.50$) was higher than concrete learners ($M = 3.40$).

Hypothesis 4b and 4c were not supported. There was not an interaction detected between learning style and content delivery method on overall satisfaction, $F_{(1, 225)} = 1.376$, $p = .242$, $PES = .01$, and the predicted interaction between learning style and pre-instructional strategy did not have a significant effect on overall satisfaction, $F_{(1, 225)} = .819$, $p = .442$, $PES = .01$.

	Estimated Marginal Mean	Std. Error	F	Sig.	Partial Eta Squared
Covariate					
Self efficacy			137.375*	.000	.375
Combined					
Learning Style			4.580*	.033	.020
Abstract	3.50(a)	.04			
Concrete	3.40(b)	.03			
Content Delivery Method			2.962	.087	.013
Non-Linear	3.41(a)	.03			
Linear	3.49(a)	.03			
Pre-Instructional Strategy			1.435	.240	.012
Control	3.49(a)	.05			
Elaborative Interrogation	3.40(a)	.04			
Factual Questioning	3.47(a)	.04			
*Learning Style * Content Delivery*			1.376	.242	.006
Abstract * Non-linear	3.43	.05			
Abstract * Linear	3.57	.05			
Concrete * Non-linear	3.39	.04			
Concrete * Linear	3.41	.04			
*Learning Style * Pre-Instructional Strategy*			.819	.442	.007
Abstract * Control	3.53	.08			
Abstract * Elaborative Interrogation	3.42	.05			
Abstract * Factual Questioning	3.56	.06			
Concrete * Control	3.45	.05			
Concrete * Elaborative Interrogation	3.38	.05			
Concrete * Factual Questioning	3.38	.05			
*Content Delivery * Pre-Instructional Strategy*			2.263	.106	.019
Non-Linear * Control	3.38	.07			
Non-Linear * Elaborative Interrogation	3.40	.06			
Non-Linear * Factual Questioning	3.45	.06			
Linear * Control	3.61	.06			
Linear * Elaborative Interrogation	3.39	.06			
Linear * Factual Questioning	3.48	.06			
*Learning Style * Content Delivery * Pre-Instructional Strategy*			2.865	.059	.024

*$p<.05$, R Squared = .079 (Adjusted R Squared = .030); Covariates appearing in the model are evaluated at the following values: SE = 26.066. *Note*. Within each independent variable, means with a different subscript are significantly different at $p < .05$ by Bonferroni pairwise comparison among estimated marginal means.

Table 5

Estimated Marginal Means, Standard Error and Summary of Three-Way ANOVA for Overall Satisfaction.

Summary Table—Satisfaction with Information Needs Fulfilled

Table 6 presents the estimated marginal means, standard error and summary statistics for *satisfaction with information needs fulfilled* after co-varying out the significant main effect of self efficacy, $F_{(1, 225)} = 52.209$, $p < .05$, *PES* = .19. There was support for hypotheses 5a, $F_{(1, 225)} = 4.442$, $p < .05$, *PES* = .02. As predicted, there was a main effect for learning style on satisfaction with information needs fulfilled. Abstract learner satisfaction ($M = 3.77$) was significantly higher than concrete learner satisfaction ($M = 3.56$).

Hypothesis 5b was not supported. There was no interaction between learning style and content delivery method on satisfaction with information needs fulfilled, $F_{(1, 225)} = 2.476$, $p = .117$, *PES* = .01. There was also no support for hypothesis 5c. The interaction between learning style and pre-instructional strategy on satisfaction with information needs fulfilled was not significant, $F_{(1, 225)} = 1.444$, $p = .238$, *PES* = .01.

However, in addition to the results presented based on the hypotheses, a significant interaction between content delivery and pre-instructional strategy on satisfaction with information needs fulfilled was found, $F_{(1, 225)} = 3.128$, $p = .05$, *PES* = .03. Between participants in the non-linear content delivery condition, satisfaction scores were highest for factual questioning (M=3.64), followed by PIS control (M=3.52), and then elaborative interrogation (M=3.51). In the linear condition, participants were most satisfied with the PIS control condition (M=4.10), followed by the factual questioning condition (M=3.67) and then elaborative interrogation (M=3.57) (Figure 1).

	Estimated Marginal Mean	Std. Error	F	Sig.	Partial Eta Squared
Covariate					
Self efficacy			52.209*	.000	.186
Combined					
Learning Style			4.442*	.036	.019
Abstract	3.77(a)	.08			
Concrete	3.56(b)	.06			
Content Delivery Method			5.193*	.024	.022
Non-Linear	3.56(b)	.07			
Linear	3.78(a)	.07			
Pre-Instructional Strategy			2.435	.090	.021
Control	3.81(a)	.09			
Elaborative Interrogation	3.54(a)	.08			
Factual Questioning	3.66(a)	.08			
*Learning Style * Content Delivery*			2.476	.117	.011
Abstract * Non-linear	3.58	.11			
Abstract * Linear	3.96	.11			
Concrete * Non-linear	3.53	.08			
Concrete * Linear	3.60	.09			
*Learning Style * Pre-Instructional Strategy*			1.444	.238	.012
Abstract * Control	3.96	.16			
Abstract * Elaborative Interrogation	3.53	.12			
Abstract * Factual Questioning	3.83	.13			
Concrete * Control	3.65	.10			
Concrete * Elaborative Interrogation	3.55	.11			
Concrete * Factual Questioning	3.49	.11			
*Content Delivery * Pre-Instructional Strategy*			3.128*	.046	.027
Non-Linear * Control	3.52	.13			
Non-Linear * Elaborative Interrogation	3.51	.11			
Non-Linear * Factual Questioning	3.64	.11			
Linear * Control	4.10	.13			
Linear * Elaborative Interrogation	3.57	.11			
Linear * Factual Questioning	3.67	.12			
*Learning Style * Content Delivery * Pre-Instructional Strategy*			1.871	.156	.016

*$p<.05$, R Squared = .079 (Adjusted R Squared = .030); Covariates appearing in the model are evaluated at the following values: SE = 26.066. *Note*. Within each independent variable, means with a different subscript are significantly different at $p < .05$ by Bonferroni pairwise comparison among estimated marginal means.

Table 6

Estimated Marginal Means, Standard Error and Summary of Three-Way ANOVA for Satisfaction with Information Needs Fulfilled.

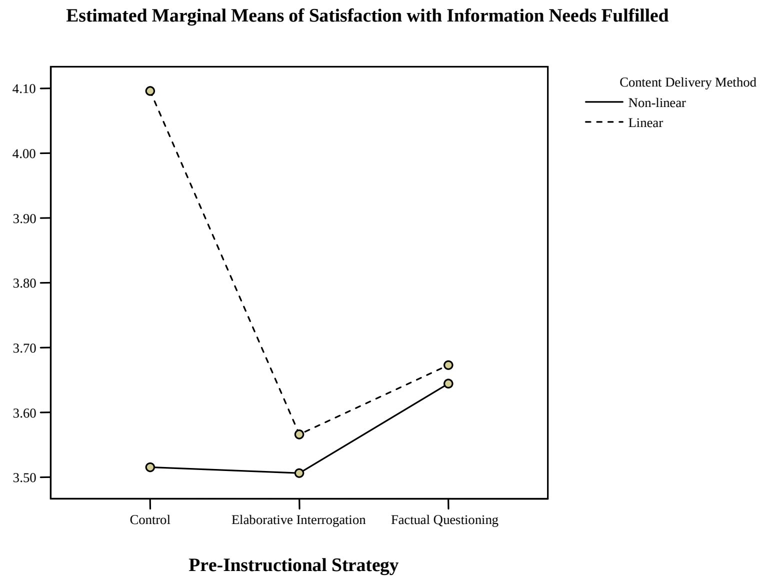

Figure 1

<u>Plot of Interaction between Content Delivery Method and Pre-Instructional Strategy on Satisfaction with Information Needs Fulfilled.</u>

<u>Summary Table—Content Satisfaction</u>

Table 7 presents the estimated marginal means, standard error and summary statistics for *content satisfaction* after co-varying out the significant main effect of self efficacy, $F_{(1, 225)} = 61.510$, $p < .05$, *PES* = .21. There was support for hypotheses 6a, $F_{(1, 225)} = 4.226$, $p < .05$, *PES* = .02. As predicted, content satisfaction for abstract learners ($M = 3.88$) was significantly higher than concrete learners ($M = 3.70$).

Hypothesis 6b was not supported. The interaction between learning style and content delivery method on content satisfaction was not significant, $F_{(1, 225)} = 2.318$, $p = .129$, *PES* = .01. Hypothesis 6c was also not supported. There was no interaction between learning style and pre-instructional strategy on content satisfaction, $F_{(1, 225)} = 1.140$, $p = .322$, *PES* = .01.

However, in addition to the results presented based on the hypotheses, a significant main effect for content delivery method on content satisfaction was found, $F_{(1, 225)} = 4.901$, $p < .05$, *PES* = .02. Here, participants were more satisfied with the linear content delivery method ($M = 3.89$) than the non-linear content delivery method ($M = 3.70$).

	Estimated Marginal Mean	Std. Error	F	Sig.	Partial Eta Squared
Covariate					
Self efficacy			61.510*	.000	.212
Combined					
Learning Style			4.226*	.041	.018
Abstract	3.88(a)	.07			
Concrete	3.70(b)	.05			
Content Delivery Method			4.901*	.028	.021
Non-Linear	3.70(b)	.06			
Linear	3.89(a)	.06			
Pre-Instructional Strategy			1.495	.226	.013
Control	3.90(a)	.08			
Elaborative Interrogation	3.71(a)	.07			
Factual Questioning	3.77(a)	.07			
*Learning Style * Content Delivery*			2.318	.129	.010
Abstract * Non-linear	3.72	.10			
Abstract * Linear	4.04	.09			
Concrete * Non-linear	3.67	.07			
Concrete * Linear	3.73	.08			
*Learning Style * Pre-Instructional Strategy*			1.140	.322	.010
Abstract * Control	4.01	.14			
Abstract * Elaborative Interrogation	3.71	.10			
Abstract * Factual Questioning	3.92	.11			
Concrete * Control	3.79	.09			
Concrete * Elaborative Interrogation	3.71	.10			
Concrete * Factual Questioning	3.62	.10			
*Content Delivery * Pre-Instructional Strategy*			2.600	.076	.022
Non-Linear * Control	3.66	.12			
Non-Linear * Elaborative Interrogation	3.67	.10			
Non-Linear * Factual Questioning	3.77	.10			
Linear * Control	4.14	.11			
Linear * Elaborative Interrogation	3.75	.10			
Linear * Factual Questioning	3.78	.11			
*Learning Style * Content Delivery * Pre-Instructional Strategy*			2.067	.129	.018

*p<.05, R Squared = .079 (Adjusted R Squared = .030); Covariates appearing in the model are evaluated at the following values: SE = 26.066. *Note*. Within each independent variable, means with a different subscript are significantly different at p < .05 by Bonferroni pairwise comparison among estimated marginal means.

Table 7

Estimated Marginal Means, Standard Error and Summary of Three-Way ANOVA for Content Satisfaction.

CHAPTER 5

DISCUSSION

Discussion and Implications

Data indicate that learning style affected recall and satisfaction as predicted. Abstract learners had higher recall scores and were more satisfied with all three measures of satisfaction. Content delivery method had an effect on satisfaction with information needs fulfilled and content satisfaction. Participants were more satisfied with information needs fulfilled and content in the linear condition. Further, the interaction between content delivery method and pre-instructional strategy had an affect on satisfaction with information needs fulfilled. Participants were most satisfied with the linear control condition.

Learning Styles

The ability to manipulate hyper-media makes it a prime candidate for customizing online content to individual learning styles (Dillon & Gabbard, 1998; Jonassen & Wang, 1993). Within the current research, learning style positively affected recall for abstract learners who were predicted to perform better than concrete learners in the online learning environment. Learning style also had a significant impact on satisfaction. Abstract learners were more satisfied in the online learning environment than concrete learners. These findings are important because given the choice, when learners are more satisfied with the learning environment, information presented, and content, they are more likely to use that particular tool for learning (Christensen, Anakwe, and Kessler, 2001; Wang, Hinn, & Kanfer, 2001). Learning style also had a significant impact on recall in the online learning environment. As predicted, abstract learners had higher recall and were more satisfied than concrete learners. When higher recall scores are combined with higher satisfaction scores in the online learning environment, it seems probable that those participants who scored higher and were more satisfied would be more likely to use the web for learning. This has important considerations for designing information that engages each of the learner types.

Previous research indicates mixed results when comparing learning across media. Although many studies comparing print and web-based learning have found learning from print is more effective than the web (Eveland & Dunwoody, 2001; Sundar, Narayan, Obregon, & Uppal, 1998; Tewksbury & Alhaus, 2000), there is some indication that students are satisfied with online learning environments and find similar achievement levels (Swan, et al., 2000; Hiltz, 1994; Kearsley, 2000; Moore & Thompson, 1990; Newman Webb & Cochrane, 1995; & Ruberg, Taylor, and Moore, 1996). The result of this research indicates a difference in recall and satisfaction between two types of learners in an online learning environment. Previous research not accounting for learning styles may have produced mixed results because the effects of abstract learners in a traditional learning environment produced lower recall and satisfaction scores than concrete learners; but abstract learners may have had higher recall scores and were more satisfied in the online environment. The reverse can be said of concrete learners, with the effects of these competing results creating the mixed findings. A comparison of traditional and online learning taking learning style into consideration might help further explain the differences when comparing learning across media.

Based on these finding, is it not surprising that there are mixed results among comparisons of traditional and online learning. There is clear evidence to support difference by learning style in this online environment, so there could be similar effects in previous research. Further, by the time students reach college; they have had at least 12 years to become skilled at how to learn through traditional methods. Consequently, their normal, conditioned learning method would be the default learning mode. This is import to consider since it is evident that online learning will continue to play an increasingly important role in web-based information seeking and information gathering for broader applications than education as presented here. Simply put, it seems inevitable that abstract and concrete learners alike will find themselves in some type of electronic learning environment (for example, seeking information on a political candidate, researching information about health care, or buying a new car). This is where the strength of multimedia and multiple information presentation can play an important role.

To this end, the best approach for customized information presentation might be "negotiated self-direction," where both types of learners are presented with several choices and are free to select one based on their preferred learning style. In this case, a combination of presentation options combined with multimedia presentations of information would be the most beneficial. Moreover, presenting the same types of information in different forms allows the learner to process information through "cognitive rehearsal" (Sundar, 2000), which can increase recall through repeated exposure to content through various media.

Of note, several participants in the current study commented that they were not interested in the material, or found it boring. Trying to determine if this is based on learning style or some other variable like motivation would help further explain the relationship among learning style, recall and satisfaction. Jones, Reichard and Kouider (2003) found that student learning styles differ by discipline, so learning style research measuring type of learners by content area would provide a more detailed picture of this relationship. Additionally, although Kolb's LSI was recommended by a number of studies based on its proclivity towards experiential learning (a key factor in the design and testing of the experimental design), it would have been useful to measure more than one learning style. A measure of learning style and its appropriateness for learning particular types of information is needed. Another useful aspect to understanding learning styles would involve advising participants of their learning styles in an attempt to understand how this knowledge affects satisfaction and recall in online learning. There is some support for the idea that learners who are aware of their learning style perform differently than those who do not (Graham, et. al., 2005).

At a minimum, the relationship among learning styles, recall and satisfaction is important to instructors creating course content for students. Further understanding of learning styles will allow information providers to 1) construct information that helps improve learning through the recognition of different types of learners, and 2) begin to develop an understanding of why some information presented to certain students does not seem to "sink in." As suggested by Wang, Hinn, and Kanfer (2001), one of the earliest course assignments should be a class survey that measures learning style, previous learning experience and self-efficacy, which has also been shown to predict performance and satisfaction in an online environment in this research and elsewhere.

Content Delivery Method

Content delivery method had an effect on satisfaction with information needs fulfilled and content satisfaction. It was predicted that learning style and content delivery method would have a significant interaction and that abstract learners in the non-linear condition would have increased recall and satisfaction scores over concrete learners in the linear condition, but there was not a significant interaction between the two variables. Instead, all participants regardless of learning style were more satisfied with the linear content delivery. An unpredicted significant interaction between content delivery method and pre-instructional strategy on content satisfaction was also detected. Here, participants were most satisfied with the content presented in the linear, control condition. Although satisfaction did provide significant difference by content delivery method, recall was not influenced by content delivery method or the predicted interaction between learning style and content delivery.

Although inconclusive through the current data, by dividing the three content areas into six different four-minute video presentations, it is possible that the information presented contributed to cognitive overload. That said, researchers have been testing different content delivery methods based on levels of interactivity in an attempt to understand how optimal levels of information presentation affect performance in online learning environments. The linear condition seemed to provide more satisfaction to both types of learners. It is possible the linear condition, which was essentially a streaming video with no interruptions, allowed all participants to passively engage the content,. In short, the linear control condition resembled a traditional classroom session with information coming at participants opposed to actively seeking it. In the context of the experimental design, it was easiest to “watch” the linear content presentation which required minimal interaction opposed to the non-linear condition which required making a navigational choice every four to five minutes.

Another consideration could be the learners’ goal strategy. Goals have both an internal (desired outcome—i.e. a perfect score on a test) and external (the condition sought—i.e. completion of a project) component (Locke, 1996).In the case of an experimentally designed research study, participants often have different goals for completion (e.g., extra credit) than the researcher. Simply put, for individuals to perform well in any task, especially a more demanding task such as that presented by the non-linear environment, an additional form of motivation would be required to reduce the possibility of conflicting goals (Ambrose & Kulik, 1999).

It is assumed that learners will be committed to a specific goal, but the level of commitment depends on a couple of things. One, that they posses the knowledge needed to perform the task, and two, their level of self-efficacy match their ability (Ambrose & Kulik, 1999; Latham & Locke, 1991; Locke, 1996). The interaction between perceived goal difficulty and commitment is strongly related (Ambrose & Kulik, 1999; Locke & Latham, 1990b), and personal or self-set goals seem to influence learners more than assigned goals (Ambrose & Kulik, 1999; Locke & Latham, 1990b). In this experiment, online learning self efficacy had a main effect on all levels of satisfaction, and approached significance for recall, so competing learner goals could explain the lack of a relationship between learning style and content delivery method.

Pre-Instructional Strategies

It was predicted that when pre-instructional strategy matched learning style and content-delivery method, both recall and satisfaction would increase. However, pre-instructional strategy failed to have any impact on recall or satisfaction in the current research despite evidence in the literature to support these ideas. The relationship between knowledge and motivation is one of the primary constructivist principles (Savery & Duffy, 1995). By associating the learning task with the learner’s experience, it should provide ownership to the student, increasing motivation and desire to learn or perform the task at hand (Savery & Duffy, 1995).

Currently information needs met online include convenience, social implications, intellectual appeal and social restraints (Kuehn, 1994). Compared to the limitations of traditional learning (i.e. classroom-based, one to many type of instruction, limited personal feedback, etc.), if learning style and motivations to use online learning match, online learning could improve the current state of online learning for abstract and concrete learners alike. Pre-instructional strategies help learners focus on the goals and objectives of each lesson, and, when matched with the learning style, provide an important tool for fostering successful learning (Sarasin, 1999).

In this research, pre-instructional strategies failed to have any effect on recall or satisfaction even though research supports goal-setting strategies that include assigning questions to learners before a learning task as an effective way to increase recall of information (Andre, 1979; Reder, 1985). It was believed that pre-instructional strategies would “prime” learners in conditions that matched their learning styles so that cognitive load would be reduced by concentrating on learning the task at hand in the mode they learn best. When the pre-instructional strategy directed the participants to concentrate on specific types of information, however, instead of triggering a cognitive process that matched the way they learn new information, they may have been sent into cognitive overload. Simply, the added task of concentrating on either factual questioning or elaborative interrogation could have acted as additional complexity to the information. If so, lower recall would be expected.

Further, often times learners lack both the sophistication required to conduct a thorough scan of content and ability to make decisions about the credibility and source of information they do find. Human ability to learn is limited by the amount of information stored in working cognitive memory which only processes small amounts of information before overloading (Kalyuga, Chandler, and Sweller, 1998; Baddeley, 1992; Miller, 1956). In this case, however, participants were working with a finite amount of information pre-determined by the nature of the content modules. Thus, their instinctual method of learning new content, which is based on twelve to fifteen years of previous experience in traditional classrooms, took over. Specifically, when instructed to “do their best,” learners were able to pick and choose important information that fit with their assimilated method of learning, and not necessarily their best method or matched method of learning.

Self-Efficacy

Self-efficacy had a significant impact on overall satisfaction, satisfaction with information needs fulfilled and content satisfaction, while failing to significantly impact recall. Efficacy is a person’s belief that they can perform a given task and the level of success they will achieve when they attempt that task (Bandura, 1999). Consequently, it seems a person's belief in their ability to learn using an online learning environments can affect their level of satisfaction with the experience regardless of the actual outcome (recall in this case). In the case of this research, participants were not informed of their recall scores prior to rating their satisfaction with the instructional models, which might have impacted their short-term evaluation of the learning environment.

Students who lack computer self efficacy often encounter frustration when working with computer-mediated communication (Sturgill, Martin, & Gay, 1999). A major concern with the display of online information is learner disorientation with the learning environment (Laurillard, 1998), and research indicates that novice users have the potential for disorientation in online learning environments, contributing to the lack of knowledge-gained (Laurillard, 1998). Disorientation increases cognitive load, thereby reducing performance and satisfaction in the online learning environment.

Additional research that deals with the presentation of information online should take self-efficacy into consideration. Since self-efficacy can affect adoption of online learning, it makes sense to understand the online learning self efficacy of future learners before placing them into an online learning environment. Learners with high self-efficacy will be less likely to experience disorientation and cognitive overload than learners high in self efficacy because they have belief in their ability to navigate successfully and overcome obstacle encountered during the learning process, and use the available resources for learning. On a practical level, learners low in online learning self efficacy should be given the opportunity to increase their self-efficacy before interacting with an online learning environment for course credit. This finding should be magnified when learners are placed in a complex learning environment, especially in the larger context of the Internet.

Limitations

This research was driven by the need to understand the relationship between customized presentations of information and strategies that affect recall and satisfaction. In this experimental setting, varying content delivery method and adding pre-instructional strategies to a limited learning task probably contributed to cognitive overload with most learners regardless of learning style. As with most experimental designs carried out in a lab situation, the current study lacks ecological validity. Trying to adopt learning styles, content delivery method and pre-instructional strategies in a constructivist-based online learning environment reduced to a 30 minute experiment has inherent limitations.

These limitations include an imposed time limit. In constructivist based learning, the goal is to allow the learner to interact with the instructional content for as long as it take to construct new information. That said, participants who finished before the elapsed time did not spend extra time interacting with the content modules, nor were they instructed to do so. Another limitation included only presenting two types of learning environments and not offering learners a choice between them.

Another concern was with note-taking. Although not available during the post-test, all participants were allowed to take notes during the content presentation. With such a short time-frame involved in the presentation of this information, it would have been a more significant challenge to the effects of learning style had participants not been allowed to take notes during the content presentation. Note-taking, however, is common practice for both online and offline learning and matches participant common practices when learning.

In light of this factor, a long-term measure of recall sometime after the initial experiment would have provided insight into the long-term and lasting effects of the learning environment.

Participant satisfaction scores were measured on three levels, but a measure of their attitude towards the learning environment could have provided deeper understanding of the relationship between learning style and the learning environment. For example, did participants believe the content delivery method they were exposed to match the way they learned best regardless of their actual learning style?

Future Directions

The results of this research indicate that there is importance in creating online learning environments that cater to different types of learners. Concrete and abstract learners interact with multimedia and interactive presentations of information differently. Also, self efficacy played a significant role in how satisfied participants were with the learning modules. Additionally, the specific nature of the information, although it was typical of the types of content students in a large communication course are exposed to, probably does not translate into general every day uses. Therefore, the successful aspects of this research should be applied to a broader context with greater appeal that fits a larger audience and utilizes a more comprehensive online learning environment.

This includes expanding the learning environment in scale and time. Previous research indicates that in addition to linear and non-linear presentations of information, there are a number of additional constructivist-based attributes that can be used to improve options for abstract and concrete learners alike. In addition to SOI, another example of a constructivist based learning theory is problem-based-learning, which can be used with a wide variety of more-complex learning environments (Duffy & Jonassen, 1992; Duffy, Lowyck, & Jonassen, 1993; Lebow, 1993; Savery & Duffy, 1995).

Problem-based-learning provides learners with the resources they need to create a deeper construction of knowledge through a negotiated exploration of complex topics. Like most constructivist-based instructional design, there needs to be clear learning goals that promote real-world type thinking that learners can apply to situations they might likely be faced with in corresponding real-work situations (Savery & Duffy, 1995). The problem-generation phase is negotiated between the learner and instructor and must create problems that can be applied to the relevant content (Savery & Duffy, 1995). Through problem presentation, students must be able to claim ownership of the problem (Savery & Duffy, 1995). And finally, the facilitator role needs to not only challenge the student's way of thinking about a problem, but also provide them with the direction to begin their search (Savery & Duffy, 1995).

A third type, and probably the most complex, of constructivist-based learning is open learning environments. Hannafin, Land and Oliver (1999) define open learning environment as setting learning goals and negotiating the methods learners use to reach those goals. The learning goals are determined using three methods. The first method is when the instructor externally specifies a problem by putting the learner in the middle of a situation that needs to be resolved (Hannafin, et al., 1999). The second is also externally specified, but in this case the learner has to come up with both problem and solution (Hannafin, et al., 1999). Finally, the third method involves unique creation of both the problem (guided by the teacher) and solution (determined by the student) (Hannafin, et al., 1999). In all three methods, as stated in constructivists learning theory, the learner finds solutions to each of these problems based on prior experience, individual needs and personal beliefs (Hannafin, et al., 1999).

Open learning environments are useful in several different situations. One important use of OLEs is when divergent opinions and ideas are valued when solving particularly complex problems (Hannafin, et al., 1999). They are also useful when learners are presented with a poorly defined problem. OLEs allow the learner to avoid predetermined and structured, or expected answers to problems (Hannafin, et al., 1999). When the goal is learning on a mass scale, however, OLEs are not the best solution for those types of learning problems (Hannafin, et al., 1999). The individual nature of OLEs makes promoting consistency difficult, and the majority of students in OLEs will develop their own interpretation of the learning problem (Hannafin, et al., 1999).

Future research using constructivist based learning and taking the results of the current research into consideration should involve three stages. The first, or introductory learning stage, is a cursory exploration of the learning environment using selecting, organizing and integrating as a starting point, and incorporating pre-instructional strategies that lead to an overview of the content area and associated issues. This first stage sets up the learning process for the second stage by alleviating some of the cognitive overload associated with navigating a new learning environment, and helping the learner to start the process of developing schemas with the new information. The second phase, or intermediate learning stage, includes problem-based learning where the instructor provides the problem to be solved and both the learner and instructor negotiate how the solution is presented. Finally, in the advanced learning stage, the learner defines a problem he or she is interested in and negotiates with the instructor all aspects of the problem and solution presentation using an open learning enviornment.

In the context of this type of learning environment, a measure of self-efficacy and how it changes throughout the process could be assessed. Additionally, a measure of learning style combined with careful tracking of the types and number of different resources used by each type of learner could provide a broader picture of how different learners use information presented to them when given a choice. Missing from the current research is an exploration of actual schemas created by learners and how they are associated with current knowledge. Building knowledge in the recommended structure would allow for a broader picture of these relationships. This type of study should be conducted over the course of an entire term versus a 30-minute experimental situation, and should be designed around an informational space with broad applications that appeal to a variety of users.

An important current topic with broad application and appeal involves training people in visual literacy and the manipulation of digital images. This topic would be an excellent context to improve on the finding presented here, because by its very nature, digital manipulating of images and visual literacy are computer-based, and the underlying relationship between technology, self efficacy and learning style can be exploited for learning. Plus, this topic is important because the understanding of visual imagery helps people make decisions about a plethora of complex topics. Visual interpretations of images are based on several different criteria, such as credibility, knowledge of media production techniques and the expression of individualized mass media messages.

Media literacy has been defined as the understanding, processing and communication of messages with media in different forms (Hobbs, 1998). According to Hobbs (1998), media literacy deals not only with the understanding, processing and communication of these messages, but the learning and teaching of media literacy skills in the classroom (Brown, 1991; Hobbs, 1994). Important to this discussion is the fact that where media literacy is taught is still open to debate. Some researchers (Hobbs, 1998) point out that there is a great need for media literacy training because schools cannot teach the necessary skills (Hobbs, 1998; Sizer, 1995). While there have been some success with media literacy programs in schools (Brown, 1991; Hobbs, 1998; Hobbs & Frost, 1997), researchers still debate the merits of teaching media literacy as part of the curriculum opposed to a special subject taught on its own (Hobbs, 1998). Paying for media literacy training is another issue. Some argue that media-sponsored literacy projects are the media's responsibility and are needed to create a critically thinking audience (Hobbs, 1998). Others disagree, claiming that the media industry is taking the critical analysis and anti-media parts of media literacy out of any training programs they develop in favor of a more simplistic view of media criticism (Hobbs, 1998). So, constructing an information rich environment that caters to different learning styles and teaches media literacy skills online will help audiences of mass-mediated messages make better decisions about the types of content they are exposed to, and the effect that content has on personal choices, while further explaining the relationship between online learning and digital media.

Conclusion

Effective online learning environments are designed with usability in mind. Learning style and self efficacy played an important role in recall and satisfaction in the online learning environment. At a minimum, learning style and self efficacy should be considered in future examinations of online learning. Mixed results produced by comparisons of online and traditional learning could also benefit from the findings presented on learning styles. Finally, although complex sites are interesting and allow information providers to demonstrate advanced web-design skills, research projects that manipulate information that can contribute to overload should be careful not to push the envelope beyond the skill level of most users.

APPENDIX (A)

TRANSCRIPTION OF THE DIGITIZING A SIGNAL CONTENT MODULE

Hello, my name is Professor Matt Eastin and I'm going to be leading the content module today that deals with digitizing a signal. When we talk about digitizing a signal, we're talking about changing an analog signal, or a signal that varies in time, to a discreet value—a zero or one. Most of this can be applied to how we convert an electrical signal or an analog signal to a light signal as well.

What is the digitizing process? When we digitize a signal, we're talking about the process of digitizing a signal so it results in a new digital binary signal that takes one of two possible discrete values. These two discrete possible values are zero and one. A lot of times these zeros and ones are called bits. When we gather some of these zeroes and ones together they are called bytes.

When we convert a signal from analog to digital, there are four steps. The first step is to filter the signal. We use a low pass filter because we want to get rid of stay high frequencies. This process is also called aliasing. Sometimes when you create a signal, stray high frequencies get in. When a high frequency gets in and hits the low-pass filter, it is removed and the signal is then cleaned and ready to be sampled, which is the second step we are talking about.

When we sample an analog signal to make it digital, we have to have a way of determining how much of it needs to be sampled. If you over-sample it, you've got a problem where you are really not taking advantage of the digitizing process because you are sending too much information. If you under sample it, you can't recreate the signal at the receiver. So, what do we do? We use the Nyquist Theorem of Sampling. The Nyquist Theorem of Sampling is defined as two times the maximum frequency component—or "2 x Fmax"—of the signal. So, let's break that down: what is the maximum frequency? If I told you the signal had a maximum frequency of two kilohertz, you would then simply multiply 2 x 2 which equals four kilohertz, or (the way we think about it in sampling) four thousand bits per second sampled.

The third step is called quantisizing. When we quantisize these samples, we're basically giving them a fixed decimal value. We do this so that we can go to the fourth step, and that is binary coding. We turn these fixed decimal values into a series of zeroes and ones.

The four basic steps are:

- Run it though a low-pass filter to check for aliasing.
- Sampling, using the Nyquist theorem at two times the maximum frequency component.
- Quantisizing: taking those samples and giving them fixed decimal values.
- And finally, binary coding, that's where we turn it into zeros and ones.

Now, when we send a digital signal, we have to actually figure out the optimal way of getting the information from point "A" to point "B". We use a process called multiplexing. Multiplexing is defined as sending two or more signals across a single channel. It would be like sending two or more signals over your co-ax cable that's running into your TV. It's how we get a lot of television signals coming in at one time. So, that is multiplexing: Two or more signals over a single channel.

The two types of multiplexing that we use in digital signals are time division multiplexing—where we have two or more signals that are interleaved between each other and then sent at the same time (they are interleaved one behind the other). The next is code division multiple access, or code division multiplexing. All of your cell phone providers are hyping this right now. What this allows us to do is break your digital signal up, and take advantage of the entire bandwidth that's available. Remember, bandwidth is the frequency needed to send the signal.

When your signal is broken up, it's given ID codes (all the information has id codes) and then it can burst through your bandwidth to find the fastest possible route to the receiver. Once it hits the receiver, it is reassembled.

Why do we digitize? Well, there are several advantages to the digitizing process. The first is bandwidth. It takes less bandwidth because we're not sending the entire signal. When we talk about going from analog to digital, analog itself stands for analogous. The signal that is sent is analogous to the signal that is received. So it's the same. When we digitize it, we don't have to send the whole signal; we only send what we've sampled. So, we actually save bandwidth which means we can send more information over the same bandwidth.

The second is compression. This is something that can get a little tricky to talk about. Compression basically means we remove all redundant information. So, for example, if there's a series of sevens in your digital signal that have been binary coded, it actually only has to send the first seven—the rest of them don't have to be sent. So we can remove redundant information. That's called compression.

And finally, we have error detection. We can actually detect whether or not the signal that is sent is the one that is received. We're able to do this with a digital signal. We can do it with an analog signal, but not as effectively. So, the three primary benefits to digitizing a signal, or merits of digitization, are bandwidth, compression and error detection.

APPENDIX (B)

TRANSCRIPTION OF THE TRANSMISSION MEDIA CONTENT MODULE

Good afternoon, my name is Professor Matt Eastin and I'm going to be leading the content module today on transmission media. This is basically the technology that we use to actually send or guide the signal from point A to point B.

Your two basic types of transmission media are guided and unguided. Guided media are any type of transmission facility that has physical constraints. Your co-ax cable or twisted pair for your phone lines—both of these have physical boundaries that control or contain your signal. There is also unguided: these are going to be any type of signal that is not constrained by physical boundaries. For our discussion today we're primarily concerned with unguided media. So let's talk about the most popular form of unguided media that's generating the biggest buzz: satellites.

There are many different types of satellites, but they primarily differ by two basic components. 1) Their orbital height: there three tiers of orbital height. The highest satellite we have is roughly 22,000 feet about the Earth, followed by a medium height and then there's low height, or orbital satellite. 2) They also vary by power. There's high, moderate and low power. Keep in mind the satellites that are the furthest away from the Earth actually require the most power because they have to send the signal the furthest, while the lowest satellite is going to require the least amount of power. How can we look at orbital height in another way? Well, we can actually look at orbital height to define what types of satellites these are. The highest orbiting satellite is called a GEO-synchronous satellite, or GEO, GEO-synchronous, or GEO-stationary. These satellites rotate with the earth so you are always in line, or always in reception with the satellite and it never moves out of detection.

The other two are called MEOs (medium earth orbit satellite), and LEO (low earth orbiting satellite). The LEO and the MEO are not GEO-stationary, meaning as the Earth rotates, they do not. This means the signals has to be passed between these different LEOs and MEOs in order for you to always stay in some type of contact with the satellite. So the GEO-stationary, or the GEO, is the only one that stays in rotation with the Earth.

Now let's take a brief look at what actually makes up these different satellites. By no means is the list we're about to look at exhaustive, or as detailed as it needs to be, but it will give you an idea of what we have on these satellites in general. First, you always have a power component. Satellites are primarily powered by solar energy. Then you have telemetry or control. This is how the satellite is maneuvered. Next you have propulsion—they use rockets to move satellites in space.

You also have communication channels and antennas. I'm going to talk about these together. You have these huge antennas that can be 30-feet long. They take the signal from the uplink and move it through the communication channel or the transponder, which then converts the signal to direct the signal to its next destination, and then it goes out the downlink. The transponder basically reconfigures the signal for its next destination.

There are some other issues dealing with satellites that you should be aware of. For example, you have probably all seen satellite delay or time delay. It's that time delay that occurs when the signal goes from my satellite phone up to the satellite and back down to the receiver or the person that's receiving my phone call.

You also have a footprint. This is the area a satellite signal covers, and it's the exhaustive footprint—it's sort of the largest area that it covers. You also have a spot beam, which is concentrating the signal into a specific area.

Single-hop versus multi-hop is how many times a signal has to bounce between a satellite and Earth back up to a satellite to get to its destination. It can also mean how many times a signal has to go from the Earth to a satellite, then to another satellite, then to the Earth. That would be an example of multi-hop. A single hop means the signal goes up to a satellite and comes back down at its destination.

You are now looking at what we consider to be the footprints and spot-beams. You can see the footprint is the wider circle. A GEO-synchronous satellite can cover about a third of the Earth's surface with its signal. And then you have spot-beams. Spot-beams come down direct on a city or location—it's concentrating on a specific area.

Now you are looking at our graph of a multi-hop versus a single hop. Just to briefly explain that to you again, a single hop is when you go up to a satellite and down to the Earth one time. A multi-hop is when you are using multiple satellites. Let's look at it that way. With a single-hop you are utilizing one satellite, and any time you utilize two or more satellites you are talking about a multi-hop.

Sending satellite signals is actually pretty cheap because they are distance insensitive: whether they are sending one, or a hundred signals, it's all the same to the satellite. I say that except for the last mile. The last mile is the distance it takes to get from the cable company to your house. Let’s say your cable company receives a satellite signal from TBS (a super-station that is sent from Atlanta)—the last mile is the distance and cost it takes to get from the headquarters of your cable company to your home.

APPENDIX (C)

TRANSCRIPTION OF THE HDTV CONTENT MODULE

Hi. My name is Professor Matt Eastin and I'm going to be leading the content module on Digital Television. Recently in the media or if you've ever gone to Best Buy or Circuit City, you've seen a lot of hype around HDTV. What this content module will do is alleviate some of the questions you may have about the different types of HDTVs are that are available.

First let me tell you that high definition is just one component of a broader scheme of digital television. There is this umbrella of digital television or advanced TV systems that is encompassed within that larger system of high definition television. In fact, there are roughly 17 versions of advanced TV systems. Of those 17, seven of them are high definition. So, when we talk about high definition TV, realize that we're giving a general idea of what high definition TV is, and not really talking about any one of the specific seven.

What do you get when you get an advanced TV system, or a high definition TV system? You get greater vertical resolution, which means more lines are being scanned on your television screen—when you have more lines, you have more information.

Next, you get a wider aspect ratio. With the high definition system, you go from a 4x3 aspect ration to a 16 x 9, so it looks more like a movie theatre when you're looking at it versus your old television set. You also get improved sound. There are six channels of audio being sent. We actually only use 5.1 of the six channels, but there are six channels of audio being sent so you can get the surround sound and that theater-like feeling.

You also get improved color and brightness. Part of the reason why you get this is because in an HD system you have to actually separate the illuminates and chromanents components of the signal when they are sent. This is different from the old system where they were sent together.

And finally, these systems are using what is called progressive scanning. Or at least six of the seven versions of HDTV are using progressive scanning. Progressive scanning is basically completing one scan of your screen in a single pass. It's identical to the way your computer is scanned. So your television screen is now more like your computer screen than your old TV set.

This is an example of the different aspect ratios. You've got 4x3 and 16x9—you can actually see the difference. If you think about your TV right now, you should be able to understand the difference between a 4x3 aspect ratio and a 16x9.

The three basic components of the HD systems are HDTV production, HDTV distribution and HDTV reception. HDTV production is basically TV stations converting to be able send these signals, which means they need new equipment, they need new converters, and they actually need more bandwidth, which brings us into the distribution. A deal that the FCC, or the Federal Communications Commission, has made with broadcast stations around the country is that in addition to the bandwidth they are receiving to send their old TV signals—which let me just tell you is called the NTSC, or the National Television Standards Committee signal—they've been given additional bandwidth once they convert over to high definition. The reason they do this is because you the consumers have not completely converted over to buying these new televisions. So, until everybody is converted, and I'm talking about from a distribution standpoint—I think they are looking at about 80% conversion of broadcast stations—stations have extra bandwidth. Once conversion is complete, the FCC is going to take back the bandwidth that they are using for the old television signals and leave just the bandwidth for the digital television signals.

So, let me go through that one more time. With HDTV production you have a conversion—your broadcast stations have to convert. They have to change their equipment, and they have to get converters. The also have to distribute the signal. One thing the FCC has done is what is called simocasting. They are broadcasting both the NTSC signal—their old television signal—and the new signal together. Finally the reception—that's you the consumers buying the actual televisions that are actually going to be reading the signals. The problem is that these TVs are expensive, and so as consumers we haven't completely converted quite as fast as the industry thought we would. But, nonetheless, these are the three obstacles to the HDTV revolution or changeover.

So, what are the standards and how did they develop? The standards for these digital TVs, or this advanced TV system began in May of 1993 with the formation of this grand alliance. This was a committee of industry leaders as well as citizens getting together trying to decide what the standards were going to be. In 1995, the Advanced Television

Standards Committee—the ATSC—developed what they called the advanced TV standards. And finally, in 1996 in the telecommunication act, these standards were adopted by the FCC. The standards we are talking about are the aspect ration, the six channels of audio, the simocasting, and the way people are going to be able to convert.

There are basically two versions of HDTV. This is important to be aware of because the first version is considered HDTV compatible, which means the TV can't receive an HDTV signal because it still needs a converter box. These TVs cost relatively low—you can get a 42 inch Toshiba for around $1500. This includes the wide aspect ratio and six channels of audio; the difference is you still need a tuner to receive the HD signal—so it's just compatible.

Then there's HDTV ready. HDTV ready is a TV that can actually receive the HD signal directly. This is where you get the quality, or the most benefit from HDTV—when you are directly receiving the HD signal. Now, what's the catch? These TVs are still running between $8,000 and $10,000. So, the two different types of TVs that are out there—HD systems—are compatible and ready. With compatible you still need a tuner, and with ready the tuner is built-in, and it can receive an HD signal.

Then there's the DVD factor. Well, the DVD factor has mostly been eliminated, but I think it's important to talk about it. When HDTV was first developed, the DVD had already been developed, and the standards for DVD had already been created. At that point, HDTV developers decided that the DVD was going to be the video component for the HD systems. So, for a while there was a little incompatibly, but now that's all been fixed and DVD systems themselves are compatible and that's why when you go to

Blockbuster it will say wide-screen ready, or wide-screen formatted. This is indicating that these tapes have been actually filmed in compliance with the advanced TV systems.

The last component of advanced TV systems I want to talk about is how we compress these actual signals. The two forms of compression that I want to mention are inter-frame: this is between frames so we remove any redundant information from frame one to frame two. The second is: intra-frame, where we remove any redundant information within each frame. Your digital TV system is taking advantage of both of these. Compression decreases information and increases utilization of bandwidth and gives us all the advantages to digitizing that we want.

APPENDIX (D)

STRUCTURE OF THE NON-LINEAR CONTENT DELIVERY METHOD

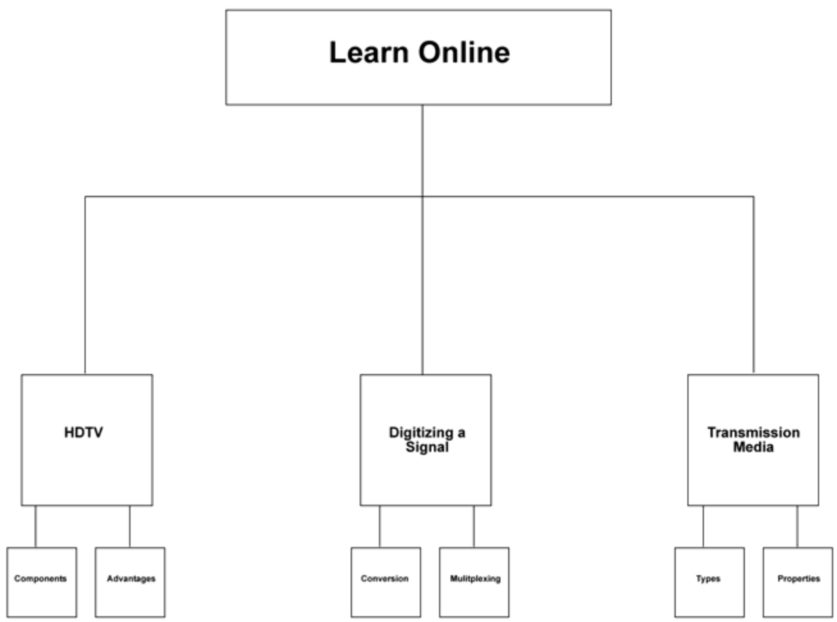

Figure 2

Structure of Non-Linear Content Delivery Method.

APPENDIX (E)

STRUCTURE OF THE LINEAR CONTENT DELIVERY METHOD

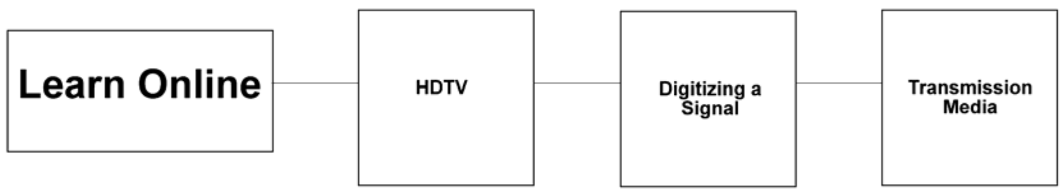

Figure 3

Structure of Linear Content Delivery Method.

APPENDIX (F)

EXAMPLE OF CONTENT MODULE INTERFACE

Figure 4

Screen Capture of Content Module Interface.

APPENDIX (G)

EXAMPLE OF CONTENT MODULE

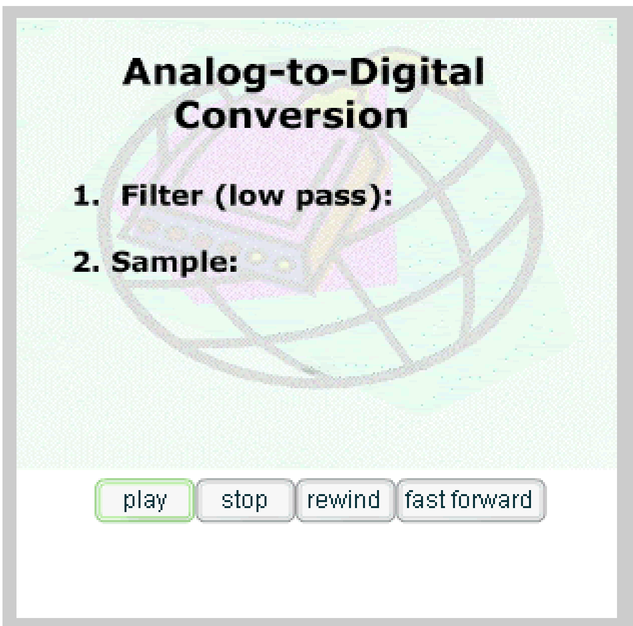

Figure 7

Screen Capture of Content Module.

APPENDIX (H)

PRE-TEST SURVEY

Part I

Below are 12 sentences that describe learning. Each has four endings. Rank the endings for each sentence according to how well you think each one fits with how you would go about learning something. Try to recall some recent situations where you had to learn something new, perhaps in your job or at school. Then, using the spaces provided, rank a “4” for the sentence ending that describes how you learn *best*, and down to “1” for the sentence ending that seems *least* like the way you learn. Be sure to rank all the endings to each sentence unit. Please do not make ties. Hint: Some people find it easiest to decide first which phrase best describes them (4) and then to decide which phrase is least like them (1). Then they give a 3 to that word in the remaining pair that is most like them and a 2 to the word that is left over.

Remember: **1**=***least*** like you

2= ***third most*** like you

3=***second most*** like you

4=***most*** like you

When I learn		I like to deal with my feelings		I like to think about ideas		I like to be doing things		I like to watch and listen
I lean best when		I listen and watch carefully		I rely on logical thinking		I trust my hunches and feelings		I work hard to get things done
When I am learning		I tend to reason things out		I am responsible about things		I am quiet and reserved		I have strong feelings and reactions
I learn by		Feeling		Doing		Watching		Thinking
When I learn		I am open to new experiences		I look at all sides of issues		I like to analyze things, break them down into their parts		I like to try things out
When I am learning		I am an observing person		I am an active person		I am an intuitive person		I am a logical person
I learn best from:		observation		personal relationships		rational theories		a chance to try out and practice
When I learn:		I like to see results from my work		I like ideas and theories		I take my time before acting		I feel personally involved in things
I learn best when:		I rely on my observations		I rely on my feelings		I can try things out for myself		I rely on my ideas
When I am learning:		I am a reserved person		I am an accepting person		I am a responsible person		I am a rational person
When I learn:		I get involved		I like to observe		I evaluate things		I like to be active
I learn best when:		I analyze ideas		I am receptive and open minded		I am careful		I am practical

Part II

Below you will find a number of statements concerning how you might feel about computers. Please indicate the strength of your agreement/disagreement with the statements using the seven point scale shown below where 1= strongly disagree and 7=

strongly agree with a particular statement. There are no 'correct ' responses; it is your own views that are important.

1. I can usually deal with most difficulties I encounter when using computers.
2. I find working with computers very easy.
3. I am very unsure of my abilities to use computers.
4. I seem to have difficulties with most of the packages I have tried to use.
5. Computers frighten me.
6. I enjoy working with computers.
7. I find computers get in the way of learning.
8. Computers make me much more productive.
9. I often have difficulties when trying to learn how to use a new computer package.
10. Most of the computer packages I have had experience with, have been easy to use.
11. I am confident in my abilities to use computers.
12. I find it difficult to get computers to do what I want them to.
13. At times I find working with computers very confusing.
14. I would rather that we did not have to learn how to use computers.
15. I usually find it easy to learn how to use a new software package.
16. I seem to waste a lot of time struggling with computers.
17. Using computers makes learning more interesting.
18. I always seem to have problems when trying to use computers.
19. Some computer packages definitely make learning easier.
20. Computer jargon baffles me.
21. Computers are far too complicated for me.
22. Using computers is something I rarely enjoy.
23. Computers are good aids to learning.

24. Sometimes, when using a computer, things seem to happen and I don't know why.

25. As far as computers go, I don't consider myself to be very competent.

26. Computers help me to save a lot of time.

27. I find working with computers very frustrating.

28. I consider myself a skilled computer user.

29. When using computers I worry that I might press the wrong button and damage it.

Part III

My Feelings about the Internet: How do you feel about using the Internet? Internet use includes sending or receiving electronic mail, visiting chat rooms, participating in discussion groups and visiting locations on the World-Wide Web. We would like you to answer them even if you are not an Internet user. Please select a number between 1 and 7, where 1 is strongly disagree, 2 is slightly disagree, 3 is disagree, 4 is neither agree nor disagree, 5 is slightly agree, 6 is agree and 7 is strongly agree.

1. I feel confident surfing the Internet.
2. I feel confident browsing the Internet.
3. I feel confident finding information on the Internet.
4. I feel confident sending a fax via the computer.
5. I feel confident receiving a fax on my computer.
6. I feel confident making changes on a home computer.
7. I feel confident downloading from another computer.
8. I feel confident creating a homepage for the Internet.
9. I feel confident recovering a file I accidentally deleted.
10. I feel confident editing (size, color) a scanned picture.
11. I feel confident understanding terms/words relating to Internet hardware.

12. I know I can avoid downloading computer viruses from the Internet.
13. I feel confident using the Internet to gather data.
14. I feel confident describing functions of Internet hardware
15. I can stay calm when my computer freezes up on line.
16. I have confidence I can get the social support I need from the Internet
17. I know how to get in touch with groups on-line who share my concerns.
18. I feel confident explaining why a task will not run on the Internet.
19. If I had a personal problem I know how I could find help on line.
20. I feel confident learning advanced skills within a specific Internet program.
21. If I ran into a computer problem while using the Internet, I would panic
22. I would know how to work around problems with the Internet to get my tasks done.
23. I feel confident understanding terms/words relating to Internet software.
24. If I had problems using the Internet, I know I could eventually work them out.
25. I feel confident trouble shooting Internet problems.
26. I am confident I can protect my privacy when using the Internet.
27. I am confident I can use the Internet to gather information about courses I am planning to take.
28. I am confident I can use the Internet to gather information for a research paper.
29. I am confident I can use the Internet to gather information to help me study for a test.
30. I am confident I can use the Internet to learn about a new subject.
31. I am confident I can use the Internet to learn about new music I am interested in.

32. I am confident I can use the Internet to learn about any health-related concerns I might have.
33. I am confident I can use the Internet to gather information about a place I am interested in visiting.
34. I am confident I can send email to a group of people.
35. I am confident I can use the Internet to gather information.
36. I am confident I can learn from a course that is offered completely online.
37. I am confident that I could gain equal knowledge from a college degree offered totally online (i.e., virtual university).
38. I am confident I can decide when information I find online is credible (i.e. accurate).
39. I am confident I can interpret information I find online.
40. I am confident I can detect when information I find online is intentionally deceiving.
41. I am confident I can accurately quote information I find online.
42. I am confident I can accurately attribute information I find online.

Part IV

Now we would like to understand how much you know about the following topics.

Generally speaking, how familiar are you with the primary steps required to convert a signal from analog to digital? Please rank you responses on the following scale.

Very Familiar	Somewhat Familiar	Somewhat NOT Familiar	Not at All Familiar

1. Generally Speaking, how familiar are you with the process of sending signals through space.
2. Generally Speaking, how familiar are you with the satellite technology?

3. Generally Speaking, how familiar are you with the different types of digital televisions (e.g., specific specifications)?
4. Generally speaking, how familiar are you with the types of satellites being used with digital radio?

Part V

About Me: Now just a few personal questions to help us classify your responses.

Gender: Female Male

What is your year of birth? 19______

Are you (CIRCLE AS MANY AS APPLY)

1) Black or African American

2) White

3) Latino/a

3) Asian (including Chinese, Korean, Japanese and Southeast Asians)

4) Pacific Islander

5) Native American or Alaskan native

6) Other? ___________________

What is your current class ranking? Freshman Sophomore Junior Senior

Is this class a(n): requirement elective

What is you current grade point average? __________________

What is your major? __________________

What is your family's total household income, before taxes?

1) Under $20,000
2) $20,000 to $34,999
3) $35,000 to $49,999
4) $50,000 to $74,999
5) $75,000 or more

Excluding kindergarten, how many years of formal education have you completed?

___ Years

Excluding kindergarten, how many years of formal education did your mother complete?

___ Years

How would you describe your hometown?

1 Urban
2 Suburban
3 Rural

APPENDIX (I)

POST-TEST SURVEY

Part I

POST-TEST: Below you will find a number of statements concerning how you might feel about online learning modules. Please indicate the strength of your agreement/disagreement with the statements using the seven point scale shown below where 1= strongly disagree and 7= strongly agree with a particular statement.

1. Use of online learning modules will increase the challenges of taking online classes.
2. Use of online learning modules will increase the opportunity for preferred future online class selection.
3. Use of online learning modules will increase the various ways of experiencing information in my learning.
4. Use of online learning modules will increase the opportunity for more meaningful learning through online classes.
5. Use of online learning modules will increase the flexibility of the types of classes I can take.
6. Use of online learning modules will increase the amount of information I remember in the long-term.

7. I would recommend an online course made up of these types of learning modules to a friend.
8. I would use online learning modules for an advanced degree.
9. I would use online learning modules for self-improvement.
10. I would use online learning modules because they are just as effective as traditional classrooms.
11. I would use online learning modules because they are better than a traditional classroom.
12. I would take all of my courses using online learning modules if I could.
13. I would never take another class using online learning modules if I can avoid them.

Part II

Below you will find a number of statements concerning how you might feel about Online Learning. Please indicate the strength of your agreement/disagreement with the statements using the 1 = almost never and 5 = almost always. There are no 'correct ' responses; it is your own views that are important.

1. Does the learning module provide the precise information you need?
2. Does the information content meet your needs for online learning?
3. Do the learning module’s slides address content that seem to be just about exactly what you need?
4. Does the system provide sufficient information?
5. Is the content module accurate?
6. Are you satisfied with the accuracy of the content module?
7. Do you think the information is presented in a useful format?

8. Were you satisfied with how the information was presented?

9. Is the information format clear?

10. Is the learning module user friendly?

11. Is the learning module easy to use?

12. Did you get the information you needed in timely order?

13. Does the learning module provide up-to-date information?

Part III

Answering the following four questions, rate your overall feelings about the content module you just experienced.

7	6	5	4	3	2	1
Good						Bad
7	6	5	4	3	2	1
Like						Dislike
7	6	5	4	3	2	1
High Quality						Poor Quality
7	6	5	4	3	2	1
Positive						Negative

Generally speaking, rate the probability that you would take a class totally online if offered in the same format as the module you just experienced.

7	6	5	4	3	2	1
Likely						Unlikely
7	6	5	4	3	2	1
Possible						Doubtful
7	6	5	4	3	2	1

Definitely Would						Definitely Would Not
7	6	5	4	3	2	1
Certain						Uncertain

Part IV

The following questions will test what your learned from the content module you just experienced.

Generally speaking, what percentage of the information in the content module would you estimate was new to you? ______

1. What is the Nyquist theorem? ___________________________________

2. What does a low-pass filter do?

    1. Makes it digital.
    2. Improved FM radio transmission.
    3. Improved FM radio transmission.
    4. Removes stray frequencies.

3. What year was the ASTC (Advanced Television Standards Committee) formed?

    1. May, 1993
    2. December, 2001
    3. June, 1998
    4. October, 1983

4. What are the four steps in converting an analog signal to a digital signal?

____

____

____

____

5. Why are GEOs more expensive? _____________________________________

6. What are unguided media?

  1. When a signal transmission is not constrained by physical boundaries.
  2. Control of the channel is decentralized.
  3. When feedback interrupts the communication process
  4. A signal is sent, but never received.

7. How many different types of advanced television systems are there?

  1. Unlimited
  2. Seven
  3. Seventeen
  4. Four

8. What are two advantages of HDTV?

____

____

9. Provide an example of unguided media not mentioned in the learning module.

____

10. Why is it important to utilize as much bandwidth as possible?

1. Increases the amount of information sent through a single channel.
2. Deregulation prohibits wasted bandwidth.
3. Using minimal bandwidth reduces quality.
4. Prevents theft of extra bandwidth.

11. What does the transponder do?

1. Converts the signal to a digital frequency.
2. Reconfigures the signal for the next destination.
3. Reduces time delay.
4. Concentrates the signal to a specific area.

12. What are the advantages to digitizing a signal?

____

____

____

Part V

My Internet Use: Now a few questions concerning your personal Internet usage. Remember, for the purpose of answering these questions, Internet use includes sending or receiving electronic mail, visiting chat rooms, participating in discussion groups and visiting locations on the World-Wide Web.

1. More over the next three months than now?
2. Less next year than this year?
3. Over three hours a week during the next three months?
4. Over eight hours a week during the next three months?

5. At some time during the next week?

6. Some time in the next 24 hours?

7. More for online learning in the next three months than now?

8. To take an online course in the next year?

9. To take more than one online course in the next year?

10. Earn another degree taking courses online?

Part VI

Thinking back over the last month, on a typical weekday, about how much time do you spend using the Internet, in hours and minutes
__ HOURS ____ MINUTES

Over the last month, on a typical weekend day, about how much time do you spend using the Internet, in hours and minutes
___ HOURS ____ MINUTES

In a typical week, about how many days do you go on the Internet?
01234567

Over the last month, about how much time do you spend surfing the Web each week, to the nearest hour?
____ HOURS

About how much time did you spend using the Internet yesterday? If you are not sure, please estimate as best you can.
__ HOURS ____ MINUTES

How did that break down into?

Web browsing?	____ MINUTES
Using e-mail/ chat/ newsgroups	____ MINUTES
Information seeking	____ MINUTES
Playing games	____ MINUTES
Watching Movies	____ MINUTES
All other uses?	____ MINUTES

On average, how often do you use an Internet browser? *By this, we mean using your browser for a specific set of tasks or activities. We do not mean how many times you launch your browser per day.*

________More than 9 times a day
________5 to 8 times/day
________1 to 4 times/day
________A few times a week
________Once a week
________Once a month
________Other

What do you primarily use the Internet for (check all that apply)?

____ Education

____ Shopping/gathering product information

____ Entertainment

____ Work/Business

____ Communication with others (not including email)

____ Gathering information for personal needs

____ Wasting time

____ Other

About how long have you been using the Internet, in years and months?

____ Years ____ Months(ENTER 0 IF YOU HAVE NEVER USED THE INTERNET)

About how long has it been since you started using the Internet on a daily basis?

____ Years ____ Months(ENTER 0 IF YOU HAVE NEVER USED THE INTERNET DAILY)

How many years have you been using computers offline (not Internet related) (round to nearest half year, e.g., 0.5, 1.0, 2.5,etc.)?

How many computer classes, courses, or seminars have you attended throughout your lifetime?

Did you have a computer in your home when you were growing up? Yes No

Did you have Internet access in your home when you were growing up? Yes No

Do you (not your family) currently own a personal computer? Yes No

LIST OF REFERENCES

Ambrose, M. L., & Kulik, C. T. (1999). Old friends, new faces: Motivation research in the 1990s. *Journal of Management*, *25*(3), 231-292.

Andre, T. (1979). Does answering higher-level questions while reading facilitate productivelearning? *Review of Educational Research, 49*(2), 280-318.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84, 191-215.

Bandura, A. (1997). *The exercise of control.* New York: W.H. Freeman.

Bandura, A. (1999). Social cognitive theory of personality. In L. Pervin (ed.) *Handbook of Personality* (pp. 154-196). New York, NY: Guilford.

Baddeley, A. (1992). Working memory. *Science*, 255, 556-559.

Banathy, B. H. (1991). *Systems design of education: A journey to create the future.* Englewood Cliffs, NJ: Educational Technology Publications.

Barber, W. B., & Milone, M. N. (1980). Modality. *Instructor, 89*(6), 44-47.

Barber, W. B., & Milone, M. N. (1981). What we know about modality strengths. *Educational Leadership, 38*(5), 378-380.

Biggs, J. B. (1989). Approaches to the enhancement of tertiary teaching. *Higher Education Research and Development,* 8, 7-25.

Biggs, J. B. (1990). Effects of language medium of instruction on approaches to learning. *Educational Research Journal*, 5, 18-28.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). *How people learn*. Washington, DC: National Academy Press.

Brown, J. (1991). *Television critical viewing skills education: Major literacy projects in the United States and selected countries*. Hillsdale, NJ: Erlbaum.

Brynda, J. (1992). End-user training: Lend me your ear, I'll teach you a PC package. *Computing Canada, 18*(1), 48.

Carbo, M. (1997). *What every principle should know about teaching reading: How to raise test scores and nurture a love of reading.* Syosset, NY: National Reading Styles Institute.

Carrier, C., Post, T. R., & Heck, W. (1985). Using microcomputers with fourth-grade students to reinforce arithmetic skills. *Journal for Research in Mathematics Education,* 16, 45-51.

Christensen, E. W., Anakwe, P. U., & Kessler, E. H. (2001). Receptivity to distance learning: The effect of technology, reputation, constraints, and learning preferences. *Journal of Research on Computing in Education, 33*(3), 263-279.

Clark, R. (1983). Reconsidering research on learning from media. *Review of Educational Research*, 53, 445-459.

Collier, G. (1987). Thoth-II: Hypertext with explicit semantics. *Proceedings of Hypertext, 1987,* University of North Carolina, Chapel Hill, 269-289.

Cronbach, L. J., & Snow, R. E. (1969). Individual differences in learning ability as a function of instructional variables. Final Report to USOE (Contract OED 4-6-061269-1217), Stanford University, School of Education, Sanford, California.

Delany, P. & Gilbert, J. D. (1992). Hypercard stacks for Fielding's Joseph Andrews: Issues of design and content. In: Delany and Landow, G. (Eds.) *Hypertext and Literary Studies* (pp. 287-298). Cambridge MA: MIT Press, 287-298.

Dewey, J. (1938) *Experience and Education*, New York: Collier Books.

Dijkstra, S. (2001). The design space for solving instructional-design problems. *Instructional Science*, 29, p. 275-280.

Dillon, A,. & Gabbard, R. (1998). Hypermedia as an educational technology: A review of the quantitative research literature on learner comprehension, control and style. *Review of Educational Research, 63*(3), 322-349.

Dillon, A., & Watson, C. (1996). User analysis HCI-the historical lessons from individual differences research. *International Journal of Human-Computer Studies, 45*(6), 619-638.

Doll, W. J. & Torkzadeh, G. (1988). The Measurement of end-user computing satisfaction, *MIS Quarterly*, *12*(2), 259-274.

Dornish, M., & Sperling, R. (2004). Elaborative questions in web based text materials. *International Journal of Instructional Media, 31*(1), 49-59.

Duffy, T. M., & Jonassen, D. H. (1992). *Constructivism and the technology of instruction: A conversation.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Duffy, T. M., Lowyck, J., & Jonassen, D. H. (1993). *Designing environments for constructivists learning.* Berlin: Springer-Verlag.

Dunn, R., Dunn, K., & Price, G. E. (1989). *Learning styles inventory.* Lawrence, KS: Price Systems.

Dutton, W., Rogers, E. M., & Jun, S. (1987). Diffusion and social impacts of personal computers. *Communication Research*, 14, 219-250.

Dijkstra, S. (2001). The design space for solving instructional-design problems. *Instructional Science*, 29, 275-280.

Ess, C. (1991). Courseware review: Intermedia. *Computers and the Humanities*, *24*(4), 324-329.

Eveland, W. P., & Dunwoody, S. (2001). User control and structural isomorphism or disorientation and cognitive load? Learning from the web versus print. *Communication research,* 28, 48-78.

Everett, D. R. (1998). Taking instruction online: the art of delivery. *CSS Journal,* 2, available: www.cssjournal.com/everett.html.

Goldstein, I. L., & Ford, J. K. (2002). *Training in organizations: Needs assessment, development, and evaluation (4th ed.)*. Belmont, CA: Wadsworth.

Good, T. L., & Brophy, J. E. (1990). *Educational psychology: A realistic approach. (4th ed.)*.White Plains, NY: Longman.

Graham, H., Heinrich, P., Lyon, P., Barratt, A., Simpson, J., Hyde, S., Gonsalkorale, S., Hyde, M., & Mgaieth, S. (2005). Helping students understand their learning styles: Effects on study self-efficacy, preference for group work, and group climate. *Educational Psychology, 25(*4), 395-408.

Gunnawarden, C., & Boverie, P. E. (1993). *Impact of learning styles on instructional design for distance education.* Paper presented at the World Conference of the International Council of Distance Education, Bangkok, Thailand. (ERIC No. ED 359 926).

Hannafin, M., Land, S., & Oliver, K. (1999). Open learning environments: Foundations, methods and models, In C. Reigeluth, M. (Ed), *Instructional-design theories and models (Vol. 2)* (pp. 115-140). Mahway, NJ: Lawrence Erlbaum Associates.

Hale, M. E. (1986). Improving research in computer science learning. *Journal of Research in Science Teaching*, 23, 471-473.

Hara, N., & Kling, R. (2000). *Student's distress with a web-based distance education course: A taboo topic in the Discourse* [Online document]. Available: www.slis.indiana.edu/CSI/wp00-01.html.

Harrasim, L. (1990). *On-line education: Perspectives on a new environment*. Praeger: New York.

Heinssen, R. K., Glass, C. R. & Knight, L. A. (1987). Assessing computer anxiety: Development and validation of the computer anxiety rating scale. *Computers in Human Behaviour 3*, 49-59.

Henderson, R. W., Landesman, E. M., & Kachuck, I. (1985). Computer-video instruction in mathematics: Field test of an interactive approach. *Journal for Research in Mathematics Education*, 16, 207-224.

Hobbs, R. (1994). Pedagogical issues in U.S. media education. *Communication Yearbook*, 17, 453-466.

Hobbs, R. (1998). Media education in Massachusetts. In A. Hart (Ed.), *Teaching the media worldwide* (pp. 127-144). Hillsdale, NJ: Erlbaum.

Hobbs, R., & Frost, R. (1997). *The impact of media literacy education on adolescents' media analysis and news comprehension skills*. Paper presented at the annual meeting of the International Communication Association, Montreal, Canada.

Hiltz, S. R. (1994). *The virtual classroom: Learning without limits via computer networks*. Ablex, Norwood: New Jersey.

Hinsz, V. B., Kalnbach, L. R., & Lorentz, N. R. (1997). Using judgmental anchors to establish challenging self-set goals without jeopardizing commitment. *Organizational Behavior and Human Decision Processe*s, 71, 287–308.

Hong, K. (2002). Relationships between students' and instructional variables with satisfaction and learning from a Web-based course. *Internet and Higher Education*, 5, 267–281.

Hoskins, S. L., & van Hoof, J. C. (2005). Motivation and ability: Which students use online learning and what influence does it have on their achievement? *British Journal of Educational Technology, 36(*2), 177-192.

Jegede, O. J., Fraser, B., & Curtin, D. G. (1995). The development and validation of a distance education and open learning environment scale. *Educational Technology Research & development*, *43*(1), 90-94.

Jenkins, J. M. (1988). A learning style approach to effective instruction. In J.W. Keefe (ed.), *Profiling and utilizing learning style* (pp. 41-45). Reston, VA: National Association of Secondary School Principles.

Jonassen, D. (1986). Hypertext principles for text and courseware design. *Educational Psychologist, 21*(4), 269-292.

Jonassen, D. (1990). Designing constructivist learning environments. In C.M. Reigeluth, (ed.), *Instructional-design theories and models, Vol. 2* (pp. 215-240). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Jonassen, D. & Wang, S. (1993). Acquiring structural knowledge from semantically structured hypertext. *Journal of Computer-Based Instruction, 20*(1), 1-8.

Jones, C., Reichard, C., & Kouider, M. (1998). Are students learning styles discipline specific? *Community College Journal of Research & Practice*, (5), 363.

Kalyuga, S., Chandler, P., & Sweller, J. (1998). Levels of expertise and instructional design. *Human Factors*, *40(*1), 1-17.

Karuppan, C. M. (2001). Web-based teaching materials: A user’s profile. *International Research: Electronic Networking Applications and Policy, 11*(2), 138-148.

Kearsley, G. (2000). *Online education: Learning and teaching in cyberspace*. Belmont, CA: Wadsworth.

Keefe, J. W. (1979). Learning style: An overview. In *Student learning styles: Diagnosing and prescribing programs (pp 1-17).* Reston, VA: National Association of Secondary School Principles.

Keller, J. (1983). Motivational design of instruction. In C. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status* (pp 386-434). Hillsdale, NJ: Erlbaum.

Keppel, G. (1991). *Design and Analysis: A Researcher's Handbook*. Prentice Hall: New Jersey.

Keri, G. (2002). College students’ learning styles differ: An opportunity for instructional diversification. *College Studies Journals,* 3, 433-441.

Klein, R. (2003). Audience Reactions to Local Television News. American *Behavioral Scientist, 48*(12), 1661-1671.

Kolb, D. (1976). *The learning Styles Inventory*. Boston: McBer and Company.

Kolb, D. (1984). *Experimental learning: Experience as the source of learning and development.* Englewood Cliffs, NJ: Prentice-Hall.

Koob, J., & Funk, J. (2002). Kolb’s learning style inventory: Issues of reliability and validity. *Research on Social Work Practice, 12(*2), 293-308.

Kotovsky, K., Hayes, J. R., & Simon, H. A. (1985) Why are some problems hard? Evidences from tower of Hanoi. *Cognitive Psychology,* 17, 248-294.

Kozma, R. (1991). Learning with Media. *Review of Educational Research*, *61*(2), 179-211.

Kozma, R. (1994). Will media influence learning? Reframing the debate. *ETR&D, 42*(2), 7-19.

Kracjik, J. S., Simmons, P. E., & Lunetta, V. N. (1986). Improving research on computers in science learning. *Journal of Research in Science Teaching,* 23, 465-470.

Kuehn, S. A. (1994). Computer-mediated communication in instructional settings: A research agenda. *Communication Education,* 43, 171-183.

Lambert, M. (1985). How do teachers manage to teach: Perspectives on problems in practice. *Harvard Educational Review, 55*(2), 178-194.

Lambert, N. M., & McCombs, B. L. (1998). *How students learn*. Washington, DC: American Psychological Association.

Larkin, J. H., McDermott, J., Simon, D. P., & Simon, H. A. (1980). Models of competence in solving physics problems. *Cognitive Science,* 4, 316-348.

Larsen, R. E. (1992). Relationship of learning style to the effectiveness and acceptance of interactive video instruction. *Journal of Computer-Based Instruction, 19*(1), 17-21.

Laurillard, D. (1998). Multimedia and the learner's experience of narrative. *Computers & Education,* 31, 229-242.

Lea, M., & Spears, R. (1991). Computer-mediated communication, de-individuation and group decision making. *International Journal of Man-Machine Studies,* 34, 283-301.

Lebow, D. (1993). Constructivist values for systems design: Five principles toward a new mindset. *Educational Technology Research and Development*, 41, 4-16.

Lee, Y., & Lehman, J. (1993). Instructional cuing in hypermedia: A study with active and passive learners. *Journal of Educational Multimedia and Hypermedia, 2*, 25-37.

Lewin, K. (1935). *A dynamic theory of personality*. New York: McGraw-Hill.

Locke, E. A. (1996). Motivation through conscious goal setting. *Applied and Preventive Psycholog*y, 5, 117–124.

Locke, E. A., & Latham, P. G. (1990a). *A theory of goal setting and task performanc*e. Englewood Cliffs, NJ: Prentice-Hall.

Locke, E. A., & Latham, P. G. (1990b). Work motivation and satisfaction: Light at the end of the tunnel. *Psychological Scienc*e, 1, 240–246.

Martinez, R., Sweger, B. (1996). Plugged in. *Vocational Educational Journal*, *71*(3), 47-59.

Marton, F., Hounsell, D., & Entwistle, N. (1984). *The experience of learning.* Scottish Academic Press: Edinburgh.

Mayer, R. E. (1996). Learning strategies for making sense of our expository text: the SOI model for guiding three cognitive processes in knowledge construction. *Educational Psychology Review,* 8, 357-371.

Mayer, R. E. (1999a). Designing instruction for constructivist learning. In C. Reigeluth (Ed.), *Instructional design theories and models (Vol. 2)*(pp. 141-159). Mahway, NJ: Lawrence Erlbaum Associates.

Mayer, R. E. (1999b). Research-based principles for the design of instructional messages: the case of multimedia explanations. *Document Design*, 1, 7-20.

Mayer, R. E., & Moreno, R. (2000). Aids to computer-based multimedia learning. *Learning and Instruction*, 12, 107-119.

Mayer, R. E., Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist,* 38(1), 43-52.

Mergal, B. (2003). Instructional design and learning theory. [On-line]. Available: http://www.usask.ca/education/coursework/802papers/mergel/brenda.htm

Merrill, D. M. (2001). Components of instruction towards a theoretical tool for instructional design. *Instructional Science*, 29, 291-310.

Messick, S. (1994). The matter of style: Manifestations of personality in cognitions, learning and teaching. *Educational Psychologist, 29*(3), 121-136.

McCain, T. A., & Maxwell, L. T., (2003) Connected learning in the information age, in Shyles, L. (ed.) *Deciphering cyberspace: making the most of the information superhighway* (pp 231-257). Thousand Oaks, CA: SAGE Publications.

McKnight, C., Dillon, A., & Rishcardson, J. (1991). *Hypertext in Context*, Cambridge: Cambridge University Press.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for procession information. *Psychological Review*, 63, 81-97.

Miura, I. T. (1987). The relationship of computer self efficacy expectations to computer interest and course enrolment in college. *Sex Roles*, 16, 303-311.

Molenda, M. (1997). Historical and philosophical foundations of instructional design: A North American view. In R. D. Tennyson, F. Schott, N. Seel & S. Dijkstra, (eds.) *Instructional design: International perspectives, Vol. 2* (pp. 41-55). Mahwah, NJ: Lawrence Erlbaum Associates.

Moller, L. (1998). Designing communities of learners for asynchronous distance education. *Educational Technology Research and Development*, *46*(4), 115-122.

Mone, M. A., & Shalley, C. E. (1995). Effects of task complexity and goal specificity on change in strategy and performance over time. *Human Performanc*e, 8, 243–252.

Moore, M. G., & Thompson, M. M. (1990). *The Effects of Distance Learning: A summary of the literature.* American Center for the Study of Distance Education. University Park: Pennsylvania.

Mory, E., Gambill, L, & Browning, J. B. (1998). *Instruction on the Web: The online student's perspective.* Paper presented at SITE 98: Society of Information Technology & teacher Education International Conference, Washington, DC.

National Center for Education Statistics, (2002). Internet access in U.S. public schools and classrooms: 1994 – 2001. [Online] Available at: http://nces.ed.gov/pubs2002/internet/.

Newman, D. R., Webb, B., & Cochrane, C. (1995). A content analysis method to measure critical thinking in face-to-face and computer supported group learning. *Interpersonal Computing and Technology*, *3*(2), 56-77.

Nielsen, J (1995). *Multimedia and hypertext: the Internet and Beyond.* Cambridge MA: Academic Press Professional.

Oblinger, D., & Verile, A. (1999). Information technology as a change agent. *Educom Review*, Jan./Feb., 46-55.

Palmgreen, P., Wenner, L., & Rosengren, K. (1985). Uses and gratifications research: The past ten years. In K. Rosengren, L. Wenner, & P. Palmgreen (Eds.), *Media gratifications research: Current perspectives* (pp. 11-37). Beverly Hills, CA: Sage.

Papanikolaoua, K.A, Grigoriadoua, M., Magoulasb, G.D., Kornilakisa, H. (2002). Towards new forms of knowledge communication: the adaptive dimension of a web-based learning environment. *Computers & Education*, 39, 333–360

Perkins, D.N. & Unger, C. (1999). Teaching and learning for understanding. In C.M Reigeluth, ed., *Instructional-Design Theories and Models, Vol. 2* (pp. 91-114). Mahwah, NJ: Lawrence Erlbaum Associates.

Phillips, G. M., & Santoro, G. M. (1989). Teaching group discussion via computer-mediated communication, *Communication Education*, 38, 151-161.

Piaget, J. (1972). *The psychology of the child*. New York: Basic Books.

Premkumar, G., Ramamurthy, K., & King, W. R. (1993). Computer supported instruction and student characteristics: An experimental study. *Journal of Educatoinal Computing Research*, 9, 373-396.

Reder, L. (1985). Techniques available to author, teacher, and reader to improve retention of main ideas of a chapter. In J. Chipman, J. Segal, & R. Glaser (Eds.), *Learning and Thinking Skills, Vol. 2* (pp. 37-64). Hillsdale, NJ: Erlbaum.

Reiff, J.C. (19920. *Learning Styles.* Washington, DC: National Education Association.

Reigeluth, C. M. (1996). What is instructional-design theory and how is it changing? *Educational Technology, 36*(3), 5-29.

Rice, R. E. (1987). Computer-mediated communication systems and organizational innovation. *Journal of Communication*, 37, 64-94.

Rice, R. E., & Love, G. (1987). Electronics emotion: Socioemotional content in a computer-mediated communication network, *Communication Research*, 14, 85-108.

Richardson, A. (1977). Verbalizer-visualizer: A cognitive style dimension. *Journal of Mental Imagery, 1*(1), 109-126.

Riding, R. & Rayers, S. (1998). *Cognitive Style and Learning Strategies: Understanding style differences in learning and behavior*. London: David Fulton.

Ruberg, L. F., Taylor, D. C., & Moore, D. M. (1996). Student participation and interaction online: A case study of two college classes: Freshman writing and a plant science lab. *International Journal of Educational Telecommunication*, *2*(1), 69-92.

Saettler, P. (1990). *The Evolution of American Educational Technology* . Englewood, CO: Libraries Unlimited, Inc.

Sarasin, L. C. (1999). *Learning Style Perspectives: Impact in the Classroom.* Madison, WI: Artwood.

Savery, J. R., and Duffy, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational Technology,* 35, 31-38.

Sax, L. J., Astin, A. W., Korn, W. S., & Mahoney, K. M. (2000). *The American Freshman: NationalNorms for Fall 2000.* Los Angeles, CA: Higher Education Research Institute, Graduate School of Education & Information Studies, University of California, Los Angeles.

Scardamalia, M., & Bereiter, C. (1996). Computer support for knowledge-building communities. In T. Koschmann (ed.) *CSCL: Theory and Practice of an Emerging Paradigm*. New Jersey : Erlbaum, Mahwah.

Schmidt, K., & Brown, D. (2004). Considerations for embedding on-line components into traditional classroom environments. *Journal of Industrial Teacher Education, 41*(4), 21-32.

Schneider, W., & Shiffrin, R. (1977). Controlled and automatic human information processing: Detection, search and attention. *Psychological Review*, 84, 1-66.

Seel, N. & Dijkstra, S. (1997). General introductions to instructional design. In R.D. Tennyson, F. Schott, N. Seel & S. Dijkstra, eds. *Instructional Design: International perspectives*, *Vol. 2* (pp. 1-16). Mahwah, NJL Lawrence Erlbaum Associates.

Sein, M. K., & Robey, D. (1991). Learning style and the efficacy of computer training methods. *Perceptual Motor Skills*, 72, 243-248.

Schamp, S. A. (1991). Mecanomorphism in perception of computer communication partners. *Computers in Human Behavior*, 8, 147-161.

Simon, S. (2000). The relationship of learning style and training method to end-user computer satisfaction and computer use: A structural equation model. *Information Technology, Learning, and Performance Journal, 18*(1), 41-59.

Sizer, T. (1995). Silences. *Dadelus*, 124, 77-83.

Skinner, M. E. (1990). The effects of computer-based instruction on the achievement of colleve students as a function of achievement status and mode of presentation, *Computers in Human Behavior*, 6, 261-272.

Sloane, A. (1997). Learning with the web: Experience of using the World Wide Web in a learning environment. *Computer Educator*, *28*(4), 207-212.

Smith, D., & Kolb, D. (1996). *User guide for the learning style inventory: A manual for teachers and trainers*. Boston: McBer and Company.

Smith, J. (2002). Learning styles: Fashion fad or lever for change? The applications of learning style theory to inclusive curriculum delivery. *Journal in Educational and Teaching International.* [Available Online:www.tandf.co.uk/journals].

Specht, J. A. & Martin, J. (1998). Individual differences in imaginable and verbal thinking habits of grade 6 students. *Journal of Mental Imagery, 22*(3 & 4), 229-236.

Stacey, E., Smith, P. J., & Barty, K. (2004). Adult Learners in the Workplace: Online learning and communities of practice. *Distance Education, 25*(1), 107-123.

Staw, B. M., & Boettger, R. D. (1990). Task revision: A neglected form of work performance. *Academy of Management Journa*l, 33: 534–559.

Sturgill, A., Martin, W., & Gay, G. (1999). Surviving technology: A study of student use of computer-mediated communication to support technology education. *International Journal of Educational Telecommunications, 5*(3), 239-259.

Sundar, S. S. (2000). Multimedia effects on processing and perception of online news: A study of picture, audio, and video downloads. *Journal of Mass Communication Quarterly,* 77, 480-499.

Sundar, S. S., Kalyanaraman, S., & Brown, J. (2003). Explicating web site interactivity: Impression formation affects in political campaign sites. *Communication Research, 30*(1), 30-59.

Sundar, S. S., Narayan, D., Obregon, R., & Uppal, C. (1998). Does web advertising work? Memory for print vs. online media. *Journalism & Mass Communication Quarterly,* 75, 822-835.

Svensson, L. (1997). On qualitative difference in learning: Study skills and learning. *British Journal of Educational Psychology*, 3, 233-243.

Swan, K., Shea, P., Fredericksen, E., Pickett, A., Pelz, W., Maher, G. (2000). Building knowledge-building communities: Consistency, contact and communication in the virtual classroom. *Journal of Educational Computing Research, 23*(4), 359-383.

Sweller, J. (1998). Cognitive load during problem solving effects on learning. *Cognitive Science*, 12, 257-285.

Sweller, J., van Merrienboer, J. J., & Paas, F. G. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251-298.

Tewksbury, D., & Althaus, S., (2000). Differences in knowledge acquisition among readers of the paper and online versions of a national newspaper. *Journalism & Mass Communication Quarterly*, 77, 457-479.

Thompson, R. L., C.A.Higgins, and J. M. Howell (1994). Influence of Experience on Personal Computer Utilization: Testing a conceptual model. *Journal of Management Information Systems, 11*(1), 167-187.

Waits, T., & Lewis, L. (2003). *Distance Education in degree-granting postsecondary institutions: 2000–2001* (NCES 2003–017). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication Research*, 19, 52-90.

Walther, J. B., & Burgoon, J. K. (1992). Relational communication in computer-mediated interaction. *Human Communication Research*, 19, 50-88.

Wang, X., Hinn, D., & Kanfer, A. (2001). Potential of computer-supported learning for learners with different learning styles. *Journal of Research on Technology in Education*, 34, 75-85.

Ward, M., & Newlands, D. (1997). Use of the web in undergraduate teaching. *Computers and Education*, 31, 171-184.

Whyte, M. M., Karolick, D. M., Nielsen, M. C., Elder, G. D., & Hawley, W. T. (1995). Cognitive styles and feedback in computer-assisted instruction. *Journal of Educational Computing Research, 12* (2), 195-203.

Williams, F., Rice, R. E., & Rogers, E. M. (1988). *Research methods and the new media.* New York, NY: The Free Press.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field dependent and field-independent cognitive styles and their educational implications. *Review of Educational Research*, 47, 1-64.

Wittrock, M. C. (1990). Generative processes in reading comprehension. *Educational Psychologist*, 24, 345-376.

Wolf, D. P. (1985). Flexible tests: Computer editing in the study of writing. *New Directions for Child Development*, 28, 37-53.

Wofford, J. C., Goodwin, V. L., & Premack, S. (1992). Meta-analysis of the antecedents of personal goal level and of the antecedents and consequences of goal commitment. *Journal of Managemen*t, 18, 595–615.

Yates, G. C. R. (2000). Applying learning styles research in the classroom: Some cautions and the way ahead. In R. Riding & R. Rayber (eds.), *International Perspectives on Individual differences: Vol. 1, Cognitive Style* (pp. 347-364). Stamford, CT: Ablex.