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IMPROVING USABILITY AND ACCESSIBILITY IN ONLINE COURSES: HOW SERVING MORE STUDENTS CAN BENEFIT ALL STUDENTS

by

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Abstract

USABILITY AND ACCESSIBILITY IN ONLINE COURSES:

COULD SERVING MORE STUDENTS BENEFIT ALL STUDENTS**?**

Online coursework offers many college students flexibility and increased earning potential that they otherwise may not have due to personal or professional responsibilities and restrictions. Unfortunately, for students with disabilities, including those using assistive technology devices to access the internet, limited accessibility compromises these opportunities for students who already face significant challenges to the completion of their post-secondary education. In the same manner that universal design of physical spaces increases usability of buildings and other facilities for all patrons, universal design of web-based courses could improve retention of course content for all learners.

In a case study based on cognitive load theory and constructivist pedagogy, the researcher will investigate the experience of postsecondary students with disabilities with user interface design of online courses, and how that design may inhibit the ability of these students to learn course content due to usability and accessibility issues. It is hypothesized that a course specifically designed with improved accessibility and usability design would result in improved course content retention among all participants, especially those with lower technology self-efficacy scores as tested with the Web-Users' Self-Efficacy Scale. Additional information derived from participant observations and interviews will be analyzed in conjunction with quantitative data collected from usability testing software.

CHAPTER I

Introduction

Minority identity of disability sees disability not as a deficiency that must be corrected, but as a point on the continuum of existence, a socially constructed state. This is in contrast to the medical view of disability which regards people who are disabled as “broken” or “deficient.” As Davidson (2006) states, "The medical definition of disability locates impairment in the individual as someone who lacks the full complement of physical and cognitive elements of true personhood and who must be cured or rehabilitated. The social model locates disability not in the individual's impairment but in the environment - in social attitudes, institutional structures, and physical or communicational barriers that prevent full participation as a citizen subject" (pp. 119).

As the majority of course management system and instructional designers are not disabled, their designs for these systems generally reflect a bias towards non-disabled users. Such design results in the need for students to request accommodations, revealing details about themselves they may or may not wish to disclose. From the minority identity standpoint, this oversight could be likened to students of color attending a predominantly white institution and repeatedly having to announce their ethnicity upon beginning a course and requesting the “special” seat reserved for them. Certainly, this would magnify one’s feelings of being out of place.

Universal design principles, rooted in architecture and expanded to a wide variety of institutional, commercial and consumer applications, works especially

well in the design of learning environments. This holds true whether the environment is physical or virtual. Universal design requires no identification or request from the potential user, rather, it encourages any user to come and interact with the system on an equal basis (Center for Universal Design, n.d.). In the same manner that ramps, sloping curbs and other architectural elements in the physical environment designed to provide access for disabled persons also offer benefits for a much wider range of users, universal design in the learning environment provides an enhanced experience for all learners (CAST, 2008).

Constructivist teaching theory highlights each student's prior experiences and knowledge as integral to the success of the course and all students enrolled therein. When designing online courses, it is very possible to create a course that will encourage collaboration between students, fostering socially constructed knowledge, effective research and information management strategies, facilitating physically constructed knowledge, and ongoing internal and external dialogue regarding what has been discovered and what remains unknown (symbolically and theoretically constructed knowledge) (Gagnon & Collay, 2006). Yuen and Hau (2006) also found that constructivist teaching facilitated deeper learning in the critique, generation, and retention of knowledge. While it is becoming more common to incorporate constructivist theory in the design of online courses, failing to acknowledge the needs of a growing segment of the postsecondary student population renders that incorporation ineffective as it stands in contrast to the importance of student experiences in the learning

process. Truly reaching all students requires that we make a concerted effort to teach all students more effectively.

Problem Statement

With increasing numbers of persons with disabilities in the general population (Erickson & Lee, 2008) and consequently in postsecondary education, it is important to design both physical and virtual learning environments that are accessible to students with a variety of disabilities (Wimberly, Reed, & Morris, 2004). The decision to retrofit web-based courses to provide accommodations to students who request them rather than redesigning the system to serve more students is based not only on cost in dollars and work hours, but also in the societal perception of disability as an individual problem or deficiency. Proper usability testing of products, services, and computer applications using various assistive technology tools takes a substantial investment in money, time, and effort, and it is difficult to determine how many students with disabilities actually enroll in online courses. However, the question should not be “is it cost effective to do this?” Instead we should ask “what do we communicate to our students, both disabled and non-disabled, if we do not?” Indeed, Crowther, Keller, and Waddoups (2004) state, “poorly designed instructional applications are unlikely to be instructionally effective; therefore, those designing computer-mediated instruction have a moral, ethical, and pedagogical obligation to create usable applications” (p. 289).

This study is a case study of the experiences of several postsecondary students with and without disabilities in online courses at different institutions.

Specifically, the goal of this research is to ascertain whether the differences in performance of postsecondary students in online courses could be influenced by the design of the course's user interface, students' self-efficacy in web-based tasks, spatial visualization ability, and level of technology literacy with regard to web-based tasks and research. The study is built upon convergent aspects of instructional design theory, web usability, and online course management, and framed with a minority identity view of disability. In addition, the researcher strove to present a complete picture of the student experience in an online course through direct observation and interview and the development of grounded theory based on both qualitative and quantitative data.

Research Questions

This study looks at the user experience of students with and without disabilities in web-based courses and how they relate to student performance and/or attrition. Through a holistic investigation of student abilities and experiences, the researcher proposed that there are ways to improve the success and retention rates of students with and without disabilities in postsecondary online courses.

The driving questions of this study are: Does the design of an online course's (or course management system's) user interface affect performance or persistence in the course of students with and without disabilities? How might we identify common usability factors for students with and without disabilities that affect the decision to complete or withdraw from an online course?

En route to answering these central questions, several component questions must be asked:

R_1: How do different usability factors influence students with and without disabilities' experience in an online course?

R_2: How do student characteristics such as self-efficacy, spatial visualization ability, and information literacy affect student perception of usability in an online course?

R_3: Which usability factors are most difficult to overcome for students with low spatial visualization ability or low self-efficacy in online tasks?

Definition of Terms

Assistive Technology Device – The Assistive Technology Act (1998) defines an assistive technology device as any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities.

Course Management System – A campus-based or commercially-licensed software designed and marketed to organize, store, record the progress and grades of and otherwise manage fully online and hybrid courses delivered by an institution; also known as a Learning Management System or a Virtual Learning Environment (Morgan, 2003).

Disability – For the purposes of this study, disability includes the legal definition from the Americans with Disabilities Act (1990) as an impairment that substantially limits one or more life activities, a record of such impairment, and

being regarded as having such an impairment; as well as cognitive (including print and other learning) disabilities and that the disability can be either temporary or permanent if it affects a student's ability to navigate the physical or virtual learning environment.

Information Literacy – "A set of abilities requiring individuals to 'recognize when information is needed [and] have the ability to locate, evaluate, and use effectively the needed information.'" (Association of College Research Libraries, 2000 p. 2) The more recent term "digital literacy" is understood to combine information literacy skills and computer literacy, but to date has no universally agreed-upon definition and has limited use outside of education and workforce development circles.

Online Course – A course delivered at least 80% via internet connection, including those that deliver all course content online but require in-person or proctored testing or exams (Allen & Seaman, 2007). For the purpose of this study, this includes blended or hybrid courses in which students receive instruction both face-to-face in a traditional classroom and online.

Spatial Visualization Ability – The ability to mentally manipulate and reconfigure a two- or three-dimensional object (Alonso, 1998).

Usability – "That quality of a system that makes it easy to learn, easy to use, and encourages the user to regard the system as a help in getting the job done." (Georgetown University Information Services, n.d.)

User Interface – The various methods of interacting with a product, device or application, such as the web pages of an online course that must be navigated in

order to access and utilize course content, resources and tools. This includes web pages required for logging into a campus course management system, if applicable (PC Magazine Encyclopedia, n.d.).

Web Accessibility – The ability of users with a range of abilities and disabilities to easily use and navigate web pages with or without assistive technology devices (World Wide Web Consortium, 2005).

Reflecting their current ubiquitous nature, throughout this document the words “web, internet, and website” will not be capitalized, although the researcher acknowledges the continuing debate on the capitalization conventions for web-based technologies.

Delimitations

In order to achieve the most usable data within the time frame allotted, the researcher took several steps to limit the scope of the study. Participants were selected from fully online and hybrid courses during the fall, spring, and summer semesters at several public colleges and universities in the southeastern United States. Observations and interviews were conducted with the aid of commercial usability testing software. Although the program requires no software installation or specific technical knowledge on the part of the participant, this delimitation may affect the findings of students with low technology literacy and low self-efficacy due to the perception of being another application to navigate in addition to the course environment. A potential limitation beyond the researcher’s control is the typically low enrollment of students with disabilities in online courses. This resulted in difficulty securing a larger number of study participants. A few

participating students had some difficulty completing the assessments, even with planned accommodations. The design of the assessments reflected accessibility attempts for a variety of visual, physical, and cognitive impairments.

Assumptions

Due to the nature of the study, the researcher had to assume that students enrolled in the online courses in this study would have regular and reliable access to a working computer and the Internet in order to complete course requirements and turn in papers and assignments. The researcher acknowledges, however, that students can and do enroll in courses both online and face-to-face, that they are ill-prepared or -equipped to complete successfully.

Purpose & Implications of the Study

The purpose of this study is to gain an understanding of the web accessibility and usability needs of students with and without disabilities as they relate to online course interface design. Several studies (Cook & Gladhardt, 2002; Kinash, Crichton, & Kim-Rupnow, 2004; Edmonds, 2004; Simoncelli, 2005; Crow, 2006) have called for further research about the experiences of students with disabilities in online courses and how to best serve them. In addition, the principles of universal design have proven to serve more than just people with disabilities. For example, kitchenware with wider, rubberized grips designed for consumers with arthritis are widely popular because they offer greater leverage, reduce strain on one's hands, and are simply easier to use.

On a university campus, one can find students deep in conversation, athletes on crutches, and delivery people with carts using a ramp instead of the

stairs to enter a building. Incorporating universal design from the beginning yields structures that are easily used by everyone, regardless of ability. Continuing to design course environments that cannot be used by a variety of people using assistive technology devices is the equivalent of an restaurant owner hastily adding a wheelchair ramp at the rear entrance of a building because it is the only door wide enough. In this token compliance with the law, the wheelchair user must separate herself from her group, go to the rear entrance, find out that the door is locked, return to the front to request that the door be open, and travel through the kitchen in order to rejoin her friends for dinner. This is the circuitous route that students using assistive technology devices to access the internet can encounter when a course is not designed with their needs in mind.

This research could serve as an initial blueprint for designing more accessible online courses, and provide additional impetus for course designers to adopt a minority identity view of disability in the same manner that many hold an inclusive multicultural view of ethnicity. At the institutional level, utilizing a proactive rather than reactive stance in serving students with disabilities in postsecondary education concretizes a mission to provide a quality, equitable education to all students enrolled.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Research in online learning has moved beyond Clark's (1983) assertion that instructional media have no more effect on student achievement than "the truck that delivers our groceries causes changes in our nutrition" (p. 445). One could certainly argue, however, that if those groceries were usually locked in the truck with no way to access them, our level of nutrition would change significantly. Students using assistive technology devices such as screen readers, input devices for users with limited mobility, and other computer-access tools that are incompatible with popular course management systems have exactly such an argument. While universal design in publicly accessed buildings and facilities is ubiquitous, students with disabilities taking web-based courses must request specific accommodations and self-identify as disabled to the faculty member and appropriate administrators.

Many reports point to the exponential growth of online course delivery at colleges and universities, management of such growth, and the probable reasons why it continues (Allen & Seaman, 2006; Allen & Seaman, 2008; Parsad & Lewis, 2008; Waits & Lewis, 2003). Other studies are concerned with the student experience in online learning, and how it may be enhanced (Cho & Jonassen, 2009; Fletcher, 2005; Gilbert, Morton, & Rowley, 2007; Howland & Moore, 2002; Richardson & Newby, 2006; Wang & Newlin, 2002). In comparison, very few studies look at implications of the actual design and usability of an online course

website, and even fewer address the accessibility of students with disabilities in online education. Of the studies available, the majority are assessments of student readiness and technological aptitude but lack an experimental component. Many of the most recent research studies in online learning, human interaction, and the application of cognitive learning theories in online learning environments have taken place overseas (Cassidy & Eachus, 2006; Gilbert, Morton & Rowley, 2007; Hammett & Collins, 2002; Pillay, Irving & Tones, 2007;Tsai, 2008).

In the 2000-2001 academic year, there were approximately 2.9 million enrollments in college-level, credit-granting distance-education courses in the United States, with 82% of those enrollments at the undergraduate level. Ninety percent of the surveyed institutions reported that they offered asynchronous computer-based instruction via the Internet (Waits & Lewis, 2003). By the 2006-2007 academic year, total enrollment in distance education courses climbed to 12.2 million, with 66% of those enrollments occurring at the undergraduate level (Parsad & Lewis, 2008).

The concept of design within instructional design takes on an additional significance when applied to the user interaction with the various functions of a web-based course. This review of the literature outlines the growth of web-based courses in higher education, the concurrent increase in attendance of students with disabilities in postsecondary institutions, and the two trends' convergence in the accessibility and usability of web-based courses. Inclusive in this review are studies of the instructional design implications of cognitive load on student

performance. In this study, constructivist learning theory is applied to the rapidly changing area of web-based course instruction, and a social constructivist perspective of disability provides a basis for approaching web accessibility via universal design as a reflection of institutional diversity.

Web usability is generally associated with commercial website design, and while the admissions and marketing departments of a college or university campus may be well-versed in the subject, faculty and instructional designers responsible for web-based course development may not. Moreover, the use of a standard course management system across the university might well limit available options for creating a simple, aesthetically pleasing user interface for online courses. Research in web usability comes primarily from business and industry, specifically in customer management and/or marketing (Nielsen, 1994). Social networking sites, designed to keep their users interested and returning often, could be an important model to emulate. As distance learning and instructional technology continue to develop and grow as academic fields of study, additional literature in this area is likely to follow.

One major factor that will drive growth in research in web usability is its complementary topic of web accessibility. As the number of declared students with disabilities in higher education grows, more and more of those students will be taking advantage of the convenience of distance education via online learning. Federal laws governing the nondiscriminatory education of persons with disabilities and accessibility of web-based technology to those persons, specifically Sections 504 and 508 of Rehabilitation Act of 1973, will become an

issue for institutions with students who are unable to access online coursework due to its incompatibility with the assistive technology devices they may use to access the internet. Research in this area is also limited, but much has been written regarding the experiences of students with disabilities in postsecondary education (Michaels, Prezant, Morabito, & Jackson, 2002; Ward & Berry, n.d.; Wimberly, Reed & Morris, 2004). As a guiding principle, universal design promotes the creation of a learning environment that is usable by all students without singling them out by requiring them to request accommodations that publicize possible limitations they may wish to keep hidden.

The potential legal implications for postsecondary institutions regarding online education and students with disabilities have been discussed in a minimal way within the context of providing accommodations for learners. Due to the increasing number of students with disabilities in higher education (Erickson & Lee, 2008), it follows that more of these students could turn to online learning as an option for its convenience and anonymity. In the same manner that ramps, sloping curbs and other architectural elements designed to provide access for disabled persons offer benefits for a much wider range of users, universal design for learning provides an enhanced experience for all learners (CAST 2008).

Students with Disabilities in Postsecondary Education

Due to medical interventions that preserve life, there are more people with disabilities living in the community. This is in marked contrast to the past, where mortality due to injury complications and congenital disorders was almost certain. Indeed, those who did live were relegated to asylums or shunned from public

view (Shapiro, 1993). The belief that “invalids” or “handicapped” people were unable to do things that “normal” people did was – and in some ways remains – prevalent and accepted. The disability rights movement developed in answer to this medical view of disability, and is a response to discrimination in employment, education, transportation, and housing. One important point to note is the difference between impairment and disability: impairment is a physical/cognitive condition, and disability is based on how society interacts with the individual with the impairment. That is, a missing leg is a physical impairment. A neighborhood or public transportation system without ramps for the person's wheelchair turns that impairment into a disability (Ferguson, 2005).

Legal statutes established to offer equality to persons with disabilities were drafted, but challenges to implementation allowed discrimination to continue. The Rehabilitation Act of 1973 is applicable to colleges and universities as recipients of federal funding via its Section 504 (hereafter referred to as Section 504), which prohibits discrimination based on disability. However, the rules governing administration and implementation of Section 504 were not signed into law until 1977 prompted by large-scale demonstrations by disability activists (Hahn, 1985; Shapiro, 1993).

In contrast, a socio-political or constructivist view of disability views the environment and society’s perceptions as being flawed, rather than the individual. The socially constructed “disabling environment” fails to serve disabled citizens as well as nondisabled ones, and demands that persons with disabilities adapt instead of the other way around. This change in view provides

the basis for a minority identity perception of disability that sees disability as similar to any other physical feature (Davidson, 2006; Hahn, 1985). Given the historical medical view of disability prevalent in many cultures, it has been challenging to persons with disabilities to integrate into the larger society to meet their personal, professional, and academic goals.

A major victory for disability rights activists, the Americans with Disabilities Act of 1990 (hereafter referred to as ADA) extended the protections of the Civil Rights Act of 1964 to people with disabilities. Based on Section 504 and ADA, students with disabilities should have access to the same facilities, coursework, and opportunities as students without disabilities. Still, the experiences of students with disabilities in postsecondary education are often more challenging and exclusionary. For example, even though public transportation vehicles are becoming more accessible, the routes may not serve residents efficiently. Areas with slowly developing transportation systems may make getting to campus almost impossible (Shapiro, 1993). Multiple adverse experiences may lead to diminished persistence of students with disabilities in the completion of bachelor's degrees in the same way that such experiences can lead to attrition for nondisabled students. However, as student services programs continue to grow and deliver the message to nondisabled students that they can find support and help from administration and peers, students with disabilities may not receive similar messages. Indeed, many well-established institutions have disabilities services offices staffed by professionals that cannot assist students beyond

fulfilling the immediate request for accommodations (Michaels, Prezant, Morabito, & Jackson, 2002).

Given the increased earning potential furnished by the completion of a four-year degree, it is important to assist all students in meeting their academic goals. In 2005, the median income of a person without disabilities with a bachelor's degree was $54,000 annually, compared to $22,000 for someone without any college experience. For bachelor's degree graduates with disabilities, the median annual income was $47,000, compared to $22,000 (National Council on Disability, 2008). The difference in earnings between persons with disabilities versus those who are nondisabled is significant, but the financial benefit of earning a degree remains pertinent. However, the percentage of working-age (21-64) people with a bachelor's or higher degree in 2005 was 13% for people with disabilities, contrasted with 30% of people without disabilities (National Council on Disabilities, 2008). These disparities persist not as a result of their individual disabilities, but because of the attitudes and policies of the institutions which serve these students (Eckes & Ochoa, 2005; Hibbs & Pothier, 2006; Sitlington, 2003).

One significant barrier to the success of students with disabilities in postsecondary education is inadequate preparation in high school for the increased rigor of the college curriculum (Garrison-Wade & Lehmann, 2009; Sitlington, 2003). Garrison-Wade and Lehmann (2009) reported that students with learning disabilities were often placed in classes that were not challenging and these students were not encouraged to take college preparatory courses,

resulting in a higher need for remedial education at the college level. In addition, the students studied also internalized low expectations for their performance, arriving in college classrooms expecting to fail. Given the numerous deterrents to pursuing postsecondary education, supporting those who push to embark on the path is essential to their success. Students with “hidden” disabilities such as ADHD, depression, and especially undocumented learning disabilities are at a disadvantage because they often do not have the benefit of a transition plan from high school, lack knowledge of the laws governing their change in status to college student, and, being unaware of their learning needs cannot advocate for themselves with faculty or administrators (Eckes & Ochoa, 2005). Students with disabilities in postsecondary education must become familiar with campus policies, services and facilities designed to assist them, often without guidance or referral. This can lead to feelings of isolation and disconnection, which are major factors in student attrition regardless of disability status (Tinto, 1987).

In a longitudinal study of students with and without disabilities at a Midwestern university, Wessel, Jones, Markle, & Westfall (2009) found that when academic aptitude and gender were controlled for, there was little difference in the graduation and retention rates of students with and without disabilities. However, they acknowledged that they did not factor the effect of interventions of the institution’s Office of Disability Support Services on the enrollment and retention of students with disabilities. They went on to explain the office’s involvement in a number of activities likely to serve students with disabilities well, such as separate orientations, faculty training, and the presence of images of

students with disabilities throughout campus literature. A supportive environment such as this one would certainly have some effect on student retention and overall performance.

The importance of a supportive and integrated postsecondary environment for students is shown in another recently published study. Investigating the experiences of students with disabilities at four institutions, Dutta, Kundu, and Schiro-Geist (2009) found that, among other major areas of improvement, students cited attitudinal barriers as a challenge and disability/civil/human rights training as a solution to accessibility on the campuses. They also found that services provided by the various Offices of Disability Services were often disjointed, with the staff members overworked and overextended. There was also little integration of the Offices' missions into the life of the university. Students recommended that there be a liaison from the offices to on- and off-campus service providers. Recommendations to university service providers include providing information about student disability services in a variety of accessible formats and disseminating the information throughout the campus.

Students with Disabilities in Online Distance Education

Online coursework could mitigate some of these challenges, but only insofar as the system and coursework themselves are accessible. Accessibility of online courses to students with disabilities is a developing area of research with the primary concern of determining the true level of access in courses designed

to serve a wide range of students. As a growing population in higher education and presumably in online learning, additional literature is essential in this realm.

Kim-Rupnow, Dowrick, and Burke (2001) conducted a review of the literature specifically seeking case studies of individual students with disabilities in distance education as well as individual studies at the institutional level. They were able to identify 10 such studies for the review. In the review, Kim-Rupnow, Dowrick, and Burke noted that there is difficulty in getting a true picture of the status of students with disabilities in postsecondary education due to the lack of research in the area, the fact that voluntary self-identification by the student is necessary, and data collection at the institutional level by the offices charged with supporting students with disabilities is nonstandard at best. The authors called for longitudinal case study research of students with disabilities in distance education, which would provide a fuller picture of the experiences of students with disabilities both in postsecondary education in general, and specifically in distance education. Kinash, Crichton, and Kim-Rupnow (2004) found in their review of the literature published between 2000 and 2003 regarding students with disabilities participating in online distance education, that of the 43 publications during that period, only 5 could be considered research. The others fell into the categories of didactic or “how-to” papers, descriptions of vendor products, and opinion pieces.

Cook and Gladhart (2002) conducted a survey of students with learning disabilities in online courses, and discussed strategies for teaching online. These authors found that faculty were mostly unaware of what accommodations were

available and required to support learners with disabilities online. They go on to explain strategies for designing courses to be more accessible to students with learning disabilities, and suggest that designing for accessibility to students with learning disabilities would benefit all learners using the online medium.

Simoncelli (2005) performed a case study of five students in a distance learning course, including two with learning disabilities and three who were not disabled. He looked at the holistic experience of students with disabilities in an online course, which led him to develop some key points for designing online instruction for students with disabilities. Rather than faulting the design of the course, Simoncelli places the onus on students to be aware of assistive technologies available rather than encouraging instructor provision of such information. He also suggests that such information is best received from the institution's disability services center. Stating that "even students that have difficulty reading prefer not to take the time to install and figure out these assistive programs," (p. 131) Simoncelli does not investigate reasons for students' unwillingness to install text-to-speech programs. Admittedly, the course was primarily textbook based, and the online medium was used mostly for printing out readings, the delivery of assignments and "to complain." (p.128). A major instructional flaw here is that the instructor did not create a learning community for students. Instructional design matters just as much, if not more, in an online environment as in a face-to-face environment, and a poorly designed course site may make it unnecessarily difficult for students to acquire learning content. Simoncelli indicates in his suggestions for online course design that

audio lectures should be longer and relevant to course content, file sizes and downloadability should be major considerations, and frequency of assignments were found to be a positive in building consistency with students.

Crow (2006) interviewed disabilities advocates and subject matter experts in accessibility, assistive technologies, and students with disabilities, and surveyed staff members in disabilities services offices at 151 doctoral degree-granting research extensive universities in the United States. One subject matter expert stated that emerging technologies for learning are not developed using universal design and therefore continue to present problems for students with disabilities who attempt to use them. Crow noted that front-line personnel in disability services offices within the study were not very knowledgeable about the concerns of students with disabilities in online learning. While not condemning the offices, Crow pointed out that with this disconnect in services to students with disabilities, these students will most likely avoid enrolling in courses where they believe that they will not be accommodated or supported. Indeed, because these individuals would be the students' first resource if they encountered a difficulty, such lack of knowledge of their own institution's policies and resources is extremely troubling.

Subject matter experts in Crow's study recommended that institutions establish and implement standard policies regarding accessibility in all of their electronic and information technologies, which would necessarily include online courses. The experts extend this recommendation to the information technology products procured by institutions and point out that pressure from institutions

could encourage commercial software and hardware developers to consider a wider variety of students in the production of their wares. Crow found that the accommodations requested most often by students with disabilities in online courses were electronic textbooks for students with vision impairments, text captioning for audio and video for students with hearing impairments, and additional time to complete assignments and examinations for students with motor and cognitive impairments. Another subject matter expert indicated that the expectation that online courses will not be accessible is probably a major deterrent to students with disabilities' enrollment in such classes. The current study addresses Crow's eighth recommendation, to "determine which disabilities create the biggest barriers to effective on-line learning, determine what measures need to be taken in order to provide accessible on-line learning to these on-line learners, and determine how best to implement and facilitate accessible on-line learning to these learners" (p. 175).

Section 508 of the Rehabilitation Act of 1973 (hereafter referred to as Section 508) was enacted in 1998 and requires all federal agencies to make their information technology and web pages accessible to people with disabilities. While Section 504 makes the Act applicable to colleges and universities, there is much debate as to whether or not Section 508 will be extended to cover recipients of federal funding and therefore to colleges and universities (Keener, 2004). In the interim, the possibility for disability discrimination litigation does exist. Given institutions' responsibility to provide an equal education to all of their students based on the Civil Rights Act of 1964 and Section 504, it is conceivable

that it would be in the best interest of colleges and universities to be proactive rather than reactive in promoting the accessibility of their websites and online courses. However, by virtue of policy and tradition, the onus for demanding equality is on the student through the requirement to self-identify and request accommodations, and subsequently “prove” that the need for accommodations exists (Hibbs & Pothier, 2006).

Accessibility for students with disabilities is important not just architecturally, but educationally. Education is the primary means by which those not born to wealth can best achieve success. A nigh ubiquitous educational medium such as online instruction must be delivered in a manner that levels the playing field, rather than giving students with disabilities a figurative "head start" through the provision of circuitous accommodations. The continuing growth of both students with disabilities and online course delivery in postsecondary education highlights the importance of the current study to determine ways in which this population of students can be best served through this medium.

Accessibility and Usability in Online Courses

Web accessibility involves making web pages understandable and applicable to users accessing them through a variety of hardware and software applications. Applied to college and university websites and online courses, accessibility means remaining true to the common mission of many institutions and providing access to education to those persons who may otherwise be excluded. Discussion of web accessibility in business and industry is ongoing, especially with regard to emerging technologies and social networking sites.

Numerous blogs and websites can be located with a simple search for “web accessibility.” Indeed, a Google search with these terms yields over 39 million hits. However, the addition of “university” to the search terms yields just over 4.5 million, “college” 3.9 million, and “post secondary” 254,000. Clearly, discussion of web accessibility at the college and university level is not proceeding apace with business and industry. This is borne out by the studies previously discussed, in which ignorance of the standards for web accessibility was a primary deterrent to compliance with Section 508 legislation.

The World Wide Web Consortium (W3C) is an independent, international collaboration of developers, communications professionals, industry leaders, researchers, and policy analysts working to develop and promote tools and products that optimize use of the web. The Web Content Accessibility Guidelines (WCAG) published by W3C are generally accepted to be the standard by which implementation of Section 508 requirements should be measured in the United States. The W3C’s Web Accessibility Initiative (WAI) focuses on developing resources to make the web and its information more accessible to people with disabilities. This group’s website offers checklists for selecting web tools, product reviews, and suggestions for working around barriers in course design and authoring software. Divided into three levels, the WAI guidelines are Priority 1 – checkpoints that must be satisfied, or some users may be unable to access the site’s information; Priority 2 – checkpoints that should be satisfied or it would be very difficult to access the site’s information; and Priority 3 – checkpoints that may be satisfied or some users would find it difficult to access the site’s

information (World Wide Web Consortium, 2007). Section 508 incorporates all of the WAI Priority 1 guidelines along with four additional requirements (Johnson & Ruppert, 2002).

National Center for Educational Statistics data collected annually from colleges and universities in the United States indicate that of the institutions serving students with disabilities via distance education, 95% of respondents reported that they used websites to deliver distance education courses, but only 18% of those reported that they followed established accessibility guidelines or recommendations for users with disabilities to major extent. Three percent did not follow the guidelines at all, and 33% did not know if their websites followed such guidelines (Waits & Lewis, 2003).

A number of studies on the usability of online courses indicate that improved usability serves learners best. Usability testing via heuristics as well as through formal studies has emerged as the primary means for evaluating student experience in online courses. Crowther, Keller, and Waddoups (2004) found that usability testing was so important to the design process that their department hired a full-time testing and quality assurance supervisor to work on the instructional design and development team.

Nielsen (2000) shows that usability testing need not be large-scale or expensive. The insight gained with only one user is invaluable, and by the 3rd person nearly 75% of possible information is obtained. As more users are included in testing, less and less new information is gleaned as new users will generally make the same errors as previously tested users. Usability testing with

five users reveals almost 85% of design issues. Fifteen users are recommended to discover all problems, but it is more useful to do three sets of 5-user tests than 1 test with 15 users. The reasoning behind this is that the first five testers discover 85% of initial design issues and this should prompt a redesign. The second 5 users assist in the discovery of other things designers may have missed, and the last 5 users should prepare the final product for deployment.

Several studies aimed at online course designers encourage universal design and the consideration of a wide range of potential learners. Dringus and Cohen (2005) performed a heuristic evaluation of WebCT, and located over 100 usability problems within an hour. Based on the problem list generated from that evaluation, they identified 13 heuristic categories: Visibility, Functionality, Aesthetics, Feedback and Help, Error Prevention, Memorability, Course Management, Interactivity, Flexibility, Consistency, Efficiency, Reducing Redundancy, and Accessibility. The ultimate result of the evaluation was a draft of an adaptable usability heuristic checklist. Dringus and Cohen's Accessibility category evaluates whether the course is designed for use by a wide range of users, including adherence to established web accessibility standards. Additionally, they indicate these important points for identifying good usability in an online course:

- Good usability facilitates learning by having the mechanics of the learning environment transparent to the user.
- Good usability involves easy engagement of the user in the instructional and communication process.

- Good usability involves supporting flexibility for creative endeavors as part of the learning process.
- Good usability involves promoting interactivity among students and between students and instructor.

Mackey and Ho (2008) remind designers that “as with connection speed, monitor resolutions will vary from one user to another. “Therefore it is important to design with an awareness of this variability and to consider the needs of a particular audience” (p. 389). An important caveat for course site designers is to be careful about the assumptions made about what students will do when accessing an online course. Miller-Cochran and Rodrigo (2006) designed and tested the usability of their online composition course. The authors found that they were somewhat inaccurate in presupposing what students would do first, resulting in difficulties for students completing the prescribed tasks. Misunderstandings about terminology were also an issue. Another component of usability testing is a “walk through” of the course, observed and recorded, by approximate users of the site of various levels of expertise. Miller-Cochran and Rodrigo (2006) used this method to evaluate an online composition course. Following Nielsen’s (2000) guidance, they conducted the study with only five users. While they were cautious about the generalizability of their findings under those conditions, they did receive much useful feedback that is indeed pertinent to users of course sites in other disciplines. For example, they found that one student, who had previously successfully completed an online course with one of the researchers, did not recognize “WebCT Link” as the method for accessing

the course system from the institution's main website. In the previous course, she had "simply bookmarked the link and used that to access the site directly" (p. 98), pointing again to the assumptions the authors made as to how students would access the course. Also, information that was found in several different places on the site was confusing, since students would not necessarily be in the same place to complete the next task. This challenge to basic usability illustrates the need to have important course information in one central location, accessible from each page of the site. Miller-Cochran and Rodrigo's study confirms that a large-scale usability study is not necessary to pinpoint important usability issues that can be fixed by the site designer.

Web accessibility in online courses is an area of challenge with few research studies conducted on the topic. Ferguson (2005) offers some valuable insight in this area through her case study of 21 instructional design and distance learning professionals, disability services coordinators and chief academic officers from two regional universities and two community colleges in one southwest state. She questioned primarily what designers were doing to accommodate students using assistive technology devices in distance education. Ferguson sought to determine what policies and activities were being undertaken at the institutional level to address the accessibility.

Ferguson also points out that the Office of Civil Rights is taking seriously and giving added attention to the accessibility of course sites as they are a major delivery method for education at the postsecondary level. With regard to the redesign of existing courses to make them accessible she states, "the cost of

ensuring equal access is typically not considered an undue burden when the same financial burden might have been substantially minimized if the matter of accessibility had been considered during the creation of the online courses" (p. 47). Also, in accreditation visits by the Higher Learning Commission, accessibility of content ranked far lower in evaluation than quality of instructional content. This low priority could be one major reason for a reactive rather than proactive stance in higher education. If accessibility were tied more closely to accreditation, it would certainly become more of a priority on college campuses.

Ferguson cites several studies where Bobby, an online web page accessibility tester that was once available as a free service to web designers, was used to evaluate college and university websites. Less than 25% of university home pages were accessible using Bobby and only 3% of second level pages were accessible. After notification, there was a small increase in accessibility but the rate remained under 25%. Ferguson posits that this means that even when scrutinized, institutions are slow to improve accessibility and that those changes are almost exclusively superficial - they only fixed the home pages. What could this mean for the progressive accessibility of course sites? Ferguson also suggests that students with disabilities are more likely to demand accommodations based on their public school experience and protection under the Individuals with Disabilities Education Act (2004), but other research previously discussed suggests that this is not the case. Students unused to advocating for themselves may not have the knowledge or tenacity to wade

through institutional policies and procedures to locate and request needed services (Hibbs & Pothier, 2006).

Ferguson (2005) expresses that very little attention has been paid to site design and construction as a barrier to access. In their reviews, Kim-Rupnow, Dowrick, and Burke (2001) and Kinash, Crichton, and Kim-Rupnow (2004) noted that while there are several didactic (how-to) publications addressing the topic, there is little true research. Ferguson (2005) also points out that textbooks on web and course site design include minimal (less than a page) instruction in accessibility. The researcher's own instructional design course text included about two to three pages on accessibility in site design and the topic was only a small portion of one lesson.

Ferguson's case study reveals conflicts between campus professionals with the responsibility of ensuring accessibility under ADA, and faculty desire for autonomy and the protection of their academic freedom and time. That is, faculty members were resistant to taking the considerable design time required to make their individual pages and course sites accessible. Also, some disability services coordinators charged with the selection and purchase of assistive technology equipment and software met with territoriality from other departments such as information technology (IT). On all of the campuses studied, faculty designed their own instructional pages.

Ferguson (2005) notes that academic freedom was cited often as a challenge to making course sites accessible. The theme was that faculty members as content experts felt that they should determine how that content was

best delivered. She also cites that individually proactive leaders can push institutions towards accessibility by developing comprehensive plans and negotiating carefully throughout the organization, with personality and people-skills contributing strongly to these successes. Financing, staffing, and general institutional support were recurring issues for most of Ferguson's respondents. One major setback was that relationships between disability services offices and IT ranged from limited to strained to nonexistent. This is perhaps the largest barrier to web accessibility on postsecondary campuses, even more so than faculty or instructional designer resistance.

The development of an accessibility plan including key personnel from both of these areas as well as other campus stakeholders – including students – would likely mitigate this and other accessibility barriers. Ultimately, Ferguson (2005) found that the most common response with regard to web accessibility among instructional technology and distance education personnel was that they will address problems as they arise. She also found that disability services coordinators were turning students with disabilities away from course enrollment, presumably because the coordinators are aware that the courses were not accessible. Ferguson’s study begins to answer some of the calls for research into the experiences of students with disabilities in online education through her examination of policies and attitudes of institutional administrators charged with providing online coursework, support, and oversight to students with disabilities.

Among disability advocates and activists, it is agreed that providing accessibility in education to persons with disabilities improves outcomes in a

wide variety of areas for all people (CAST, 2008; Center for Universal Design, n.d.; Wessel, Jones, Markle, & Westfall, 2009). Universal design, the principle of designing for the widest possible variety of potential users, provides a foundation for designing online courses to serve a wide variety of learners. It is reasonable to believe that employing universal design principles in the beginning can help mitigate or avoid costly retrofitting to provide accommodations after the course, product, or building has been completed. Combined with a constructivist minority identity view of disability, using universal design to promote online course accessibility could be simply identified as implementing better design to serve the purpose of online learning, namely to provide another vehicle of access to learning for those students who cannot or choose not to attend on-campus courses.

Based on data collected through September 2006, Erickson, Trerise, VanLooy, and Bruyère (2009) explain how increasing reliance on online applications and functions by admissions and financial aid offices at community colleges can create a disparate effect for students with disabilities due to the inaccessibility of college websites and individual pages. It is interesting to note that although 57% of respondents had diversity plans in place, only 48% of those with plans included students with disabilities in the plan. This is another major disconnect in the provision of equal access to a full and complete postsecondary experience for students with disabilities. Among the institutions studied and colleges and universities in general, there is extensive use of online student services enabling the completion of institution-related business at a distance,

without the need to visit the campus. The authors found that the main barriers to accessibility were lack of awareness of the need for web accessibility, the time and fiduciary costs involved, and lack of knowledge of what is needed to make a web page accessible to persons with disabilities. As several of the respondent institutions had moved several student services *exclusively* online, it is imperative that the gap between knowledge of accessibility laws and the actual practice of producing accessible web and course sites be reduced quickly.

Only one study was found that investigated the accessibility of course management systems with a practical review using common assistive technology devices, and all of the systems evaluated at the time are now one system. Johnson and Ruppert (2002) analyzed Blackboard 4 and 5, Prometheus 3 (a system developed by George Washington University), and WebCT 3 according to W3C/ WAI guidelines using Lynx (a text-only browser), IBM Homepage Reader (a text-to-speech browser), and JAWS (screen reading software). Since the study was conducted, Blackboard has acquired Prometheus and WebCT, and is the leading course management system used in colleges and universities in the United States. Although the software studied is now obsolete, the study's methodology provides a useful mechanism for performing an in-depth accessibility review of larger scale course management systems currently in use may inform the method of evaluating the accessibility of the treatment course in the current study.

Although accessibility for students with disabilities should certainly be a primary goal, ultimately course site designers should be working towards

universal access for students via universal design. The ultimate goal of the current study is to determine how to improve online learning outcomes for all students. It is important to understand the fundamental difference between accessibility and universal design. Accessibility refers to the design provision that the site can be used specifically by persons with disabilities. Universal design provides for the use of a site or product by *all* persons, regardless of ability. Moreover, universal design informs good design in general, with an equally rich experience for any user.

Self-Efficacy and Information Literacy in Online Students

Since distance education courses require students to work independently towards their learning goals, it is important for the student to see these goals as reachable. Additionally, the student must believe that they have the technical skills and abilities required to reach those goals.

Self-Efficacy

Central to a constructivist view of teaching and instructional design is acknowledging and respecting the prior knowledge and experiences of the learner. The learner characteristics specifically observed in this study are the self-efficacy and information literacy of the participants. Bandura (1977) described self-efficacy as the belief that one has the ability and/or experience to produce a desired outcome. Moreover, “efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences” (p. 194). Network outages, bandwidth problems, and forgotten login information are all potential obstacles that would

face all students in online courses. Given the mostly independent and self-regulating nature of distance education, it might be assumed that students enrolling in online courses believe that they will be successful. However, as many students enroll in courses each semester (both face-to-face and online) due to scheduling conflicts or with erroneous expectations of the work involved, several studies have looked at the concept of self-efficacy in online students and its relation to successful performance.

Wang and Newlin (2002) examined how student expectations for course content and the computer portion of an online course predict performance. They studied juniors and seniors majoring in psychology over three semesters in an advanced psychology course. To control for instructor differences, all six sections were taught by the same instructor with the same materials and assignments. Based on their findings that self-efficacy correlated with student performance, Wang and Newlin suggest that students complete self-efficacy surveys at the beginning of online courses each semester.

Contrary to expectations, DeTure (2004) found that cognitive style and online technology self-efficacy were not predictors of success in online courses. However, the study was conducted with six different instructors, with widely varying levels of interaction and structure. Because of the inability to control for instructor and course differences in her model, it is difficult to accept the result that online technology self-efficacy cannot predict course success. DeTure acknowledged that there was little difference among the final grades of students in the study, with 74% earning As and Bs. Due to the subjective nature of course

term grading, final grade alone is not likely to be a strong indicator of student learning or absorption of course content.

Using the same instrument as DeTure in a non-experimental quantitative study, Liu (2007) also found that self-efficacy was not a predictor of final grade. Liu did find that psychological and social readiness were in fact predictors for retention and grade. Further, Liu suggests that future research consider the interaction between psychological, social, and technological factors in the retention and performance of students in online courses.

Pillay, Irving, and Tones (2007) determined that there is a possibility that perceived complexity can affect self-efficacy, especially in students that have lower technology literacy. The study's purpose was primarily to validate a measure designed by the authors to determine the prerequisite learner characteristics that indicate success in online learning. The measure's subsets included items related to 'Technical Skills,' 'Computer Self-Efficacy,' 'Learner Preferences,' and 'Attitudes Towards Computers.' The validation revealed that the subsets held good to fair reliability and validity with the exception of Learner Preferences, which held poor reliability and validity. Determining the learner characteristics that predict success in online courses can assist academic advisors and other enrollment professionals in developing screening tools that support students in course completion, or that steer students to other delivery modalities in which they may be more successful.

Cho and Jonassen (2009) found that the more self-efficacy a student has in being able to contribute to the online course community, the greater the

interaction strategies employed. The study participants were primarily nontraditional age female graduate students, who often have different motivations and tend to be more secure in their academic and learning goals. Also, graduate students are generally more likely to be self-directed learners to begin with. It is the researcher's opinion that developing a true learning community could be particularly important for students with low self-efficacy and their participation and success in online courses.

Information Literacy

Information literacy is understood to be "a set of abilities requiring individuals to recognize when information is needed [and] have the ability to locate, evaluate, and use effectively the needed information" (Association of College Research Libraries, 2000 p. 2). Information literacy includes the ability to navigate the web and other resources to conduct research in a variety of areas. While numerous research studies discuss information literacy instruction, a review of the literature found no studies that specifically discuss how information literacy affects student success in online courses or in academic coursework in general. Such literacy is commonly understood to be important to student success as all disciplines require the ability to locate, manage, and synthesize information. The current study does work from this assumption, but specifically seeks to understand how a student's level of information literacy affects his or her ability to complete an academic course in an online format.

Constructing the Student Experience through Instructional Design

The development of a collaborative learning community is one method by which course designers and instructors can promote learning in online courses. Constructivism offers a pedagogical basis for making design decisions that build collaboration among students.

Constructivism in Online Course Design

The theoretical foundation of this study is that the variety of experiences and realities of a diverse set of potential learners should drive the design of their instruction, regardless of the delivery medium. In order to authentically allow students to participate in the learning process in an online course, the course must necessarily be usable and accessible to enrolled students. Constructivist pedagogy supports the learner's active role in the process of receiving and interpreting new information, and incorporating it into one's previous experiences as a frame for understanding (West, Farmer & Wolff, 1991). The role of the teacher in the learning experience is to provide active learning experiences in which learners can connect new information being taught with what is already known in meaningful and transferable ways. Teaching abstract concepts within a real-world context can help students recognize the ways in which knowledge and disciplines can work together as they think critically about their lives outside the classroom (Bronack, Riedl, & Tashner, 2006; Bruner, 1966; Gagnon & Collay, 2006; Hammet & Collins, 2002; Yuen & Hau, 2006). Students cannot be passive receptors of data or course web pages. They must be intellectually engaged and interactive with the learning content (LeGrand, 1987).

Hammett and Collins (2002) reviewed a seminar delivered at the completion of an all-course master's program at their institution. Citing the possibility that learners in this degree track may feel that they have not proven their overall acquisition and independent construction of knowledge, the seminar was developed to assist in this area and allay potential fears. The seminar was delivered online for the convenience of the students, who were mostly full-time teachers and administrators. Hammett and Collins found that students did indeed construct new knowledge through the synthesis of their personal and professional experiences and their previous coursework. The web conferences and other online tools (i.e. email) promoted both social and intellectual collaboration that may not have been possible with the additional time constraint of traveling to a physical campus. The development of an interactive and self-sustaining learning community has been found in many studies to be an indicator of effective instructional design and course management.

Chapman, Ramondt, & Smiley (2005) also stress the importance of community and collaboration in a constructivist online learning environment. They point out that a true community takes time to develop, and requires regular, comprehensive, and purposeful guidance by an experienced advisor, most often the course instructor. These authors also found that asynchronous bulletin board-style discussions provided opportunities for learners to self-reflect between postings in addition to supporting students' ability to navigate and synthesize course content in their own time. Ultimately, Chapman, Ramondt, and Smiley suggest that in the interest of building a strong community, online instructors

should take time at the beginning of an online course to encourage students to build a rapport that will later lead to a stronger learning community. Another very important point they make that is often overlooked is that the instructor should participate in the discussions and model appropriate meaningful interactions just as in face-to-face classrooms.

Bronack, Riedl, and Tashner (2006) found that students taking courses in a virtual world medium reported deeper learning through problem-solving and developing their own understanding of the concepts to be learned. Their self-study extended their understanding of how students learning from a distance benefit from the development of an engaged and interactive learning community. Although Bronack, Riedl, and Tashner looked at a three-dimensional virtual world developed exclusively for their students, the information they gained is useful to the broader community of instructional designers for online learning.

Tsai (2008) conducted a study of over 600 university students investigating their preferences with regard to constructivist learning environments. His findings indicate a number of concerns that should be addressed in effective instructional design. For example, Tsai found that male students in the study preferred challenging problem-solving environments more than the female respondents. In addition, instruction for advanced students should offer opportunities for individual reflection as well as authentic knowledge construction and collaboration. As can be expected, Tsai also found that students with higher levels of internet experience desired more tools and features than those students with less experience.

Constructivist pedagogy supports many of the choices that an instructional designer makes to promote effective learning. The development of an interactive learning community, authentic experiences or problem-based instruction, and the usable design of a course site interface are all decisions that acknowledge and encourage the learner's participatory role in the learning process (Gagnon & Collay, 2006; Mayo, 2004). The treatment course of the current study incorporates these and additional constructivist characteristics to promote intentional and purposeful student interaction. The minority identity view of disability is constructivist in nature (Dudley-Marlin, 2004; Hahn, 1985) and viewed through a social constructivist lens, effective instruction requires the authentic participation of a wide variety of learners.

Cognitive Load Theory

Cognitive load theory states that individuals have a finite amount of working memory as described by Miller (1994 – reprint of 1956 article), and if that limit is exceeded, they are unable to process additional information (Kalyuga, Chandler, & Sweller, 1999; Sweller, 1988). Therefore, increased cognitive load impedes effective learning. Kalyyuga, Chandler, and Sweller explain that a constructivist emphasis on problem-solving may impede the development of schemas that will aid in improving skills in problem solving. Sweller points out that self-efficacy is important to cognitive load in that a person must recognize the problem not only as solvable, but as part of a particular set of problems that he or she knows how to solve (Sweller, 1988).

There are three main types of cognitive load: intrinsic load, germane load, and extraneous load. Intrinsic load is part of the work of solving a difficult problem and should be appropriate to learner knowledge level and instructional goals. Germane load is the mental work necessary to learn the intended lesson and extend the student's understanding. Extraneous load is unintended and unnecessary mental work used to process information that is irrelevant to the topic at hand or the lesson in general. Extraneous is often due to factors well within the instructional designer's purview, such as nonstandard item placement on a page, or unnecessarily redundant information (Clark, Ngyuen, & Sweller, 2006).

It is possible to increase the capacity of working memory through the presentation of information in two formats such as text and audio, because the use of two sensory channels (visual and auditory) allows for the processing of more information than delivery of content via one channel alone. It is important to note that the delivery of visual and auditory information must be simultaneous to get the enhanced effect – the cognitive load increases with asynchronous or sequential delivery (Kalyuga, Chandler, & Sweller, 1999). Moreno and Valdez (2005) found evidence that supported the assertion that "students learn better when provided with visual and verbal knowledge representations rather than visual or verbal representations alone" (p. 43), supporting the dual-channel instructional model.

Managing extraneous load is a major task of instructional designers, as "…schema construction and automation are the primary functions of learning and

the learning process may be inhibited if a learner is required to devote limited working memory resources to activities that are not directly related to schema construction and automation" (Kalyuga, Chandler, Tuovinen, & Sweller, 2001, p.579). Means-ends analysis involves seeing a problem in its current state and devising a series of steps to reach a desired goal-state. Each step minimizes the differences between the current state and goal-state. When high school students are taught to solve algebra problems for an unknown, the process of grouping like terms and ultimately solving for *x* illustrates means-ends analysis. This technique is often implemented in teaching via problem solving.

When examples that have been partially solved for instructional purposes (worked examples) have parts that cannot be understood in context, that is, the diagram and its describing text are physically separate, the examples themselves impose a heavy cognitive load that inhibits learning similar to teaching via problem solving. The user must divide attention between the illustration and the text that explains it. This division is termed the 'split-attention effect.' Worked examples can produce a 'redundancy effect' that increases cognitive load when the example repeats information that has already been learned. The learner, having moved towards more sophisticated problem solving (means-ends), would benefit more in this case from simply being given the completely solved problem and practicing problem solving. These concerns should be addressed by learner assessment during the instructional design process to determine learners' levels of expertise (Kalyuga, Chandler, Tuovinen, & Sweller, 2001).

Mayer & Moreno (2003) offer solutions to design concerns affecting cognitive load, such as managing split-attention effect by having an animated graphic object narrated rather than represented in text. This way, the user can focus on one input and the cognitive load is dispersed to both the visual and auditory channels as suggested by Kalyuga, Chandler, and Sweller (1999). Additionally, this dispersion may increase a user's capacity for cognitive load.

Instructional design based on cognitive load theory is necessarily constructivist, as the design of instruction must take learners' mental capacities into account. The current study seeks to determine whether the extraneous cognitive load imposed by an interface that is not user-friendly is a significant obstacle to student learning in an online course. Implementing universal design to produce a course site that is highly usable and can be navigated intuitively is expected improve student outcomes.

Spatial Visualization Ability and the User Interface

Spatial visualization ability (SVA) is the ability to mentally manipulate two- or three-dimensional images, objects or patterns (Alonso, 1998; Bodner & Gray, 1997). This cognitive ability has been shown in various studies to correlate with information-seeking strategies and navigation of hierarchical data structures such as library research databases. Evaluation of website use by persons with high and low SVA can provide insight into the intuitive usability of a commercial or instructional website.

Alonso (1998) used an information processing cognitive model to explain possible interference between spatial visualization and verbal tasks in a

technology enhanced classroom. She proposes that low SVA users may try to represent spatial objects verbally, taking resources away from verbal processing. For example, when navigating program menus of several levels, a user with low SVA does not visualize the site structure. Rather, the low SVA user follows verbal site links in a sequence that may seem random to them, potentially getting lost in the site along the way. The high SVA user might maintain a mental picture of the site map, remembering where resources are located, how she came to be at the current location, and where she needs to go next.

In a study that also indicates the importance of information literacy, Kim (2002) reviewed the interface of a library search engine and its usability by users with different access styles, specifically high and low SVA. Written from the perspective of a library and information sciences degree seeker, this work is relevant in indicating ways to assess the various constructs in the current study. Kim expressed that when a search requires a series of evaluations or actions, especially the reorganization or prioritizing of previous searches, the task may require a very high SVA. He found that SVA correlated with search command selection, combination of search commands, and application of boolean logic (the use of search terms linked by ‘and’, ‘or’, or ‘not’, among others) – the basics of information seeking in a catalogue database and a primary competency in information literacy.

Structure preview is a navigation style now commonly used on websites with multiple layers, including commercial sites such as Target, Babies ‘R Us, and Walmart, and many university sites. When a menu link is highlighted, all of

the next level (and often sublevel) choices available from that link are displayed, and the user can efficiently choose the next step in the search for information (Zhang & Salvendy, 2001). The majority of course management systems in use do not use structure preview, although they commonly use “breadcrumbs,” the list of links at the top of the page which indicate where the user has been and how he or she arrived at the current location. Incorporation of the structure preview menu style may help students navigate the course site more effectively, keeping them from constantly returning to the home page of a course to find additional information in a different area. Zhang and Salvendy found that the search performance of both low and high SVA participants improved with structure preview with all students locating more items with fewer steps per item. This supports the hypothesis that better usability is beneficial for all students, regardless of ability or expertise.

In another study of SVA and interaction with a user interface, Downing, Moore, & Brown, 2005) evaluated structured searches by students in business and biology. These authors looked at time to first article and total number of articles in a timed test. Downing, Moore, and Brown suggest that although training to improve SVA is available, it is time consuming and not really a viable idea for most adults. Rather, future research directions should investigate changing the user interface to be more easily usable by those with low SVA. Also, designers should focus on the task to be accomplished more than the interface itself, and look at the information seeking (or course access) as a problem solving process. Downing, Moore, and Brown found that users with high

spatial visualization ability (SVA) accessed information in a hierarchical format (such as in a search engine) faster and more effectively than those with low SVA, resulting in the acquisition of more relevant sources of information from a web search.

These studies in spatial visualization ability highlight the need to attend to the usability of the site, search, and course interface to promote successful outcomes for the students who access them as proposed in the current study. The majority of improvements to design that increase accessibility for students with disabilities are the same improvements that would serve users with low SVA better. Therefore, a shift in the perception of course designers from providing accessibility one additional set of users to improving overall design using universal design would benefit non-disabled and disabled users alike, without stigmatizing either.

Summary

This review of the existing literature in distance learning via online coursework, disability identity and the experiences of students with disabilities in postsecondary education, constructivist pedagogy, cognitive load theory, spatial visualization ability, and information literacy is framed in a commitment to universal design methodologies and the importance of usability in user interfaces. The current study is designed with the intent to begin to understand whether any or all of these factors can be used to predict student outcomes when online courses are or are not designed specifically to provide accessibility to students with disabilities of various types. The impact of this study at the societal

level could be that the purposeful inclusion of students that remain largely disenfranchised educationally and professionally will facilitate their being able to more fully participate in postsecondary education – the primary mechanism for gaining profitable employment that subsequently reduces the burden on vocational and social services. Institutionally, improved student success in distance education courses would likely reduce attrition in such courses significantly and increase enrollments further, resulting in a faster return on the investment in online distance education and reduction in costs related to physical plant and space demands on cramped campuses. For students with disabilities at the personal level, the standardized use of universal design in online courses could be the difference between the pursuit of postsecondary education and advanced degrees with the associated increase in income and professional recognition, and the decision to undertake vocational training in a worthwhile but less personally desirable trade, or more likely, the un- and under-employment that is presently common among the majority of Americans with disabilities.

CHAPTER III

METHODOLOGY

This study will examine whether or not the user interface of an online course affects students with disabilities' ability to learn instructional content when considering user technology literacy, self-efficacy, and spatial visualization ability. This study is framed by constructivist pedagogy, which drives the questions asked in participant interviews. This case study follows five students from several institutions.

Participants were categorized using status data that were collected using the Web User's Self-Efficacy Scale and the Purdue Visualization of Rotations (ROT) Test. Additional data were collected through observation and interview of participants using TechSmith's Morae usability testing software and analyzed using a grounded theory approach. Participants were enrolled in introductory courses as prescribed by their academic programs.

Accessibility and compliance with the World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG) were evaluated for the course systems used by participants in their individual institutions. The W3C is an international group of software developers, teachers, businesspeople, and other professionals with the goal of improving the web experience for all users. The council within W3C that produces the WCAG has as its goal universal web accessibility for persons with disabilities. A number of accessibility and usability tests have been developed from the W3C guidelines. For this study, several W3C-approved tools, in additional to heuristic analysis, were used to determine

the level of accessibility of course management systems used by participant institutions.

Research Design

The participants were categorized by status as high or low spatial visualization ability and self-efficacy in web-based tasks. In addition, demographic data collected included gender, type of institution, academic classification, major, minor, GPA, age, type of disability (if any), number of online courses previously taken, location where this online course were accessed most often, type of Internet connection at that location, household income level, home zip code, parents' highest level of education, and anticipated terminal degree. This categorization allows the researcher to frame participant responses within evaluated competencies and self-efficacy.

A descriptive case study method was implemented to observe students accessing their courses in as natural a manner as possible. In collecting both qualitative and quantitative data from each participant, the researcher was able to triangulate via analysis to form a contextual picture of each student's experience. Yin (2009) proposes case study as an empirical method of investigating "how" and "why" questions as are posed in the current study.

Participants

Once approval of The University of Southern Mississippi Institutional Review Board was obtained, electronically mailed letters were sent out to institutional disability services officers at several public institutions requesting assistance in notifying students of the study. Students within the offices were

then asked generally to contact the researcher if they wished to participate in the study. Permission to contact the students was concurrently provided by individual institutional review boards.

Participants in the study were five undergraduate and graduate students with and without a variety of disabilities at several public postsecondary institutions in the southeastern United States enrolled in first-year or introductory level courses delivered in a fully online or hybrid format. Selected to reflect the general population of both traditional and nontraditional undergraduate students with disabilities enrolled in online courses, participants reflected a range of 18 to over 65 years of age. The participants, all female, reflect a variety of ethnic, racial, and socioeconomic characteristics as represented in the general population of students.

To protect the identities of participants and the confidentiality of their data, several steps were taken. During the recorded sessions, their identities were recorded as an alphanumeric series known only to the researcher. During analysis and coding, pseudonyms were created and used to identify each case. The video recordings and electronic copies of paper data from each session are encrypted and password protected at the researcher's home. Paper data are kept in a locked container also in the researcher's home. All data will be securely stored for a minimum of five years and subsequently destroyed.

Instrumentation

The data collection instruments used in this study were: the Web Users' Self-Efficacy Scale, the Purdue Spatial Visualization Test – Visualization of

Rotations, and Morae user experience/usability assessment software. Participant demographic data were collected via a basic online questionnaire at the beginning of the interview session.

Web-Users' Self-Efficacy Scale

The Web Users' Self-Efficacy scale is a 40-item questionnaire of five-level Likert items in four domains: information retrieval, information provision, communication, and internet technology. It was developed by Cassidy & Eachus (2006) to measure confidence in internet tasks related to online learning, and administered online to a web sample group and on paper to a group of students at their institution. The four domains are represented in the questionnaire in subscales of 10 items each. Scores on the WUSE scale range from a minimum of 40 to a maximum of 200, with a minimum of 10 and maximum of 50 for each domain. For their web sample, Cassidy and Eachus found a mean of 45.19 for Information Retrieval (SD 4.90), 39.29 for Information Provision (SD 9.84), 38.24 for Communications (SD 5.70), and 41.12 for Internet Technology (SD 5.41). The mean for the WUSE as a whole was 165.53 (SD 20.34). For the combined samples, Cassidy and Eachus found means of 40.59 for Information Retrieval (SD 7.70), 30.67 for Information Provision (SD 12.36), 34.69 for Communications (SD 7.22), 34.23 for Internet Technology (SD 9.59), and 138.92 for the WUSE as a whole (SD 33.76). Eighteen of the items require reversal of values before scoring, and validity testing of the WUSE scale yielded Cronbach's alpha of .755

to .883 for the four domains and .943 for the scale as a whole when administered to students comparable to participants in this study (Cassidy & Eachus, 2006).

Purdue Spatial Visualization Test – Visualization of Rotations

The Purdue Spatial Visualization Test – Visualization of Rotations (ROT) tests individual ability to mentally manipulate and recall the structure of an object if the item is moved or changed. This study will use Bodner and Guay's adapted 20-item test rather than the original 30-item Purdue instrument. The 20-item measure "was constructed by removing questions 6, 8, 11, 14, 20, 21, 22, 24, 26, and 30" (p. 8) from the original test. The ROT were administered with the strict 10-minute time limit prescribed by Bodner and Guay. The adapted instrument was tested for internal reliability using the Kuder-Richardson 20 and/or split-half reliability coefficients. Results reported by Bodner and Guay for Kuder-Richardson 20 were .78 to .80 and for split-halfs, .78 to .85. Construct validity was tested on the full 30-item ROT test in Guay's previous studies, and it was found to be one of the tests of spatial ability that is "least likely to be confounded by analytic processing" (Bodner & Guay, 1997, p. 10).

Morae™

Morae is a user experience testing software application developed by TechSmith in order to conduct participant observations live or remotely. The program records screen activity, keyboard input, mouse movement, and mouse clicks in addition to live video and audio. With the Morae software, the researcher can observe and record the participant wherever he or she usually accesses the course website, while interviewing and interacting with the participant. The

sessions were recorded either on campus at the student's institution, or at a mutually agreed-upon location. The recorded screen video and participant audio were analyzed for statements indicating various emotions such as frustration, confusion, pleasure and relief. The recorded screen, keyboard, and mouse activity were analyzed for length of time spent on particular web pages, redundancy in clicking on links in search of specific information, errors, time on task, and other web page statistics. Morae also produces descriptive statistical data based on each session.

Procedures

Once approval to proceed was obtained from The University of Southern Mississippi Institutional Review Board, the researcher approached the officers of disability services departments of several southeastern colleges and universities offering introductory courses fully online or in hybrid format in order to request assistance in contacting students who may wish to participate in the study. Once a commitment of assistance was confirmed in writing, the researcher then approached the Review Board representative at each institution for permission to conduct research using their students and data. The researcher assured the Board that student characteristics were masked to protect participant privacy, and no personally identifiable information were to be viewed by anyone other than the researcher and the dissertation chair, if necessary.

The researcher scheduled observation and interview sessions with volunteer participants. The researcher sent emails to participants reminding them

of the appointment time at one week, and then three days before the appointment. During the appointments, the participants logged into their courses and gave the researcher permission to observe their screen activity via Morae. Once the technical aspects of the session were covered, the researcher began the assessment, interview and observation by indicating this to the participant and starting the recording process. Students were assured that the software does not record keystrokes – only the activity on the course website itself.

During the session, the researcher directed the participant to complete demographic information, the Web-User's Self-Efficacy Scale, and the Purdue Visualization of Rotations Test. Upon completion of the assessments, the researcher began the interview, inquiring about the user experience in accessing course materials and documents, moving from one task to another, and submitting course assignments. The researcher listened for evaluative, positive, and negative remarks of participants and assigned markers to these events. During the analysis of the timeline for the session, the researcher determined what the participant was doing and what task was being completed at the time of the event using a marker, or event identifier. After the session was completed, the researcher delivered financial compensation to the participant in gratitude for their time. Once all participants had been interviewed, the researcher began coding the collected data for comparative analysis.

Data Analysis

This study used interview and direct observation to develop a descriptive case study of five students at different institutions in online courses. The research questions analyzed were:

R_1: How do different usability factors influence students with and without disabilities' experience in an online course?

R_2: How do student characteristics such as self-efficacy, spatial visualization ability, and information literacy affect student perception of usability in an online course?

The study evaluated themes across the observation and interview data, and categorized them according to the status data collected via the two assessments. Markers established during the observation phase were manually coded by commonality among participant experiences and statements, as well as researcher observations. The qualitative data were considered with the quantitative data collected via the usability testing software to develop a theory of the authentic experiences of these students in online courses.

The data were manually coded, as the focused nature of the interviews and observations and small number of participants lent itself to deeper familiarity with each case. Including the quantitative data gathered from the WUSE scale and Test of Rotations with each participant's interview transcript and the researcher's observation notes increased the opportunity for accurate analysis. The discrete data sources converged through triangulation and iterative analyses of the results (Yin, 2009) across four main themes related to the study's guiding research questions:

- User Interface and User Experience
- Self-Efficacy
- Cognitive Load
- Information (or digital) literacy

Repetitive actions (both successful and unsuccessful), problem-solving activities, prior experience in online courses and computer usage, and proactive/reactive use of resources were all examined through a user experience and self-efficacy lens. Each case reflects different levels of these markers, as will be discussed in the following chapter.

Role of the Researcher

As Marshall and Rossman (1999) point out, the researcher is herself an instrument in this qualitative study. This researcher engaged in direct observation, and interpretation of the data collected is reported through known and unknown biases. The observations and interviews occurred concurrently and were recorded using the Morae software. Observation notes were taken during the interview sessions using pen and paper. After the sessions, the recorded video and notes were transcribed into Microsoft Word by me.

From an ethical standpoint, the researcher has an extensive background in academic advisement and technology instruction, which helped define the role of direct observer. This professional knowledge also generates certain inherent biases which should be taken into account. The primary bias is related to ensuring that students are adequately equipped to complete their courses successfully. In these observations and interviews, my role was as researcher

only – I did not make any suggestions as to student placement or support for course completion. The secondary bias is in favor of technology integration and usage as a means for providing access to students who would not otherwise be able to engage in formal study. Having first-hand professional knowledge of the design and structure of instructional websites and usability evaluation informed my observations and review of the Morae data. This particular background made it simpler to assess what participants were searching for (i.e., hyperlinks) within their online courses.

CHAPTER IV

FINDINGS

The purpose of this descriptive case study was to begin to ascertain relationships between usability, self-efficacy, and cognitive load in the experiences of students with and without disabilities in online courses. Additionally, the researcher sought to identify specific usability barriers reported by students or observed and recorded. Qualitative data were collected via interview and recorded observation sessions, with follow-up communication via email and phone as necessary to provide a complete, holistic view of each participant's experience. Quantitative data were collected via the Web-User's Self Efficacy scale and Purdue's Test of Rotations. These assessments were useful for categorizing participant ability, but did not yield useful statistical information due to the small sample size. Although three of the participants have disabilities as defined in this study, none use assistive technologies to regularly access the courses evaluated for this study. As a result, barriers to usability for assistive technologies could not be assessed.

This study used interview and direct observation to develop a descriptive case study of five students at different institutions in online courses. The research questions analyzed were:

R_1: How do different usability factors influence students with and without disabilities' experience in an online course?

R_2: How do student characteristics such as self-efficacy, spatial visualization ability, and information literacy affect student perception of usability in an online course?

The case study format allowed the researcher to study participants' actual activity within the contextual conditions of prior experience, level of information literacy, self-efficacy, and technology skill (Schram, 2006). The descriptive nature of the study allowed for the research to provide a focus on "moving toward a better understanding, perhaps better theorizing, about a more general phenomenon" (p. 107). A descriptive case study also affords the researcher the ability to identify phenomena in their real-life contexts (Yin, 2009).

This chapter presents the findings from this study in relation to the guiding research questions and begins with background on the study participants. The chapter will then report the cross-case findings organized by the major themes identified in the analysis.

The Participants

Melina

Melina is a 52 year-old nursing student. She is an LPN working part time at a facility over an hour from her home on rotating 12-18 hour shifts, usually overnight and arrived for our session immediately after work. Melina's self-efficacy score was the lowest of the group, and she has the least experience with computers and the internet. Despite having one at home, she does not use it – her daughter checks her email daily and relays assignment information from the

course. Melina's institution uses a proprietary course management system designed in-house, but with a standard layout.

Carol

Carol is a 51 year-old accounting major with complications due to a blood disease. She is returning to school to complete her degree after stopping out to marry and have children, and currently works in a bookkeeping department. Carol's self-efficacy score was lower mid-range. She uses computers and the internet daily. Carol's institution uses a commercial course management system with a standard layout.

Karen

Karen is a 48 year-old business student who sustained a severe brain injury as an adult and reports some trouble concentrating and remembering processes. She has taken several hybrid courses successfully and plans to take a fully online course in the near future. Karen had the second-highest self-efficacy score of the group, and uses computers and the internet daily although she is currently unemployed. Her institution uses a commercial course management system with a standard layout.

Mai

Mai is a 19 year-old business student with a chronic autoimmune disorder which affects most of her major systems. Unexpected flare-ups have required hospitalization more than once, and she has recently graduated from an alternative high school which does not require daily attendance. Mai had the

highest self-efficacy score of the group, and uses computers, the internet, and various consumer technology devices daily. Her institution uses a commercial course management system with a customized layout.

Donnalee

Donnalee is a 69 year-old retired nursing administrator in a graduate nursing program. She intends to teach online nursing courses and has enrolled in a self-paced online course to learn more about “how it works.” Donnalee is also enrolled in a digital literacy course. Her self-efficacy score was mid-range for the group, and her institution uses an enterprise-class open-source course management system with a standard layout.

Themes

User Interface

A course management system’s user interface is like a door between the user and relevant content. It remains closed until the user learns how to navigate the system using the right keys. While four of the five participants described their course layout as simple to navigate, only Karen, with previous knowledge of the system, was able to complete all of the requested tasks efficiently and accurately. The other participants described their access challenges in terms of their own inability and lack of skill, rather than simply related to inexperience and unfamiliarity with the system. It was unclear if there was any correlation with spatial visualization ability due to the small sample size and the fact that all participants scored 20% or below on the Purdue assessment.

All of the course systems in use at the participating institutions used a variation of a standard online course template with navigation links on the left of the main content. All included breadcrumb navigation at the top of the screen. Figure 1 below shows an illustration of this basic layout from a previous online course taken by the researcher and is very similar to those in use at the

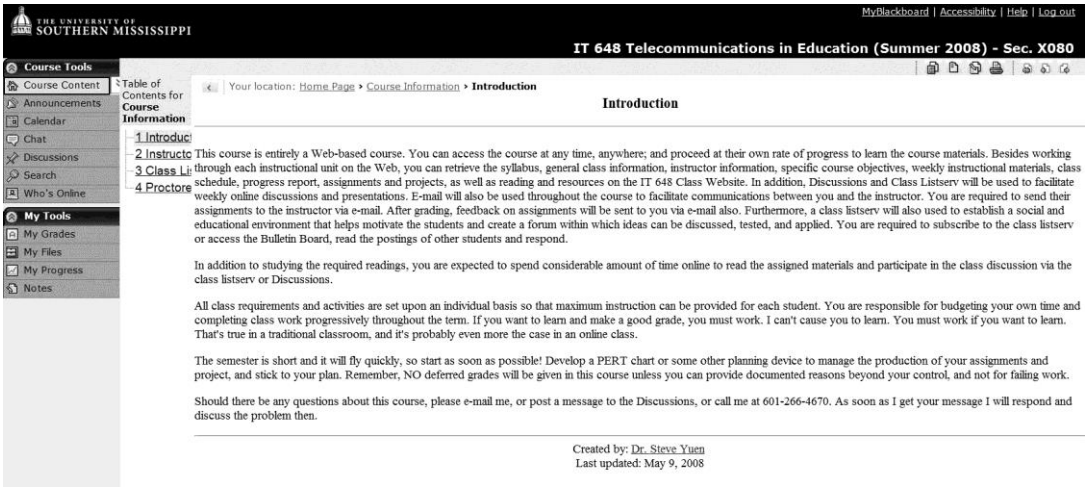

Figure 1 - Standard online course layout.

participating institutions.

Although the layout meets most conventions for ease of navigation, the majority of participants were unable to easily navigate their course to locate specific course information as requested. The large chunk of text in the main content area was generally ignored as a source of relevant information, even when it included instructions for accomplishing the task as directed:

> LR: Thank you. Please show me where you would find the course syllabus.
>
> Mai: [Still in Workbook view. First paragraph on page has heading “Your Syllabus” and indicates that the Syllabus can be accessed via the

> Syllabus link at the top of every page. M scans page, and focuses immediately on left navigation. Does not seem to be reading the page for text, but rather scanning for visible hyperlink.]
>
> Carol: [Goes directly to text heading “Your Syllabus” which is not hyperlinked. Text below that heading states that the Syllabus link is at the top of the page. C goes back to the heading several times, and looks confused when nothing happens when she clicks the text. C expects the heading, which is colored purple (color commonly applied to “visited” links) to lead her to another page. Facial expression shows frustration, confusion. C then clicks on the “Introduction to Economics” module, which is also the main course introduction page. Nothing happens, page does not reload. C clicks this link several more times.]

In Carol’s case, she was correct in that it is common for paragraph headings to be hyperlinked. This is a standard in website design. However, upon realizing that this was not the case, she did not read the associated text. Rather, she went to the next common location for site navigation, the left side of the screen. This did not yield the desired result of being taken to the main course information page, resulting in some frustration for Carol and for other users. The course site does not conform to established web development and design conventions, which led to an increased barrier to content access.

In Mai’s case, simple exposure to the latest technologies did not necessarily lead to an understanding of systems work; she was mostly

unsuccessful in completing the skills tasks. When asked if she would change anything about the layout and organization of the course, she described it as an "older model," implying that courses should look like the sites she frequents:

> LR: I understand. Now, as you're looking at the course, would you change anything about the way it's laid out or the organization?
>
> Mai: Yes.
>
> LR: What might you change?
>
> Mai: It kind of pulled up as an "older model" [emphasis as spoken] to where it's kind of confusing if you're used to something new. It doesn't look the way I'd expect courses to look. You kind of have to adjust to the older model again.
>
> LR: Could you explain what you mean by older model?
>
> Mai: It looks like the way old websites do. It's boring. Not like the ones I use every day.
>
> LR: Such as?
>
> Mai: Well, I'm on Facebook a lot.

Mai goes on to describe other websites designed to the Web 2.0, user-generated content standard. It should be clarified that the design of the user interface can be customized by the institution. Although those in this study are using variations of the default template, it is not a universal practice.

Overall, participants accepted the course interface as a given, and did not attempt to customize the interface to suit their needs using available user controls. None adjusted the basic settings in their browser to improve visibility, nor did they adjust the color scheme from the default to make contrasts between body text and hyperlinks more visible. Of the group, Karen alone seemed to have

achieved “interface invisibility,” that is, the interface of the course management system receded to the background to give priority to course content. When asked about her experience in the course, her focus was on what she was required to learn about spreadsheets rather than difficulties with the system itself. Discussion of possible ways to achieve this result for students with low technology background will appear in the following chapter.

Most of the participants described the course system as simple or easy to navigate despite challenges locating basic information:

> LR: Would you change anything about the organization of the course? The way it’s laid out, where information is located?
>
> Carol: No, it’s pretty straightforward.
>
> Donnalee: I can definitely access everything. It’s pretty simple to find your way around.
>
> Karen: It’s pretty self-explanatory. I wouldn’t change anything.

Additionally, Mai’s critique of the layout was more aesthetic than functional.

Self-Efficacy

Participants in this study scored between a high of 149 and a low of 72 points on the Web User’s Self-Efficacy (WUSE) scale, which correspond to one and five standard deviations below the mean reported by Cassidy and Eachus (2006), respectively. The distribution is similar for the individual domains in the assessment. With the exception of Melina, self-efficacy score did not indicate actual technical skill. Mai, with the highest self-efficacy score, was the least

efficient in accomplishing the skills tasks within the course environment. Carol, at lower mid-range, exhibited confidence in her abilities, but was unable to successfully complete the majority of skills tasks. There was a disconnect overall between what participants reported they could do on the WUSE scale, and the practical application of those skills in the observation interviews. Donnalee reported not feeling as "comfortable with the computer as I want to be," but her performance on tasks was comparable to Karen's.

Given that self-efficacy reflects one's belief that they can and will be successful in a task or endeavor and self-perception of self-efficacy leads to improved performance (Bandura, 1975; Bandura, 1982), it follows that self-efficacy combined with applicable instruction leads to successful accomplishment of tasks. This was evident in Karen and Donnalee's sessions. In Karen's case, the benefit of familiarity with the system was useful in efficiently and accurately completing the directed tasks. In Donnalee's case, intentionally seeking additional computer literacy instruction was the key to successful completion. This is in line with Wang and Newlin's (2002) assertion that there are benefits to having a prerequisite course or examination to assess student readiness for online learning.

Cognitive Load

Increased cognitive load was most apparent in Melina's case. Extreme fatigue and lack of technology background made it nearly impossible for her to complete any of the skills tasks effectively. She became more and more distraught, until she was no longer able to continue the session. Conversely,

Karen's responses tended to focus on course content because the course interface was no longer a barrier to information access. Cognitive load issues were less apparent in Mai and Carol's sessions.

Donnalee's case illustrates cognitive load reduction as described by Mayer and Moreno (2003). Taking the digital literacy course is akin to the pretraining described in their study, with the result being an improved ability to process the navigation of the site despite layout and design issues. In pretraining, components of a lesson are identified and explained before students learn how the parts work together. This mitigates cognitive load as a result of two channels being overloaded with essential processing, in the case of this study, listening to researcher instructions and visually searching for site information. The same could be said for accessing the course site from a noisy home or campus location.

Synthesized Analysis and Findings

This study used interview and direct observation to develop a descriptive case study of five students at different institutions in online courses. Synthesized analysis of the qualitative data was focused around the research questions posed at the beginning of the study.

R_1: How do different usability factors influence students with and without disabilities' experience in an online course?

Site navigation, layout, course information completeness and accessibility, and visibility of text elements were assessed through various skills tasks. Participants were asked to complete typical online course actions such as

locating the course syllabus, determining when the next assignment is due, and composing an email to the course instructor. The usability testing software recording illustrated mouse tracking, mouse clicks, and keyboard entries in addition to session audio and video of the participant. Evaluation of these recordings allowed the researcher to record the length of time necessary to complete each task, as well as clicks on links that did not accomplish the stated task.

Most participants had difficulty locating the course syllabus. In most cases, placement of this essential link within the course pages is the responsibility of the instructor, not the system administrator. Indeed, most of the course-level customization and information presentation is at the instructor's discretion. The researcher was unable to contact individual instructors to gather their input on the course design.

Additionally, large chunks of text on the course pages was largely ignored. While some of the courses featured lesson-related images and graphics, primary course information pages lacked such breaks in the text. When important navigational information was embedded in the text, it was overlooked. Again, this user interface element is dictated by the course instructor.

Participants reported that the course was usable, despite the observed challenges in interacting with course elements, and generally described their feelings towards the course system as positive.

R_2: How do student characteristics such as self-efficacy, spatial visualization ability, and information literacy affect student perception of usability in an online course?

Study participants have very low spatial visualization ability as assessed by the Purdue Test of Rotations, and very low to moderate-high self-efficacy in completing web-based tasks as assessed via the Web User's Self-Efficacy scale. All participants have low to moderate digital literacy as assessed through the directed completion of online information retrieval and evaluation tasks within and outside of the course system. Three of the five participants describe the course system layout as presented as easy to navigate, and "pretty self-explanatory" despite navigation and information retrieval challenges. The conclusion here must be that these factors have no effect on student perception of usability.

Summary

The standard user interface at the course level presented barriers to navigation and information retrieval by participants, primarily due to ineffective layout of information. Interface invisibility was achieved by one participant, who has had several successful experiences with online learning. Self-efficacy was not found to be a reliable measure of technological skill and ability, as most participants performed below the level suggested by their self-efficacy score. Cognitive load was found to be considerable in the participant with the lowest technical ability and self-efficacy. This load may be reduced through pretraining in computer literacy. Usability factors such as course layout negatively affect

student ability to access and navigate the course website. However, this difficulty does not affect student perception of the usability of the course.

CHAPTER V

CONCLUSIONS

The purpose of this descriptive case study was to ascertain whether the differences in performance of postsecondary students in online courses could be influenced by the design of the course's user interface, students' self-efficacy in web-based tasks, spatial visualization ability, and level of technology literacy with regard to web-based tasks and research. The study was built upon convergent aspects of instructional design theory, web usability, user experience design, and online course management, and framed with a minority identity view of disability.

This case study research was intended to look at the user experience of students with and without disabilities in web-based courses and how they relate to student performance and/or attrition. Through a holistic investigation of student abilities and experiences, the researcher proposed that there are ways to improve the success and retention rates of students with and without disabilities in postsecondary online courses. Several studies (Cook & Gladhardt, 2002; Kinash, Crichton, & Kim-Rupnow, 2004; Edmonds, 2004; Simoncelli, 2005; Crow, 2006) have called for further research about the experiences of students with disabilities in online courses and how to best serve them. This study is a response to this call and is a first step towards filling this crucial gap in the literature.

The study sought to answer: Does the design of an online course's (or course management system's) user interface affect performance or persistence in the course of students with and without disabilities? How might we identify

common usability factors for students with and without disabilities that affect the decision to complete or withdraw from an online course? Through semi-structured interviews, self-efficacy and spatial visualization assessments, and direct observation of the completion of course-related tasks online, the researcher collected diverse data and triangulated these results to identify recurrent themes that began to answer these questions (Yin, 2009). The themes identified were centered around cognitive dissonance between participants observed experience in accessing the course and their description of the course's usability, self-efficacy and self-perception as factors related to overall evaluation of usability, and cognitive load effects resulting in the overlooking of important information on the course page.

Themes and Implications

Cognitive Dissonance: Experience vs. Opinion

Based on completion rates for directed tasks, the researcher found that the user interface presented a barrier to accessing – and therefore learning – course content in the areas that did not comply with standard website design practice. However, the participants generally did not view or understand their access difficulties as usability barriers or failings in the course site design. Despite encountering errors that directly inhibited their progress through the course site, most participants described the system as easy to use and indicated that they would not make any changes for improvement.

This dissonance between actual experience and description of the experience was surprising, given the recorded levels of frustration that some of

the participants experienced while using the system. The disparity could be attributed to gender-related approaches to computer systems and online communication, manifestations of computer anxiety, or simply to a desire not to seem critical. It would be useful in later studies to assess whether male participants would respond in a similar manner, as well as include measures of gender self-perception and computer anxiety. While a number of studies have investigated gender-related attitudes and self-perceptions towards computing (Laosethakul, 2009; Saadé & Kira, 2009; Sullivan, 2001; Venkatesh & Morris, 2000), none explain why participants would describe a system as easy to use after having considerable difficulty using it. Saadé and Kira (2009) found that self-efficacy seems to moderate computer anxiety and thereby impact perceived ease of use of a learning management system, but their study did not address gender differences within or among samples. Future versions of the current study will incorporate their Mediation of Computer Self-Efficacy on Perceived Ease of Use and Computer Anxiety model within the assessment of gender differences in approach to computing.

Self-Efficacy and Self-Perception

Self-efficacy as reported by the participants in the Web User's Self-Efficacy scale did not accurately indicate actual technological skills. However, combined with (or preceded by) computer literacy instruction, technological and web-based problem-solving skills appeared to be improved. Although Mai scored the highest in the WUSE scale, her performance was the least accurate and efficient in accomplishing the directed tasks. This disconnect between reported

self-efficacy and actual ability held among all but one participant. Karen, having the most experience with her institution's course system, both scored highly on the WUSE scale and performed with the highest accuracy. Negative self-talk captured during the observation session indicated that the participants did not fault the system for their errors, but themselves. This may be another contributing factor to the disparity between actual and reported experience, and it bears further examination.

Laosethakul (2009) compared Chinese and American women's gender self-perception and computer self-efficacy as it related to computer anxiety and the pursuit of IT education and careers. In the study, Laosethakul pointed out that although computing is a male-dominated field in both China and the United States, female enrollment in IT and computer science programs is declining in the US, but increasing in China. The study sample revealed that Chinese women reported less computer anxiety, felt themselves equal to their male counterparts, and felt that their difficulty advancing professionally was due to weaknesses associated with being women, rather than simply because they were female. In contrast, American women reported more computer anxiety, and more aversion to computing and technology fields as they perceived these fields to be masculine pursuits. These findings support the possibility that the combination of gender self-perception as being "not technical" or "smart enough," self-efficacy, and computer anxiety clashed to inhibit the success of participants in the current study, and influenced their report of the system being usable despite experience to the contrary. In effect, "it can't be the system, it must be me."

Cognitive Load Effects: "I didn't see that there"

Cognitive load was shown to be an absolute barrier to successful completion of tasks for the participant with the lowest technology background, and a source of frustration for users with more technology experience. Usability challenges such as navigational links located within blocks of text increased extraneous cognitive load and consequently inhibited participants' ability to effectively access course information. Although all of the institutions' course management systems conformed to the standard layout described earlier, this standard presents undue hindrance to online learners when individual course sites do not reflect common web design and user experience developed in practice online. Participants tended to completely overlook the main text area if it was comprised of a single text block. The women all looked for navigation information along the top and left sides of the web page, but were confounded by confusing navigation labels and nonstandard locations of navigation information.

It is important to note that frustrating experienced users may result in similar attrition as that of learners with lower technology literacy. Although experienced users are presumably equipped to adjust better to design flaws, they may also reject a flawed course system altogether to remove an unwanted source of stress. They may stop logging into online courses because memorizing information locations and unusual naming conventions takes up valuable mental processing bandwidth that should be utilized for developing new mental schemas needed for learning course content. Indeed, Aragon and Johnson (2008) found

that a significant percentage of students do not complete online courses due to the design of the course. Students stated that confusing information and layout ultimately made them give up on the course altogether. The findings in this study support their assertion, especially for students with minimal exposure to online courses and low technology literacy.

Discussion

It is unclear why participants described the online course system as easy to use in spite of their observed difficulty using it. Were they simply used to encountering these difficulties? Many government agency websites are similarly designed and it is possible that this is what users generally expect of online systems. Given that online education programs present significant revenue opportunities for academic institutions, it is essential that the product they deliver be considered usable by the greatest range of the intended audience.

Mai's expectation that an online course would fit her experience with social networking sites is aesthetic on its face, but deeper reflection suggests that the ease of use of these sites holds useful information for course designers. Web 2.0 (user-generated content) sites depend on their applications being easy to use, accessible across platforms, and encourage users to return several times per day. In a similar fashion, the Wordpress self-publishing platform and other WYSIWYG (what-you-see-is-what-you-get) site building platforms automatically encourage usability and include accessibility features such as labeling links and providing captions and alternative information tags for images that meet the needs of disabled users and those browsing the web with various restrictions and

preferences. The characteristics that keep users returning to these sites could well be incorporated into online course design. From a cost standpoint, implementing these changes may seem prohibitive, however, combined with secure open-source options, these changes could become feasible or even cost-free. Additionally, the challenge of educating instructors in the implementation of these methods could be mitigated through the use of webinars and free online tutorials that not only begin to immerse the instructor in the environment, but give hands-on opportunity for learning best practices for teaching online. These online resources are often delivered in short segments that could well be incorporated into instructors' schedules.

Mai's case also reinforced that being a "digital native" was not a measure of, nor did it indicate digital literacy. Mai's age and experience with technology suggested that she would have performed well on the technology tasks of the study, and her self-efficacy score supported this expectation. However, when presented with the need to problem solve within the course system, she was unable to do so. Her institution does have a computer literacy requirement, but it was unclear whether it must be fulfilled before enrolling in an online course. The usability issues identified in the study also contributed to her difficulty performing the directed tasks.

Since Carol is employed in an analytic profession, she was also expected to perform well. As a regular computer user, she did show familiarity with the online environment and digital problem-solving ability. She, too, was confounded by usability problems. Carol was well aware of where things should have been,

but were not. This visibly frustrated her, and she was ultimately at a loss as to how to proceed after exhausting her knowledge of general website architecture. Frustrating experienced users may be just as harmful as excluding low technology literate users, as experienced users can feasibly identify a poorly designed course and their possibility for success in such a course. Surprisingly, however, Carol described the course as “pretty straightforward” and “self-explanatory.” It is possible that the interview question designed to gauge reaction to usability problems was unclear or ineffective. In later iterations of this study, it will likely be revised to reflect more specific attitudes and opinions of the course system and its perceived ease of use.

Donnalee and Karen had the benefit of instruction and repetition, respectively. Karen, familiar with the course system, was able to efficiently and accurately complete all tasks as expected. Donnalee did nearly as well, as a new user. It is likely that Donnalee’s decision to take a computer literacy course voluntarily to learn skills for teaching strongly improved her confidence and ability to evaluate and navigate the course system as presented. While not achieving interface invisibility as Karen did, Donnalee was equipped to apply problem-solving skills to addressing usability challenges. Bandura (1977) stated that self-efficacy was based on viewing a problem as solveable, knowing how to arrive at the solution, and being confident in that ability. Donnalee fits that description with the decision to improve the skills necessary to provide the best education for herself and her future students.

Recommendations

The findings in this study raise a number of further questions for additional research, and review of the completed process has revealed areas where it could be improved. Current literature is lacking in studies investigating the usability and learning experiences of students with disabilities in higher education, and specifically in online courses. This study contributes to this gap in the literature. The current study represents a jumping-off point for research with an underserved population within the growing field of online learning.

As a prerequisite to enrolling in an online course, students should be required to document their digital literacy, whether by commercial standardized examination or institution-designed assessment. The costs to the institution and the student are negligible when compared to the costs of attrition for users and institutions as well as the expenses of instituting a common requirement of a semester-long computer literacy course of all students, regardless of background. Such a prerequisite would very likely begin to diminish online course attrition and improve successful completion for more students.

Study Improvement

This study could be improved in several ways. First, the number of participants included in the study was not ideal. For a number of reasons related to the low relative number of students with disabilities in online courses, it was difficult to secure participation from the desired population. In order to encourage more in-depth statistical analysis of the study's themes, a much larger pool of participants is necessary. This study was additionally hindered by the

researcher's inability to travel outside of the study region to recruit a broader pool of applicants.

Also, a more universally accurate assessment of participant technology knowledge and critical thinking skills related to technology-based tasks would yield more measurable and comparable results across participants. One commercial assessment which has recently become available is the Internet Core Computing and Certification (IC^3)Fast Track exam. This single exam alternative to the established IC^3 digital literacy certification program is far more cost- and time-effective within the context of a larger study. The complete certification program consists of three 50-minute examinations of 45 items each covering Computing Fundamentals, Key Applications, and Living Online, and is commonly used as an alternative strategy for satisfying institutional computer literacy requirements. By contrast, the Fast Track exam is 73 items taken from all three assessments and completed in one 60-minute sitting. The Fast Track exam is not scored, rather, entities using the exam are able to set their own cut-off points (Certiport, n.d.). This newer exam presents a useful opportunity to standardize the technology literacy portion of this study and potentially remove human assessment error from the equation.

The interview protocol was designed to yield a holistic view of the student experience and included several task-based commands interspersed with queries regarding participant feelings and motivations within the online course environment. However, it became apparent during the analysis that the protocol was skewed towards assessing the design components of the system through

the task directives, and did not delve deeply enough into the experience of participants as they completed each task. Later iterations of this study will include several further in-depth questions related to each participant's feelings about navigating the online course experience, and also draw out more detail about their experiences in committing task errors. Additional questions will investigate participants' self-perception as computer users, students, and men or women. The inclusion of gender-related self-perception assessment in the current study may have shed additional light on the puzzle of participants reporting the system as usable despite their experienced difficulties.

Further Research

Further research in the online experiences of students with disabilities and low technology background is strongly recommended, and a longitudinal version of this study would be expected to yield more conclusive results. Such a study would incorporate repeated assessments of participants' technology skills over the course of their academic career, including a review of success in online courses, and may include a group receiving the intervention of formal computer literacy instruction prior to enrolling in online courses. It would be necessary to develop strong relationships with participating institutions and potential participants far in advance of initiating the study.

It is also recommended that researchers in online education consider investigating the seeming disconnect between what is accepted as standard web interface design and the way students view and interpret website information. Mitigating this disconnect between functional correctness and the actual behavior

of users is the specialization of user experience professionals, who should be included in the site design or platform selection process. How much of student attrition results from frustration with learning how to navigate the course environment or inadequately prepared students tackling new content in an unfamiliar system? How much of the site navigation difficulty is due to instructors being inadequately trained to make their course sites usable? Research into the user interface at the course level necessarily requires inclusion of online instructors in the study.

Expansion of the study to include multiple groups of participants receiving different interventions would also illuminate other potential issues in the design and usability of online course sites. Given the variety of platforms available, including those designed for the highest levels of accessibility, it would be enlightening to determine exactly which usability factors promote or deter access to information and ultimately, learning.

Conclusion

With increasing numbers of students with disabilities entering higher education and mature students continuing to return to update skills needed for employment, online learning will continue to provide access and convenience for millions of students. Creating additional barriers to access in the user interface is to offer false hope to learners who are expected to fail. Granted, the usability issues identified in this study come not from IT system administrators but from instructors. Instructors teaching online should be receiving the necessary instruction in basic website design protocols, and students should be instructed

in how to customize their view of the course environment so that it works for their preferences. Both paid and free learning opportunities exist expressly for this purpose.

Although it remains unclear whether higher education institutions are covered by Section 504 as recipients of federal funding for financial aid, it is in the best interests of the institution to provide students with the basic skills necessary for academic success. Many students will continue to arrive on campus – both physically and virtually – without the background necessary for success. This instruction could be conducted effectively and inexpensively via online video of step-by-step screen recording, and made available to students on a regular basis.

Not knowing how to do something that you believe “everyone else” can do is emotional. Melina was completely distraught with what she perceived as her own shortcomings. There is high value attached to the *ability* to learn for those who seek learning. Online learners are not just faceless students who may never be involved in campus life – they are people with lives, work setbacks, money problems, triumphs and failures. Success and self-efficacy reinforce one another, and it is desirable that we as educators support this success cycle.

Design research in conjunction with formal user experience and usability testing could be the key to a more rewarding and inclusive experience for students who represent the broad range of ability and experience in our nation’s colleges and universities.