Does Online Course Design Encourage Attrition? Assessing Usability Factors in Learning Management Systems

Lisa Theresa Richardson
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DOES ONLINE COURSE DESIGN ENCOURAGE ATTRITION?

ASSESSING USABILITY FACTORS IN LEARNING MANAGEMENT SYSTEMS

by

Lisa Theresa Richardson

Abstract of a Dissertation
Submitted to the Graduate School
of the University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

December 2011
ABSTRACT

DOES ONLINE COURSE DESIGN ENCOURAGE ATTRITION?

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by Lisa Theresa Richardson

December 2011

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 disadvantaged technology backgrounds or disabilities 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 investigated the experience of postsecondary students with varying levels of technology background 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 was found that for students with the least technology background, course design could be an absolute barrier to successful course completion. Additionally, online courses with design features that deviate from common HTML standards and W3C norms can frustrate experienced users and also result in increased course attrition.
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Director

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Dean of the Graduate School

December 2011
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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 and are certainly not impeded by a limited technology background, their designs for these systems generally reflect a bias towards users most like themselves. Such design results in the need for students to request accommodations and additional assistance, 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 invaluable to all students enrolled. 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). The experiences of students with limited technology background can be very similar to that of students with disabilities who require
assistive technologies to access internet and computing resources. Courses created using universal design standards could be just as usable by students with limited previous technology access as to students with disabilities. That is, improved usability serves to benefit all students.

This study is a case study of the experiences of several postsecondary students in online courses at different institutions. Specifically, the goal of this research 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 (or technology skill) with regard to web-based tasks and research. The study was 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 looked at the user experience of students 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 were: Does the design of an online course’s (or course management system’s) user interface affect students’ performance or persistence in the course? How might we identify common usability factors 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:

R₁: How do different usability factors influence students’ experience in an online course?

R₂: How do student characteristics such as self-efficacy, spatial visualization ability, and information literacy affect student perception of usability in an online course?

R₃: 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. Throughout this document, technology literacy and technology skill are used interchangeably to describe the practical application of information (or digital) literacy.

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 and Implications of the Study

The purpose of this study is to gain an understanding of the web accessibility and usability needs of students as they relate to online course interface design. Several studies (Cook & Gladhardt, 2002; Crow, 2006; Edmonds, 2004; Kinash, Crichton, & Kim-Rupnow, 2004; Simoncelli, 2005) 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
doors 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

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 limited
technology background or 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 the role of technology background and self-image in student enrollment choices, and 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).

Postsecondary Student Characteristics:

Technology Background, Gender Differences, and Disability Status

The Digital Divide

The Digital Divide is a term coined in the early 1990s to describe the inequity of access, distribution, and use of information technologies between two
or more groups (Mossberger, Tolbert, & Stansbury, 2003; Wilson, 2004). As technology has rapidly advanced since the term was introduced, so has its interpretation. The divide is no longer simply within physical access to technologies, but also in access to the underlying utilities necessary to utilize those technologies effectively, such as broadband internet.

The true disparity is in the inability of persons to benefit from the access and use of these technologies as their peers in other communities do. More than simply receiving access to the same technologies, users must be educated in their use and how these tools can help them accomplish their goals. Students educated in environments without such enhanced technology usage and connectivity may be at a disadvantage once they reach postsecondary education, especially if they choose to engage in online learning. Learners in these communities are often working and caring for families in addition to pursuing their studies, and may opt for the convenience of online courses despite their limited background in technology usage. These disparities increase when socioeconomic status is considered.

For example, Livingston (2011) reports that Latinos are significantly less likely than their white counterparts to access the internet, have a broadband connection at home, or own a cellphone—until you look at the data across similar levels. That is, Latinos at similar education and income levels as white adults have identical usage and access patterns. This suggests that the divide is far more pronounced at variant socioeconomic levels than between races and ethnicities, as reported by Jansen (2010). Native Americans, representing the
highest poverty levels in the nation, generally have the lowest technology adoption rates (Brescia & Daily, 2007).

Sims & Vidgen (2008) found that there is a “circular pattern of exclusion” in digital access and online learning: income and education are primary factors in exclusion from digital access, yet education and digital access are themselves primary factors in higher income. Costs, practical knowledge, and competing priorities deter many with lower incomes from technology adoption, which in turn preclude the population from changing their socioeconomic circumstance. Sims argues that the “widespread access” promoted by institutions as a result of increasing reliance on online learning is a myth – those students with the financial ability to participate in further education will continue to do so, and the population the institutions claim to serve will remain excluded.

Differences in technology use and access in higher education is also discussed by Hargittai (2010), who points out that socioeconomic status in an important predictor of how users use the web. That is, users from more privileged backgrounds are more likely to make more informed decisions about internet and technology use, and use it for a wider range of activities. This is important for instructors who may believe that merely being a part of the “net generation” makes a student technologically savvy. Hargittai goes on to assert that access alone is not the end of the digital divide. She argues that simply being online does not remove the inequity. Rather, how a person uses and incorporates internet access into their lives is a more accurate indicator of technology literacy.
Quality of use is even more important than years of use or quantity of hours spent online in gauging skill.

*Gender-Related Differences in Computer Use and Online Learning*

Differences in computer usage and attitudes between men and women are well-documented in the literature (Kay, 2006). The persistent inequities in employment and earnings among men and women in computer-related occupations and technology-based startups in the United States make it prudent to continue to assess possible causes and remedies for these disparities within the educational environment. Hargittai (2010) also found in her study of American undergraduates that there was an independent relationship of race/ethnicity, gender, and education to internet usage skills that was not explained by access, use hours, or years of use.

However, there is evidence globally that women have similar or even greater self-efficacy than men in computing skills and occupations. Laosethakul (2009) found that Chinese women saw themselves as equal to Chinese men and were more likely to pursue computer-related majors than American women. Aremu & Fasan (2011) found that among the 589 Nigerian teachers in their study preparing to teach with technology, women had a higher level of self-efficacy than men. Moreover, Varma (2010) found that Indian women were highly confident in their technical skills, despite limited computer access early in their lives. Mathematical preparation in school and peer successes also contributed to overall confidence. These studies suggest that the dearth of women in computer science, engineering, and other technology fields in the United States could be
cultural in nature, rather than due to any truly gender-related beliefs regarding computing self-efficacy.

*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 non-handicapped 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 students with disabilities are 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 and usability for students 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).

Hammet 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. Kalyuga, 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 Wal-Mart, 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 locate the first article and the 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 examined whether or not the user interface of an online course affects students’ ability to learn instructional content when considering user technology literacy, self-efficacy, and spatial visualization ability. This study was framed by constructivist pedagogy, which drove the questions asked in participant interviews. This case study followed five students from two institutions in the Southeast United States.

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 required or elective 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 allowed 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. A descriptive case study seeks to investigate possible causative relationships between phenomena under study, and develop hypotheses from the data collected (Tellis, 1997). 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

Upon approval of The University of Southern Mississippi Institutional Review Board, electronically mailed letters were sent out to institutional disability services officers at several public institutions requesting assistance in notifying students of the study. Two institutions responded positively with permission to proceed. Students within the offices were then asked generally to contact the researcher if they wished to participate in the study, and flyers advertising the research were left with office staff. One administrator sent two email blasts to their student list to encourage participation. Permission to contact the students was concurrently provided by the individual institutional review boards. Upon completing the interview sessions, participants were presented with Visa gift cards in the amount of $50 in gratitude for their time.

Participants in the study were five undergraduate and graduate students with and without a variety of disabilities at two public postsecondary institutions in the southeastern United States enrolled in required or elective 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 19 to 69 years of age. The participants, all female, reflect a variety of ethnic, racial, and socioeconomic characteristics as represented in the general population of students. The women responded to fliers, emails, and word-of-mouth messages calling for participants. There were seven respondents in total.
However, repeated scheduling conflicts prevented the researcher from meeting with two potential participants.

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 were kept in a locked container also in the researcher’s home. All data were 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 used 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-halves, .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 on-site or remotely from off-site locations. For this study, the researcher recorded the observation sessions live and interviewed participants on-site at each location. 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 observed and recorded the participant wherever he or she usually accessed 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 produced 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 might have wished 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. The researcher met with participants for one session each, with session lengths ranging from one to two hours. The sessions were scheduled for after the
midpoint of the semester, however, one institution was on the quarter system at the time of the study, and that student was interviewed and observed at the beginning of her course.

During the session, the researcher directed each 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 in the form of a $50 Visa gift card 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 structured interview and direct observation to develop a descriptive case study of five students at different institutions in online courses. The research questions analyzed were:

R₁: How do different usability factors influence students' 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?

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.

Usability Factors

The usability factors assessed in this study were course site navigation, course information layout, course information “completeness,” visibility of text elements, and ease of locating relevant course information such as syllabi and instructor contact information. The assessment of these usability factors related to student motivation is supported by Zaharias & Paulymenakau (2009), from which the interview questions were adapted. Their methodology was selected based on its holistic nature – specifically the inclusion of affective domain of learning as integral of the development of the questionnaire. The Zaharias & Paulymenakau methodology addresses the online student’s role both as a technology user and as a learner, combining traditional usability evaluation with instructional design.

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 was reported through my own 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.

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

Data Collection

The purpose of this descriptive case study was to begin to ascertain relationships between usability, self-efficacy, technology skill, 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 the Purdue Visualization of Rotations Test, delivered via pencil-and-paper. 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.

This study used interview and direct observation of participants and their screen activity to develop a descriptive case study of five students at different institutions in online courses from different course areas using different course management systems.

The research questions analyzed were:
R1: How do different usability factors influence students’ experience in an online course?

R2: How do student characteristics such as self-efficacy, spatial visualization ability, and information literacy affect student perception of usability in an online course?

R3: Which usability factors are most difficult to overcome for students with low spatial visualization ability or low self-efficacy in online tasks?

The case study format allowed the researcher to closely 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). Data collection for participants’ emotional state and screen activity was conducted by recording video of their faces, keystrokes, and mouse movement (or “tracking”) using Morae usability and user experience testing software. This allowed for extensive analysis of participant self-talk and task-related decision-making during the interview and observation portion of the study sessions.

This chapter presents the findings from this study in relation to the guiding research questions and begins with background on the study participants. The cross-case findings organized by the major themes identified in the analysis were
then reported. Participant names have been replaced with pseudonyms to protect the confidentiality of their identities.

The participants generally described the online course system as easy to use, despite observed difficulty navigating the system and completing several of the designated tasks. This was rather surprising, given that observation of the video from each session shows increased frustration when encountering various difficulties in navigating the course and accessing course-related information. Aragon and Johnson (2008) found that a significant percentage of students do not complete online courses due to the design of the course. In their study, students stated that the confusing information and layout of materials led them to withdraw from the course. The findings in the current study support Aragon and Johnson’s assertion, especially for students with low technology literacy and limited experience with online environments.

The Participants

The five participants in this study are women ranging in age from 19-69 who have a variety of professional goals. Three of the five women have grown children. Some of the children work in technology-related fields, and their mothers stated that they regularly rely on their children’s expertise. The general similarity of ages, ethnicities, and technology backgrounds is not quite comparable to the greater online student population, which is more widely diverse. However, the majority of participants do represent a growing population of older adults returning to school and enrolling in online education. While most of the women attend institutions where there is no formal computer literacy
requirement, college catalogs from each institution were reviewed and all included some statement of improving or strengthening the skills of their graduates in the area of information and digital literacy within the general education and/or major curriculum areas. This and other demographic information collected during the sessions is catalogued in Table 1 below.

Table 1

Descriptive Data of Study Participants

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Age</th>
<th>Race/Ethnicity</th>
<th>Disability Status</th>
<th>Profession</th>
<th>WUSES Score</th>
<th>ROT-1 Score</th>
<th>Computer Literacy Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melina</td>
<td>52</td>
<td>Hispanic-American</td>
<td>None</td>
<td>LPN</td>
<td>72</td>
<td>3</td>
<td>N</td>
</tr>
<tr>
<td>Carol</td>
<td>51</td>
<td>African-American</td>
<td>Anemia</td>
<td>Bookkeeper</td>
<td>115</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>Mai</td>
<td>19</td>
<td>African-American</td>
<td>Lupus</td>
<td>Student</td>
<td>149</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>Karen</td>
<td>48</td>
<td>White</td>
<td>Brain Injury</td>
<td>Student</td>
<td>131</td>
<td>0</td>
<td>N</td>
</tr>
<tr>
<td>Donnalee</td>
<td>69</td>
<td>African-American</td>
<td>None</td>
<td>Retired RN</td>
<td>124</td>
<td>4</td>
<td>N</td>
</tr>
</tbody>
</table>

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. Figures 1 and 2 are screen shots from two study participants, illustrating this standard layout pattern. This general layout is common among commercial, proprietary and open source course management systems alike. It usually affords the student a complete view of the course’s information and materials.
Although the layout itself meets many conventions for ease of navigation, the majority of participants were unable to easily navigate their course to locate specific course information as requested. Labeling conventions for navigation and course documents varied among the institutions. The large block 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:
Researcher: Thank you. Please show me where you would find the course syllabus.

Mai: [Still in Workbook view. First paragraph on web page has heading Your Syllabus and indicates that the Syllabus can be accessed via the “Go to Syllabus” link at the top of every page. Mai scans the page, and focuses immediately on left navigation. Does not seem to be reading the page for text, but rather scanning for a 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. Carol goes back to the heading several times, and looks confused when nothing happens when she clicks the text. Carol expects the heading, which is colored purple (a color commonly applied to visited links in conventional HTML coding) to lead her to another page. Facial expression shows frustration, confusion. Carol then clicks on the Introduction to Economics module, which is also the main course introduction page. Nothing happens, page does not reload. Carol clicks this link several more times.]

In this case, Carol 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.

*Melina*

Melina is a 52-year-old, married nursing student pursuing RN licensure. She is currently an LPN working part-time at a facility over an hour from her home on rotating 12-18 hour shifts, usually overnight. She arrived for our session immediately after work. Last year, her husband suffered a stroke that resulted in paralysis on his right side and an inability to speak clearly. Their household now relies solely on Melina’s income. Her self-efficacy score was the lowest of the group, and she has the least experience with computers and the internet. Despite having had a desktop computer at home for several years, she has never used it – her daughter checks her email daily from her own home and relays Melina’s assignment information from the course by phone. Her institution uses a proprietary course management system designed in-house, but with a standard layout.

Melina contacted the researcher via phone to participate in the study after seeing one of the study flyers outside her classroom. She was concerned that her lack of technology background would disqualify her from participating, and repeated several times during the interview that she “really shouldn’t even bother, but I could use the gift card.” The author reassured her that her level of skill was more than acceptable for participation in the study, and we made arrangements to conduct the interview session within the next week at a private office near Melina’s campus secured by the researcher.
Melina has been working as an LPN for 27 years, and with the same organization for the last 18. Despite urging from family and friends, she did not decide to pursue RN licensure until her longtime employer laid her off earlier this year. Taking a part-time position similar to the one she lost, Melina enrolled in a local community college’s nursing program. She has been doing well in the face-to-face courses she attends on her days off, and enrolled in an online course upon finding that there were no more on campus seats available in the class she needed. She described herself in the session as “technophobic,” and reports dreading the healthcare industry’s current movement towards digital record-keeping.

During our session, Melina was visibly tired, and grew more and more agitated with each error she made. During the Purdue Test of Rotations (ROT-1), which was delivered as a pencil-and-paper assessment, she was fairly calm and comfortable. The Web User’s Self-Efficacy Scale (WUSES), delivered online, posed some difficulty for her. The survey was embedded in a frame within the web page, which necessitated scrolling within each page. Melina’s distress increased as she had to scroll to navigate the entire survey page. Advancing to the next page required scrolling within a small area, and was rather difficult for her as a user unfamiliar with the use and control of a mouse.

During the observation portion of the session, Melina seemed unfamiliar with the layout of the course. When questioned about this, she revealed that her daughter actually logged into the course for her and she simply completed the assignments as they were relayed to her. She has never actually logged into the
course herself. For those assignments and discussion posts that must be both conducted and submitted online, she again enlisted her daughter to post her submissions. She made it very clear that she did all of her own research and writing, and that her daughter simply uploaded the documents. Occasionally, her daughter has typed as she dictated her thoughts. When called upon to do her own typing, Melina reports that it takes forever.

Now that her daughter has recently returned to full-time work in addition to her part-time weekend position, Melina must access and navigate the course system on her own. Frustrated with her inability to complete the directed tasks efficiently, Melina did not complete the list of objectives for the observation portion of the interview. Soon after our meeting, she reported that she had withdrawn from the course with the intention of taking it in a traditional classroom section in the next semester.

Carol

Carol is a 51-year-old, divorced accounting major with health complications due to a blood disease. She has returned to school to complete her degree after stopping out to marry and have children, and currently works in a bookkeeping department. Her marriage was marred by the emotional abuse of her husband, who regularly belittled her and her aspirations. It has taken many years since her divorce for her to actively pursue the completion of her bachelor’s degree. Carol intends to continue through graduate school to complete certified public accountant licensure in her state. She has two grown children that she has raised as a single parent, a son and a daughter. Her son is a repair technician for
a mobile carrier, and her daughter is a full-time college freshman. Carol's self-efficacy score was lower mid-range, despite the fact that she uses computers and the internet daily. Her institution uses a commercial course management system with a standard layout.

Carol was referred to the author by another participant in the study, and after a series of emails to establish a convenient time for her to complete the session, we met at a coffee shop near her place of employment. After setting up in a relatively quiet corner of the shop, the session commenced. Carol quickly completed both the ROT-1 and the WUSES, and we moved on to the observation portion. Carol was initially at ease while completing the observation tasks, although her frustration with site navigation and the confusing labeling of several hyperlinks within the course site soon became apparent.

Being in an analytic profession, the researcher expected Carol to perform well across all tasks. As a regular computer user, she did show familiarity with computer and application functions, as well as digital problem-solving ability. However, her prowess was confounded by usability problems within the course system. For example, Carol was well aware of where navigation and course items should have been, but instead in her course were inexplicably located on other pages or located elsewhere on the page. This visibly frustrated her, and she was ultimately at a loss as to how to proceed after exhausting her knowledge. 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 questions designed to gauge reaction to usability problems (Q11, Q13, Q16) were unclear or ineffective.

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 is single with no children, and she has completed several hybrid courses successfully with 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.

Karen was very comfortable with the computer, course system, and tasks. She spoke easily of the difference between her initial fear of taking online classes and how that fear contrasted with the reality she has experienced. After several semesters of hybrid courses, Karen feels ready to take on a fully online course in the next quarter. Although she expects that she will miss the face-to-face interaction between herself, her instructor, and her classmates, she admits that it would be convenient not to have to come to campus when she goes back to work.

Karen was referred to the study by a campus administrator, and after exchanging several emails, the author secured a room on campus through the referring administrator for the interview and observation session. Karen quickly completed the ROT-1 and WUSES assessments and efficiently moved through
the tasks during the observation portion of the session. She did have a few challenges in locating information within the course site, which she described in the interview session as, “sometimes forgetting where things are located.” Beyond these occasional missteps, Karen stated that any problems she’d had with the course were related to the course content, rather than accessing necessary information. Karen’s ability to see past the course system framework to the course content encompasses the goal of effective online course design.

Karen’s attribution of forgetting the location of course-related items to her own memory difficulties illustrates another usability issue that can deter users – unclear navigation labels, or nonstandard placement of navigation information. Clear, standardized definition and positioning of site navigation and the inclusion of a site map (a descriptive, hierarchical listing of all site links) would improve usability for students and reduce the need to memorize the location of information for each online course within a management system.

*Mai*

Mai is a 19-year-old business student with a chronic autoimmune disorder which affects most of her major systems and also causes generalized pain and fatigue. 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. Mai contacted the researcher after hearing of the study from another student on her campus. Rather than calling to schedule an appointment, she first
sent a text message to verify that the study was still accepting participants. The researcher called Mai and scheduled a time to meet on her campus.

Mai’s institution uses a commercial course management system with a customized layout. While generally conforming to the standard layout, the system interface has been adapted to reflect access to other campus resources, such as a library book and journal search, from within the course system. The customizations also include a real-time status update system that allows users who are logged in to communicate within or across courses.

Mai experienced great difficulty navigating through the course system and was hindered most by nonstandard navigation labels and the absence of a central point within the course website to locate all associated information such as the syllabus and course reading materials. Several course-related links opened in new windows without warning, rendering the browser’s Back button irrelevant. New to the system, but not technology, the researcher expected to find that her high self-efficacy score was an accurate representation of technical and problem solving ability. However, Mai struggled with the location of basic course information, and did not exhibit the expected digital problem-solving ability. It is interesting to note that the disparity between self-efficacy and actual ability was the greatest in Mai’s case.

Mai did not self-talk during the observation session, although her facial expressions indicated deep thought and occasional frustration. While she asked for clarification of several directions, she did not seek assistance in completing the directed tasks. This may indicate a desire not to appear uninformed, as she
clicked on several links on each page until she achieved a change that she
determined was correct. Upon completing the session, Mai stated that although
the system was an older style, she thought it was easy to use, and that she
looked forward to participating in the course throughout the term.

Donnalee

Donnalee is a 69-year-old, married, retired nursing administrator in a
graduate nursing program. Her husband is a systems analyst, and she intends to
teach online nursing courses. She has voluntarily enrolled in a self-paced online
course to learn more about how it works. Donnalee is also enrolled in a
commercial 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.

Donnalee was the eldest member of the group, but the most inclined to
actively remedy her lack of technology background. When she was actively
working in nursing, her schedule did not allow for additional learning beyond
continuing education for her licensure. However, now that she has retired,
Donnalee has chosen to continue to serve in her field as an educator, and is
pursuing a graduate degree that will allow her to do so. This impetus has affected
the way she approaches problems she encounters on the computer or in the
online environment. Donnalee stated that she relies on her grown children, who
both work in technology-related fields, to answer her questions and review her
learning progress. She has, in effect, created an informal personal learning
network that supports both her ongoing technology and nursing education
learning goals. Such a network could prove useful to other learners with low technology background or with low self-efficacy in computer-based tasks.

Donnalee met the author after the conclusion of an interview session with another participant and asked to participate in the study. After qualifying her during the conversation, we returned to the meeting room to conduct the session. Donnalee completed the WUSES and ROT-1 assessments quickly, and confidently continued into the interview and observation phase of the session. Completing most of the designated tasks quickly and efficiently, she was visibly proud of her performance. On encountering difficulty, she stated to the author that she would note the process and “ask one of the kids about that one.” Donnalee was clearly taking an active role in her learning process, and despite several challenges, was relaxed throughout the session.

Themes

Cognitive Dissonance: Experience vs. Opinion

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 experiential knowledge of her institution’s 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 being simply related to inexperience and unfamiliarity with the system. It was unclear if there was any correlation of self-efficacy or skill with spatial visualization ability due to
the small sample size and the fact that all participants scored 20% or below on the Purdue assessment.

In Mai’s case, simple exposure to and regular usage of the latest consumer technologies did not necessarily lead to an understanding of how computerized systems work; she was mostly unsuccessful in completing the directed 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:

Researcher: 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.

Researcher: 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.

Researcher: 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.

Researcher: 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 overall 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. It is possible that they were not aware of these options, or did not know how to implement them. 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.

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

Researcher: 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.

Carol’s response is especially surprising, as she was visibly frustrated while completing tasks. Her difficulties were directly related to the design and
HTML coding of the course, and yet, she indicated that given the chance, she would not change it. While Carol’s case is most illustrative of the dissonance between the participant’s actual activity and their opinion of the system, only Melina described the system as difficult to use. Mai’s critique of the layout was more aesthetic than functional in that she would change the look of the course system rather than the location of information within the system.

**Self-Efficacy and Self-perception**

Participants in this study scored between a high of 149 and a low of 72 points on the Web User’s Self-Efficacy scale (WUSES), 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 was not related to 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 significant disconnect between what participants reported they could do as reported on the WUSES scale, and the practical application of those skills in the observation interviews. For example, 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.

Participants were prone to make self-deprecating remarks about their technical skills and abilities, and several appeared to accept this lack of ability as a given, unlikely to change. Previous research in gender differences in computer usage and technology adoption (Herring & Marken, 2008; Laosethakul, 2009; Mercier, Barron, & O’Connor, 2006; Venkatesh, Morris, & Ackerman, 2000) suggest that this attitude is common to women users. Melina and Carol made explicit negative self-statements regarding their errors consistent with women’s self-perception attitudes found in previous gender and computing research:

Melina: I don’t know why I thought this might be easier. I knew I couldn’t do this.

Carol: I’m so silly, I should know how to do this.

In general, the majority of the participants seemed to expect to have problems with the system. However, they did not seem inclined to independently
pursue remedies to these problems, nor were they aware that remedies were available to them.

**Cognitive Load Effects: “I didn’t see that there.”**

Prohibitive cognitive load was most apparent – and extreme – 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 completely shut down and was no longer able to continue the session. Conversely, Karen’s responses tended to focus specifically 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. Figure 3, developed by the author, illustrates how various aspects of the online learning environment relate to the three types of cognitive load. Each aspect of the course system that the student interacts with visually,
aurally, or otherwise, carries with it some load – it must be interpreted and processed accordingly.

![Diagram of Factors Influencing Cognitive Load]

**Figure 3.** Factors Influencing Cognitive Load in an Online Course.

The processing of visual information takes place via one of several channels available. While working to process information is a necessary part of learning new material, inefficient presentation of information detracts from student ability to acquire the intended knowledge. Primary stumbling blocks for participants were confusing labeling of navigational links, ineffective site hierarchy, navigational information hidden within large blocks of text, and deviations from commonly accepted HTML coding protocols. It was unclear what portion of these course design and layout issues are related to the default settings of the course management system template versus instructor design choices, or if the difficulties experienced by participants were simply a result of their limited technology experience. Karen mentioned having difficulty remembering where things are located in conjunction with her injury. However,
labeling conventions that make the locations of important documents and information clearly identifiable would remove the necessity of memorizing the various locations of these items.

During the observation sessions, mouse tracking indicated where participants had consistent difficulty. Moving the mouse to different navigation labels and repeated hesitation prior to clicking, for example, indicated lack of confidence that following the link would take them to the information they sought. Carol’s repeated clicking on the Syllabus heading (which was colored as a visited link but not hyperlinked) indicated the challenge presented by deviating from common HTML conventions and design practice. Even though all of the systems studied included breadcrumb navigation at the top of the page, none featured a complete site map which would clearly explain where all site links led and information was located. These design characteristics significantly increased extraneous cognitive load to the point that germane cognitive load was only accessed by Karen, who was familiar with the system and used it often.

Synthesized Analysis and Findings

This study used interview and recorded 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.

R1: How do different usability factors influence students’ experience in an online course?
The participants’ abilities and reactions to site navigation, layout, course information completeness and accessibility, and visibility of text elements were assessed through various skills tasks. The women 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 and other functions that did not accomplish the stated task.

Most participants had difficulty locating the course syllabus. In most postsecondary institutions, placement of this essential link within the course pages is the responsibility of the instructor, not the IT 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 determine their level of input on the participating course designs.

Additionally, large chunks of text on the course pages were largely ignored by participants. 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. When the location of navigational links within the main text block was pointed out, participants expressed surprise.
Mai: Oh! I didn’t even look at that area.

Donnalee: Wow, I wouldn’t have even known to look there for it.

Carol: I didn’t see that, and it was right in front of me!

Melina: Oh, they were hiding it from me.

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. The usability challenges visibly produced frustration for several of the women, but that frustration quickly dissipated on being instructed in how to maneuver through the environment. Unfortunately, it soon returned on being asked to complete similar tasks without assistance. Participants were asked to describe their experience and give an opinion of the course system. The researcher expected the participants to outline the hardships and difficulties encountered in their use of the system. Surprisingly, the women all described the system as simple to use and moreover indicated that the course layout did not require any changes related to the location of important information.

R2: 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 had very low spatial visualization ability as assessed by the Purdue Visualization of Rotations test, 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 had 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. Four of the five participants described the course system layout presented as easy to navigate, and “pretty self-explanatory” despite navigation and information retrieval challenges. Given the parameters of the question posed, the conclusion in this study may be that these factors have no discernible effect on student perception of usability, or that other factors prevented or discouraged participants from accurately reporting their experiences with the system. The small sample size precludes the ability to make a generalizable assessment of R2.

R3: Which usability factors are most difficult to overcome for students with low spatial visualization ability or low self-efficacy in online tasks?

For Melina, the study participant with the lowest self-efficacy and technology literacy, even minor usability difficulties seemed insurmountable. She was unable to overcome navigation issues related to location and labeling, and ultimately declined to continue the session. The cognitive load induced by her extreme fatigue, anxiety about accessing the course, and lack of technology background combined to make basic problem-solving in a digital environment especially difficult. Her ultimate decision was to drop the course, which led to unrecoverable costs in financial assistance and course materials, although the course materials may be useful when she retakes the course in the future.

Carol, the other participant scoring below the group’s median self-efficacy score, had the most trouble with deviations from common HTML design practice such as text headings that were not hyperlinked, and ineffective labeling of
navigation links. As an experienced computer user, these impediments to successful task completion produced significant frustration – nearly comparable to Melina’s, in fact. Like other participants, she overlooked important navigation information located within the main text block while scanning the course web pages. It was then quite puzzling that Carol still described the system as simple to navigate and usable.

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, confusing labeling of primary navigation links, and important navigation-related text located within the body of the main text. While these barriers are extremely frustrating to a user with low technological skills and self-efficacy scores, they may not be as problematic for experienced, skilled users. Interface invisibility was achieved by Karen, who has had several successful experiences with hybrid online learning. In her session, the interview and observation discussion moved to the relative difficulty of course content, and her self-perceived ability to succeed in the course compared to her peers.

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. As related to self-perception, self-efficacy may lead users to overlook actual difficulties encountered in using a computer or online system. Since participants’ self-efficacy scores were consistently higher than their actual
ability, the women interviewed here may have transferred this perception of their own skill into their overall assessment of the course environment.

Cognitive load was found to be most considerable in the participant with the lowest technical ability and self-efficacy. This load may be reduced through pretraining in computer literacy for new users, or enforcement of a standard computer literacy requirement prior to enrolling in online courses. Basic usability errors in the design of the course websites presented resulted in frustration and negative user experiences for nearly all participants, with the greatest visible negative effect in users with greater technology familiarity and knowledge. It appears, however, that the negative feelings engendered by usability problems encountered by the participants were short-lived.

Usability factors such as ineffective course layout negatively affected participants’ ability to access and navigate the course website. Suboptimal location of important information was a consistent stumbling block for all participants, as were major deviations from standard HTML coding and design practice. Large blocks of unbroken text deterred participants from carefully reading the page for necessary information and understanding. However, these difficulties did not negatively affect student perception of the overall 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 within a minority identity view of disability.

This case study research was intended to look at the user experience of students in web-based courses and how that experience relates 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, especially those with a limited technology background, in postsecondary online courses.

The study sought to answer: Does the design of an online course’s (or course management system’s) user interface affect students’ performance or persistence in the course? How might we identify common usability factors 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 1.) cognitive dissonance between participants observed experience in accessing the course and their description of the course’s usability, 2.) self-efficacy and self-perception as factors related to overall evaluation of usability, and 3.) 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 as in Donnalee’s case. 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. The current study’s 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 participant success. This may have influenced the women’s 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 in that Melina ultimately chose to withdraw from the course. Increased cognitive load proved to be 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 solvable, 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 limited technology background in online courses. This study contributes to this gap in the literature. The current study represents an initial point for extended research with an underserved population within the growing field of online learning, and also supports similar research into the needs of students with disabilities in 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 (IC3)Fast Track exam. This single exam alternative to the established IC3 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.

Finally, the Web User’s Self-Efficacy Scale proved somewhat difficult to maneuver. This particular issue was due to the embedding process and in later studies, the native survey link will be used. The native survey link opens in a page designed by the survey manufacturer, and its full-page layout does not require scrolling to navigate between pages.

**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 for online courses and the way students actually 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.

Recommendations for Policy and Practice

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.
APPENDIX A

INSITUTIONAL REVIEW BOARD APPROVALS
& SAMPLE PARTICIPANT CONSENT FORMS

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

Notices of Committee Action

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 50.11), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is obtained and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated serious, or continuing problems encountered regarding risks to subjects must be reported immediately but not later than 10 days following the event. This should be reported to the IRB office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 10511964

PROJECT TITLE: Comparative Study of the Experience of Usability by Students with Disabilities in Online Courses

PROPOSED PROJECT DATES: 08/10/2010 to 10/28/2010

PROJECT TYPE: Dissertation or Thesis

PRINCIPAL INVESTIGATORS: Lisa T. Richardson

COLLEGE/DIVISION: College of Education & Psychology

DEPARTMENT: Educational Studies & Research

FUNDING AGENCY: N/A

HSRRC COMMITTEE ACTION: Expedited Review Approval

DATE OF APPROVAL: 08/14/2010 to 08/13/2011

Lawrence A. Heimer, Ph.D.
HPRC Chair

Date
October 20, 2019

Ms. Lisa T. Richardson
7010 Chilkat Ct., SW
Atlanta, GA 30331

Dear Ms. Richardson,

I have reviewed your request for research and have approved it as presented. Thank you for your interest in conducting research that can benefit our students. Please provide a copy of your results to Dr. Kristen Douglas, Vice President for Institutional Effectiveness, when you have concluded your study.

Sincerely,

[Signature]

Skip Sullivan, Ed.D
President
Dissertation Research Interviews

Gregg, Patricia <Patricia.Gregg@gpc.edu>  Mon, May 9, 2011 at 1:18 PM
To: "Lisa T. Richardson" <lisa.richardson@eagles.usm.edu>
Cc: "Kinney, Christopher" <Christopher.Kinney@gpc.edu>, "Martin, Bonnie"
    <Bonnie.Martin@gpc.edu>

Ms. Richardson,

I have reviewed your prospectus and Informed Consent document. Before I can conditionally approve this study, I need a better understanding of how you expect to identify and communicate with prospective study participants prior to their agreement to participate. I presume our Office of Disability Services has graciously offered to assist you in this regard. I will need to know the logistics.

Also, in your Informed Consent document, I will need you to make 2 modifications to the version that will be provided to GPC students:

1. Under the heading “Voluntary Nature of the Study” on page 2, please substitute “Georgia Perimeter College” for “your institution.”

2. Under the heading “Contacts and Questions,” in the second paragraph, which begins on page 3, please modify the first sentence to read “This project and this consent form have been reviewed by the Institutional Review Boards of both Georgia Perimeter College..."
and the University of Southern Mississippi, which ensure .... “

Thank you,

Patti

Patricia L. Gregg, Ph.D.
Associate Director, Planning & Assessment and Acting Director
Office of Institutional Research and Planning

Research. Relevance. Results.

From: Lisa T. Richardson [mailto:lisa.richardson@eagles.wsm.edu]
Sent: Wednesday, April 27, 2011 12:00 PM
To: Gregg, Patricia
Subject: Re: Dissertation Research Interviews

Good morning Dr. Gregg,

[Quoted text hidden]
Interview Questions

1. What is your major? Class level/number of credits? Career goal?
2. Is this your first online course? If not, how many have you previously taken?
3. Is this course an elective or required for your major?
4. Please describe your experience in this online course.
5. Please show me where you go in the course to find out when the next assignment is due.
6. Please open the course syllabus from the course website.
7. Where is the class title and instructor name and contact information located?
8. Does the instructor know that you have an impairment?
9. Did you self-identify with the Office for Students w/ Disabilities? Why or why not? How do you feel about that?
10. Do you find completing tasks related to the course simple or difficult?
11. How would you describe the ability to communicate with the instructor and your classmates?
12. Do you feel comfortable requesting assistance from your instructor or classmates?
13. Would you change anything about the organization of the course? If so, what?
14. Where do you access this course most often?
15. Do you use any assistive technologies to use your computer or access the internet?
16. How would you describe the ability to navigate the course?
17. What accommodations have been made for you in face-to-face courses? In this and/or other online courses?
18. Do you receive emails within the course management system? How would you describe the ease of accessing and reading them?
19. Do you feel that you have the same opportunity for success in this course as other students?
20. Does the support you receive here at your institution differ from what you received in high school? For better or worse? Explain.
21. Where you discouraged by college administrators from taking an online course? By your friends? Family? What were the reasons they gave you?
22. Do you find the online course more or less convenient than a face-to-face course? Please share examples.
Web Users’ Self-Efficacy Scale

This brief survey will only take a few minutes to complete but it is important that it is completed in full. Please note that there are no correct answers, don’t be influenced by the way in which you think other people may respond, it is your own personal opinion that is important.

Before starting please provide:

Your full name: ………………………………………………………………………

Your age: ………….        Your sex:      Male     Female     (Please circle one)

Your Major: ………………………………………………………………………

Academic Level (Fr, So, Jr, Sr):

……………………………………………………………………

Please continue…..

Below there are forty short statements concerning your thoughts and feelings about Internet use. Please indicate the strength of your agreement or disagreement with each statement using the scale shown, where 1 indicates that you Strongly Disagree and 5 means that you Strongly Agree with the statement provided. Circle a number on the scale to indicate your response.

Again there are no right or wrong answers, it is you own opinion that is important.

1. I rarely have problems finding what I am looking for on the Internet....
Strongly Disagree  1  2  3  4  5
Strongly Agree

2. I wouldn't have any problems creating a simple web page.
   Strongly Disagree  1  2  3  4  5
   Strongly Agree

3. I find using email easy....
   Strongly Disagree  1  2  3  4  5
   Strongly Agree

4. I am not really sure what a modem does...
   Strongly Disagree  1  2  3  4  5
   Strongly Agree

5. I sometimes find using search engines like Google, Bing, or Yahoo can be difficult...
   Strongly Disagree  1  2  3  4  5
   Strongly Agree

6. I know how to use software (e.g. Dreamweaver, Nvu or Frontpage) for creating web pages...
   Strongly Disagree  1  2  3  4  5
   Strongly Agree
7. Using messenger software, like AIM, MSN or ICQ always causes me some problems...
   Strongly Disagree  1  2  3  4  5  
   Strongly Agree

8. I think I could write a simple CGI script for a web site...
   Strongly Disagree  1  2  3  4  5  
   Strongly Agree

9. Finding my way around web sites is usually easy for me...
   Strongly Disagree  1  2  3  4  5  
   Strongly Agree

10. I would never try to download files from the Internet, that would be too complicated....
    Strongly Disagree  1  2  3  4  5  
    Strongly Agree

11. I would find it very difficult to write a web page in html...
    Strongly Disagree  1  2  3  4  5  
    Strongly Agree

12. I would have few problems setting up a web cam...
    Strongly Disagree  1  2  3  4  5  
    Strongly Agree
13. I much prefer using letters or the telephone to communicate with people, rather than the Internet...

   | Strongly Disagree | 1 | 2 | 3 | 4 | 5 |
   | Strongly Agree    |

14. I am not sure how to prevent spam...

   | Strongly Disagree | 1 | 2 | 3 | 4 | 5 |
   | Strongly Agree    |

15. I wouldn't know how to capture pictures from the Internet...

   | Strongly Disagree | 1 | 2 | 3 | 4 | 5 |
   | Strongly Agree    |

16. I am not sure how to use javascript in web pages...

   | Strongly Disagree | 1 | 2 | 3 | 4 | 5 |
   | Strongly Agree    |

17. Adding an image to a web page would be very difficult for me...

   | Strongly Disagree | 1 | 2 | 3 | 4 | 5 |
   | Strongly Agree    |

18. Newsgroups are a good way of reaching people...

   | Strongly Disagree | 1 | 2 | 3 | 4 | 5 |
   | Strongly Agree    |
19. I know how to test my computer for the presence of spy ware...
   Strongly Disagree 1 2 3 4 5
   Strongly Agree

20. Pop-up advertisements are a nuisance you just have to put up with...
   Strongly Disagree 1 2 3 4 5
   Strongly Agree

21. Downloading music from the Internet is something I feel competent to do...
   Strongly Disagree 1 2 3 4 5
   Strongly Agree

22. Adding hypertext links to an image (i.e. an image map) is quite straightforward...
   Strongly Disagree 1 2 3 4 5
   Strongly Agree

23. I am not too familiar with the use of cascading style sheets for web site production...
   Strongly Disagree 1 2 3 4 5
   Strongly Agree

24. I have little real idea what peer to peer (p2p) software is for...
   Strongly Disagree 1 2 3 4 5
   Strongly Agree
25. If my computer became infected with a virus, I wouldn't know how to get rid of it...

   Strongly Disagree  1  2  3  4  5

   Strongly Agree

26. Most Internet terminology is easily understood...

   Strongly Disagree  1  2  3  4  5

   Strongly Agree

27. I have no security worries when it comes to buying things over the Internet...

   Strongly Disagree  1  2  3  4  5

   Strongly Agree

28. I feel confident about using most types of browsers...

   Strongly Disagree  1  2  3  4  5

   Strongly Agree

29. I would know how to go about registering a domain name for a website...

   Strongly Disagree  1  2  3  4  5

   Strongly Agree

30. Adding links to a text document wouldn't cause me any problems...

   Strongly Disagree  1  2  3  4  5

   Strongly Agree
<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. Using ftp to upload web pages to a server is too complicated for me...</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td></td>
</tr>
<tr>
<td>32. I sometimes &quot;get lost&quot; when trying to navigate through the Internet...</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td></td>
</tr>
<tr>
<td>33. I regularly exchange music and/or video files with friends...</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td></td>
</tr>
<tr>
<td>34. Using the Internet makes it much easier to keep in contact with people...</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td></td>
</tr>
<tr>
<td>35. I regularly use the Internet for playing games...</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td></td>
</tr>
<tr>
<td>36. I'm not sure how to communicate with people using chatrooms...</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td></td>
</tr>
<tr>
<td>37. I can usually sort out any Internet access problems I may encounter...</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td></td>
</tr>
</tbody>
</table>
38. I am not very confident about my ability to use the Internet...
   Strongly Disagree  1  2  3  4  5
   Strongly Agree

39. I wouldn't have any fears about using an online help service to help me troubleshoot a problem...
   Strongly Disagree  1  2  3  4  5
   Strongly Agree

40. I know how to deal with annoying advertisements that appear while I'm using the Internet...
   Strongly Disagree  1  2  3  4  5
   Strongly Agree

Thank you, you have now completed all the sections.

Thank you for your time in helping with this research

Scoring:

18 of the items have been worded negatively and therefore the participant’s response has to be reversed before scoring can commence. This means if the participant circled 5 as their response then after reversal this becomes 1. If they circled 4 it becomes 2, if the circled 1 it becomes 5 and so on. The items that need to be reversed are: 4,5,7,10,11,13,14,15,16,17,20,23,24,25,31,32,36, and 38.

The four subscales can then be calculated by adding the 10 items of each sub scale:

   Information Retrieval = 1+5+9+10+15+21+28+32+38+40.
Communications = 3+7+12+13+18+24+33+34+35+36.

Technology = 4+8+14+19+20+25+26+27+37+39.

Scale originally designed by Dr. Peter Eachus
School of Community, Health Sciences and Social Care
Directorate of Psychology
University of Salford
Frederick Road
Salford M6 6PU
United Kingdom
DIRECTIONS

This test consists of 20 questions designed to see how well you can visualize the rotation of three-dimensional objects. An example of the type of question included in this test is shown below.

For each question, you should:

1. Study how the object in the top line of the question is rotated.
2. Picture in your mind what the object shown in the third line of the question looks like when rotated in exactly the same manner.
3. Select from among the five drawings (A, B, C, D, or E) given in the bottom line of the question the one that looks like the object rotated in the correct position.

What is the correct answer to the example shown above?
1. IS ROTATED TO

AS IS ROTATED TO

2. IS ROTATED TO

AS IS ROTATED TO
5. IS ROTATED TO

AS

IS ROTATED TO

A B C D E

6. IS ROTATED TO

AS

IS ROTATED TO

A B C D E
7  \[ \text{rotated to} \]

8  \[ \text{rotated to} \]

\[ \text{as} \quad \text{rotated to} \]

\[ \text{as} \quad \text{rotated to} \]

\[ \text{rotated to} \]

\[ \text{rotated to} \]
9  IS ROTATED TO

AS  IS ROTATED TO

A    B    C    D    E

10  IS ROTATED TO

AS  IS ROTATED TO

A    B    C    D    E
11  \[\text{IS ROTATED TO}\]

\[\text{AS}\]

\[\text{IS ROTATED TO}\]

A  B  C  D  E

12  \[\text{IS ROTATED TO}\]

\[\text{AS}\]

\[\text{IS ROTATED TO}\]

A  B  C  D  E
13. The shape in the left diagram is rotated to the shape on the right.

14. The shape in the left diagram is rotated to the shape on the right.
15 IS ROTATED TO

AS IS ROTATED TO

A B C D E

16 IS ROTATED TO

AS IS ROTATED TO

A B C D E
17 IS ROTATED TO

AS IS ROTATED TO

A B C D E

18 IS ROTATED TO

AS IS ROTATED TO

A B C D E
19 IS ROTATED TO

AS IS ROTATED TO

A B C D E

20 IS ROTATED TO

AS IS ROTATED TO

A B C D E
THE PURDUE VISUALIZATION OF ROTATIONS (ROT) TEST

The Purdue Visualization of Rotations test was originally developed by Roland Guay and Ernest McDaniel as a 36-item test of spatial ability. This test was licensed by the Purdue Research Foundation. The version now in use is a truncated, 20-item version created by George Bodner by removing questions 6, 8, 11, 14, 20, 21, 22, 24, 26 and 30. This test is presumed to load on the spatial visualization factor of spatial ability and has been shown to be one of the spatial ability tests least likely to be confounded by analytic processing.

We limit the amount of time students have to complete this 20-item exam to exactly 10 minutes. Students are given one point for each question they answer correctly.

Answer Key:

1  A
2  D
3  A
4  B
5  E
6  C
7  B
8  E
9  A
10  C
11  B
12  E
13  A
14  E
15  D
16  A
17  B
18  D
19  D
20  E


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