Wrestling With Online Learning Technologies: Blind Students’ Struggle to Achieve Academic Success
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ABSTRACT
This study examines the usability challenges and emotional reactions of blind college students in their attempts to access online educational materials and to communicate with colleagues through online technologies. A case study approach was adopted. Five students were interviewed regarding their online learning experiences using Blackboard, a popular Course Management System. Analysis of the interviews revealed that Blackboard was poorly accessible to the blind students, which affected achieving their academic goals. The study also showed that the blind students were motivated and optimistic of their successes despite their frustrations and feelings of marginalization. The study suggests that academic administrators and database designers work jointly with adaptive software developers in developing enhanced user interfaces to ensure universal access and usability of online technologies and to reduce educational inequalities and frustrations encountered by blind students.

Keywords: Accessibility, Adaptive Software, Assistive Technologies, Blackboard, Course Management System, Online Learning, Usability

INTRODUCTION
According to the Sloan Consortium, over 3.9 million college students in the United States representing over 20% of the total student population were taking at least one online course during the fall of 2007; a 12 percent increase over the number reported the previous year (Allen & Seaman, 2008). With the increasing popularity of online or blended courses, course management systems (CMS) such as Blackboard have become essential instructional media for reaching the majority of students. Blackboard, the term used in this paper to represent the 2008 and 2009 versions of the Blackboard Learning System, WebCT, or Blackboard/WebCT Vista, is one of the most widely-adopted CMSs by the U.S. postsecondary institutions and it “has become the Microsoft of higher-education technology” (Young, 2008, p. A1). While CMSs are vital media used for instruction and communication, information ac-
cess in these complex and highly visual virtual environments can be problematic for the blind or visually impaired students who are dependent on adaptive software for web navigation.

Adaptive software is a general term used to refer to computer applications used by people with disabilities to access and retrieve electronic information from computers (Lazaro, 2001). Although referred to as adaptive software, they are only adaptive to specific environments for which they were designed. Consequently, their functionality is limited. While research on Web-based distance education has found that sighted students persistently endure frustrations in their computing tasks (Hara & Kling, 1999), studies focusing on blind student populations engaged in Web-based learning has been largely overlooked.

The purpose of this study, therefore, is to examine challenges of online technologies associated with accessibility and usability that are experienced by blind college students. Through this examination, we hope to better understand the impact of online technologies on the blind students' pursuits for their academic goals.

Theoretical Framework

Adaptive Software, Assistive Technologies and Blind Individuals

A wide body of research indicates that while there has been a great improvement in universal access to technology, blind individuals still struggle with poorly designed computer interfaces and that adaptive software continue to lag behind in detecting web design features (Gerber, 2003; Craven & Brophy, 2003; Irwin & Gerke, 2004; Leporini & Paterno, 2004; Salampasis, Kouroupetrogloou, & Manitsaris, 2005). Gerber (2003) and Craven and Brophy (2003) further observed that most of the adaptive technologies used by blind individuals only navigate the Internet in a linear and serial pattern. Yet, web designs are increasingly incorporating Java-based hypermedia and multimedia elements with various sophisticated visual elements such as graphics and pop-up windows. The conflicts between the linear navigation of adaptive software and the trend of non-linear web designs frustrate, demoralize, and limit blind users from accessing and using information, which sometimes results in abandoning their educational pursuits.

Undoubtedly, most Web content developers, page authors, site and tool navigation designers try to follow W3C accessibility and usability guidelines that recommend procedures to ensure universal accessibility to Web content (WAI, 1999). Emphasis, however, is placed on Web accessibility at the expense of usability concerns for people with disabilities. Leporini and Paterno (2004) view the concepts of accessibility and usability as closely related, but describe accessibility as focused on making a website available to a wider user population, and usability as aiming at making users' experiences with the websites more efficient and satisfying. Leporini and Paterno (2004) observe that “often, when designers consider people with special needs, they tend to address only accessibility issues, and ignore those regarding usability... yet, even if a site is in principle accessible, because it completely complies with technical accessibility standards, it can still be so hard to use for people with disabilities that they may not succeed in reaching their goals” (p. 57). This is because the available screen reading software or synthesizers used by the blind, including Job Access with Speech (JAWS), Braille displays, Window-Eyes, Magic, and Zoom Text, can only navigate virtual environments that can be re-configured to be accessed in sequential and linear, rather than parallel formats. This problem is compounded by web designers, who not only neglect accessibility and usability needs of the visually impaired, but also underestimate the percentage of the population adversely affected (Zaparzinik & Montgomerye, 2005).

In academic environments, studies around the globe have found serious accessibility and usability obstacles to web navigability by blind and visually impaired students who use a variety of adaptive software to access educational materials on the Internet. For example, a study of home pages of 51 liberal arts colleges in the
United States found that the needs of students with disabilities did not appear to be considered in the interface design of web pages or the organization of web content (Irwin & Gerke, 2004). Irwin and Gerke found that the majority of home pages in the study were not developed with accessibility standards in mind, and that it was difficult to locate the information about disability services.

Schmetzke (2000) found that 23 out of 24 university websites audited in the United States did not comply with Web Accessibility Initiative (WAI, 1999) guidelines. This resulted in multiple severe accessibility problems for blind and visually impaired students using adaptive technologies. Negatively impacted was their logical grasp of the layout of these websites. Zaparyniuk and Montgomery (2005) and Sloan, Gregor, Booth, and Gibson (2002) conducted audits on Web resources for 311 higher education institutions in Canada and in the U.K. respectively. They found that the educational resources for academic staff and students contained design errors that seriously hindered accessibility and usability for individuals using adaptive software to access information. They further observed that the most prevalent accessibility drawback of all websites was the lack of equivalent or alternative interpretation in textual terms to graphical features such as images, animations, and multi-colored elements in a clear, logical, and comprehensible manner. Even the most promising and comprehensive Practical Experimentation by Accessible Remote Learning (PEARL) project, which developed applications to enable students with diverse disabilities to conduct scientific experiments from remote locations via the Internet, could not be used effectively with screen magnification software (Cooper, Santa Cruz, Donnelly, & Sergeant, 2000). Although some features of PEARL could respond to versions of JAWS for windows, blind students could not work independently using some of the features and would need sighted assistance for description of the various visual aspects of experiments (Cooper, Colwell, & Amaral, 2002).

This disparity in accessibility and usability of information in schools accentuates the digital divide between the able-bodied and physically handicapped individuals because the latter are denied "access to the more valuable information sources... that are not included in the freely available information on the Internet" (Cullen, 2001, p. 311). This observation was echoed by Berners-Lee (2002) who stated that Internet access by everyone regardless of disability is essential since the true power of the Internet lies in its universality. This problem is further severely online classes when online instructors have little knowledge about the special needs that the students with disabilities have in working with web-based educational media. As a result, the blind students' learning experiences are further compromised by poor communication with their online instructors and by online instructors' anxiety or uncertainty for teaching students with disabilities (Ling, Allison, Nicholl, Moodley, & Roberts, 2007).

Research on the notion of frustration in computing encounters found that frustration is a universal reaction to disruptions in computer use and accessibility of information manifested through emotional swings such as helplessness, loss of control and esteem, or resignation from pursuing a goal (Bessie, Newhagen, Robinson, & Shneiderman, 2006; Lazara, Jones, Hackley, & Shneiderman, 2006). Bessie et al. (2006) and Lazara et al. (2006) observed that frustration excludes users from vital information that could have contributed to their social empowerment and prosperity. According to Bessie et al. (2006), many frustrated computer and Internet users become "net evaders or net drop-outs" (p. 942) to some extent: either because they lack the self-confidence to access or use the technology, or because they tried and gave up since the designs were too complex for them to navigate or to find the information they needed to realize their respective goals.

Unlike regular or sighted students who see the displays on a computer screen and easily move from one point to another by a click of the mouse, blind students use only the keyboard to navigate the Internet. In addition, blind students
engage in online learning through listening using special software that reconfigures the material on web pages into formats that the respective software can audibly read back to them. Unfortunately, the available screen reading technologies are still not developed enough to enable blind students to independently navigate highly complex and visually-oriented designs such as Blackboard. To access their educational materials and realize their academic goals, blind students need to rely on sighted individuals, a time consuming and expensive undertaking. This results in loss of autonomy and in frustration that impedes them from attaining their academic goals on time.

Frustration Theory, Goal Theory and Media Being the Message

Frustration theory suggests that the interruption of a process towards the attainment of a goal or accomplishment of a task causes individuals to become frustrated, emotional, helpless, and moody, lose control, or even give up the pursuit of a goal (Freud, 1921; Amsel, 1992). Freud and Amsel also state that internal and external factors may also cause frustration. According to these theorists, internal factors may include the level of goal commitment, the severity of the interruption, and the strength of the desire to obtain the goal. Freud and Amsel outline such external factors as cultural and societal influences upon the individual as likely to cause frustration and thwart efforts in attaining a goal.

Closely associated with frustration theory is goal theory which stresses that experience, self-efficacy, and the importance of the goal to the individual are critical elements in the accomplishment of a given task (Campion & Lord, 1982). Campion and Lord suggest that when goal interruption occurs, the level of goal commitment, viewed in terms of the importance of the task to the user, the user’s self-efficacy and experience will directly determine the level of frustration and anxiety experienced. Theorists also posit that devotion to goal attainment is usually a source of motivation that inspires individuals to adopt techniques that enable them to overcome emotional setbacks until they accomplish a given task and ultimately achieve the set goal.

In addition, McLuhan (2002) suggested that the media are equally important; if not superior to the content or message they transmit (McLuhan, 2002). In fact, McLuhan (2002) indicated that medium is the message and that it’s the medium that determines the message rather than the other way around. The medium influences how the content is accessed and perceived by recipients. The emphasis placed on the medium rather than on the message by McLuhan suggests that consumers of such media must be capable of not only accessing and using them but also understanding them and therefore appreciating and getting influenced by the messages they transmit. McLuhan (2002) stated that “by continuously embracing technologies, we relate ourselves to them as servomechanism” (p. 235). It is this dependency and linkage to technology that makes it an integral part of our lives. As such, whether intentional or not, we become one large bio-mechanical system. This includes our teaching and learning systems.

While previous research on computing experiences of blind individuals has acknowledged difficulties encountered using the available adaptive software, the research has exclusively focused on navigating regular websites and has largely overlooked challenges and frustrations encountered by blind students engaged in online learning environments. This study, therefore, will examine such challenges and frustrations, when blind college students access educational materials through a CMS, in particular Blackboard.

The Study

The following questions guided this research study: What effect does the design of Blackboard have on the academic goals of the blind students? What features help and what features impede the academic goals of the blind students? What can be done to improve the usability of Blackboard and other online technologies
in order to help blind students achieve their academic goals?

Research Methodology

To answer the above questions, a case study methodology (Yin, 1984) was utilized to understand the blind students' experiences of using Blackboard in online learning. An interview questionnaire was developed, which included two sections. The first section sought demographic information about the participants. The second section was comprised of open-ended questions which asked the participants to recall, describe, and narrate their experiences using Blackboard. The questions included what Blackboard features they liked or disliked, what features easily responded to the commands of the adaptive software they used, what obstacles they encountered, and which features they would like to see changed in Blackboard. The participants were also asked about other online websites they liked, their views on online classes as compared to face-to-face classes, and their feelings and strategies in dealing with difficulties and failures.

Five blind students were purposefully selected and interviewed individually, face-to-face, in a room located in the Office of Disability Accommodation (ODA) of the university where the study was conducted. A purposeful sample is particularly productive in case study research because participants are selected on the basis of their diversity and depth of knowledge about a problem under investigation to provide a deeper understanding about that specific phenomenon (Creswell, 2003). Each interview lasted 45 minutes on average. The interviews were taped-recorded and transcribed for coding, labeling, and analysis.

Data Source

The five participants were blind undergraduate and graduate students at a research university with no specific age limit. The rationale for an open age range was because it is hard to determine whether blind students spend the same amount of time in college as other students. Participants were identified through the ODA and through a snowball technique (Atkinson & Flint, 2000). A snowball technique, used as a referral system to gain access to acquaintances of previously interviewed participants, is particularly effective in finding respondents for studies involving marginalized or "hidden" members of society (Atkinson & Flint, 2000).

The five participants included one male and four females with ages ranging from 18 to 31 and with an average age of 24.8. All five had more than three classes on Blackboard before the interviews took place in December 2008. Two of the participants had taken more than eight classes in Blackboard. All the participants reported that many of the classes were blended or integrated, meaning they combined both online learning and face-to-face classroom instructions and communications. While all the students were recognized as legally blind, two of the participants were totally blind, one of them since birth, while the other became totally blind two years prior to the study. The other three students had various degrees of blindness that affected them as children and worsened into adulthood. Only one participant reported a stable vision condition over the last ten years.

Each of the participants was at a different level in their college education. One was a freshman, one a sophomore, one a junior, one a senior, and the other was pursuing a master's degree. Similarly, all five pursued different majors ranging from education, history and political science, social work and biology, psychology and anthropology, and library and information sciences. Owing to their diverse levels of blindness, the participants used a variety of software appropriate to their vision conditions.

The two who were totally blind reported using JAWS for Windows and Windows-Eyes. One participant, whose vision condition was rapidly degenerating, reported to be training to switch from Victor reader and Zoom Text to JAWS. The other two participants reported using Zoom Text and Magic, two software applications used to enlarge the characters on computer screens. All the participants reported use of the regular
computer keyboard for commands to their software and none reported using the Braille keyboard to access the Internet. Two also used a mouse to navigate the Internet using Zoom Text and Magic software. Thus, the diversity of the purposefully-selected participants afforded the study a better and deeper understanding of the computing experiences of blind college students while using Blackboard to access educational materials.

The following table (Table 1) provides a summary of the participants’ demographic information arranged from the oldest (31 years old) to the youngest (18 years old):

**Data Analysis**

A grounded-theory approach (Glaser & Strauss, 1967) was utilized for data analysis because it is a rigorous method used to create understanding and to draw conclusions inductively from data through labeling and the constant comparison process. This method enabled the concepts found in the data to be clarified and the categories to emerge. It helped create an understanding based on the participants’ own descriptions of the challenges they encountered while accessing educational materials in Blackboard. Two researchers independently analyzed the interviews and labeled the emerging themes from the transcripts before agreeing upon the themes to report in this paper. One of the researchers is legally blind and uses Blackboard regularly. This personal experience also helped to add depth and insight to the study.

Close attention was paid to how blind students described their encounters while accessing educational materials from Blackboard and how their various adaptive software applications interfaced with design features of Blackboard. The researchers also examined how the participants emotionally responded to interruptions they experienced using Blackboard and the solutions they proposed to ensure their productive use of Blackboard. Finally, the researchers examined the extent to which the access to online materials, instructors and the other students helped the blind students to obtain their academic goals.

**Table 1. The participants in the study**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Education</th>
<th>Major</th>
<th>Years Blind</th>
<th>Adaptive software</th>
<th>Visual experience</th>
<th>On-Campus Blackboard</th>
<th>Braille proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jane</td>
<td>31</td>
<td>Female</td>
<td>Master</td>
<td>Info. Sci.</td>
<td>17 yrs (legally blind)</td>
<td>ZoomText, Magic &amp; Kurzweil 1000</td>
<td>1.5 yrs</td>
<td>8</td>
<td>poor</td>
</tr>
<tr>
<td>Mary</td>
<td>27</td>
<td>Female</td>
<td>College Soph.</td>
<td>Psych &amp; Amhr</td>
<td>5 yrs. (legally blind)</td>
<td>ZoomText, Victor Reader, Stalin &amp; Magic</td>
<td>1 yr</td>
<td>6</td>
<td>poor</td>
</tr>
<tr>
<td>Suzie</td>
<td>24</td>
<td>Female</td>
<td>College Jr.</td>
<td>Soc. Wk. Bio.</td>
<td>16 yrs. (legally blind)</td>
<td>ZoomText &amp; Magic</td>
<td>1.5 yrs</td>
<td>3</td>
<td>poor</td>
</tr>
<tr>
<td>Bob</td>
<td>24</td>
<td>Male</td>
<td>College Sr.</td>
<td>Pol. Sci. &amp; Hist.</td>
<td>24 yrs (since birth)</td>
<td>JAWS, Windows-Eyes</td>
<td>2.6 yrs</td>
<td>12</td>
<td>excellent</td>
</tr>
<tr>
<td>Linda</td>
<td>18</td>
<td>Female</td>
<td>Freshman</td>
<td>Educ.</td>
<td>18 yrs (since birth)</td>
<td>JAWS</td>
<td>4 months</td>
<td>3</td>
<td>excellent</td>
</tr>
</tbody>
</table>

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Findings and Discussions

Four primary themes emerged from the data analysis. These themes were labeled as follows: poor accessibility and usability of Blackboard, frustration and motivation, marginalization and optimism, and training and improvement of Blackboard design. In the qualitative research approach, the focus is to create understanding, through descriptive data, the holistic picture of a specific process by reinforcing emergent themes with experiences (voices) of the research participants (Creswell, 2003; Yin, 1984). Therefore, each of the four themes will be discussed in greater detail below with the participants' own voices. We expect that the quotations from the participants will strengthen the themes derived from the data.

Poor Accessibility and Usability of Blackboard

The first major theme that emerged from the data centered on participant's descriptions of the poor accessibility and usability of Blackboard when they used adaptive software to navigate and access the information they needed. The participants described failures to locate and process materials or information they need from virtual environments to solve their respective problems. When participants were asked to recall and describe their personal experiences accessing educational materials in Blackboard, their responses were not only spontaneous but remarkably similar. Among the participants, Bob was one who had the least problem accessing Blackboard:

I have had a good experience with the screen reader on Blackboard. It has not been a big problem. When I get a security warning, I simply close with All F4 and I easily log into the courses.

Yet, Bob quickly added:

...The navigation is haphazard because it is very visual and while the email feature is extremely accessible...the chats are problematic. They are JAVA based and do not interface well with JAWS. Web-based emails are difficult with JAWS. And another big issue I have with Blackboard is that I cannot send attachments. I have not found a button for one needed to send attachments of my essays to professors. The third problem is in my history class, linking to PDF files is impossible and very problematic because I cannot read PDFs on Blackboard and I cannot directly save a PDF document on Blackboard and that happens all the time and is very frustrating because it is time-wasting.

Bob was able to access Blackboard being the most experienced and effective user of JAWS software among the participants. However, he still encountered significant difficulties navigating and accessing materials in Blackboard. Most narratives from the other four participants clustered around poor accessibility and usability of Blackboard as major impediments in the realization of educational objectives. For example, Linda stated:

My professors put their notes and PowerPoint on Blackboard, yet JAWS does not read PowerPoint. I have to ask the Office of Disability Accommodation to download and reformat them for me in order to read them as word or rtf documents. ... The email feature on Blackboard is also confusing because of the many links that you have to go through to send an email. So, I gave up using it. When I want to communicate with my professor, I use the regular email. I also do not use the chat or discussion functions on the Blackboard because I tried and failed and thought it was not possible to access and use with JAWS. All these things have a negative impact on my performance in class.

Similar sentiments were echoed by Bob, Suzie and Mary, who use ZoomText and Magic to access educational materials on Blackboard. All three complained about the color schemes and other animations in Blackboard that their adaptive software cannot navigate. Many of
the color schemes and animation cause their software application to freeze. Mary stated:

_I cannot get to access or use the chat function with Zoom Text because of the color schemes... because I have to have a black background with white print in order to see it using Zoom Text. If I have it on those color schemes, the way the chat information comes up, literally you cannot see it with Zoom Text._

The above statements demonstrate the accessibility and usability difficulties experienced by blind students while attempting to obtain educational materials from Blackboard. The inability to access and use some of the features on Blackboard as highlighted in this study is consistent with observations by Gerber (2003), Craven and Brophy (2003), Irwin and Gerke (2004), and Salampasis, Kouroupetrogou, and Manitsaris (2005), who stated that while there has been a great improvement in universal access to technology, blind individuals still struggle with poorly designed computer interfaces that do not consider their visual impairments and their use of adaptive software that are still incapable of detecting some design features on the Internet to accomplish their computing tasks. Similarly, Leporini and Paterno (2004), Sloan, Gregor, Booth, and Gibson (2002), Zaparyniuk and Montgomery (2005), and Schmetzke (2000) observe that while poor and inaccessible Web designs cause unnecessary frustrations to all users of websites, blind and visually impaired students who cannot access large portions of information on academic websites that do not use the universal HTML format or comply with accessibility recommendations, are denied a basic human right to use their adaptive software to effectively interpret all the available information to enhance their educational goals. While it can be argued that ideal accessibility in a rapidly changing technological environment is a pie in the sky, the need to abide with universal HTML formats in Web designs is of top importance especially in academic programs to ensure universal accessibility and usability.

This finding also answers the first research question which sought to discover the effects of the design of Blackboard on the academic goals of blind college students. Poor usability of Blackboard is a significant drawback to the educational progress of blind students. This has far-reaching implications on the need to develop compatible interfaces that can enable blind students to access the educational materials. Doing so will help bridge the knowledge and digital gaps that exist between the blind and sighted students. Indeed, Kidney, Cummings, and Boehm (2007) proposed an eight-point rigorous and continuous quality assurance strategy to improve e-learning. The eight points included “reviews of instructional design, web development, editing, usability and accessibility, maintainability, copyright, infrastructure impact, and content and rigor” (Kidney, Cummings, & Boehm, 2007, p. 17). It would therefore be prudent for university administrators, software developers, and instructors to constantly monitor the impact of a CMS such as Blackboard on student academic performance with a view to improving their accessibility and usability. Simply posting educational materials on CMSs and assuming that they effectively facilitate teaching and learning for all students fails to respond to the rigor suggested by Kidney et al. (2007).

The poor accessibility and usability of Blackboard experienced by blind students indicated a strong link to frustration and loss of time. However, the students’ commitment to the pursuit and attainment of their academic goals motivated them to persevere and overcome their barriers.

**Frustration and Motivation**

The second theme emerged from the data was labeled frustration and motivation. While participants emphasized the extent to which frustrations during computing tasks resulted in loss of time and lag in academic progress, they demonstrated a high degree of perseverance and commitment to their respective goals. Responding to questions about how they reacted
to failure to access educational materials using their adaptive software, most participants stated that they would temporarily put off the task and later return to it or seek sighted assistance. While seeking sighted assistance is time-consuming and often detrimental to their academic progress, these learners remained highly motivated and committed to their ultimate goals. Mary stated that

*It causes me emotional stress, physical stress, and it causes me to lag behind and have to spend more time and effort on my academic goals than other students. When I fail to get what I need, I become exhausted and sometimes get moody. But I eventually regain my composure and move on. For example, one time I was kicked out of my timed test or quiz on Blackboard when the system went down. Blackboard support told me to wait an hour. I got a ticket, contacted my professor to re-open the test, and took another two hours to retake it. Something a sighted person would have done in 15 minutes. It was very frustrating and wasted a lot of my time and energy. But I never gave up.*

Jane stated:

*I always get frustrated and even fight back tears because I know I am losing time and lagging behind my fellow classmates. Despite the setback, I would never give up because I need to complete my education.*

Linda was equally illustrative:

*Every time I try and fail to get what I want, I get mixed up and when I try again, I get more frustrated and I end up asking ODA or some sighted individuals to help me. I can tell you, it sucks... I do not like it that much. It makes me lag behind in class......and by the time I get the material converted into accessible formats, time is gone......and definitely that affects my academic goals because I lose time to review my notes and yet want to do well and get a good grade, pass the class, and continue with my education.*

On standardized methods Suzie had this to add:

*Because every professor designs his or her class on Blackboard differently, it always takes me a lot of time to figure out how to access the material and by the time I do, my classmates are already ahead. But that is what all us blind people endure and it cannot be reason to give up.*

Bob reinforced the issue of frustration, but was also as definite on attaining the educational goal as the others:

*It has taught me that you cannot procrastinate. I always prepare and hope for the best and prepare for the worst. More often than not, it happens. It frustrates me but I have learned to manage the frustration. I experience it temporarily and move on. It is not my fault. It is a fault of technology, but I do not use it as an excuse not to do what I am supposed to do.*

The comments by these participants reflect varying degrees of efficacy with the use of their respective software to access educational materials on Blackboard. Furthermore, the statements show that while all the participants get frustrated and lose time because of the failure to access the materials they need, they eventually overcome the emotional setbacks and find ways to access the materials, because they are motivated to enhance and attain their academic goals.

Besse, Neuhagen, Robinson, and Shneiderman (2006) and Lazara, Jonesa, Hackleya, and Shneiderman (2006) state that while frustration in computing tasks is experienced by all users, inability to manage it can result into failure to access and use vital information that could transform the knowledge base of an individual. Thus, while the frustration encountered by blind students in their computing tasks and the subsequent loss of time are clear drawbacks in
their access to educational materials, they only delay them, but do not derail them completely as to give up their ultimate academic goals. The findings in the study are consistent with elements of the frustration and goal theories. While the interruption of a process towards the attainment of a goal or accomplishment of a task causes individuals to become frustrated, emotional, helpless, or moody (Freud, 1921; Amsel, 1992), experience, self-efficacy, and the importance of the goal to the individual are critical elements in the accomplishment of a given task (Campion & Lord, 1982). While concepts of the related frustration and goal theories have previously been extended to computing experiences of sighted individuals, research on computing encounters of blind individuals had until now overlooked emotional reactions of blind individuals in accomplishing their computing tasks.

Also noteworthy are the comments by Suzie who indicated that there is lack of standardization in the way professors design and present content on Blackboard, an observation that reinforces findings by Ling, Allison, Nicholl, Moodley, and Roberts (2007) who noted that instructors of blind students who use the Internet to access educational materials adopt ad hoc plans to respond to the special needs of students, because there is inadequate information exchanged between the two parties.

Marginalization and Optimism

The third theme from the data was a dichotomy of two opposing reactions to computing experiences by blind students. While all of them expressed that university administrations and technology designers marginalize their needs because they are minority users of technology, they also expressed optimism about some Blackboard features and the irreversible inclination towards CMS which have become essential instructional tools for reaching the majority of students.

Most participants expressed sentiments that reflected a sense of marginalization towards blind and disabled students by the university administrations and developers of learning technologies. Their statements tapped into the general societal stereotypes towards people with disabilities as insignificant minorities whose needs are usually overshadowed by those of the majority. Bob captured it in these words:

I guess it's not too much of a strange motivation. I grew up in a sighted world. And I know this is a sighted world... yeah, it is a lot harder... but I mean, the cold reality is life isn't fair. And it is worse for us blind people...

Mary stated:

... instead of looking at the problem of access and use of Blackboard from the perspective of what they need to do to accommodate blind students, it should be looked at as what needs to be done for students. I think that in many cases, the university will say for all students we provide a gym, but specifically put the stigmatization on blind students. It encourages the stereotype we have as a charity issue. The services should be provided as they should be provided not because the government commands them to accommodate blind students.... if Blackboard had a link that no student could access, it could be fixed immediately. It is a problem with the system. It is a technical and administrative problem that needs to be addressed.

The findings supported observations by Zaparyniak and Montgomery (2005) and Ling, Allison, Nicholl, Moodley, and Roberts (2007), who stated that although access to education and information especially through the ubiquitous World Wide Web is a fundamental human right to all, the ideal is yet to be realized even in civilized societies, because students with diverse disabilities continue to be discriminated against in the provision of e-learning. The findings also appear to support the notions of technological determinism (McLuhan, 2002), in that the medium is the message, when universities offer
online credit courses without being mindful of the special needs of the minorities such as the blind students.

On the other hand, the participants expressed a sense of optimism when they were able to use certain Blackboard features to find information they needed in their academic pursuits. Bob stated:

*I am happy with Blackboard because I can access the quizzes and my grades and do not have to wait for the professor to give them to me in class.*

Jane stated:

*With Zoom Text, I can download and read PDFs, PowerPoint, and even send emails to both my fellow students and professors. While it strains my eyes, I do it. I can even go to class in my pajamas!!*

Bob stated:

*The email features, discussion boards, and general navigation of the page with my software are relatively okay...and I think, online learning holds hope for both blind students and other disabled individuals who cannot commute to schools, but study from home. But a lot needs to be done to improve usability of other features.*

Mary remarked:

...with online learning on Blackboard, I am able to do things I want according to my schedule and do not have to be in a classroom all the time.

These statements indicate that despite the problems blind students encountered while accessing and using Blackboard, they recognized the positive attributes of online learning, a degree of pragmatism that previous studies on experiences of blind people in computing environments had not highlighted. At the same time, the data answers the second research question which sought to identify the features on Blackboard that help and those that impede the academic goals of the blind students. The data also supports some elements of the eighteen usability criteria by Leporini and Paterno (2004) who suggest that “satisfaction with a website is achieved when the site is more pleasant and easier to navigate” (p. 63).

**Training and Improvement of Blackboard Design**

The fourth theme derived from the data was labeled training and improvement of Blackboard design. Statements from participants that highlighted this theme coalesced around the need for educational institutions to provide some form of training to blind students on how to access and use Blackboard features in their academic pursuits, since the trend towards online learning and instruction is irreversible. At the same time, participants recommended some improvements in the technical design of Blackboard to make it more user friendly—universal accessibility and usability. Bob stated:

...there seems to be a lot of clutter on the Blackboard sites such things as “begin frame” “frame, frame end” and other things of that sort. What is visually pleasing does not always translate into practicality or functionality. So, I would recommend that all that clutter is removed from the site to make it more user friendly to all students including us the blind who use adaptive software to access materials from Blackboard. They should also use HTML formats instead of Java because Java is not compatible with most adaptive software.

Bob then added:

...the university should work on short term programs to help train students who have problems accessing and using Blackboard instead of thinking that all of us can use it. They should also provide tutorials on Blackboard...
to help some of us get the skills needed to navigate Blackboard. The Technology people who developed Blackboard should make it accessible to everybody instead of catering for sighted people only and ignore the blind and other disabled people. Maybe they should work with adaptive software developers and design websites that are compatible with the software we use. If I also had more training on JAWS, I could probably do better on Blackboard.

The above remarks are representative of all the participants who recommended training to students who need help to access Blackboard because some might hear the word "Blackboard" for the first time and might never have accessed or used the virtual environment. At the same time, the statements by the participants indicate that university administrators, adaptive software developers, and designers of Blackboard or other CMSs should work jointly in developing compatible interfaces that ensure universal access and usability to bridge the gap that could be perpetuated by failure of sections of students to access materials they need to achieve their academic goals.

To overcome accessibility and usability difficulties experienced by blind and visually impaired individuals, Salampasis, Kouropetrouoglou, and Manitsaris (2005) recommended that accessible web designs be adopted by designers to include enhanced annotations, short cuts, and cross walks. The researchers also recommended that software developers work jointly with web designers to create new interfaces that are interoperable with enhanced semantic browsers and voice recognition software to enable blind individuals to independently navigate web pages. Craven and Brophy (2003), Irwin and Gerke (2004), Salampasis, Kouropetrouoglou, and Manitsaris (2005) concluded that good interface usability could prevent frustration and loss of time encountered by blind individuals attempting to access information on the Internet. Leporini and Paterno (2004) suggested eighteen criteria that would improve navigability of websites for blind and visually impaired individuals and classified them into three categories that emphasized logical and consistent organization of Web content. The three categories included 1) effectiveness criteria composed of applications that would enable users to overcome difficulties, find the information they seek, and accomplish their tasks and achieve their goals; 2) efficiency criteria that allows users to find the desired information more quickly; and 3) satisfaction criteria that helps to produce a Web site that is more pleasant and easier to navigate (Leporini & Paterno, 2004, pp. 59-63). Blind learners must maximize the time spent on finding the relevant information needed to accomplish a given computing task.

The recurring accessibility and usability issues and risks could be mitigated if an eight-point rigorous and continuous quality assurance strategy proposed by Kidney, Cummings, and Boehm (2007) were adopted. While the foregoing finding further demonstrates how blind students continue to encounter challenges in online learning, the data also fully answers the third research question which sought to identify features that could be added on Blackboard to improve its access and usability to help blind students achieve their academic goals.

CONCLUSION AND SIGNIFICANCE OF STUDY

This study examined the usability challenges and emotional reactions of five blind students in their attempts to access educational materials in Blackboard to fulfill their academic requirements. The study is limited in its scope. Future studies will include interviews with participants in diverse geographical settings and even quantitative data to explain, clarify, and test hypotheses between variables that characterize accessibility and usability of CMSs by blind college students in their academic goals. Future studies will also include interviews and document reviews of the university offices responsible for accessibility, which will greatly strengthen this work and extend the impact of the line of inquiry.
Limited as it is, however, the current case study provided insights and helps designers and teachers better understand the blind students' online learning experiences. The study revealed that Blackboard is poorly accessible to the blind students, which prevented great obstacles for the blind students to obtain their academic goals. The poor accessibility and usability were prevalent in important Blackboard features and functions, including, but not limited to, the following: 1) the chats were Java-based and unreadable by screen readers; 2) the attachments were not deliverable through Blackboard; 3) PDF files were difficult and almost impossible to link to, save, or read in Blackboard; 4) PowerPoint slides in Blackboard were not readable through JAWS; 5) Color schemes and animations were impossible to navigate in Blackboard even for users of Zoom Text software.

The data also showed that the blind students were motivated and optimistic about their academic success despite the frustrations and feeling of marginalization that they experienced in their academic processes. The study encourages university administrators, database designers, and adaptive software developers to work jointly in developing enhanced user interfaces that will ensure universal access and usability of Blackboard and minimize frustrations and the resultant educational inequities. It is important to realize that interface designs and interoperability of systems bear in mind the needs of diverse end-users of systems not only are matters of a technical nature, but also have access and usability policy implications. Findings of the study could also be used for application to other course management systems that use other virtual learning environments other than Blackboard to ensure some degree of standardization for universal accessibility and usability.

The major difference or advantage of this study is that it focused on college students' experience with one of the most popular course management systems (CMS)—Blackboard/WebCT Vista while most other accessibility and usability studies look at the Web in general.

Another important contribution of this study is that it connected the accessibility and usability of CMS to students' academic success using several theoretical frameworks including frustration theory, goal theory and media theory. While previous studies on computing experiences overlooked the emotional reactions of blind individuals, this case study provided insights into how blind students manage their computing frustrations and presented dimensions that have hitherto not been examined and highlighted. Finally, findings of this study are helpful as a first step in understanding computing experiences of other people with disabilities and other sections of the struggling Web-based learning populations.

REFERENCES


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