Monitoring for Accessibility and University Websites: Meeting the Needs of People with Disabilities

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Abstract

Under the Americans with Disabilities Act (ADA), people with disabilities are guaranteed access to all postsecondary programs and services. The purpose of this study, conducted by the Center for Excellence in Disabilities, was to evaluate the current status of a major university's web accessibility. The results indicated that in 2011 only 51% of 509 web pages (sample) at a large public university in the northeastern United States passed automated web accessibility tests with Cynthia Says for Section 508 compliance (WCAG 1.0). Only 35% passed using the WAVE Accessibility Tool for the Web Content Accessibility Guidelines (WCAG 2.0 Level A) Priority 1 compliance, which is a more rigorous evaluation level. The stricter the level of testing, the more university web pages failed. Stricter web accessibility requirements may be legally imposed instead of Section 508 in the future. Universities will succeed in meeting an important mandate of the ADA by making institutional websites accessible to current and future students and employees with disabilities.

Keywords: Web accessibility, web usability, equal access, disability, higher education

People with disabilities (i.e., physical or mental conditions that cause functional limitations that substantially limit one or more major life activity, including mobility, seeing, hearing, speaking, and learning) may have difficulties browsing the Internet because they use assistive technology such as screen readers (software that reads text aloud), refreshable Braille displays (devices that convert the text to Braille), and screen magnifiers needed to interpret website content. Users who are blind or have low vision use keyboards to navigate, sort through lists, and select links. These types of disabilities impact the ability to use the web.

The 1990 Americans with Disabilities Act (ADA) requires federally funded institutions to provide accommodations, and thus equal access, for students with disabilities. Since the ADA, additional legislation has been passed concerning accommodations for students with disabilities. In 1998, the U.S. Congress amended the Rehabilitation Act of 1973. According to Section 508 of the Rehabilitation Act, federal agencies are required to make their electronic and information technology accessible to all people including those with disabilities (Section 508, n.d.).

Section 508 of the Rehabilitation Act is relevant for federally funded organizations; however, the matter of website inaccessibility has resulted in lawsuits against some private agencies and businesses. Such companies as America Online (AOL), Barnes and Noble, Inc., Claire's stores, Metropolitan Atlanta Rapid Transport Authority (MARTA), Priceline.com, Ramada.com, Southwest Airlines, and Target Corporation have been sued for failing to make their websites accessible to those with disabilities (Parmanto & Hackett, 2011). The 2006 Target vs. the National Federation of the Blind (NFB) litigation about the corporate social responsibility and website accessibility may have prompted other companies and organizations to improve the accessibility of their websites (Frank, 2008; Ogden & Menter, 2009).

"One organization that seeks to move Internet technology beyond basic Section 508 compliance is the Web Accessibility Initiative (WAI) of the World Wide Web Consortium" (Vandenbark, 2010, p. 25). The World Wide Web Consortium (W3C) does not have any legal jurisdiction over higher education institutions. Rather, the W3C is the international oversight body for protocols and operations of the Internet. According to

the W3C (2007), web accessibility means that people with disabilities can perceive, understand, navigate, interact with and contribute to the Web. W3C released the Web Content Accessibility Guidelines (WCAG) or recommendations for making Web content more accessible (W3C, 2008). Web Content Accessibility Guidelines (WCAG) 1.0 version was developed in 1999. "Section 508's web standards comply with W3C's Web Content Accessibility Guidelines (WCAG) 1.0; stricter compliance is optional" (Fulton, 2011, p. 35).

There are three levels of web accessibility, according to WCAG 2.0 version; each level has a set of checkpoints. The three levels for conforming for WCAG 2.0 are Level A, Level AA, and Level AAA. In this article, the levels are labeled "priorities." The word "priority" is not listed on WCAG specifications. Therefore, in this article, what is listed as Priority 1 is WCAG 2.0 A, and Priority 2 is WCAG 2.0 AA, and Priority 3 is WCAG 2.0 AAA (http://www.w3.org/TR/UNDERSTANDING-WCAG20/conformance.html). The W3C provides that Priority 1 guidelines *must* be satisfied; Priority 2 guidelines *should* be satisfied; and Priority 3 guidelines *may* be satisfied. To be considered minimally accessible, a web page must satisfy all Priority 1 checkpoints. Verifying a site's accessibility can be a time-consuming task. However, there are a number of free accessibility tools such as the automated accessibility evaluators for scanning a set of web pages and automatically evaluating their compliance with WCAG.

WebXACT was once referred to as "Bobby." This free online service tests single pages of web content for accessibility based on WCAG Priority 1, 2, 3 and also Section 508 compliance standards. Research conducted by Floyd and Santiago (2007) using WebXACT showed that higher education institutions were more likely to be compliant at the Priority 1 level, yet only reaching closer to 50%.

Problem Statement

People with disabilities are guaranteed access to all postsecondary programs and services under the Americans with Disabilities Act (WebAIM, 2007). Online programs and services should be easily accessible to students with disabilities. If university websites are inaccessible, people with disabilities do not have the equal access they are guaranteed by law.

Purpose Statement

The authors' university was selected for this study because the Center for Excellence in Disabilities was selected to conduct a research project that was grant-funded by the Higher Education Access: A Universal Design Demonstration Project, Office of Postsecondary Education, U.S. Department of Education. The purpose of this study was to evaluate a large public university's websites accessibility for students and other users with disabilities. The research will be used as a guide for future improvement in website accessibility. The intent was to start offering university-wide trainings on making web pages and online materials accessible and providing instructors and administrators with current information about ADA requirements. By assessing the accessibility of online materials now, universities may avoid legal problems in the future and possibly recruit more students with disabilities.

Research Questions

This study investigated three research questions. The first research question (RQ 1) was: What percentage of the sample of this university's websites would pass automated web accessibility tests with web-based evaluation tools such as Cynthia Says for Section 508 compliance and WAVE for WCAG Priority 1? The second research question (RQ 2) was: What accessibility issues do university websites currently face? The third research question (RQ 3) was: What recommendations can be offered in order to improve accessibility?

Literature Review

Legal Requirement and Laws

Access to the web is important to students and university employees. Equal access to public information resources such as the Internet is a central precept of American democracy (Davis, 2003). People with disabilities are locked out of full participation in their educational experiences due to numerous inaccessibility issues (Parry & Brainard, 2010).

Section 255 of the Telecommunications Act (February 8, 1996) established accessibility requirements and services applying to the design and manufacture of telecommunications equipment (e.g., the telephone and the television). It also concerns delivery of telecommunications services (47 U.S.C.A. § 225).

Section 504 of the Rehabilitation Act (1973) applied to the federal government and all entities receiv-

ing federal funds. Section 504 specifies:

> No otherwise qualified individual with a disability in the United States . . . shall, solely by reason of her or his disability, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance (29 U.S.C.A. § 794).

Section 508 of the Rehabilitation Act Amendments, originally passed as part of the Workforce Investment Act of 1998, addressed the accessibility problems of federal employees and other individuals with disabilities (Center for Excellence in Disabilities, 2011; Jaeger, 2003; Ogden & Menter, 2009). Accordingly, "…government agencies procuring electronic and information technology products and services are required under federal law to award contracts to those companies who develop products and services that comply with government accessibility standards" (Thomas & Bhargava, 2011, p. 5). If a state gives money to private schools, it can require compliance with Section 508 to receive such funds. Section 508 applies to state universities and colleges in those states that passed Section 508-type statutes (Golden, 2008).

The ADA (1990) was passed to mandate equal access for individuals with disabilities in situations not covered by Section 504 of the Rehabilitation Act, such as state governments, local governments, and private businesses. The ADA prohibits discrimination against persons with disabilities by various private and public institutions, stating that "no qualified individual with a disability shall . . . be excluded from participation in or be denied the benefits of the services, programs, or activities of a public entity" (42 U.S.C.A. § 12132). When it was passed in 1990, the ADA did not directly address issues related to the World Wide Web, as cyberspace is not a physical place. The ADA, nonetheless, has applications to websites maintained by federal, state, and local governments that are required to equally include individuals with disabilities in all services, programs, or activities of public nature.

What constitutes a "place of public accommodation" needs to be mentioned in the context of website accessibility litigation. The term "public accommodation" could be extended to virtual spaces. This same concept of a public accommodation not having to be a physical location was also at issue in litigations stating that a website could qualify as a public accommodation.

Lawsuits. Some website accessibility-relevant lawsuits have involved higher education institutions. Key examples begin with a lawsuit against San Jose State in the mid 1990s. San Jose State University faced a lawsuit in September of 1995 (Krach, 2007). It was filed with the United States Department of Education, Office for Civil Rights (OCR). A student who had a vision impairment complained of difficulty with converting images into speech. The case was closed after the university agreed to implement a voluntary resolution plan (Clayton, 1998).

In September of 1997, California State University in Los Angeles dealt with a similar complaint (Krach, 2007). The complaint was filed with the OCR. California State University made voluntary agreements to resolve the accessibility issue (Krach, 2007). The OCR stated that websites should be accessible to all students, including those with disabilities.

In February of 2009, the NFB, with more than 50,000 members joined with a blind law applicant to sue the Law School Admissions Council (LSAC) over its website inaccessibility. The defendant chose to litigate (Qualters, 2009). Additional law schools were added to the defendant's side because they hosted their application materials on the LSAC website: The University of California Hastings College of the Law, Thomas Jefferson School of Law, Whittier Law School, and Chapman University School of Law (County of Alameda's Superior Court of California, 2010, case number RG09436691). According to Disability Rights Advocates (2013):

> As a result of a settlement reached in 2011, LSAC has made its entire website fully accessible to blind law school applicants who use screen reader software. In addition, law school applicants with learning and mobility disabilities who rely on screen reader software will also benefit from LSAC's agreement to add accessibility to its website.

In November 2010, the NFB filed a complaint with the United States Department of Education, OCR, accusing Pennsylvania State University of violating the civil rights of blind students, employees, and faculty members. The university's course management software and websites, with the library catalog, the banking site, an ATM, and the website for the Office of Disability Services, were found to be inaccessible (NFB, 2010). In October of 2011, the NFB and Penn State reached an

agreement to resolve this complaint in the future. There was no admission of any wrongdoing (NFB, 2011).

In July 2013, the U.S. Department of Justice published an announcement that it had reached a settlement with Louisiana Tech University and the University of Louisiana System vis-à-vis violations of the ADA. This lawsuit was successfully won against higher education institutions concerning web accessibility. The University violated the ADA by using online learning course materials inaccessible to a blind student. Under the settlement agreement, the university agreed to pay a blind student $23,500 in damages. The university agreed to make university web pages and course content accessible to individuals with disabilities following the WCAG 2.0 Level AA standard. The university also agreed to make existing web pages and materials created since 2010 accessible and train its instructors and administrators on the requirements of the ADA (U.S. Department of Justice, 2013).

Current Accessibility Need in Society

People who have physical, cognitive, and/or sensory disabilities benefit from using accessible websites. Other groups of peoples need accessible websites as well, including aging populations and special populations such as returning veterans. The most common disabilities affecting website accessibility are visual and hearing impairments. In addition, difficulty grasping objects affects the use of a mouse, which creates additional access issues related to using computer hardware.

Numerous statistics present large numbers for the rate of disability in the United States. According to the U.S. Census Bureau (2012), 57 million individuals (18.7% of all U.S. residents in 2010) were individuals with disabilities; an estimated 38.3 million (12.6%) of these individuals had a severe disability. The estimates of people with specific impairments that impact website accessibility are as follows: 8% had difficulty lifting or grasping, 6% had a cognitive, mental, or emotional impairment, 3% had vision impairments, and 3% had a hearing impairment. It should be noted that the magnitude of the disability can be overstated because the Census relies on self-selection or self-identification.

According to the U.S. Department of Education, 88% of the estimated 4,170 degree-granting postsecondary institutions (2-year and 4-year, public, private not-for-profit, and private for-profit) participating in Title IV federal student financial aid programs reported enrolling students with disabilities in the 2008-2009 academic year (see Raue & Lewis, 2011). In the 2007-2008 academic year, there were 20,928,000 undergraduate students enrolled in the U.S. postsecondary institutions. Of this group, 2,266,000 (10.8%) had disabilities and of the 3,456,000 graduate students counted that year, 261,000 (7.6%) had disabilities (U.S. Department of Education, National Center for Education Statistics, 2009). How many have disabilities that impact their use of the web? According to Rowland, Mariger, Siegel, and Whiting (2010), "for the 8.5 percent of the U.S. population who have at least one disability that affects computer and Internet use, inaccessible websites can inhibit or severely restrict their participation in higher education" (p. 20).

Accessible Web as an Accommodation for People with Disabilities

For various types of disabilities, audio and/or visual information should be presented in an alternative format. Complex language presents serious difficulty for people with cognitive disabilities or limited language skills. Websites that use sudden, flashing images could trigger symptoms for those with seizure disorders (Golden, 2008). The following examples may help to clarify the types of obstacles that can be encountered by an individual with a disability.

Audio material. An instructor has recorded lesson information in his voice and made this recording available to students on the web as an audio file. This is an example of an obstacle for any student who is hard of hearing or deaf, as the audio file cannot be heard.

Visual material. The same teacher also placed photographs or images on the web page. The high quality photographs visually convey new information for the lesson. These photographs are an example of an obstacle for students who are blind or visually impaired. They are unable to see the image and, therefore, unable to interpret its meaning.

Language complexity. If the content displayed on the web page is written in unnecessarily complicated language – including the use of technical terms, special phrases and rare words -- comprehension obstacles can be faced by all users, including people with learning disabilities or limited language skills. Language complexity is also frequently an issue for the deaf and hard of hearing population.

Material navigated with/without a mouse. When a webmaster designed an aesthetically pleasing image map in a form of a graphic, a visual user can see that

this graphic has five distinct regions that are each entitled with the name of a territory. When the user places the mouse on a region of the graphic, text is displayed to the right of the graphic that provides details of this area. Likewise, when the mouse is moved to a different region of the graphic, the text changes to represent the territory to which the mouse has been moved. These distinctly different regions are not described anywhere else on the web page and the descriptions can be accessed only through correct placement of the mouse. This graphic represents an obstacle for a user who cannot use the mouse but relies on the use of a mouth wand to press keys on the keyboard.

Accessibility Empirical Research Studies

The general purpose of testing websites is to address their usability. Usability is a combination of factors that impacts the quality of a user's experience when interacting with a website. Such factors include: (a) ease of learning (i.e., how fast a user who has never seen the user interface before can learn it to accomplish basic tasks); (b) efficiency of use (i.e., how fast a user can accomplish tasks, having experienced the system); (c) memorability (i.e., how easy a website is to remember in order to use effectively for a user who returned after a time-lapse between visits); (d) error frequency and severity (i.e., how often users make errors while using the system, how serious these errors are, and recovery mechanism from these errors); and (e) subjective satisfaction (i.e., the extent to which the user likes using the system).

Making a website accessible is believed to be a design practice rather than an application of highly developed technologies. A decade ago, it was estimated that only 1% of web developers took into account accessibility for uses with disabilities when designing web pages (Carter & Markel, 2001).

Hackett, Parmanto, and Zeng (2005) compared a random sample of general websites with a convenience sample of U.S. government websites over a five-year period (1997-2002). They reported that, despite increasing complexity, U.S. government websites remained accessible, which was not the case for other websites.

Loiacono (2004) tested the accessibility of the home pages of 96 nonprofit organizations. The results showed that more than 87% of those home pages had severe barriers. After examining 50 websites and making comparison of the results obtained for the same 50 in 2002 and 2003, Lazar and Greenidge (2006) pointed out the decreasing accessibility tendency over time.

A number of empirical studies examined school websites for accessibility issues. These studies were conducted in order to test accessibility of web pages in postsecondary institutions such as colleges and/or universities (e.g., Erickson, Trerise, VanLooy, Lee, & Bruyere, 2009; Floyd, & Santiago, 2007; Flowers, Bray, & Algozzine, 2001; Krach, 2007; Rowland & Smith, 1999; Thompson, Burgstahler, & Moore, 2010) and secondary schools (e.g., Bray, Pugalee, Flowers, & Algozzine, 2007; Klein, Myhill, Hansen, Asby, Michaelson, & Blanck, 2003).

Rowland and Smith (1999) analyzed a random sample of the home pages of 400 higher education institutions within the Unites States. Only 22% of these sites were free from accessibility errors. Having conducted a longitudinal investigation of higher education websites over a 5-year timeframe, researchers concluded that the websites of postsecondary institutions had a tendency to become increasingly complex and inaccessible over time (Hackett & Parmento, 2005).

Kane, Shulman, Shockley, and Ladner (2007) used a multi-method design to evaluate the accessibility of 100 top international university web pages. They used automated evaluation tools (e.g., Bobby and Cynthia Says) and manual tests to measure compliance with accessibility standards and image accessibility. Of the 100 sites tested, 36 had no Priority 1 errors in evaluation tool and only 2 passed Priority 1, 2, and 3. Bobby found 2.65 more errors per site than Cynthia Says (Kane, et al., 2007).

Floyd and Santiago (2007) used a random sample of 60 U.S. public institutions of higher education from Alaska/Hawaii, Southwest, West, Midwest, Northeast, and Southeast. The researchers did not find a significant statistical relationship between the size of an institution and its level of compliance, although they initially thought that the larger institutions would be more likely to be compliant than smaller schools. Overall, the majority of the sample failed to provide even minimal accessibility requirements outlined by Section 508 and the WCAG standards.

Similarly, Kane et al. (2007) did not find a strong link between university reputation and website accessibility, nor did they establish any statistically significant difference in the number of accessibility errors between the U.S. private and public universities. Thompson, Burgstahler, and Moore (2010) analyzed the accessibility of home pages of 127 higher education websites. The testing was done three times within 6 months in

Table 1

Type of Potential Accessibility Errors, Priority of Error, and Ease of Fixing Error

Type of accessibility error	Priority	Ease of fixing
Alt text is not used for each region of an image map	1	Easy
For tables not used for layout (e.g., spreadsheet), identify headers for table rows and columns	1	Easy
If color is used to convey information, ensure information is also provided in another way	1	Moderate
Did not provide alt text for images that convey content	1	Easy
Did not provide label tags for form fields	1	Moderate
Live regions are not specified with appropriate WAI-ARIA attributes	3	Hard
Page does not have logical heading structure	1	Moderate
Programmatic objects should not cause screen to flicker	1	Hard
Did not ensure that background and foreground colors contrast sufficiently	2	Easy
Did not provide descriptive titles for links	2	Easy
Did not provide abbreviations for long row or column labels	3	Easy
Used absolute (pixels) rather than relative sizing and positioning (% values).	2	Moderate
When scripts created pop-up windows or changed the active window, page did not ensure that user was aware that this was happening	2	Moderate
Used deprecated language features	2	Moderate
Did not identify language of text	3	Moderate
Did not specify logical tab order among form controls, links, and objects	3	Moderate
Did not provide keyboard shortcuts to frequently used links	3	Moderate
Did not provide summary and caption for tables	3	Moderate
Did not group related links	3	Moderate
Used tables to format text documents in columns	2	Hard
Did not provide linear text alternative for tables that laid out content in parallel word-wrapped columns	3	Hard

Note. Table adapted from Flowers, C., Bray, M., & Algozzine, R. (2001). Content accessibility of community college websites. *Community College Journal of Research and Practice, 25*(7), 475-485.

2004-2005 and again in 2009. The authors found that the keyboard accessibility was the area of decline.

Table 1 shows the complexity levels of some accessibility errors. It also shows how easy it is to address their repairs.

The review of literature demonstrates a growing need for addressing the current problem of web accessibility. Many university websites are not designed with equal access for all users in mind (Bradbard & Peters, 2010; Bradbard, Peters, & Caneva, 2010). It is highly desirable that institutions of higher learning make greater efforts to ensure that the students with disabilities have equal access to its websites.

Method

Sample Selection

The most useful method for measuring website accessibility is content analysis. The unit of measure for this research were the web page links provided on the university A-Z index. It is an alphabetical listing of sites housed within the university domain. Many are official sites of the university; others are related. In order to avoid potential sample selection bias, a sample of convenience was chosen that consisted of the entire A to Z list at the outset. This list consists of web pages with links described with different key words. Because the same webpage can be described with different key words or a combination of key words depending on their first word in alphabetical order, the list represents not-mutually exclusive items. For example, one and the same link can be listed under Numbers such as "20/20 plan" in the beginning of the list and under the letter P, such as "plan, 20/20" closer to the end of the A to Z list. Therefore, repetitions can be identified and eliminated after clicking on every hot text linked to web pages and entering the URL addresses of the entire A to Z list into Excel spreadsheets.

The original list consisted of 1,130 working links. After deletion of irrelevant links (i.e., commercial sites with .com or other organizations such as sports.net), the sample included 520 mutually exclusive URLs. After elimination of irrelevant links that were initially overlooked (i.e., non-affiliated with the university), our ultimate sample for further analysis was finalized (N=509).

Instrument

Automated analyses were performed using web-based evaluation tools, which validate one page at a time (i.e., HiSoftware's Cynthia Says used in testing for Section 508 compliance and WAVE developed by WebAIM in testing for WCAG Priority 1). The URL for each web page (e.g., http://www.w.edu) was entered into a required field and submitted for validation.

WAVE is a free web accessibility checker that examines a page for accessibility errors and provides feedback by color coded "flags" as triage for accessibility problems found on a web page. The HiSoftware's Cynthia Says is a free web accessibility checker that performs testing about one page per minute/per site. It is possible to select the level of content testing related to Section 508 standards and/or the WCAG guidelines Priority 1, Priority 1, 2, and Priority 1, 2, 3, for example. Priority 2 and 3 are relevant for dynamic web content and applications.

Procedures

Data collection and analysis took place in September, 2011. The hyperlinks were placed into an Excel spreadsheet. In one column there were hyperlinks and in the next column there were web addresses corresponding to hyperlinks. All web addresses were checked against duplicates, which were deleted consequently.

Using free online automated checking is a first step in the process of accessibility evaluation in order to gain insight into what issues web page(s) might contain. Online automated evaluation tool WAVE developed by WebAIM was used for testing the sample of 509 university web pages on September 13, 2011. If there were no violations (errors), the webpage passed the test. If the page had errors, it failed automated testing. The list then was sorted into three sections: one represented "P" (i.e., passed), the second and the third sections represented those web pages that got "F" (i.e., failed) because they had accessibility violations (errors). Depending on the type of errors and their number, those failed pages were placed either into a section signifying one specific common type and single number of errors or into a section representing a variety of errors that were ranging from two to 28. The URLs were sorted from lowest number of errors to highest number of errors. The failed pages were reviewed again in order to identify and document the commonalities and differences in types of errors.

The same process was used for testing all 509 web

pages on the list again with Cynthia Says for Section 508 compliance check on September 27, 2011. This time, the three sections of the entire list of 509 entries were sorted out and split into six sections (for those web pages that passed Section 508 compliance and for those that failed Section 508 compliance, depending on whether "p" for passed or "f" for failed occurred in each of the original three sections).

Random manual evaluation by a professional technologist was performed for those web pages that failed automated evaluation. This professional technologist reported the severity of the issues and how much expertise would be required to correct the problems. Testing for Section 508 compliance was done because it is a legal federal requirement and testing with WAVE by WebAIM was performed at the level of WCAG Priority 1 because it is the level designers must assure.

Results

Our first research question was, "What percentage of the sample of university websites would pass automated web accessibility tests with web-based evaluation tools such as Cynthia Says for Section 508 compliance and WAVE for WCAG Priority 1?" The results indicated that 51% of 509 university webpages (sample) passed automated web accessibility tests with Cynthia Says for Section 508 compliance and 35% passed using WAVE for WCAG Priority 1 compliance, which is a more rigorous evaluation level (Table 2). So, the stricter the level of testing applied, the greater the number of university pages that failed. This note is of particular importance given that stricter web accessibility requirements may be legally imposed instead of Section 508 in the future. As Nakata (2012) noted:

> The first change is that the United States Access Board has started updating the Federal version of Section 508 standards. While these standards are unlikely to be finalized until late 2013 or even 2014, current drafts clearly show that the Federal Government is moving toward WCAG 2.0 level AA as the basic standard to Web accessibility (p. 5).

The second research question was, "What accessibility issues do the university websites currently face?" The most common errors were "Form label missing," "Alt-tag" missing, empty links, improper heading structure, and issues with the footer. Many websites with high traffic were found to be accessible. The examples included the following: Admissions Portal, Admissions, Administration and Finance Business Office, Biometric Systems, Building Key for University Buildings, Department for University Events, Employment Portal, Payroll, Tax and Employee Data Services, Scholarship Portal, Faculty Senate, Grievance Procedure, Student Organization Services, and President. Some university centers and academic departments were included into the list of organizations with accessible websites. The examples were the Center for Excellence in Disabilities, Job Accommodation Network, and Department of Statistics.

The third research question was, "What recommendations can be offered in order to improve accessibility?"The university established a web accessibility group in the spring of 2011. Different levels of developer can check the institutional web pages

Table 2

The Percent of 509 University Web Pages (Sample) Passed Automated Web Accessibility Tests

	WAVE for WCAG Priority 1 compliance	Cynthia Says for Section 508 compliance
Passed	35%	51%
Failed	65%	49%

for accessibility. There are "Content Managers" who have little to no web development experience and "Developers" who have programming expertise. The issues involving alternate text and color can be solved by a Content Manager. The label, heading, and issues solved with Cascading Style Sheets (CSS) require a developer's attention. The amount of money needed for fixing these problems can be calculated on the basis of actual time involved. The amount of time a developer takes to solve a problem is dependent on his or her skill set. Heading structure may be difficult to solve because new CSS and possibly a new page structure must be written to preserve the page design.

We recommend further testing to be done by the professional technologists beyond the testing that we have done. This can be done using the automated web validators we used (Cynthia Says and WAVE) or other validators.

Discussion

Study Limitations

Web pages used in the manual tests were not downloaded by the research team and analyzed offline in order to eliminate the possibility of pages changing during analysis. It was not possible for practical reasons. WAVE and Cynthia may underestimate or overestimate the number of accessibility errors on a web page. Bobby was found to overstate 2.6 percent of the problems and did not detect 0.05 percent of errors (cited in Krach, 2007, p. 33). We did not have this type of information for WAVE and Cynthia Says. Priority 2 and 3 are great contributions to a" must comply" set of rules. Additional testing for Priority 2 and 3 was not attempted because those priorities are relevant for dynamic web content applications.

Evaluating Website Accessibility

Accessibility testing involving persons with disabilities is a desirable way to determine whether websites are accessible. However, relying only on those evaluations are not quite advisable. The reason is that not all problems can be detected only by those users because if something is inaccessible, users with disabilities may not discover it because it is inaccessible. Manual testing by a group of professionals (e. g., web developers, webmasters, and content managers) is necessary in combination with using multiple automated validation tools for accessibility. For example, there are such online tools as WAVE (http://wave.webaim.org/), TAW(http://tawdis.net/index.html), or Cynthia Says (http://www.cynthiasays.com/).

Yet, there are some limitations of these automated accessibility-check tools. Tools such as the two used in this study will pick out, with a fair degree of accuracy, the defined accessibility flaws in a web page. However, there is a great deal about accessibility that has not yet been fully captured in the definitions that these tools use. Even a web page that scores relatively high with one of these tools may nonetheless have significant usability flaws from the perspective of, for example, a blind user (i.e., a page may be technically accessible but poorly organized for a blind person who cannot view the gestalt of a page and spot what he or she is looking for). For an overview such as this study, the automated tools are a reasonable place to start; just bear in mind what such tools cannot do.

Automated testing tools are designed to test the logical order of HTML elements and the inclusion of accessibility technologies such as WAI-ARIA roles and alt attributes in images. However, they cannot check for the usability of the layout or the simplicity in which the material is presented. They also cannot check for proper use of WAI-ARIA roles or the clarity of alternate text. For example, a developer can use an "alert" WAI-ARIA role to interrupt a screen reader to notify a state change of a web application, but it may or may not make sense to cue the interruption at the time. Similarly, the developer may add alternate text to an image that is repetitive to a heading or annotation directly below the image. This is improper use of alternate text. A human accessibility specialist can examine the layout of the web pages, use a screen reader and a keyboard to test for appropriate WAI-ARIA roles, and read through the values of alt attributes in images for clarity. Manual Checklists are presented by WebAIM (http://webaim.org/standards/wcag/checklist).

It is recommended to first review the most important or frequently viewed web pages including the home page, admissions page, college directory of offices and departments, course registration process, class schedule, and disability services pages (Cornell University, the Employment and Disability Institute, 2011).

Brajnik, Yesilada, and Harper (2011) studied the effect of expertise in web accessibility evaluation methods with 19 expert and 57 non-expert judges. A Barrier Walkthrough (BW) evaluation method was used

to manually assess the accessibility of web pages for different users with disabilities (e.g., motor-impaired, low vision, blind, and mobile). They discovered that when pages were evaluated with non-experts, a drop in validity and reliability occurred. After five experts evaluated the web pages, reproducibility stabilized, but this was not true for non-experts. "The ability to detect all the problems increases with the number of judges: With 3 experts all problems can be found, but for such a level 14 non-experts are needed" (p. 242). Although the experts in this study rated pages differently, the difference was small. Less time was needed for the experts to find problems and the variability among them was smaller. Their self-ratings were more productive and more confident. Thus, the level of expertise in web accessibility evaluation matters a great deal.

Consider someone with vision problems. Web accessibility is especially important since blind people have much more difficulty browsing the web in comparison to sighted people (Brunsman-Johnson, Narayanan, Shebilske, Alakke, & Narakesari, 2011) and people with other types of disabilities (Federici, et al., 2005; Lazar & Jeagar, 2011). Important images should not be used as backgrounds because screen readers cannot read backgrounds. Screen readers can only read text typically from top-left to bottom-right corner. They cannot interpret images, animations, movies, navigational buttons, as well as some portable document formats (PDF) and may have difficulties with reading layout tables and charts (Crow, 2008). Therefore, images should be described indicating their purpose and not appearance (ALT-tags). Non-textual elements on the web page should be with text-only alternatives. A significant image is intended to convey content, while an insignificant image is used for page decoration or spacing. To allow screen readers to skip the image if that image has no meaning (e.g., bullet), a null ALT attribute should be assigned as ATL="" (quote quote without any space between the quotes). If the alternative text is omitted, the file name of the image could become for the screen reader what to read, continuing to be confusing the user. The ALT-tag of an image should not be repeated in the adjacent text.

At times, an image is too complex to be described in a few words in an alt attribute (e.g., charts and graphs). Perhaps the description is more than 125 characters, for example. In that case a long description is needed. A long description for images can be provided with (1) a long description in the context of the document itself, (2) a link to a long description via a normal text link, (3) a link to a long description via the longdesc attribute, and (4) a link to a long description via a "d" link (http://webaim.org/techniques/images/longdesc).

The longdesc attribute is deprecated as of HTML5 against the recommendation of the Web Accessibility Initiative. In time, the use of this attribute may fail automated tests and may become entirely unusable as modern browsers cease to support its use. Moving forward, a paragraph or accessible pop up with text conveying the function of the image with relative placement is recommended in lieu of using the longdesc attribute.

Screen readers are dependent on proper heading levels (heading 1, heading 2, heading 3, body text, etc.) for navigation. Each page should have some option to pass over the navigation section using a "skip navigation" link (Crow, 2008).

The best way to ensure keyboard navigation is to have a logical and consistent navigation and page structure consisting of semantic mark-up. If design calls for the user to step outside of the page structure with a pop up window or dynamic content change, the screen reader user needs to be notified prior to the change with a text note or another method. If screen reader only content is needed, and screen space is a concern, it should be rendered off screen and not hidden with CSS.

Some Portable Document Format (PDF) files have to be edited in order to be accessible (Fichten et al., 2009). PDFs can be made accessible in Adobe Acrobat Pro.™ Similar to a web page, you can specify the language the document, (e.g., English, Spanish, Chinese), alternate text for images, heading structure, and reading order (e.g., first column followed by the second column). PDFs of scanned documents, however, cannot be made accessible as each page scanned is designated as an image with no text recognition.

People with low vision can use screen readers such as Job Access with Speech (JAWS), available from http://www.freedomscientific.com/products/fs/jaws-product-page.asp or Window Eyes (i.e., a screen reader for Microsoft Windows). In order to learn how a screen reader for a person with vision loss would orally present the text of a website, developers can use a Firefox plug-ins such as Fangs Screen Reader Emulator (https://addons.mozilla.org/en-US/firefox/addon/fangs-screen-reader-emulator/).

Consider someone with color blindness and low vision. For individuals who have color blindness or color vision deficiency (CVD), known as "Daltonism," it is difficult to differentiate between some colors and

shades (e. g., reds, greens, blues, and yellows). Very few individuals with this type of vision problems are able to name the colors of a weather radar display correctly (Mertens & Milburn, 1996). About 8% of men and 1% of women are affected (eyePilot, 2006). There should be other ways to convey information without reliance on color alone to signify meaning. The Section 508 states, "Color coding shall not be used as the only means of conveying information, indicating an action, prompting a response, or distinguishing a visual element" (U.S. Patent and Trademark Office, Section 508 Reference Guide, 2007, 1194.25(g)). Some programs (e.g., eyePilot or Visolve) can increase the contrast between confusing colors. To see colors on screen as people with color vision impairments see them, Color Oracle software can be used by designers freely from http://colororacle.org (Bernhard & Kelso, 2007). The color contrast between the background and the foreground with text should be sharp and distinct.

Individuals with low vision use screen magnifiers, which enlarge areas of the screen to make text and images bigger and easier to see. Screen readers are also commonly used. Text on web pages should also be resizable without breaking the page's template.

Avoid italics and serif font because they are difficult to read on computer screens with limited resolution (Crow, 2008). Sans-serif fonts are recommended.

The W3C recommends a standard of 125 brightness or greater, ((Red value X 299) + (Green value X 587) + (Blue value X 114)) / 1000. Regarding color contrast, the W3C recommends a standard of 500 or greater, (maximum (Red value 1, Red value 2) - minimum (Red value 1, Red value 2)) + (maximum (Green value 1, Green value 2) - minimum (Green value 1, Green value 2)) + (maximum (Blue value 1, Blue value 2) - minimum (Blue value 1, Blue value 2)). Color combinations can be checked online with a new tool: http://www.etre.com/tools/colourcheck/. The Color Blindness Simulator is also available online: http://www.colblindor.com/coblis-color-blindness-simulator/

Consider someone who is deaf. Users with hearing impairments should be provided with text captioning for all content featuring audio or offered printed text transcripts of audio content, provided copyright protections are preserved. Closed Captioning (CC) should use at least 16 point font, high contrast, and should indicate whether the narrator is male or female. Non-speaking elements (e.g., if music is playing) are recommended. Crow (2008) pointed out that, under Section 508, a printed version of the text does not replace real-time captioning.

MAGpie 2 is a tool for creating closed captions and audio (video) descriptions. Authors can add captions and audio descriptions to various multimedia presentations. MAGpie Version 2.5.0 for Windows adds the creation and integration of closed captions into MP4 and 3GP source files, which can be played with captions decoded on BlackBerry® smartphones.

Docsoft:AVS is a software solution designed to audio mine (capture) the spoken content in digital audio and video (AV) files. This online service can be used to automatically generate text transcripts and closed captioning formats and can be configured to output virtually any text based format. The result can be converted to formats such as Quicktime Text, RealText, SAMI or plain text. It is important to note that the accuracy of the transcript is dependent on audio quality and volume. It is recommended to have high quality audio. The DocSoft software can be overly sensitive to any discrepancy in audio presentation. If transcribing a video, additional technical knowledge is needed to interface the transcript with the video file. Additional settings on video playing software may also need to be configured.

YouTube also offers closed captioning services for videos uploaded to their site. Once a video is uploaded to YouTube, you may submit a request to have a transcript created for you. You can then download this transcript, correct any mistakes and upload it back to the YouTube site. YouTube will then inject the captions into the videos at the appropriate time intervals.

Consider someone with learning disabilities, having distractibility, inability to remember or focus on large amounts of information. Individuals may have difficulty with memory, perception, and attention. Web sites should be created to minimize effort for reading comprehension, complexity, slower learning, limited motor control and spatial perception.

One must consider orientation, distractibility, perception, consistency, and predictability in web design from page to page. Friedman and Bryen (2007) published four top recommendations to be used: (1) pictures, graphics, icons, symbols along with text, (2) clear and simple text, (3) consistent navigation and design on every page, and (4) headings, titles, and prompts.

To further minimize distractibility, avoid background noise, automatically playing videos or music and scrolling or blinking text. Eliminate clutter on the

page and avoid displaying irrelevant information to maintain focus on the purpose of the page's content. Use large relative font sizes and maintain white space and large margins to improve readability. Also, be sure to give the user as much time as he or she needs when requiring input (e.g., examination questions with limited time to answer). Avoid flashing or frequently refreshed content that may distract from other elements on the page or induce seizures.

Consider someone with motor disabilities. One must consider if a high degree of motor complexity is required for site interactions such as chatting, playing a game, or simulation. People with various forms of motor impairments may have increased difficulty using a keyboard or mouse. Specifically, rollovers and drop-down menus are difficult to use without a mouse.

An individual with a motor disability may be using an assistive technology such as a mouth stick or a puff and sip device. These assistive devices are dependent on the web page structure for navigation. Heading order, page layout, and logical navigation with skip links will help the user with a motor disability engage with the content. Avoid phrases for a link such as "click here," which fails to tell users any details about the destination of the link. Include visual cues when a user has focused on a link or other selectable content so that the user understands his or her peripheral's location on the page.

Disability, Web, and Future Projections

The U.S. population is projected to increase by 19.6% by 2030 (Rehabilitation Research and Training Center on Disability Statistics and Demographics, 2010). As population increases, so does the proportion of people with disabilities. The disabilities number is expected to double by 2030 due to an aging population, military personnel with disabilities returning from wars in Iraq and Afghanistan, and high obesity rates (Zwillich, 2007).

Since the creation of the world's first web server, web browser, and website in 1991, the numbers of Internet users have skyrocketed. In 1995, the number of users amounted to 16,000,000. In 2007, there were 1,319,000,000 World Wide Web users (Abrar & Dingle, 2009). The proliferation of technologies makes the issues of web accessibility for people with disabilities ongoing and acute.

Barriers to Making Websites Accessible

The examples in this section represent only a few potential barriers that an individual with a disability may encounter on the web. Faculty members are also encouraged to become familiar with potential barriers to meet the needs of people with disabilities. It is highly desirable to increase the awareness of web designers and university community toward access barriers. Doing so will promote consistent monitoring and repairing efforts that result in web pages free of such obstruction.

Universities as a whole are having difficulty keeping up with web accessibility efforts. Any third party who is trying to monitor, check, and compare websites and web pages for research purposes faces barriers that spring from the dynamic nature of websites. Individual faculty members have shown concern about their ability to keep up with technological advances and ways to address web accessibility. Wisdom et al. (2006) conducted a phone interview concerning web accessibility needs of the 17 Oregon community colleges. They found that inadequate funding and staff time, as well as limited confidence in accurately interpreting legal requirements, were barriers.

Erickson et al. (2009) surveyed nearly 700 American community colleges (a 79% response rate) about their web accessibility policies and practices. Among the barriers to creating accessible websites were: (1) lack of knowledge about what is required to make websites accessible (54%), (2) costs and time involved (53%), and (3) lack of awareness about need for web accessibility (48%). About half of the survey participants indicated that all three barriers were an issue for their campus.

Conclusion

According to Krach (2007), Priority 1 accessibility requirements were met by (a) 30 of the 51 colleges top-ranked by the 2006 U.S. News and World Report, (b) 12 of the 25 top-ranked special education programs, and (c) only seven of the 23 top-ranked educational psychology departments.

Thus, the findings of this study are not unique to one university. Other researchers also found that missing alternate text for images was one of the most common website accessibility errors (Flowers et al., 2007; Schmetzke, 2001). Missing alternate text is also one of the easiest accessibility problems to fix (Kane et al., 2007). It would be beneficial to universities to ensure accessibility of the institutions' websites for current and future students with disabilities.

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