ADA Digital Accessibility on Academic Library Websites

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Studying ADA accessibility at library websites of top universities selected from the *U.S. News and World Report*, the authors used WAVE and AChecker to assess data in compliance with WCAG 2.0 standards. Almost 8 out of 10 public university academic libraries reported accessibility errors as one of the major findings. Low color contrast was becoming a more commonly occurring accessibility issue, making it difficult for people with vision impairments to perceive the color of the image. The outcomes of the study suggest that academic libraries around the world should continue improving their website accessibility.

Introduction

We are embarking upon the 2020s with assistive and accessible websites continuing to elude many public academic library websites. This became more evident when we faced a global pandemic beginning in 2020. It included a lockdown that shut down schools, universities, and many public libraries, forcing students of all ages and abilities to learn from home via the internet. Digital accessibility (or the lack thereof) became more evident during this time since the most adversely affected students were those with disabilities. Inaccessibility and incompatibility in educational software, hardware, and websites became increasingly apparent when the students had to use varied devices and internet services to learn.

Under Title II of the Americans with Disabilities Act (ADA), public universities must provide equal access to services and programs including activities and architectural changes to physical facilities,[1] yet digital accommodations and access still face legal scrutiny. Common inaccessibility errors and noncompliance issues include but are not limited to improper text size, missing alt text in images, missing labels for input text types, anchor links with no text, incorrect H1 or header tag placement, and images with low-contrast text.[2]

In determining the level of accessibility for individuals with disabilities accessing academic library websites at public universities, this study collected data starting in 2019 and continued through the global pandemic in 2020 and 2021. The intent is to demonstrate the importance of digitally accessible library websites for students and others with disabilities.

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Literature Review

Research on the accessibility of websites can be found everywhere in the world. Website inaccessibility errors significantly affect users with disabilities. In their 2018 study, Acosta-Vargas, Acosta, and Lujan-Mora[3] used the Web Accessibility Evaluation Tool, WAVE[4] to study Latin American University websites and found that many of them lack accessibility in one key area—alternative image text.

In a 2019 qualitative study conducted by Mulliken,[5] eighteen blind library users tested an academic website using screen readers, a common assistive technology.[6] One of the results from the study demonstrated that screen readers significantly increase the amount of time needed for disabled students to access information. A task that would take a few minutes for the nondisabled person to complete took upwards of 20 to 30 minutes[7] for an individual with disabilities to complete. Even with a screen reader, a student with a degree of low vision would need much more time to complete something as simple as an essay question and could quickly fall behind.

Cassner, Maxey-Harris, and Anaya[8] reviewed public academic library websites for usability with people with disabilities as the end users. Focusing specifically on the topic of accessibility, the topics they explored were the library services offered or which should be offered for easily locatable services or items from library websites. Their recommended general guidelines of accessibility were: ease of website navigation, a friendly welcoming website, and a site that is designed with accessibility for end users versus staff.[9]

Liu, Bielefield, and McKay in their 2018 study examined 122 library homepages of Urban Library Council [ULC] members and found that only 7 homepages presented as error free when tested for compliance with the Section 508 standards.[10] Following this examination, Liu led another team probing private colleges in 2020.[11] This evaluation indicated that although errors described as *missing form label* still occur on these websites, other known accessibility errors and issues have been significantly improved compared to the results found five years earlier.

Susan B. Asselin stressed the importance of knowledge in the area of learning/assistive technologies for the success of students with disabilities.[12] She believes that the accessibility of these technologies gives the student necessary flexibility and addresses their unique needs to successfully learn in the ever-growing digital academic environment.[13]

Relevant studies and articles indicate recommendations for improving digital accessibility through training and updated information. Library staff members must be better informed through training sessions to understand the updates of ADA law and assistive technology advancements. For web designers, ADA accessibility should be included in the development of websites. Accessibility, usability, and inclusion must be considered with the current and well-established guidelines such as WCAG. Deque University[14] offers accessibility training and certification on their website, www.dequeuniversity.com. Professional organizations such as International Association of Accessibility Professionals (IAAP) are also leading the way for certifications including resources, membership, and international chapters.[15]

The related literature shows accessibility is never over and done with; it is a constantly evolving responsibility. In light of the global pandemic, critical work, along with continued improvements in technology and employee training, should provide greater digital accessibility for all.

Legal Implications

Disabilities are not just physical but can also be mental. An individual with a disability can

be defined as a person who has a physical or mental impairment that substantially limits one or more major life activities; has a record of such impairment; and/or is regarded as having such impairment. Being disabled, one can acquire employable skills and tools, but without accessible places of employment, it can be a struggle to support oneself and gain personal independence. The inception of the ADA made way for individuals with disabilities to lead independent lives that would not segregate them from working, living, and accessing the physical world along with their nondisabled peers.[16]

Until recently, many plaintiffs with disabilities had a difficult time gaining access to most websites.[17] Even now, despite the uptick of litigation and the requests for clarification, there is no clear legal resolution to the issue of cyberspace being a public place of accommodation.[18] Websites and online communications based on the fundamentals of availability ought to appear accessible to all.[19] In 2019 there was some movement in the legal discussion of digital space as a public arena of accommodation. At that time, however, the U.S. Supreme Court declined to hear an appeal from Domino's Pizza Inc. [*Domino's Pizza v. Robles*] over its website and mobile app and whether they were required to comply with federal disability law.[20] In short, it was deemed that all websites with physical public locations must be accessible to disabled citizens.

During the inception of the ADA in 1990, Section 508 was written without digital accessibility in mind. Given the current digital world, an update was needed. The "Refresh of 2018" began in January 2017 when revisions and court interpretations gave way to updated requirements for information and technology to Section 508.[21] The Refresh became effective on January 18, 2018.[22] The major requirements included in the Refresh were: the functionality of the web page, accessibility for individuals with disabilities, and keeping pace with advances in technology.[23] The Refresh also included how software, operating systems, and the equipment interact with assistive technologies.[24]

The Internet does not have geographic borders and can be accessed globally. With global accessibility in mind, the Refresh of 2018 incorporated the global standards from the *Web Content Accessibility Guideline*s under the federal guidelines. These global standards are more commonly known as WCAG 2.0 under the W3C. Section 508 was now using recognized and accepted global standards of practice for accessibility, including giving clarity on the use of assistive technologies, and creating and displaying accessible content on the web.[25]

Research Design and Methodologies

As a continuing effort from earlier studies of the ADA and digital accessibility on ivy league library websites[26] and urban public libraries websites,[27] this study combined quantitative and qualitative content analysis to examine the library websites of 100 Top Ranked U.S. Public Universities and Colleges from *U.S. News and World Reports*.[28]

A population sample this size would allow for the review of a broad range of colleges and universities with various student body sizes from across the United States, plus be large enough to examine trends and patterns within the results. In this way, the results of the study would impact a larger number of students.

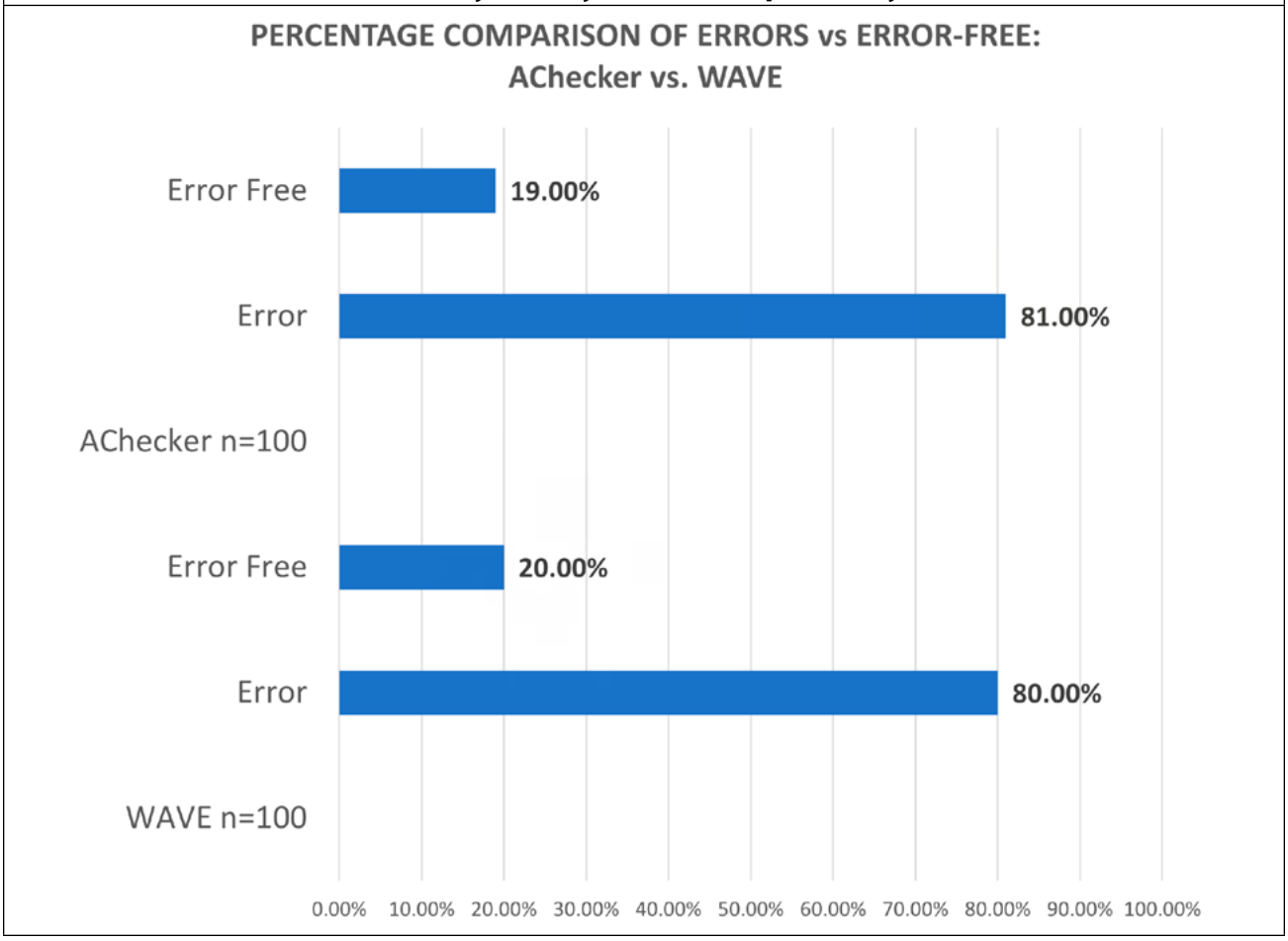
Globally recognized website evaluators, WAVE & AChecker, evaluate a website's accessibility by checking its HTML and XML codes. Both WAVE and AChecker aim to check websites against Section 508 standards and WCAG 2.0 guidelines. Studies that successfully identify website accessibility issues using WAVE can be seen in *Challenges to Assess Accessibility in Higher Education Websites: A Comparative Study of Latin American Universities*[29] and *Evidence of Our Values:*

Disability Inclusion on Library Instruction Websites in 2018.[30] A recent study using AChecker to evaluate website accessibility can be found in *Journal of King Saud University—Computer and Information Sciences* titled *Accessibility of Indian Universities' Homepages: An Exploratory Study* written by Ismail and Kuppusamy.[31] Data collection occurred over an extended period from 2000 to 2015 in a review of digital accessibility at universities in India.[32]

In this study, each library's home webpage was put into the WAVE and AChecker tools and outcomes for the number of total accessibility errors were recorded. After the data was collected, Excel spreadsheets were used to record precise data in a custom-designed codebook. Each of these randomly selected errors was recorded, calculated, and reviewed, with recommended options to fix them. The objectives were to identify errors using Web Content Accessibility Guidelines along with human evaluation and observation of web content, and then pinpoint them into these categories: reported errors, contrast errors, alerts, features, and structural elements.

WAVE and AChecker found errors that were labeled differently; in WAVE as *reported errors* and in AChecker as *known problems*. For the simplicity of this research study and limitation of time, data from the tabs *reported errors* and *known problems* were compiled and the specific errors: *missing form label* and *low contrast* under WAVE and *img element missing alt attribute* and *id attribute were not unique* under AChecker were randomly selected and quantified.

FIGURE 1
Overall Errors of University Library Websites reported by Website Evaluators



Research Findings

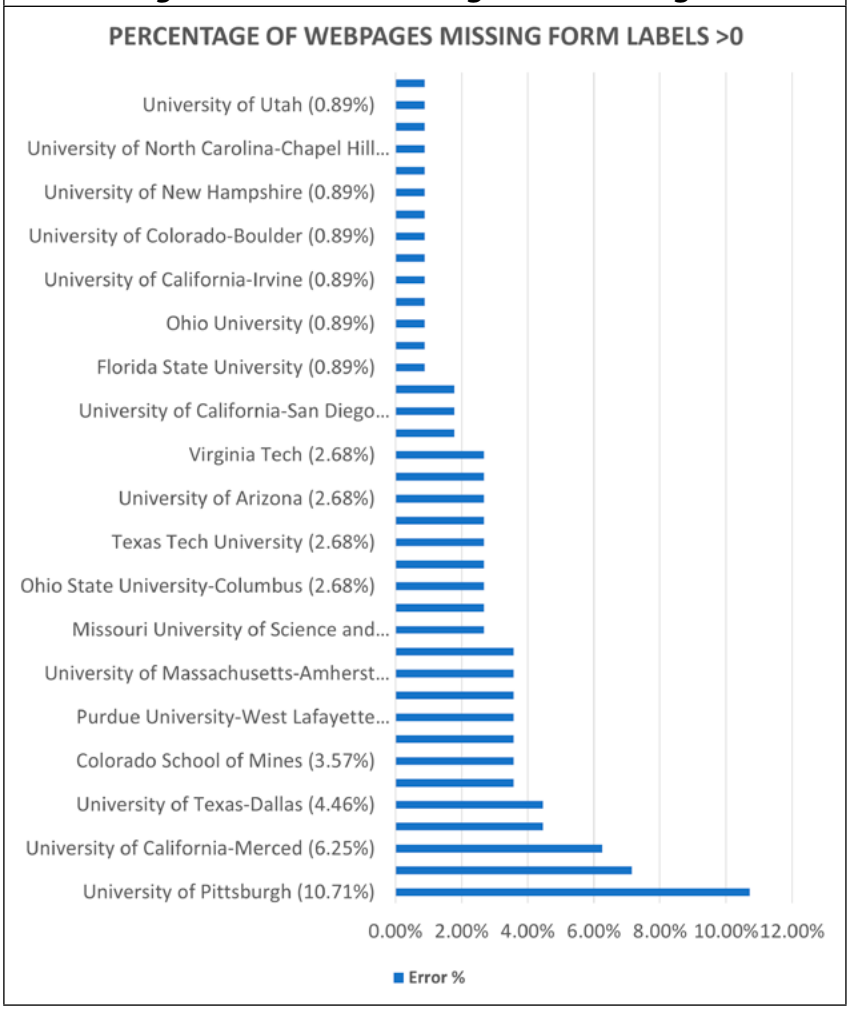
Samples of accessibility errors were reviewed, tabulated, and analyzed in this study indicating there are continued obstacles to accessibility despite the Refresh of 2018. Accessibility errors continue to be a major issue on most university library websites. While WAVE and AChecker report issues differently, the online tools give out a similar percentage of the overall error-free count. Both evaluators employ the global WCAG standards to run their error reports with independent algorithms and programming parameters, but both reach similar conclusions.

Overall error reporting results from WAVE and AChecker indicated that 80 percent and 81 percent of public university academic libraries had accessibility errors under WCAG 2.0 (Level A) guidelines [See Figure 1] and conversely 20 percent and 19 percent respectively were error-free. Software overlap in error-free data was found in two universities: Montclair State University and University of Wyoming.

Top Major Error

In WAVE, the *missing form label* error means "a form control does not have a corresponding label."[33] In Section 508, *missing form label* is defined as a text label for a form control is missing or hidden.[34] Form labels provide important descriptions for screen readers and help disabled users navigate around a page and perform simple tasks like searches and data input. If there is no associated text label, screen readers will not read what is on the screen and disabled users will be unable to input information. The *missing form label* error represents a failure of basic website accessibility and creates a deterrent to academic success and independent learning for individuals with disabilities.

FIGURE 2
***Missing Form Label* Percentage in Ascending Order**



Statistics from the data set analyzed by WAVE indicated that 38 percent of schools had the *missing form label* error and 62 percent did not. Figure 2 displays the percentage of the webpages with errors in ascending order. The reported errors ranged from less than 1 percent to 10.71 percent as the highest.

In terms of the mean, it was 1.12 of *missing form labels* per school; in terms of num-

bers, the lowest count was 1 and the highest individual count at 12 was the University of Pittsburgh.

WAVE's recommendation to correct or avoid the *missing form label* error is: "If a text label for a form control is visible, use the <label> element to associate it with its respective form control. If there is no visible label, either provide an associated label, add a descriptive title attribute to the form control, or reference the label(s) using aria-labelled (sic) by. Labels are not required for image, submit, reset, button, or hidden form controls."[35] This study recommends that when labels are hidden (implicit) visually, then the website developers need to provide code that is supported by assistive technology.

Additional Errors

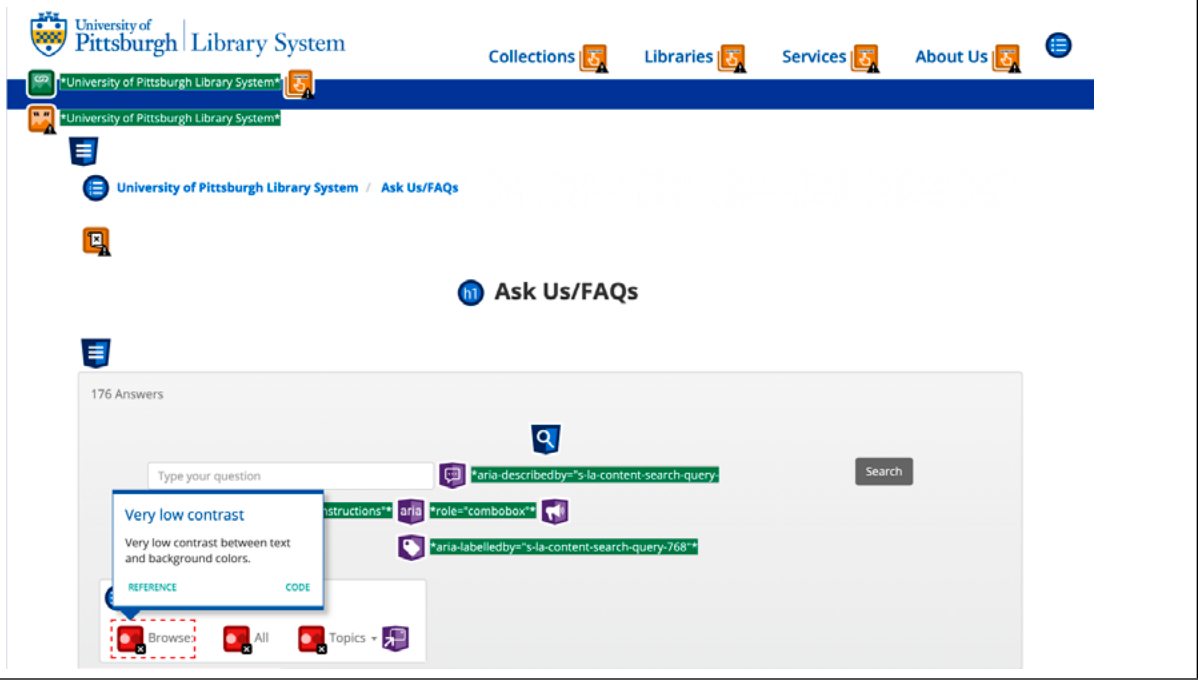
Low Contrast

The *low contrast* error per WAVE occurs when there is little color difference or contrast between foreground and background colors.[36] This error can affect (but is not limited to) color blind and low vision individuals. Many individuals with colorblindness have specific shades or color frequencies that are difficult to distinguish in both digital and non-digital environments. One example of a *low contrast* error would be a white font on a yellow background.

Of the 100 academic library websites reviewed with WAVE, 94 percent reported *low contrast* errors. Purdue University-West Lafayette had the largest sum of reported errors per school, with 111 *low contrast* errors. Only 6 percent of universities had error-free presentations: Arizona State University-Tempe, Temple University, University of Connecticut-Storrs, University of Maryland-College Park, University of Virginia, and the University of Wisconsin-Madison. The mean was 4.01 errors; the adjusted mean removing the skew of 111 contrast problems from Purdue University, went down to 2.90 errors.

When text and images of texts are utilized, contrast ratios must be 4.5:1 according to WCAG 2.0 (Level AA) Distinguishable rule 1.4.3.[37] When utilizing larger text, a minimum of

FIGURE 3
Example of Low Contrast of Screen View[38]



18 point should be used.[39] The minimum font size for smaller content is 14 points, with a bold font size of 14. A contrast ratio of at least 3:135 is required for both text sizes.[40]

A screen view sample of the *low contrast* error from the University of Pittsburgh (www.library.pitt.edu/) is shown in Figure 3. The lighter lettering appears to be difficult to read on the white background. The recommended fix would be to use a larger, black font. This would correspond with the WAVE guideline for enhanced contrast.

Id Attribute is Not Unique

The *id attribute is not unique* error resulted in a roughly 50/50 split between schools with and without the error. Forty-four percent of the 100 data points had an *id attribute that is not unique* error, while 56 percent did not. With assistive technology at the heart of ADA accessibility, this finding is highly disheartening since the need for unique identifiers while using assistive technologies is essential for disabled users.

This data shows that over half of the public universities studied do not acknowledge or accommodate assistive devices. A student with a disability attending a state institution may have a tough time navigating their college library website with this kind of oversight. Failure to accommodate disabled users significantly limits college options for students with disabilities who may already face financial challenges, whether they choose to live away from home or stay close to home. Because not all universities provide the same programs or the same level of accessibility with those programs, disabled students end up limiting their career or life aspirations.

The University of California System provides a good example of assistive technology incompatibility. Because several schools appeared on the sample set, they were regarded as a good sample within the data set demonstrating this error. The error computations were a statistical inverse of the overall data set, which was an intriguing side note. Nonetheless, they revealed how many universities within a single state were adversely affected. More than half of California public colleges' academic libraries lacked software or hardware that made websites accessible to people with disabilities. In comparison to the entire data, the compatibility vs incompatibility of assistive technology accessibility is almost 50/50. When looking for schools in California, students with disabilities may find it difficult to believe that less than half of the California university library websites recognize their assistive technology. Table 1 shows compatibility and incompatibility among the California Public Universities.

TABLE 1
California Public Universities Assistive Technology Compatibility Results

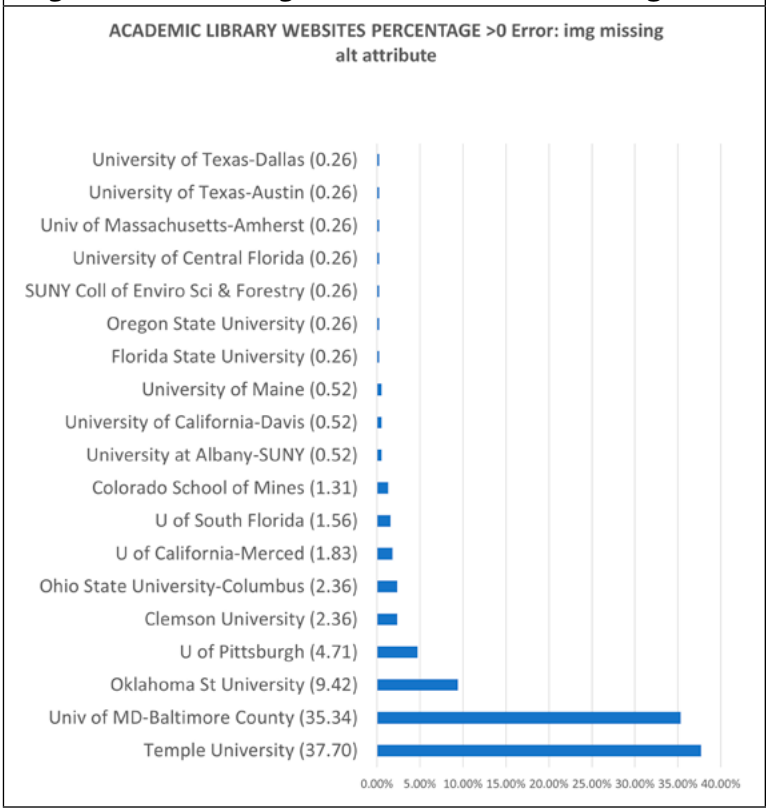
Compatible
Davis
Los Angeles
Santa Barbara
San Diego
Incompatible
Berkeley
Irvine
Merced
Riverside
Santa Cruz

Img Element Missing Alt Attribute

The *img element missing alt attribute* is an ongoing source of frustration for people with disabilities. Missing image alternative text and attributes, or the *img element missing alt attribute*, was found in 19 percent of the surveyed institutions, with the total error count of 382 and a mean of 3.82. Skewed data occurred from two universities with very high counts of this error:

University of Maryland-Baltimore County (135) and Temple University (144). When removed from the mean for skewness; the adjusted mean went down to 1.05 errors per university. The data indicated that there is often only one error per full webpage, which is somewhat encouraging, but means there is still work to do. Figure 4 illustrates 19 schools with the percentage *img element missing alt attribute* error per academic library website; the remaining 81 schools had a zero count. The percentages ranged from 0.26 percent to 37.70 percent.

FIGURE 4
***Img Element Missing Alt Attribute* in Ascending Order**



Individuals with auditory and visual disabilities are most affected by the *img element missing alt attribute*, which as stated in the WCAG 2.0 (Level A) guideline 1.1 requires that organizations provide a text equivalent for every non-text element on a webpage. In the same way that the *missing form label* hampered academic achievement, the *img element missing alt attribute* hampered digital access, academic performance, and autonomous learning at the post-secondary level. According to the reasoning of this study, individuals with visual disabilities can use alternate text to substitute for the image they can't see, while those with auditory disabilities can read.

For any image or video on a page, there needs to be alternate text and/or closed captioning (CC). When using CC, it is important to review and edit it, as errors in automatic transcription from audio software may occur. When observed on the University of Pittsburgh's website (www.library.pitt.edu), the label "GIVE NOW" had no explanation, audio, or alternate text of its purpose. When using assistive technology, the user would hover over the box with their assistive technology, with no alternate attribute of the image to what is the box's function. A study recommendation: place a tag next to the "GIVE NOW" with a simple explanation and label for those using screen readers or similar tools.

Conclusion and Future Study Perspectives

According to "WCAG Guideline 1.3. Adaptable," to be adaptable for individuals with disabilities, content should be presented in accessible layouts that don't lose the content or structure of the webpage and make it easier for disabled users to operate and navigate content. At the very least, website designers should supply alt text for images so there are detailed descriptions of what an image is. A bigger fix would be to run their pages through WAVE or AChecker and correct all the errors they can.

Section 508 was updated in 2018 with technological and legal improvements, including the adoption of WCAG standards that are universally acknowledged. Many parents, educators, and researchers were reminded by the ongoing epidemic that a lack of academic accessibility for people with disabilities was becoming more obvious than ever. According to the findings of this and other studies, there is a dearth of substantial support for digital accessibility in the United States, especially assistive technology detection. When students are looking for post-secondary institutions, a lack of accessibility may obstruct or interfere with their college choices, academic achievement, as well as life goals such as independent living and future earning potential.

Additional longitudinal studies revisiting the same data set in the future would be valuable and advantageous by comparing data from the studies in a quantitative way over time. The argument for using the same data set is that collecting error data and using the same error samples would disclose a lot of important information for suggestions on how to improve accessibility and/or make modifications, as well as how to design more error-free websites. This study's findings confirm and reinforce the necessity of digital accessibility in today's ever-changing digital ecosystem, where it is required, achievable, and possible.

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Appendix A. Table of Relevant Studies

Alphabetical by author.

SOURCE	KEY POINTS
Acosta-Vargas, P.; Acosta, T; Lujan-Mora, S. (2018) *Challenges to Assess Accessibility in Higher Education Websites: A Comparative Study of Latin America Universities*	Study on web accessibility at Latin American universities. The universities had a lack of alternative text on images. WCAG and WCAG-EM were used as benchmarks and WAVE was used as a research and evaluation tool.
Carter, C.J. (2004) *Providing Services for Students with Disabilities in an Academic Library*	Study delved into bibliographic instruction, web page design, and staff training. Focus was on students with disabilities, yet all students could benefit from the different learning styles and develop sensitivity to those different from themselves.
Cassner, M.; Maxey-Harris, C.; Anaya, T. (2011) *Differently Able: A Review of Academic Library Websites for People with Disabilities*	Study on academic library websites for individuals with disabilities. Topics included services offered, services that should be offered, and ease of access of library homepage for disabled users. Recommendation by the authors included: ease of navigation, positive tone to create a welcoming website, and cater website to end users instead of staff.
DeLancey, L.; Ostergaard, K. (2016) *Accessibility for Electronic Resources Librarians*	Study explained how to make resources electronically accessible and how universities can create strategies in initiating accessibility. WCAG was discussed.
Fulton, C. (2011) *Web Accessibility, Libraries, and the Law*	Article details background federal laws and how the states use the ADA law; discusses how and why librarians are "gatekeepers of information and research resources and should be on the forefront of making information 'unrestricted and unhindered.'"
Graves, S.; German, E. (2018) *Evidence of Our Values: Disability Inclusion on Library Instruction Websites*	Study looked for visible evidence of inclusive practices in library instruction programs; content analysis of library instruction websites and accessibility language was studied. WAVE was used as a web accessibility tool for library content.
Hackett, S.; Parmanto, B. (2005) *A Longitudinal Evaluation of Accessibility: Higher Education Web Sites*	Websites were viewed from 1997–2002. The findings in the study were that the more complex a website became, the more inaccessible it was. At the time of the study, there were limited longitudinal studies to explore study subject matter.
Jaeger, P.T. (2002) *Section 508 Goes to the Library: Complying with Federal Legal Standards to Produce Accessible Electronic and Information Technology in Libraries*	Discusses the active role librarians can take to make their website technology accessible using vendors and manufacturers of software. It should not be considered a matter of cost and complexity but a matter of accessibility and usability.
Mullican, A. (2019) *Eighteen Blind Library Users' Experiences with Library Websites and Search Tools in U.S. Academic Libraries: A Qualitative Study*	A qualitative study with blind academic library users. The users found the first time using the website that navigation was time-consuming. Each human subject used screen readers, a common adaptive technology. Some subjects found it took them upwards of 20 to 30 minutes versus a few minutes for sighted user to use the website; the constant time constraint would add more pressure to keep up with academic course load than their sighted peers.

SOURCE	KEY POINTS
Stitz, T.; Blundell, S. (2018) *Evaluating the Accessibility of Online Library Guides at an Academic Library*	Reviewed 18 online library resource guides against a rubric of 14 criteria from WCAG 2.0. Study showed that the library guides failed against seven of the rubric criteria.
Thompson, T.; Burgstahler, S.; Comden, B. (2006) *Research on Web Accessibility in Higher Education*	Bobby was used as an evaluation tool. Viewed the sample universities' websites such as university home page, campus directory, course listings, and employment home page. Bobby had limitations in testing accessibility yet still pulled some valuable data. Stressed the importance of informing faculty, administration, and web designers of accessibility needs.
Wentz, B.; Jaeger, P.T.; Lazar, J. (2011) *Retrofitting Accessibility: The Legal Inequality of After-the-Fact Online Access for Persons with Disabilities in the United States (2011)*	Various industries have a poor history of ADA compliance. Sites are not designed with accessibility in mind.

Appendix B. Data Set

College Name	Library Website
Arizona State University-Tempe	https://lib.asu.edu/
Auburn University	https://www.lib.auburn.edu/
Ball State University	https://www.bsu.edu/academics/libraries
Binghamton University-SUNY	https://www.binghamton.edu/libraries/
Clemson University	https://libraries.clemson.edu/
College of William and Mary	https://libraries.wm.edu/
Colorado School of Mines	https://www.mines.edu/library/
Colorado State University	https://lib.colostate.edu/
Florida International University	https://library.fiu.edu/
Florida State University	https://www.lib.fsu.edu/
George Mason University	https://library.gmu.edu/
Georgia Institute of Technology	https://www.library.gatech.edu/
Illinois State University	https://library.illinoisstate.edu/
Indiana University-Bloomington	https://libraries.indiana.edu/
Iowa State University	https://www.lib.iastate.edu/
Kansas State University	https://www.lib.k-state.edu/
Louisiana State University-Baton Rouge	https://www.lib.lsu.edu/
Miami University-Oxford	http://www.lib.miamioh.edu/
Michigan State University	https://lib.msu.edu/
Michigan Technological Institute	https://www.mtu.edu/library/
Missouri University of Science and Technology	https://library.mst.edu/
Montclair State University	https://www.montclair.edu/library/
New Jersey Institute of Technology	http://library.njit.edu/
North Carolina University-Raleigh	https://www.lib.ncsu.edu/huntlibrary
Ohio State University-Columbus	https://library.osu.edu/
Ohio University	https://www.library.ohio.edu/
Oklahoma State University	https://library.okstate.edu/
Oregon State University	https://osulibrary.oregonstate.edu/
Pennsylvania State University-University Park	https://libraries.psu.edu/directory
Purdue University-West Lafayette	https://www.lib.purdue.edu/
Rowan University	https://www.lib.rowan.edu/
Rutgers University-New Brunswick	https://www.libraries.rutgers.edu/
Rutgers University-Newark	https://www.libraries.rutgers.edu/dana
San Diego State University	https://library.sdsu.edu/
Stony Brook University-SUNY	http://www.library.stonybrook.edu/
SUNY College of Environmental Science and Forestry	https://www.esf.edu/moonlib/
Temple University	https://library.temple.edu/
Texas A&M University-College Station	https://library.tamu.edu/
Texas Tech University	https://www.depts.ttu.edu/library/

College Name	Library Website
University at Albany-SUNY	https://library.albany.edu/
University at Buffalo-SUNY	https://library.buffalo.edu/
University of Alabama	https://www.lib.ua.edu/#/home
University of Alabama-Birmingham	https://library.uab.edu/
University of Arizona	https://new.library.arizona.edu/
University of Arkansas	https://libraries.uark.edu
University of California -Los Angeles	https://www.library.ucla.edu/
University of California-Berkeley	http://www.lib.berkeley.edu/
University of California-Davis	https://www.library.ucdavis.edu/
University of California-Irvine	https://lib.uci.edu/
University of California-Merced	http://library.ucmerced.edu/
University of California-Riverside	https://library.ucr.edu/
University of California-San Diego	https://library.ucsd.edu/
University of California-Santa Barbara	https://www.library.ucsb.edu/
University of California-Santa Cruz	https://library.ucsc.edu/
University of Central Florida	https://library.ucf.edu/
University of Cincinnati	https://libraries.uc.edu/
University of Colorado-Boulder	https://www.colorado.edu/libraries/
University of Connecticut-Storrs	https://lib.uconn.edu/
University of Delaware	https://library.udel.edu/
University of Florida	http://www.uflib.ufl.edu/books.html
University of George	https://www.libs.uga.edu/
University of Hawaii-Manoa	http://manoa.hawaii.edu/library/
University of Houston	https://libraries.uh.edu/
University of Idaho	https://www.lib.uidaho.edu/
University of Illinois-Chicago	https://library.uic.edu/
University of Illinois-Urbana Champaign	https://www.library.illinois.edu/
University of Iowa	https://www.lib.uiowa.edu/
University of Kansas	https://lib.ku.edu/
University of Kentucky	http://libraries.uky.edu/
University of Louisville	http://library.louisville.edu/home
University of Maine	https://library.umaine.edu/
University of Maryland-Baltimore County	https://library.umbc.edu/
University of Maryland-College Park	https://www.lib.umd.edu/
University of Massachusetts-Amherst	https://www.library.umass.edu/
University of Massachusetts-Lowell	https://www.uml.edu/library/
University of Michigan-Ann Arbor	https://www.lib.umich.edu/
University of Minnesota-Twin Cities	https://www.lib.umn.edu/
University of Mississippi	https://libraries.olemiss.edu/
University of Missouri	http://library.missouri.edu/
University of Nebraska-Lincoln	https://libraries.unl.edu/

College Name	Library Website
University of New Hampshire	https://www.library.unh.edu/
University of New Mexico	https://library.unm.edu/
University of North Carolina-Chapel Hill	https://library.unc.edu/
University of Oregon	https://library.uoregon.edu/
University of Pittsburgh	https://www.library.pitt.edu/
University of Rhode Island	https://web.uri.edu/library/
University of South Carolina	https://sc.edu/about/offices_and_divisions/university_libraries/
University of South Florida	https://www.lib.usf.edu/
University of Tennessee	https://www.lib.utk.edu/
University of Texas-Austin	https://www.lib.utexas.edu/
University of Texas-Dallas	https://www.utdallas.edu/library/
University of Utah	https://lib.utah.edu/
University of Vermont	https://library.uvm.edu/
University of Virginia	https://search.lib.virginia.edu/
University of Washington	https://www.lib.washington.edu/
University of Wisconsin-Madison	https://www.library.wisc.edu/
University of Wyoming	http://www.uwyo.edu/libraries/
Virginia Commonwealth University	https://www.library.vcu.edu/
Virginia Tech	https://lib.vt.edu/
Washington State University	https://libraries.wsu.edu/
n=100 Source: *U.S. News and World Reports*	

Appendix C. Overall Error Counts for Wave

Totals in descending order

College Name	Quantity Error	Error Y=1, N=0	Error Free Y=1, N=0
University of New Hampshire	84	1	
University of Pittsburgh	42	1	
University of South Florida	34	1	
University of California-Davis	29	1	
Ohio State University-Columbus	26	1	
University of Kentucky	25	1	
University of California-Santa Cruz	24	1	
University of Texas-Austin	23	1	
Iowa State University	22	1	
Pennsylvania State University-University Park	22	1	
University of California-Santa Barbara	21	1	
University at Albany-SUNY	20	1	
Illinois State University	18	1	
University of Texas-Dallas	17	1	
University of California-Merced	16	1	
University of Maryland-Baltimore County	16	1	
University of Massachusetts-Amherst	16	1	
Ohio University	14	1	
University of Mississippi	12	1	
University of New Mexico	12	1	
Rowan University	11	1	
University of Colorado-Boulder	11	1	
University of Illinois-Chicago	11	1	
Florida International University	9	1	
New Jersey Institute of Technology	9	1	
Purdue University-West Lafayette	9	1	
Texas Tech University	9	1	
University of Connecticut-Storrs	9	1	
University of Delaware	9	1	
Virginia Tech	9	1	
University of Alabama-Birmingham	8	1	
University of Utah	8	1	
Clemson University	7	1	
Michigan Technological Institute	7	1	
University of Maine	7	1	
University of Tennessee	7	1	
Kansas State University	6	1	

College Name	Quantity Error	Error Y=1, N=0	Error Free Y=1, N=0
Miami University-Oxford	6	1	
Missouri University of Science and Technology	6	1	
San Diego State University	6	1	
University of California-Los Angeles	6	1	
University of Hawaii-Manoa	6	1	
University of Minnesota-Twin Cities	6	1	
Virginia Commonwealth University	6	1	
University of Georgia	5	1	
University of Michigan-Ann Arbor	5	1	
Arizona State University-Tempe	4	1	
Colorado School of Mines	4	1	
Florida State University	4	1	
Oregon State University	4	1	
Temple University	4	1	
University of Arizona	3	1	
University of California-San Diego	3	1	
University of Central Florida	3	1	
University of Houston	3	1	
University of Maryland-College Park	3	1	
Binghamton University-SUNY	2	1	
SUNY College of Environmental Science and Forestry	2	1	
University of Arkansas	2	1	
University of California-Berkeley	2	1	
University of Iowa	2	1	
University of Louisville	2	1	
University of Missouri	2	1	
University of North Carolina-Chapel Hill	2	1	
Washington State University	2	1	
Ball State University	1	1	
College of William and Mary	1	1	
Colorado State University	1	1	
George Mason University	1	1	
Louisiana State University-Baton Rouge	1	1	
North Carolina University-Raleigh	1	1	
Oklahoma State University	1	1	
Texas A&M University-College Station	1	1	
University of California-Irvine	1	1	
University of Florida	1	1	
University of Idaho	1	1	

College Name	Quantity Error	Error Y=1, N=0	Error Free Y=1, N=0
University of Nebraska-Lincoln	1	1	
University of Rhode Island	1	1	
University of Wisconsin-Madison	1	1	
Auburn University	0	0	1
Georgia Institute of Technology	0	0	1
Indiana University-Bloomington	0	0	1
Michigan State University	0	0	1
Montclair State University	0	0	1
Rutgers University-New Brunswick	0	0	1
Rutgers University-Newark	0	0	1
Stony Brook University-SUNY	0	0	1
University at Buffalo-SUNY	0	0	1
University of Alabama	0	0	1
University of California-Riverside	0	0	1
University of Cincinnati	0	0	1
University of Illinois-Urbana Champaign	0	0	1
University of Kansas	0	0	1
University of Massachusetts-Lowell	0	0	1
University of Oregon	0	0	1
University of South Carolina	0	0	1
University of Vermont	0	0	1
University of Virginia	0	0	1
University of Washington	0	0	1
University of Wyoming	0	0	1
TOTALS	**758**	**79**	**21**
	7.58	**79.00%**	**21.00%**
	mean	**percent**	**percent**

Appendix D. Total Known Errors with AChecker

This table is in descending order.

College Name	Quantity Error	Error Y=1, N=0	Error Free Y=1, N=0
Stony Brook University-SUNY	106	1	
Montclair State University	94	1	
Colorado State University	72	1	
Florida State University	69	1	
North Carolina University-Raleigh	49	1	
University of Nebraska-Lincoln	48	1	
Purdue University-West Lafayette	43	1	
Binghamton University-SUNY	43	1	
Pennsylvania State University-University Park	35	1	
University of New Mexico	27	1	
Texas A&M University-College Station	26	1	
University of California -Los Angeles	25	1	
University of Alabama-Birmingham	25	1	
San Diego State University	23	1	
Kansas State University	23	1	
Illinois State University	23	1	
Florida International University	23	1	
University of Oregon	22	1	
Washington State University	21	1	
University of Colorado-Boulder	21	1	
University of California-San Diego	21	1	
University of California-Riverside	20	1	
University of Washington	18	1	
Miami University-Oxford	17	1	
University of California-Davis	15	1	
University of California-Irvine	12	1	
University of North Carolina-Chapel Hill	11	1	
University of Minnesota-Twin Cities	11	1	
University of Central Florida	11	1	
University of California-Berkeley	11	1	
Ohio State University-Columbus	11	1	
Louisiana State University-Baton Rouge	11	1	
University of Virginia	10	1	
University of Idaho	10	1	
University of Alabama	9	1	
Auburn University	9	1	
University of Missouri	8	1	

College Name	Quantity Error	Error Y=1, N=0	Error Free Y=1, N=0
University of California-Santa Barbara	8	1	
Rowan University	8	1	
Colorado School of Mines	7	1	
Ball State University	7	1	
Arizona State University-Tempe	7	1	
University of Maine	6	1	
Missouri University of Science and Technology	6	1	
Michigan State University	6	1	
University of New Hampshire	5	1	
University of Georgia	5	1	
University of Florida	5	1	
University of Arizona	5	1	
Temple University	5	1	
University of Mississippi	4	1	
University of Massachusetts-Lowell	4	1	
University of Iowa	4	1	
University of California-Santa Cruz	4	1	
New Jersey Institute of Technology	4	1	
Michigan Technological Institute	4	1	
Indiana University-Bloomington	4	1	
Clemson University	4	1	
Virginia Tech	3	1	
University of Kansas	3	1	
University of Houston	3	1	
Georgia Institute of Technology	3	1	
College of William and Mary	3	1	
University of Wyoming	2	1	
University of Rhode Island	2	1	
University of Pittsburgh	2	1	
University of Michigan-Ann Arbor	2	1	
University of Massachusetts-Amherst	2	1	
University of Maryland-Baltimore County	2	1	
University of Delaware	2	1	
University of Arkansas	2	1	
University of Texas-Dallas	1	1	
University of Tennessee	1	1	
University of South Florida	1	1	
University of Maryland-College Park	1	1	
University of Illinois-Urbana Champaign	1	1	
University of Cincinnati	1	1	

College Name	Quantity Error	Error Y=1, N=0	Error Free Y=1, N=0
University at Albany-SUNY	1	1	
Rutgers University-Newark	1	1	
Rutgers University-New Brunswick	1	1	
Oregon State University	1	1	
Virginia Commonwealth University	0	0	1
University of Wisconsin-Madison	0	0	1
University of Vermont	0	0	1
University of Utah	0	0	1
University of Texas-Austin	0	0	1
University of South Carolina	0	0	1
University of Louisville	0	0	1
University of Kentucky	0	0	1
University of Illinois-Chicago	0	0	1
University of Hawaii-Manoa	0	0	1
University of Connecticut-Storrs	0	0	1
University of California-Merced	0	0	1
University at Buffalo-SUNY	0	0	1
Texas Tech University	0	0	1
SUNY College of Environmental Science and Forestry	0	0	1
Oklahoma State University	0	0	1
Ohio University	0	0	1
Iowa State University	0	0	1
George Mason University	0	0	1
TOTALS	**1,186**	**81**	**19**
	11.86	**81.00%**	**19.00%**
	mean	**percent**	**percent**

Notes

1. ADA Network, "What Are the Public or Private College-University's Responsibilities to Students with Disabilities?" https://adata.org/faq/what-are-public-or-private-college-universitys-responsibilities-students-disabilities.

2. Mike Cristancho, "How to Make Your Site ADA Compliant," *Medium*, August 18, 2017, https://medium.com/gauge-interactive/how-to-make-your-site-ada-compliant-74eb2a92ff3f.

3. Patricia Acosta-Vargas, Tania Acosta, Sergio Lujan-Mora, "Challenges to Assess Accessibility in Higher Education Websites: A Comparative Study of Latin American Universities," *IEEE Access*, vol. 6 (2018), https://ieeexplore.ieee.org/document/8388714.

4. WAVE, Web Accessibility Evaluation Tool, "Site-Wide WAVE Tools," http://wave.webaim.org/sitewide.

5. Adina Mulliken, "Eighteen Blind Library Users' Experiences with Library Websites and Search Tools in U.S. Academic Libraries: A Qualitative Study," *College and Research Libraries*, vol 80, no. 2 (2019), https://crl.acrl.org/index.php/crl/article/view/16947/19428.

6. Ibid.

7. Ibid.

8. Mary Cassner, Charlene Maxey-Harris, Toni Anaya, "Differently Able: A Review of Academic Library

Websites for People with Disabilities" *Behavioral & Social Sciences Librarian*, vol. 30, no. 1, (March 2011): 33–51, https://tandfonline.com/doi/abs/10.1080/01639269.2011.548722.

9. Ibid.
10. Wenfang Yang, Bin Zhao, Yan Quan Liu, and Arlene Bielefield "Are Ivy League Libraries' Websites ADA Compliant?" *Information Technology and Libraries*, vol. 39, no. 2 (2020); https://doi.org/10.6017/ital.v39i2.11577.
11. Yan Quan Liu, Arlene Bielefield, and Peter McKay, "Are Urban Public Libraries' Websites Accessible to Americans with Disabilities?" *Universal Access in the Information Society* 18 (2019): 191–206. https://doi.org/10.1007/s10209-017-0571-7.
12. Susan B. Asselin, "Learning and Assistive Technologies for College Transition," *Journal of Vocational Rehabilitation*, vol. 40, no. 3 (January 2014): 223–230, https://content.iospress.com/articles/journal-of-vocational-rehabilitation/jvr687.
13. Ibid.
14. Deque University, "Become an Accessibility Expert" (May 25, 2021), www.dequeuniversity.com.
15. International Association of Accessibility Professionals (IAAP), "About IAAP," https://www.accessibilityassociation.org/s/about.
16. Arlene Mayerson, "The History of the Americans with Disabilities Act, A Movement Perspective," *Disability Rights Education and Defense Fund* [DREDF] (1992) https://dredf.org/about-us/publications/the-history-of-the-ada/.
17. Trevor Crowley, "Wheelchair Ramps in Cyberspace: Bringing the Americans with Disabilities Act into the 21st Century" *Brigham Young University Law Review*, vol. 2013 issue 3, no. 11, (2013): 651–690, https://digitalcommons.law.byu.edu/lawreview/vol2013/iss3/11/.
18. Kimberlieanne Podlas, "Website Accessibility and the Americans with Disabilities Act" *Journal of Internet Law*, vol 19 no. 5 (2015): 3–16.
19. Ibid.
20. Amanda Robert, "Disability Law, SCOTUS Rejects Pizza Delivery Company's Appeal Over Web and Mobile App Accessibility," *ABA Journal. American Bar Association* (October 7, 2019), http://www.abajournal.com/news/article/supreme-court-rejects-dominos-appeal-over-web-and-app-accessibility.
21. Martin LaGrow, "The Section 508 Refresh and What It Means for Higher Education" *Educause Review* (December 4, 2017), https://er.educause.edu/articles/2017/12/the-section-508-refresh-and-what-it-means-for-higher-education.
22. Ibid.
23. U.S. General Services Administration [USGSA], "2017 Accessibility Refresh Fact Sheet," https://assets.section508.gov/files/2017_508-Refresh-Fact-sheet-updated.pdf
24. Ibid.
25. Ibid.
26. Yang, Zhao, and Liu, "Are Ivy League Libraries' Websites ADA Compliant?"
27. Liu, Bielefield & McKay, "Are Urban Public Libraries' Websites Accessible to Americans with Disabilities?"
28. U.S. News & World Report. *Top Public Schools, National Universities [2019]*, Data released and published Fall 2018.
29. Acosta-Vargas, Acosta, and Lujan-Mora, "Challenges to Assess Accessibility in Higher Education Websites: A Comparative Study of Latin American Universities."
30. Stephanie J. Graves and Elizabeth German, "Evidence of Our Values: Disability Inclusion on Library Instruction Websites," *portal: Libraries and the Academy* 18 no. 3 (July 2018): 559–574 https://doi.org/10.1353/pla.2018.0033.
31. Abid Ismail, K.S. Kuppusamy, "Accessibility of Indian Universities' Homepages: An Exploratory Study," *Journal of King Saud University—Computer and Information Sciences*, vol. 30, no. 2 (April 2018): 268–278, https://doi.org/10.1016/j.jksuci.2016.06.006.
32. Ibid.
33. WAVE, "Site-Wide WAVE Tools."
34. Ibid.
35. Ibid.
36. Ibid.
37. W3C, "Web Standards," https://www.w3.org/standards/.
38. Screen view taken from University of Pittsburgh, www.library.pitt.edu retrieved in September 2022.
39. W3C, "Web Standards," https://www.w3.org/standards/.
40. Ibid.