

## **Accessibility in Learning Management Systems: A Review of Literature**

**Abstract:** There has never been a more critical time to consider accessibility issues in learning. Beyond the ethical duty educators have to ensure that all learners have equal access to learning materials, educational institutions are legally required to ensure such access. Enforcement activities related to accessibility violations are trending upwards, and educational institutions ignore accessibility at their own peril. Literature shows that, despite improvement, there are still significant issues with accessibility in higher education institutions. This research examines the state of accessibility in learning management systems used by many educational institutions, and seeks to develop a number of recommendations for future research.

### **Introduction**

The value in understanding accessible learning technologies has never been more pertinent. Over the last decade (2006 - 2016) the number of number of cases violating Americans with Disabilities Act (ADA) has almost doubled (USEEOC, n.d). Moreover, the amount of money that was awarded to plaintiffs in ADA cases has grown by \$82.2 million (USEEOC, n.d). This points to a clear trend of increased enforcement of accessibility requirements on the part of the United States government. The remainder of the Western world is also realizing the need for a unified approach to accessibility, with the European Union (EU; European Commission, n.d.) currently pursuing the “European Accessibility Act” to harmonize accessibility laws throughout the member nations of the EU. Based on these facts, the developed world clearly places significant value on ensuring that resources are accessible to those who might be constrained by a disability.

The research thus far has shown accessibility of websites is generally not ideal. Most recently, Coleman (2017) examined accessibility of higher education homepages, finding that most of the institutional pages examined had significant issues. This echoes the sentiments expressed by Alahmadi and Drew (2016), Comeaux and Schmetzke (2013), Gonçalves, Martins, Pereira, Oliveria, and Ferreira (2013), and Fulton (2011), all of whom found most websites they examined to have problems with accessibility.

Learning management system (LMS) accessibility research appears to be underrepresented in the literature, considering that 99% of higher education institutions utilize web-based learning management systems (Dahlstrom, Brooks, & Bichsel, 2014). Moreover, at those institutions, 85% of faculty and 83% of students use the LMS, and 56% report using the LMS in all or most all courses (Dahlstrom, et al., 2014). Given their extensive use and prominent role in instruction, LMS accessibility and usability is of critical importance for students to achieve positive learning outcomes. This need is increasingly more important when students with learning disability/ accessibility issues are considered (Babu & Midha, 2007). Moreover, it remains unclear to what degree guidelines prescribed by the Web Content Accessibility Guidelines (WCAG 2.0) are being conformed.

### **Standards for Accessibility**

Consideration of accessibility issues begins in the physical world. According to the National Institute of Building Sciences (2016), one of the earliest examples of accessibility standards for building design emerged in 1961 when the American National Standard Institute (ANSI) adopted standard A117.1. This standard set the precedent, for accessibility and usability guidelines in buildings and facilities. ANSI A117.1 also helped prompt the Architectural Barriers Act of 1968 and the Rehabilitation Act of 1973; both of which addressed physical accessibility for federally-funded construction. These architectural requirements were later extended in 1988 when

the Federal Housing Act was passed, which required accessibility features in newly constructed multi-family dwelling facilities (like apartment complexes).

Despite physical accessibility having been considered first, electronic accessibility was not terribly far behind. In 1986, the Rehabilitation Act of 1973 was amended to add Section 508 (“Section 508 Law”, n.d.). Section 508 created requirements for accessibility in electronic and informational technologies. Physical and electronic accessibility were both addressed in greater detail with the passage of the Americans with Disabilities Act (ADA) in 1990. In particular, Title IV of the ADA addressed telecommunication services for hearing and speech-impaired individuals. While this only explicitly covered telecommunication providers, electronic accessibility was covered in ADA’s Title III requirements which forbid discrimination against individuals with disabilities in publicly funded services and accommodations. Though not all learning management systems are operated by public institutions that are publically funded, these institutions can be considered public accommodations. As a result, educational institutions are compelled to ensure that the learning management systems utilized are accessible to all students.

In 1990, the United States implemented the Americans with Disabilities Act (“Current ADA Regulations”, n.d.). With this law, the intersection of accessibility and technology was expanded. Despite the step forward made by signing the ADA into action, its growth could not yet be seen because societal infrastructural was largely still pre-Internet. By the end of the 1990s, the Internet was maturing, and had gone from a service used by tech savvy agencies to a source of mainstream communication. Understanding a need to make online content accessible, the World Wide Web Consortium (W3C) undertook an effort to develop accessibility standards for designing web pages. The result of that effort was the 1999 release of the first version of the Web Content Accessibility Guidelines (WCAG).

Being released in the early days of the Internet, the WCAG 1.0 was visionary for accessibility online, but its relevance was short-lived. By 2008, the advent of dynamic “Web 2.0” content and mobile computing, led by the Apple iPhone, rendered the original specification as largely obsolete. Moreover, the guidelines provided by WCAG 1.0 were not easily assessable, thus it proved difficult to test for conformance. This led to a redeveloped, technology-independent specification with assessable guidelines which were adopted in December 2008 as the WCAG 2.0 standard. In 2012, WCAG 2.0 would be adopted as ISO 40500.

## **Examining the State of Accessibility**

The remainder of this paper/research will be dedicated to examining literature at three levels. The first level being the macro level; where the general development and accessibility of web design will be considered. Secondly, the meso-level will explore accessibility of websites in higher education. Lastly, at the micro level, consideration will be given to the specific area of LMS accessibility.

### **The Macro Level**

It is generally understood by those who study website accessibility that despite greater understanding and legal pressure, the comprehension of this topic remains relatively poor. The oldest study consulted in this review of literature consisted of an examination of fifty websites from varying locations /types of organizations in the United States (Lazar, Beere, Greenidge, Nagappa, 2003). Lazar et al. (2003) concluded that not only was accessibility of these sites poor, but some of the worst offenders came from inside the web development industry; a surprising and unexpected find.

Ten years later, Gonçalves, Martins, Pereira, Oliveira, and Ferreira (2013) reached similar conclusions in their analysis of web accessibility. In this study of web accessibility of Forbes’ 250 corporate websites, Gonçalves et al. found “a considerable number of accessibility errors... without exception” (p. 373). Gonçalves et al. made a few additional, interesting additions to the conversation on accessibility (2013). First, they developed an “accessibility value network” (p. 371, 2013) that provides insight into the various actions required to create an accessible web site. Second, they boldly called for organizational leadership to take responsibility for leading the charge towards in accessible web design; they also cited the, need for “virtuous leadership from various global actors” (p. 374).

Abuaddous, Jali, and Basir (2016), joined the cause laid out by Goncalves et al. (2013) when they unearthed four potential problematic factors in accessibility and website design. The first factor suggests that perhaps web design professionals may not be furthering their skills in web design accessibility. Second, they noted there were limited resources dedicated to accessibility issues. They suggested that this included both tangible (i.e. money) and intangible (i.e. stakeholder buy-in) resources that may be required for site development. Third, they note a shortage of professionals familiar with accessibility evaluation methods, and thus furthering the need for training

and development. In their conclusion, they suggest the root cause of web developers seeking to learn more about accessible website design lies in the inadequate supply of resources/materials.

Yesilada, Brajnik, Vigo, and Harper (2015), suggest a slightly different cause for accessibility problems. In Yesilada, Brajnik, Vigo, and Harper's (2015) study of perceptions towards accessibility, the reliance of designers on automated tools to determine accessibility is determined to be a significant factor when considering web accessibility problems. While these tools are helpful for designers in pointing out major accessibility problems they are not completely accurate. Moreover, both the old WCAG 1.0 and new WCAG 2.0 standards rely on subjective determinations of accessibility. Thus, the knowing whether certain websites are truly accessible becomes impossible unless usability and accessibility tests are conducted with actual users.

### **Web Accessibility at Higher Education Institutions**

Having examined the general state of web accessibility, attention can be turned to university websites using the broader context of web accessibility as a backdrop. Most recently, Coleman (2017) assessed the state of WCAG 2.0 conformance in higher education websites by examining the websites of the largest university in each American state. This was a short study conducted to quickly examine the current state of accessibility of university websites. Though this study did not account for the subjective elements in determining accessibility, it did generate quantitative results like those used by others. Just as was the case in studies before, Coleman (2017) concluded that there were considerable accessibility issues in the websites of American universities. Only two of the university websites examined were found to conform to WCAG 2.0 specifications, insofar as they could be validated by the AChecker tool. The remainder of institutional websites had serious accessibility issues. The average number of known accessibility issues for the sample was 12.94 at the WCAG 2.0 AA level (Coleman, 2017, p. 391).

Besides WCAG guideline adherence issues, accessibility for higher education libraries has been raised of an issue for concern (Fulton, 2011). Fulton was one of the first in the literature examined to look specifically at accessibility in the educational context, examining the accessibility of libraries. Rather than look at measures of accessibility, Fulton examined some of the ideas and practices that lead to an accessible site. The result was that Fulton identified a number of potential challenges to web accessibility in libraries.

First, of these challenges, Fulton (2011) notes that only seventeen states have made laws to ensure accessibility of state websites. Second, Fulton finds that most states do not reference Section 508 requirements or the ADA in their own accessibility laws, moreover, only Minnesota specifically references WCAG 2.0 in state law. In fairness, Fulton points out that most states do reference these laws and standards in supplementary guidance, however not being part of the law can could create a false sense of or impede compliance in some cases. Finally, Fulton finds that many libraries, including those in higher education, are not included by states as entities that must comply with accessibility laws, thus it becomes difficult to enforce accessibility standards in excluded organizations.

Beyond these challenges, Fulton (2011) also notes and dispels three common organizational objections regarding web accessibility. First among these is that learning and applying accessibility guidelines is difficult or a pointless exercise. Notwithstanding the previously noted findings of Abuaddous, et al. (2016) regarding training resources, Fulton suggests that just complying with Section 508 would resolve 90% of accessibility issues. The degree to which that is true is debatable, given Fulton does not elaborate on why this is so. Nevertheless, the underlying point that adopting and conforming to a basic accessibility scheme is better than using no accessibility guidelines at all. Fulton (2011) further suggests that using a content management system (CMS) may be one way solve many of these accessibility issues.

The second of these objections Fulton (2011) addresses is that accessible websites are time consuming and resource intensive, and constitute an "undue burden" under Section 508. The problem with claiming an undue burden is that, as Fulton writes, "the institution must extensively document why creating an accessible website would cause a burden" (p. 38). Moreover, "undue burden" is generally understood within the larger context of the organization, not just at a specific level. It may well be that, given existing resources, accessibility may create a burden, but it cannot be considered "undue" unless the organization is incapable of shifting internal resources to meet accessibility obligations. Thus, "undue burden" may be an excuse many use to avoid accessibility, but it does not mean what they may think it means.

Finally, the third objection Fulton (2011) notes is the belief of administrators that people will not sue educational institutions over accessibility issues, and that it is good enough to provide individual assistance and accommodation when needed. Such an attitude is nothing short of wishful thinking. While Fulton provides an excellent case study of a lawsuit involving the Law School Admission Council (LSAC) and several law schools over accessibility issues in the LSAC's credential assembly website (required for law school applications), it is easy enough to visit the ADA website and see the enforcement activity taking place. Listed among them are several

universities, libraries, and K-12 school districts. Thus, the belief that educational institutions will not be sued for accessibility issues is demonstrably false.

Comeaux and Schmetzke (2013), meanwhile, performed a longitudinal study of the actual state of accessibility in academic library websites. Using the Bobby program for analyzing web pages for accessibility errors, Comeaux and Schmetzke effectively counted the number of accessibility errors per page. Their conclusion is that while the total number of accessible pages has remained consistent at around 60% of those examined, the total number of errors per page declined over time, indicating at least some improvement. Unfortunately, however, their study utilized older accessibility standards, such as WCAG 1.0. Interestingly, however, Comeaux and Schmetzke also examined the role of a CMS in facilitating accessible design. They noted that sites utilizing a CMS for management tended to have better accessibility than sites not using a CMS, thus providing empirical support for Fulton's (2011) suggestion that utilizing a CMS might improve accessibility.

Alahmadi and Drew (2016), utilized an approach like Coleman (2017), albeit with a slightly different methodology. They sampled webpages from 20 universities from across the world, by randomly selecting participants from the top 100 universities in the world per the Academic Ranking of World Universities (ARWU). This study is interesting because it not only collected data on institutional homepages, an admitted limitation in Coleman (2017), but it went further to sample web pages further down in the site's hierarchy that includes pages for admissions and course descriptions. Not only do Alahmadi and Drew conclude that accessibility in global university webpages is lacking, they further demonstrate that accessibility issues are likely to increase as visitors move farther from the home page.

Finally, because of the similar approaches taken by Alahmadi and Drew (2016) and Coleman (2017), it is interesting to compare the results of these studies. Both studies reported data for WCAG 2.0 Level AA conformance as determined by the AChecker tool. Alahmadi and Drew (2016) reported a mean of 30.25 known errors (minimum 0, maximum 414) for global university websites where Coleman (2017) reported a mean of 12.94 known errors (minimum 0, maximum 171). The results are encouraging on one hand, as they demonstrate at least one university in each sample has no detectable accessibility issues; yet on the other hand, both studies record at least one institution with well over 100 accessibility issues on the home page. Thus, it is evident that accessibility is still a major problem for education institutional homepages. The only saving grace, for American universities at least, is that this comparison does suggest that American universities are ahead of the global accessibility curve; however, that is a proposition that would need to be tested more thoroughly by future research.

### **Accessibility of Learning Management Systems**

Kent (2015), argues in conclusion of his own review of literature on LMS accessibility, that the problem of accessibility in learning management system and other online tools used in concert for online instruction is one that poses a threat to the inclusion of people with disabilities in online learning. With this in mind, it seems that Alahmadi and Drew (2016) were correct in pointing out that LMS software is a significant area of concern; however, their results do not explicitly address accessibility concerns in LMS-based websites. We would presume, based on the suggestion of Fulton (2011) and findings of Comeaux and Schmetzke (2013) and understanding that a LMS is a specific type of content management system, that a LMS would contribute to greater accessibility. However, the literature examined thus far does not speak directly to accessibility in LMS-based sites. To assess the accessibility of LMS sites, we must continue our literature review.

A significant contribution to the discussion of accessibility in learning management systems comes from Babu and Midha (2007). In this study, 32 physically challenged students, 22 students with impaired vision and 10 students with impaired hearing were surveyed to examine the relationship between accessibility, usability, media richness, learning motivation, and perceived success (Babu and Midha, 2007). While the study is limited by its sample size, the results were significant. Babu and Midha (2007) hypothesized that perceived success of learning would positively correlate with accessibility, usability, media richness, and learning motivation. As it turns out, significant correlations were only found when examining accessibility and usability. These results indicate that, at least for students with disabilities, accessibility and usability are far more important in perceived learning outcomes than the richness of content or learning motivation – both of which are typically seen as important factors in conventional electronic learning wisdom.

In a study by Orfanou, Taelios, and Katsanos (2015) a Greek translation of an English research instrument for analyzing LMS usability, collected telling data regarding the usability of the Moodle and eClass learning management systems. In their research, they collected a student usability score (SUS) calculated by the scored instrument and a usability rating assigned by the participating learner. On a scale of 0-100, the total overall mean SUS was 76.27, with Moodle having a mean SUS of 75.00 and eClass having an SUS of 76.81. Meanwhile, the

usability rating, on a scale of 1-7, had an overall mean score of 5.08, with Moodle having a mean of 5.15 and eClass having a mean of 5.05. It becomes apparent from the data collected by Orfanous, Taelios, and Katsanos (2015) that the average learner would give both learning environments a “C” for usability. While this does not specifically address the question of accessibility, it does raise an important question: If students without disabilities find it challenging to use a LMS effectively, how then can we reasonably expect students with disabilities to perform well in online environments when usability issues are further compounded by accessibility problems?

This issue is spoken to in a more qualitative approach to LMS accessibility comparisons by Rangin, Petri, Richwine, and Thompson (2011). Rangin et al. compared the accessibility and usability of Blackboard 9.1, Desire2Learn 9.2, Moodle 1.9, and SAKAI 2.8.0. Their approach, rather than developing usability scores, was to establish a set of accessibility criteria and determine if each LMS could meet the set criteria. In summarizing their findings, they note that the LMS products tested in their examination are “more accessible now than they have ever been.” However, they also specifically mention the importance of usability and accessibility together, writing:

...in spite of significant strides that have made many Learning Management Systems more accessible, using these applications can still be a challenge for users with disabilities. A key reason for this is that significant usability factors that would have directly benefited all users' interaction and experience have been overshadowed by the more immediate, “pure” accessibility problems... These essential fixes can sometimes obscure broader usability concerns and can even distract vendors from core problems that affect usability universally (Rangin et al, 2011).

While Rangin et al. (2011) do not provide us with any real quantitative measures regarding usability or accessibility, the sentiment they express is as simple as it is profound. As important as WCAG standards are, accessibility of LMS products is more than just adherence to technical guidelines. Accessibility is just as much about usability as it is anything else, and it is in usability where they find issues. For example, they note Blackboard requires “too many layers of micronavigations” and that “navigation is too cumbersome.” Similar findings are noted for other LMS products as well. Many of these problems are not problems that prevent a disabled person from using accessible technology as much as they are design inefficiencies that would annoy most users, but in turn make LMS use more difficult for the disabled.

Usability issues are not just reserved for students. In an examination of usability issues in the Moodle LMS, Muniz and de Moraes (2012) further explore the problem of usability from the perspective of faculty. To study Moodle’s usability, Muniz and de Moraes conducted a qualitative study using focused interviews of six different professionals: a tutor/course coordinator, two instructional designers/course coordinators, a web designer, a tutor/instructional designer, and a tutor. The researchers conducted a free-form, unstructured interview session in which the interviewee was encouraged to speak about openly about tools for communication and collaboration. Muniz and de Moraes (2012) found that the interviews supported their hypothesis that usability issues in Moodle inhibit teachers’ ability to collaborate and communicate with their classes.

These findings were echoed in a later study by Calvo, Iglesias, and Moreno (2014). Rather than depending on a self-report, Calvo, et al. took the approach of studying whether content creation tasks could be completed successfully by a user using a screen reader as their primary interface. This included tasks that would be common not only for students, but teachers and LMS administrators as well. After assessing Moodle 1.9 against WC3’s Authoring Tools Accessibility Guidelines (ATAG) 2.0, Calvo, et al. concluded that Moodle does not conform to ATAG 2.0, and that many of the required tasks would be difficult or impossible to complete when using a screen reader.

As if accessibility and usability issues are not difficult enough as barriers to LMS use, technology skills may further the level of difficulty. In a study intended to examine the impact of expert versus non-expert skill levels on LMS usability, Pretorius and van Biljon (2010) used eye tracking to examine the usability of a LMS used by a South African university. The underlying idea of the study is that by examining eye movement and fixation points, you can pinpoint behavior differences between expert and novice users. Indeed, the study found that whereas expert eye movements were fixed in a general area, even when they were unfamiliar with the system, novice users’ eye movement tended to wander around on the screen. These results suggest that usability and accessibility are moderated, to some degree, by learners’ degree of technology comfort and skill level.

The discussion of accessibility raises the question, what kind of LMS is most accessible? Iglesias, Moreno, Martínez, and Calvo (2010) attempted to address this question a few years ago, by examining open source LMS products ATutor 1.6.2, Moodle 1.9.4, and Sakai 2.54 against ATAG 2.0 and WCAG 1.0 specifications. As has been the case with accessibility so far, their findings demonstrated each of the analyzed LMS products encountered some barrier in either ATAG or WCAG specifications. The takeaway from this study is at least all three of these LMS products are insufficient to guarantee accessibility. Furthermore, we should expect, based largely on the general trend in accessibility that has been observed, that few, if any, LMS products are truly, fully accessible.

## **Discussion and Recommendations**

From the literature consulted, it is clear there have been significant accessibility issues in web-based software in general and in LMS software in particular. Unfortunately, the degree to which these issues persist is not clear. For example, Iglesias, et al. (2010), tested ATutor 1.6.2, Moodle 1.9.4, and Sakai 2.54 more than seven years ago. As of the writing of this paper, the current stable versions of those LMS families were ATutor 2.2.2, Moodle 3.4.1, and Sakai 11.4. Each LMS is at least one major version ahead of those originally tested, rendering their findings out of date. Further, it appears that developers of these systems have put significant effort into improving accessibility (“Accessibility”; “Accessibility Working Group”). Despite this, there do not appear to be any comparative evaluations of accessibility using modern releases. It is recommended that these comparative studies be updated and repeated with modern versions of these learning management systems using a consistent evaluation methodology to examine the present, overall state of LMS accessibility.

It should also be acknowledged that this literature review is limited by the lack of information regarding accessibility of popular and proprietary LMS products such as Blackboard Learn, Canvas, Desire2Learn. Certainly, Rangin, Petri, Richwine, and Thompson (2011) provide useful insights in this area; however, they take a more subjective approach and do not quantify accessibility in terms of WCAG criteria conformance. Further, their analysis suffers from the same limitation noted in Iglesias, et al. (2010) – the products evaluated are now outdated. Since accessibility is arguably subjective, it is not surprising that studies take this approach; however, future studies may make comparisons between systems easier by better translating their subjective observations into quantitative data. Regardless of the specifics, future research should generally attempt to better compare the usability of proprietary systems with open source alternatives. This may be difficult, considering these solutions can be more difficult to source and test, especially in their pristine form.

This raises another point of contention in accessibility studies – the focus on a pristine version of a LMS. While it is certainly important to test a LMS in a clean state to establish an accessibility baseline (is it accessible out of the box or not), this is not necessarily straightforward nor is it particularly helpful in predicting accessibility under normal use conditions. A baseline analysis is not straightforward, largely because of the practice of theming. Themes are packages that allow administrators to change the look and feel of the LMS. Most LMS products ship with several default themes that can then be customized to match the branding of the institution, and many also allow user-developed or downloadable themes. These themes make significant changes to the user interface, and, in so doing, have the ability to significantly impact accessibility. Thus, it may not be enough to simply test the accessibility of the LMS, but instead individual themes should be tested for accessibility. Future research may examine the role of themes in influencing LMS accessibility.

Additionally, such an analysis is not necessarily a good predictor of accessibility in the future. Even if the system provides an accessible user interface, much of whether the content delivered to learners is accessible depends on whether or not that content is designed to be accessible by instructors and course designers. Future studies should explore “real-world” LMS installations and examine accessibility within that context. This can help answer questions about LMS software such as, “what internal support do LMS products provide to facilitate accessible content design?” Moreover, this area of research may also help explore and identify institutional strategies, policies, training, and other administrative tasks outside of the LMS that can help improve accessibility.

Research regarding the legal and regulatory climate of accessibility in higher education should be also be updated. Fulton’s (2011) findings regarding Minnesota being the only state to mandate WCAG 2.0 are now dated. For example, a Wikipedia article claims additional states have adopted some form of WCAG compliance (“U.S. State Laws”, n.d.). Admittedly, a Wikipedia entry hardly constitutes a scholarly treatment of the issue; nevertheless, it underscores the idea that scholarly literature may not be keeping up with changes in law. As a result, a more thorough and scholarly examination of state laws and policies may be needed to determine what states require and how they are requiring it. This should assist in determining whether states apply adequate pressure on educational institutions (as well as other agencies) to adhere to accessibility guidelines.

From the perspective of how LMS products relate to instruction, further research should be performed to confirm the findings of Babu and Midha (2007), that usability and accessibility relate more to student success than aspects of content. If this is shown repeatedly to be the case, then it will provide significant evidence for enhancing usability and accessibility in all online learning systems, including LMS products. It is important to note that Babu and Midha (2007) specifically examined usability in the context

Finally, future research comparing results from Alahmadi and Drew (2016) and Coleman (2017) (that suggests a potential difference in accessibility rates in America and abroad) may be useful. Such an understanding

would clarify website usability in higher education internationally, and would help to identify areas where website accessibility may be best. This might be followed with an exploration of differences in governance issues and practice that may contribute to increased accessibility.

## **Conclusion**

This literature review has examined articles concerned with web accessibility and with the accessibility of LMS products. It has shown a clear trend in literature pointing not only to accessibility issues in websites, but in higher education websites and learning management systems. It is the author's hope that this treatment of the subject adds a unique perspective to the conversation on website accessibility, particularly as it relates to higher education and to effective use of LMS. Moreover, the author hopes that this will help guide future research in this area.

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