Time for a Response: Responsive Design, Accessibility, and University Websites

by

Matthew L. Estes, B.A.

A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Arts

Auburn, Alabama
August 6, 2016

Keywords: Responsive Web Design, Accessibility, University Websites, Digital Inclusiveness, Diffusion of Innovations Theory

Approved by

Norman E. Youngblood, Chair, Associate Professor, Communication & Journalism
Debra Worthington, Associate Professor, Communication & Journalism
John Carvalho, Associate Professor, Communication & Journalism

Abstract

The purpose of this research is to investigate the connection between responsive web design, web accessibility, and university websites. The study examined 100 of the top university websites, based on *U.S. News and World Report* Rankings, investigating how well each one of them used suggested responsive web design principles, as well as how well each one observed WCAG 2.0 and Section 508 Accessibility standards. Scores based on a 20-point codebook were gathered regarding responsive web design scores, and the researcher used ATRC AChecker to investigate accessibility compliance. The goal was to find out if the top universities are adopting responsive web design and accessibility standards, as per the Diffusion of Innovations Theory. The study found no connection between responsive web design and tuition costs, total enrollment, acceptance rate, or geographic area. However, it did find a correlation between total enrollment and accessibility standards. The conclusion is that top universities are early adopters of responsive web design, and the smaller universities will likely follow the pattern given enough time.

Acknowledgements

I would like to thank my thesis chair, Dr. Ed Youngblood, for his assistance on this project. He has been instrumental in both teaching me the concepts, as well as guiding the research contained within this project. I would also like to thank my other two committee members, Dr. John Carvalho and Dr. Debra Worthington. Their instruction during my time at Auburn has been nothing short of exceptional. I would like to thank my family for being supportive of my educational pursuits and career goals. Finally, I would like to thank my fiancée, who has been patient, supportive, and helpful during the many hours of research that went into this project.

Table of Contents

Chapter 1:

Introduction

Contemporary American society relies heavily on mobile devices. The age of individuals accessing the internet on a designated desktop-based computer is fading. Even laptops, which typically share the same interface as desktops, are often being replaced by convertible tablet computers with attachable keyboards, such as iPads, Microsoft Surfaces, and Android tablets (Gkanatsios & Retalis, 2015).

The design of these mobile devices and their interfaces are far from static, and the "technology is in a constant state of flux" (Rempel & Bridges, 2013, pg. 8). While 73% of Americans have desktop or laptop computers, that number has remained relatively stagnant over the last decade. In contrast, mobile computing device ownership has increased rapidly (Anderson, 2015a). As of 2015, around 64% of adult American owned a smartphone, and 42% owned a tablet computer. These mobile devices have become a tool for bridging the digital divide, and Hispanic and non-Hispanic Black adoption of smartphones is higher than for the general population (Pew Research Center, 2015; Helton, 2012).

The spread of mobile devices also includes users with disabilities. According to Prevent Blindness (2015), an organization devoted to researching and preventing vision-related illness, there are currently over one million people who are completely blind in the United States, and many other people who are at least partially blind. In a survey of screen reader users, 70% of respondents reported using a screen reader on a mobile device (WebAIM, 2015).

Young adults, ages 18-29, are among the most likely to use mobile devices, and young adult mobile device ownership is 85% (Pew Research Center, 2015). Many young adults will likely visit college and university websites to explore institutions as they debate which schools to apply, and will interact regularly with the website of the school they ultimately attend. Given the percentage of young adults with smartphones, some of this online interaction will likely take place through a mobile device. To date, however, there has been little research into how higher education institutional websites are prepared for these mobile-based interactions. The few studies that have explored mobile design have typically focused on how a specific institution has approached moving to a mobile-friendly design (e.g. Bohyun, 2013; Rempel & Bridges, 2013), or examined the mobile readiness of a specific course or utility management system (e.g. Gkatzidou, et al., 2015; Wen & Zhang, 2015). In most of these cases, designers have relied on responsive web design as the go-to method for crafting the best overall website for maximum audience self-efficacy (Achterkamp, Hermens, & Vollenbroek-Hutten, 2015).

At the same time that universities and colleges are attempting to meet the needs of mobile users, they also need to meet the needs of users with disabilities as required by numerous legal and ethical requirements. These standards include Section 508 of the Federal Acquisition Regulation and the 2010 Americans with Disabilities Act standards for accessible design, which exist in order to further the goal of digital inclusiveness, which is the state of providing every citizen free, accessible use of essential technologies needed for everyday functionality in society (Digital Inclusion, 2016). While regulations allow for more awareness of the accessibility gaps, incorporation of these standards has

proven more difficult than initially suspected. According to Vanderheiden (1997), "although there may be residual specifics concerning disability access that must be covered, the bulk of the issues involved are addressed automatically through the process of developing environment/situation-independent interfaces" (pg. 300). Therefore, the more advanced the technology, the more naturally accessible devices will be, especially due to their ability to adapt to unique environments.

Linking advancing technology with an increased ability to connect with all available audiences provides a connection point between responsive web design, which by its nature adapts to a user's device, and accessible design, which accommodates to a user's disabilities. This concept of digital inclusiveness brings responsive design and accessible design together. By its nature, digital inclusiveness calls for websites to be usable regardless of what platform or disability a user might have.

This study examines each website's focus on accessibility based on specified parameters using AChecker (ATRC, 2015), a web-based tool that examines a page for various aspects of WCAG 2.0 compliance. Together, these scores will provide a good snapshot about an individual university website's current level of digital inclusiveness. Finally, this study used data provided by *US News and World Report* (U.S. News, 2015) to examine institutional factors that may affect the adoption of mobile readiness: acceptance rate, tuition cost, overall enrollment, and whether an institution is a public or private college.

Chapter 2:

Literature Review, Hypotheses, and Research Questions

Literature Review

This research brings together two critical components of digital inclusiveness, mobile design and accessible design, and discusses the importance of these design areas in the context of making online material available to historically underserved audiences, users with disabilities, and users with low socio-economic status (SES). The research also discusses the theoretical framework for predicting the adoption of these design techniques—diffusion of innovations theory. The following section examines how web design has changed to fit the shifting landscape of technology, including the introduction of responsive web design as a reaction to the widespread adoption of mobile devices, how researchers have studied responsive design, and the interplay between mobile usability and accessibility. Investigating this research will help guide the study's methods and accompanying analysis.

Advancements in Mobile. Mobile computing technology is advancing rapidly. Designers need to address a growing range of devices, and must contend with constant changes in how users interact with these technologies. One example of a recent advancement in mobile technology is the adoption of multitouch gestures, which allows a user to use more than one finger when interacting with a device. In the past, users were

often only able to interact with touch-screen devices with a single touch. Many devices, such as gaming systems, are still bound by this limitation.

Most smartphones and tablets, however, now rely on multi-touch gestures (Park & Han, 2014). A common example of a multitouch gesture is the zoom or "pinch" response, in which the relative distance between a user's two fingers determines the size of on-screen objects. Another new feature in the latest generation of mobile devices is the ability to accept responses of varying pressure, known as 3D touch (Chamary, 2015). Not only is improved hardware allowing for easier and more convenient use of mobile devices, but how people use the devices are changing. The adoption of multitouch and 3D touch gestures are examples of how mobile developers have to stay ahead of the curve when designing for applications and the web.

Mobile development is entering a cycle where enhanced device customization is being introduced into a user's repertoire of available options. New methods of technological advancement are constantly being proposed and developed. Many of these innovations pertain to the customization of devices based on user preferences and the formation of adaptive user interfaces for mobile applications (Desruelle & Gielen, 2015). For example, the Android operating system offers the ability to incorporate plug-ins and widgets into the user interface, allowing for a more customizable and unique user experience than rivaling products (Cipriani, 2012).

One thing that has not changed, despite these mobile advancements, is the nature of the web (Zakas, 2013). Even though programming and markup languages have changed, server technology has improved, and users often have access to more

bandwidth, the basic infrastructure of the web has remained the same – a series of links connected by networked computers that give a user access to various media information, such as text, images, audio, and video.

Unlike two decades ago, when it was more common to see a minimalist presentation of text, images, and links, there is now much more to consider when developing an effective design. Better training and the evolution of CSS and HTML have produced a more streamlined web, as well as users who expect and require a more consistent user experience. Satisfactory design is the difference between a user who is frustrated and a user who is able to internalize the compelling message of the site (Neilson, 1999).

The state of flux of mobile hardware has necessitated a new form of web design (Rempel & Bridges, 2013). It necessitates a form that is adaptable to whatever device the user chooses to view the information on. Because users now visit a site using a wide range of devices, it becomes critical for the developer to provide a sense of unison in content, design, and user experience between platforms (Anderson, 2015b). Responsive design is the solution to these challenges.

What is Responsive Design? The quick adoption of smartphones and similar mobile devices following the introduction of the iPhone caused some early stumbling among developers in the industry, because "when many people first imagine designing for mobile, they picture a hurried businessman on the street" (Wroblewski, 2011, p. 25). This idea turned out to be a somewhat shallow assessment of mobile design, as mobile devices are now used in a wide range of settings. In addition, the mobile device user base

changed quickly due to its dramatic increase in adoption. In 2011, 35% of Americans owned a smartphone; however, in 2015 that total was nearly double at a 68% adoption rate (Pew Research Center, 2015). Additionally, smartphones have become bridge devices for many individuals, particularly those of lower socioeconomic status without consistent access to desktop devices. Minorities, such as Hispanics and Blacks are more likely to be dependent on their smartphone (Youngblood, 2015). In addition, adoption of smartphones by young adults is considerably higher than other demographics (Smith, 2015).

Smartphones and tablets are used by a wide range of individuals, from the college student strolling across campus to the grandmother who just wants to keep in touch with her family. While the iPhone was not the first smartphone conceptually, it certainly was the breakout device that made mobile computing mainstream (Sager, 2012). While less than a decade old, the iPhone and similar devices permeate American society and many users, particularly young adults, now see themselves as dependent on their smartphone (Pew Research Center, 2015). At the same time, web developers have struggled to keep up with the brisk pace of advancing hardware implementation and use. With designers still disagreeing on how to effectively create content for desktop devices, adding smartphones, tablets, and other mobile platforms into the development process makes website production even more complicated (Zakas, 2013).

The innovation of responsive web design offers a uniform solution to many of these issues. There are three main schools of thought about successfully delivering content to a mobile audience. The first method involves using software-based

applications as opposed to websites. These “apps” were popular at the time, but their usefulness is waning as web browser responsiveness increases and device functionality improves (Jobe, 2013). A market for apps still exists in more specialized forms, such as the concept of “gamification” (Zichermann & Cunningham, 2011; Gallaugher & Ransbotham, 2010). For example, the well-known Starbucks app, which grants customers a variety of rewards based on purchase quantity, provides a niche area for companies and consumers. The second method, used exclusively for smaller devices, is to design a separate mobile site. These mobile sites often look noticeably different when compared to their desktop counterparts, and may not contain the same depth of information found elsewhere (Zhou, 2013). The third method is responsive web design, which allows the page to adapt to a user’s screen size. In short, responsive web design is a change in web development philosophy, which emphasizes a focus on responding to the user’s device, environment and situation (Mohorovicic, 2013).

The goal of responsive web design is to create a fluid, universal website for all devices, from high definition monitors, to tablets, all the way down to small smartphones. Instead of the designer splitting information on a website in multiple directions by using a mobile-specific site, users receive the same website and information, displayed in different formats depending on screen size. The different versions of a responsive site usually have similar colors, themes, and information, but the look is optimized for the media used by the client.

These limitations force developers to take a “less is more” approach by only putting in the information the audience needs, and doing it in the most efficient way

possible, particularly when website design is coupled with a mobile first philosophy (Wroblewski, 2011). A side effect of this approach is the need for laser-focused content across all platforms, which can manifest positive usability for the consumer. Positive usability leads to more productive discussion among the users of a website, particularly in comments and forum posts (Euerby & Burns, 2014). Likewise, positive usability, which is emphasized by responsive design (Marcotte, 2010), manifests higher credibility regarding the organization (Fogg, 2002). It also allows the user to receive a similar aesthetic and informational experience no matter the device.

Responsive sites often incorporate a fluid, grid-based design using percentage-based units of measure, such as percent and em, rather than using fixed-size units of measure, such as pixel or point (Marcotte, 2014). One way to tell if a site is responsive is by testing how a page reacts to resizing the browser window. If the site makes automatic changes based on the size of the window, avoiding forced horizontal scrolling, it is likely built with responsive web design in mind. The dimensions of common devices, such as the iPhone or iPad, delineate the adjustments made to a site (Charski, 2015). In some cases, designers will swap out images depending on the size of the browser display, or will code images to be flexible and resize on the fly, helping to prevent awkward resizing, or a section of the image falling outside the boundaries of the display area (Jehl, 2014). Having examined what responsive web design is, it is necessary to develop understanding of how researchers and designers evaluate responsive design.

Evaluating and Researching Responsive Design. Bohyun (2013) examines a variety of websites that used responsive web design as part of the redesign process for the Oregon

State University Library, and compares the responsive sites to pages that use other approaches. The researcher found that if the designer uses responsive web design, as opposed to an app or mobile-specific website, the end user has a less complicated experience navigating the site. Based on the research, the university launched a large-scale redesign of the site using responsive web design. Student and staff reactions were overwhelmingly positive based on longitudinal surveys. The results from this study suggest that, when done well, responsive web design is an effective usability tool for designers and developers.

Another goal of researching responsive web design is to prevent forced cross-device web usage, particularly when it comes to accessing a site using a mobile device (Shuguang, Zhen, & Daqing, 2015). Cross-device web usage occurs when a user is unable to complete a task using a device (often a mobile device) and must switch to another device, such as a desktop or laptop computer, to complete the task. This type of negative experience is especially prevalent when a user attempts to fill out a form on a website (Marcotte, 2014). Cross-device web usage can drive users away from the site altogether, especially if they can find the needed information or products elsewhere, or require time-sensitive access to certain web-based tools. The universal style of responsive web design helps prevent the user from having to chase much-needed information. Researchers are examining a variety of approaches to help solve cross-device web usage, including experimenting with an enhanced point-and-click style mobile search system (Shuguang, Zhen, & Daqing, 2015).

Researchers have also explored responsive web design's limitations. Responsive web design is not an all-inclusive panacea for every web-based need. In some instances, the end user may require more precise control of the content, and that content may not lend itself to responsive web design. Mobile applications are often the solution to these types of web-based interactions. Healthcare, for example, is an industry more prone to using apps than websites. Users tend to feel more secure filling out health-related data on an application-based platform rather than through a web browser and recent studies (e.g. Gkatzidou, et al., 2015) suggest that privacy and security are critical user concerns when it comes to health care, closely followed by source credibility and legitimacy

e-Learning software is another area in which apps may be more appropriate than responsive websites. While people are likely to explore university websites on mobile devices, it is difficult to take a test or assimilate content from a mobile, responsively designed site. In an effort to find better methods of mobile learning, Wen & Zhang (2015) explored the best platforms for microlecture-based education. Microlectures are short videos that fit the hurried nature of the typical student's lifestyle. Though it is possible to use some elements of responsive web design for microlectures, administrators likely need a platform designed strictly for that purpose.

Mobile learning has been the subject of much research, and Cochrane (2014) compiled a best practices article for utilizing Web 2.0 for mobile learning, arguing that technological and pedagogical support are the keys to sustained engagement in the online classroom. By analyzing the successes and failures of the past, the researcher searched for the best way to create a sustained culture of trust and engagement for the students.

Despite the wide range of research on successful mobile learning, it has become clear that responsive web design does not offer any solutions that positively contribute to a student's learning experience.

Applying Responsive Web Design to University Websites. Despite e-learning typically needing its own unique platform to effectively cater to student needs, university websites in general present a good fit for responsive web design. With college-aged students being heavy adopters of smartphones, university websites need to be mobile-ready (Smith, 2015). Responsive web design, first-and-foremost, is about saying as much as possible in a limited amount of space (Marcotte, 2014). Marcotte (2014) developed a field guide to responsive web design in *Responsive Design*, which serves as an easily understandable guide for those who want to incorporate its principles. He also wrote the seminal article on responsive web design's architectural process, which is widely considered the origin of responsive web design as an accepted designer philosophy (Marcotte, 2010). Marcotte's works have been used as a central focus for responsive design research (e.g. Kim, 2013; Mohorovicic, 2013), as Marcotte "outlined a method for creating fluid layouts that are screen-resolution agnostic and 'future proof'" (Gardner, 2011). Jehl's (2014) follow-up, *Responsible Responsive Design*, delves deeper into the coding and rationale behind the production process.

Both books are helpful starting points for those looking to incorporate responsive design into their web development, and they serve as a guide for developing this research. This study will analyze the use of responsive web design and build a scale based on the standards set in *Mobile First*, *Responsive Design*, and Jehl's (2014) *Responsible*

Responsive Design. *Mobile First*, although acknowledging the benefits of responsive web design, focuses on designing websites with mobile in mind through every step of the development process (Wroblewski, 2011). The study will also incorporate best practices from the W3C's latest mobile accessibility guidelines (Patch, Spellman, & Wahlbin, 2015), which have been used in previous studies to evaluate mobile accessibility (e.g. Alshawi & Alalwany, 2009). Many of the elements of effective responsive web design coincide with the suggestions of W3C, which is the predominant organization that upholds standards of web development.

The Need for Accessibility. As stated by Tim-Berners Lee, the inventor of the World Wide Web and one of the founders of World Wide Web Consortium (W3C), "The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect." (W3C, 1997). The W3C argues that, "web accessibility and usability are closely related; their goals, approaches, and guidelines overlap significantly. It is most effective to address them together in many situations, such as when developing websites" (Henry & Abou-Zahra, 2010). Vanderheiden (1997) paints a challenging view of equal access, pointing out the difficulties of accommodating every person, as the needs of a sight-impaired and a tactically impaired individual may be completely different. The author describes the "nomadic computing device of tomorrow," which could be perceived as a type of smartphone, detailing what is necessary to achieve "every-citizen interfaces," that is, devices with perfect accessibility. This description of the technology seems similar to the capabilities of mobile devices of 2016.

Web-related accessibility ensures a positive experience for people with physical or age-related disabilities. Common accessibility tools include screen readers, voice-recognition software, and on-screen magnifiers. The W3C addressed a system of guidelines for developing sites with good accessibility, whose suggestions are now known as the Web Content Accessibility Guidelines, or WCAG. First developed in 1999, the most current version, WCAG 2.0, was adopted in 2008. The W3C's goal with the revised standards was to make the guidelines objectively testable, despite rapid changes in user interface and design standards (Reid & Snow-Weaver, 2008). WCAG 2.0's standards are divided into four subtopics: the perceivable, the operable, the understandable, and the robust (Caldwell, et al., 2008). WCAG checkpoints are divided into three sections which are, in order of priority, A, AA, and AAA. Level A checkpoints represent the minimum-level requirements for WCAG 2.0 conformance, and feature things like including a stop/start button for automatically playing media. Level AA checkpoints must meet level A requirements, as well as an additional set of standards, while level AAA checkpoints must meet all three sets of criteria. Coding for this research involved checking for known problems across all three WCAG 2.0 checkpoints.

Self-imposed regulations for U.S. government websites include several key accessibility tips. These include not relying on color as a method for differentiating objects, making sure to include alternate text with every image, and providing transcripts for podcasts and videos, all of which are covered under WCAG 2.0. This research focuses on a few specific pieces of legislature regulating web accessibility. Section 508, an amendment of the Rehabilitation Act of 1973, "require[s] Federal agencies to make

their electronic and information technology accessible to people with disabilities" (Section508.gov, 2016). WCAG and Section 508 are different, as one is a federally mandated law applying to government websites, including public universities (Higher Education, 2014), while the other is set of recommendations put forth by W3C.

Another law is the Americans with Disabilities Act of 1990, which mandates that all services, including state education, provide "equal access to their programs, services, or activities unless doing so would fundamentally alter the nature of their programs, services, or activities or would impose an undue burden" (ADA Tool Kit, 2016). As the internet developed, that law was reinterpreted into ADA Title II 2010 Standards for Accessible Design, which included methods for developing web-based content and documents in accessible format, specifically regarding state and local governments.

Other laws include the Twenty-First Century Communications and Video Accessibility Act of 2010, which mandates television programming that is aired with captions must be captioned when it is distributed online. A recent Federal Communication Commission act extended this to video clips in addition to entire programs (FCC, 2015; Youngblood & Lysaght, 2015). The European Union has also passed several laws mandating equal accessibility for all government websites (Easton, 2013).

Similar laws exist across a spectrum of legal areas and geographic locations, with broad discussions in the research community about the effectiveness of how well these mandates are actually followed (Jaeger, 2004). The accessibility of public university websites is of particular importance, due to them falling under the jurisdiction of ADA

and Section 508 because of their receipt of federal funding (University System of Georgia, 2016). From a moral standpoint, accessibility is especially necessary considering the priority of education to career advancement and financial well-being. Therefore, this research will score not only how well university websites utilize responsive web design, but also how effectively they incorporate use of standardized accessibility guidelines.

Researchers have examined accessibility issues across a range of disciplines (e.g. Fagan, 2004). For example, Kushalnagar et al. (2015) discussed the need to make health websites accessible to American Sign Language. Similarly, Maatta Smith (2014) examined urban public library websites and identified substantial accessibility problems. Youngblood (2015) noted that library accessibility problems were not limited to local-level libraries, but often occur in state library websites as well. Many researchers (e.g. Vanderheiden, 1997; Henry & Abou-Zahra, 2010) have pointed out that well-crafted accessibility often fosters a website that is better for all users, regardless of disabilities. This study used an automated accessibility checker (ATRC A-Checker) to locate accessibility errors on the websites, a technique used in a number of other website accessibility studies (e.g., Fuglerud & Røssvoll, 2011; Gilbertson & Machin, 2012; Youngblood, 2015). While Jaeger (2006) points out that automated testing tools do not render results as accurately as human inspection of the material, large sample sizes, such as the one for this study, typically use automated analysis. To help compensate for the limitations of automated code inspection, researchers (e.g. Youngblood, 2015) and this

study couple automated analysis with a manual inspection of the code for proper use of alt-attributes, something machines have difficulty discerning.

The Importance of Organizational Credibility. The experience of trying to access information from sites not built for a mobile device can be frustrating, and a user's experience on a site could affect the perceived credibility of the institution, as usability can play an important role in both user loyalty and user trust of a website (Flavián, Guinalíu & Gurrea, 2006). Even small errors, such as typographical errors and broken links, can damage a site's credibility (Fogg, 2002). Fogg (2002) states "sites win credibility points by being both easy to use and useful. Some site operators forget about users when they cater to their own company's ego or try to show the dazzling things they can do with web technology." Fogg et al. (2003) demonstrated the importance of usability in a study over 2,500 users viewing two live websites, finding that usability was a critical component in the three most important items for users when determining site credibility—informational structure, visual design and informational focus. Papachristos & Avouris (2011) echoed these findings, noting that while visual appeal was the most important element for a user in drawing a first impression of the site, perceived usability was also important. Pollach (2005) argued that companies can increase their credibility through content by providing "third-party evidence, numbers, or humanization" (pg. 298) and avoiding overestimations and overstatements. He also noted that need to make their sites usable to maintain credibility, emphasizing that website users are not passive, but rather make choices based on their informational needs. Overall, when sites look

professional and are organized in intuitive patterns, users are more likely to trust the information presented and, by extension, the organization (Fogg, et al., 2003).

Public perceptions of credibility and trustworthiness are critical issues for universities and colleges and failure by school administrators to pay attention to these issues can have severe ramifications (Seymour, 1992). As website usability is an important factor in user perception of credibility, colleges and universities need to pay attention to the state of their websites. An institutional website may often be a prospective student's first contact with the university and college-age students are heavy adopters of mobile devices (Smith, 2015). In addition, mobile device often serve as bridge devices for the digital divide, particularly among user with low socio-economic status (SES).

Universities are increasingly trying to diversify their student bodies, particularly by recruiting minority students and first generation students (McCance, 2015). These students are often from lower income families, and are more likely to be smartphone dependent due to device affordability (Smith, 2015).Universities not embracing responsive design, or some other form of mobile-first development, run the risk of disadvantaging mobile users who may not have access to desktop devices due to the digital divide (Helton, 2012). If potential students, visiting the site through a mobile device, finds the page difficult to navigate, it may negatively affect their decision to further investigate the college. Similarly, a student with disabilities may avoid a particular school if he or she encounters accessibility problems on the site. In the end, a website could be the difference between a student choosing to attend a specific school, or

pursuing some other avenue of career advancement. Digital inclusiveness, whether in the form of responsive web design or accessibility, should never contribute to a potential student's assessment of a school.

What much of this research in web credibility has in common is the concept of self-efficacy. Self-efficacy is an important component of the social cognitive theory, and is a measure of a person's internal perceived capability to successfully perform an action (Bandura, 2006). When one's confidence and capability increases, so does his or her acceptance of the technology (Waheed, et al., 2015). Comparatively, responsive web design as an idea exists to make the threshold of self-efficacy smaller, with features designed to reduce confusion and give readers a similar experience over a multitude of devices. In short, websites that are easier to use may inspire more confidence in their users and in their users' sense of self-efficacy.

Universities are also becoming more and more commercialized. Athletics are taking center-stage, and quality of education and scientific research is undergoing a similar competitive transition (Bok, 2009). It follows that the university's website would serve as the focal point for that commercialization, with many people who visit the digital platform likely never setting foot on the campus. These individuals, especially if they are opinion leaders or hold a significant audience, can still control to some extent the credibility and global perception of the university.

About Diffusion of Innovations. The nomadic nature of computing has increased dramatically since Kleinrock (1996) discussed it two decades ago. Mobile devices, by their wireless nature, facilitate nomadic computing from a person's pocket at any time.

As diffusion of innovations Theory looks at how members of specific groups decide to adopt technologies, it offers a good theoretical underpinning for examining and predicting the university adoption of innovative techniques like responsive web design.

In *Diffusion of Innovations*, Everett Rogers argues that, "diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system" (2003, pg. 5). Diffusion of innovations seeks information on how and why an idea or concept picks up steam and spreads through a specific social system. Innovation is the driving force behind social and economic progress, as well as the user recognition behind products that are involved in the marketplace (Sáenz-Royo, Gracia-Lázaro, & Moreno, 2015). Diffusion of innovations is a clearly defined social process, and the density or sparseness of individuals in a community can have a significant impact on how efficiently an innovation is perceived as normal (Eboli, 2015).

Rodgers (2003) delineated subjects of innovation into five strata of adopter categories: innovators, early adopters, early majority, late majority, and laggards. Innovators have the freedom, either by available funds or social expectations, to take risks and try new products. This stage is where failure may take place, but if a concept succeeds, it continues through the process of adoption. The acceptance begins with the opinion leaders (early adopters), whose embracement of a product can help to begin advancement of the innovation (Seebauer, 2015). The advent of social media, such as Twitter, have allowed these opinion leaders to flourish in more non-traditional environments (Cha, et al., 2010). Leadership acceptance is followed by a majority

consensus, before innovation is peaked with the late majority, leaving only the laggards to intentionally avoid innovation.

The process is repeated for all forms of emerging technology, including concepts not manifested as a physical product, such as a website design technique. The status of an innovation as an intermediary product does not render it invalid, as "software is 'the information base for the tool'" (Rogers, 2003, pg. 259). Therefore, universities need to constantly have their finger on the pulse of emerging technologies.

Diffusion of Innovations and Emerging Technologies. Diffusion of innovations is centered on technologies that are newly entering society, so much of the research involving the theory is focused on recent breakthroughs. For example, Chen & Lu (2016) analyze the acceptance of the usefulness of green transportation methods. Likewise, other research delves into the adoption of eBook readers used in place of other, more traditional, forms of reading media (Waheed, et al., 2015).

A weakness of the theory is that diffusion of innovations may not be effective in market areas which are intentionally controlled or manipulated, such as with the police force (e.g. Gayadeen & Phillips, 2014, Valente, et al., 2015). In markets like this, products are subject to intense scrutiny by various governing bodies, which is explored thoroughly in Winston's (1986) law of suppression of radical potential. Independent coalitions such as W3C tend to regulate web development by improving the programming languages and offering standards for solid design (Patch, Spellman, & Wahlbin, 2015). Likewise, a collective social concept of uniform website development keeps organizations and designers generally within a consistent structure.

Very little current research exists regarding the relationship between digital inclusiveness, responsive web design, and diffusion of innovations, likely due to responsive design's relatively recent conceptualization (approximately 2008) and the term being coined as recently as 2010. Diffusion of innovations and categories of adoption provide an avenue to explore how well diffused responsive web design is among highly regarded colleges, which are institutions one might expect to be at least early adopters of a cutting edge technique.

The purpose of this material is to guide researchers into a method of studying this pairing in a tangible and quantitative format. Responsive web design is especially significant for application to the theory because of how rapidly it has become the new normal for professional websites (Marcotte, 2010). Many Fortune 500 companies, including Starbucks, Time, Sony, and Disney, all have websites built on the platform of responsive web design as of January 2016 (Sepehr, 2014). There are, however, some significant exceptions when it comes to Fortune 500 adoption of responsive design, including Chevron, Berkshire Hathaway, and Valero.

The lack of universal adoption of responsive design cements design technique as being in the early adoption phase, as many innovative companies are using it, but not enough to count as a full market share among groups who should be opinion leaders. Responsive web design is an intriguing concept to study under the lens of diffusion of innovations, because it is not a physical product like a smartphone or tablet. Rather it is a design technique that offers the potential to make a site more usable, and hence more trustable and credible. In essence, it serves as an intermediary product between the

company and the consumer's willingness to become a customer. In the case of university websites, one of those products is a potential student's attendance of the university. Similarly, accessibility, which is also an aspect of usability and part of being digitally inclusive, has the potential to draw in or push away potential students who might have a disability. In addition, federal and state laws mandate this type of digital inclusion. The question then, is how well do top national universities meet the call for digital inclusiveness?

Research Questions and Hypotheses

An important piece of information gained from this research is the understanding of how many of the top 100 university websites use a responsive web design approach. By finding this information, one can make inferences as to the current acceptance of responsive web design among the broader web community. Likewise, this research seeks to determine the status of accessibility in university websites. Combined, one can develop a snapshot of the industry's current attention to digital inclusiveness. A highlighted element of this research is to determine the current status of responsive design in websites. By observing the websites in the sample, the research should provide an indication of how universities overall are responding to the push for both responsive web design and accessibility compliance. The information secured in the responsive web design and accessibility scores allows the research to draw associations between the two. It determines if there is any indication that effective responsive web design is also conducive of a strong emphasis on accessibility.

In this study, digital inclusiveness refers to the combination of responsive web design and accessibility of each university's home page. The central concept of quantifying and improving digital inclusiveness guided the research process. Early adopters are often opinion leaders, and top universities are likely to set the standards for other academic institutions. Based on this, the following research questions were proposed:

RQ1: To what extent have top universities have adopted responsive design for their homepages?

RQ2: To what extent have top universities have adopted WCAG 2.0 guidelines and Section 508 standards for their homepages?

Vanderheiden (1997) argued that more accessible an interface was the more suitable it would likely be for use across a variety of devices and situations. Youngblood (2015) found an association between responsive state library website homepages and homepage accessibility—responsive websites tended to fair better when it came to accessibility than non-responsive sites. Based on this, I suggest the following:

H1: Websites that score higher in responsive design will also be rated as more accessible.

Just as students use a number of factors to make their decision to attend a specific university, it is possible that a range of factors may affect a university's decision and/or ability to incorporate responsive design and accessibility into their website. This study explores several variables that may be associated with a university's use of responsive

design and accessibility. Because few, if any, of these variables have received previous attention, the following research questions are asked:

RQ3: What are the associations between responsive web design scores and

- Total enrollment
- Tuition costs
- Acceptance Rate
- Status as a public or private institution
- Geographic area

RQ4: What are the associations between WCAG 2.0 scores and

- Total enrollment
- Tuition costs
- Acceptance Rate
- Status as a public or private institution
- Geographic area

RQ5: What are the associations between Section 508 scores and

- Total enrollment
- Tuition costs
- Acceptance Rate
- Status as a public or private institution
- Geographic area

Chapter 3:

Methodology

The study examines a census of the top 100 national universities, as ranked by *U.S. News & World Report* in 2015 (U.S. News, 2015). The organization aggregates survey data with quantitative measures such as retention rates and financial resources to rank universities and provide that data to the public (Clarke, 2002), making it easy to incorporate into a study such as this one (Morse, Brooks, & Mason, 2015). Although the metrics and scoring systems behind this ranking have been criticized (Tierney, 2013), this list of schools provides a good mixture of public and private universities, as well as a range of different demographics, acceptance rates, and enrollment information. Additionally, the rankings are commonly used across many research topics pertaining to universities (e.g. Bastedo, & Bowman, 2010; Pike, 2004).

Another benefit to using such high-ranking institutions is the examination of diffusion of innovations. The question should be posed: do these 100 top colleges provide an accurate picture of the future industry-standard for university websites? In theory, these well-respected institutions are on the frontier of implementing technologies that contribute to reputational awareness. Researching this sample, as opposed to a stratified sample of 100 random universities across the U.S., benefits the collective sum of knowledge, especially because it can be used as a starting point for future research of many other responsive web design related topics.

Geographic areas were determined using U.S. Census Bureau information publicly available online (Regions and Divisions, 2016). The United States is divided into nine different zones, each consisting of a number of states (Appendix C).

In order to foster accuracy and reliability, the following standards must exist within the coding scheme. First, the coding criteria creates a scale that correctly grades the mobile usability. Second, one 20-point scale has a focus on the best practices of responsive design. Third, another scale must provide accurate representation of a design-focus on accessibility. Fourth, these scores can be easily transformed into frequencies in order to correlate the scores with information, such as students enrolled or tuition costs. Fifth, this grading scale must be replicable with any university website.

Responsive web design scores were based on 20 criteria derived from best practice guidelines from commonly cited works *Mobile First* (Wroblewski, 2011) and *Responsive Design* (Marcotte, 2014). Coding criteria were also derived from *Responsible Responsive Design* (Jehl, 2014), a follow-up guide to specific aspects of the method, as well as the World Wide Web Consortium's latest mobile accessibility guidelines (Patch, Spellman, & Wahlbin, 2015). Scores are dichotomous and additive, with each qualification represented in the Codebook (Appendix A). Each positive attribute is worth one point, while each negative attribute will gain zero points. The scale allows for a maximum overall score of 20 points, and a minimum of zero points, per university home page. The higher the score for each university homepage, the better the site according to the responsive web design scale. A score of 20 indicates perfect use of responsive design.

The desktop form of the websites were tested using an Apple MacBook Air, 13-inch screen, on the Google Chrome web browser at a screen resolution of 1440 x 900. Sliding the edge of the screen inwards allowed for the coder to view how the website responds according to responsive web design. The mobile form of the sites were tested using a Motorola Droid MAXX smartphone on the Google Chrome web browser with a resolution of 360 x 640. Two additional tools are used in this research to code for responsive design. First, the mobile-friendly readiness test from Google Developers was used to check mobile websites on a third party device. This tool checks to confirm the overall mobile-friendly nature of each website tested. Second, the built-in inspect element tool for the desktop version of Google Chrome was used to easily access the HTML and accompanying CSS.

After coding, calculations determined any correlation between mobile usability and tested information. Correlations were calculated to look for possible relationships between mobile readiness scores and the following: total enrollment, tuition, and acceptance rates. A one-way ANOVA determined associations with geographic area. In-state tuition rates were used if available, usually based on the university's status as a public or private institution. Accessibility scores were derived from W3C guidelines and previously referenced government recommendations using the web-based tool AChecker. The ATRC Web Accessibility Checker, or AChecker, is a recognized tool developers use to check for WCAG 2.0 and Section 508 flaws in the accessibility of websites (ATRC, 2015). Multiple studies, specifically in the realm of usability, e-government, and e-

commerce, have used AChecker to quantify WCAG 2.0 and Section 508 errors (e.g. Youngblood, 2014; Fuglerud & Røssvoll, 2012; Gilbertson & Machin, 2012)

AChecker indicates the number of known problems in both WCAG 2.0 and Section 508 guidelines, which is important as both are still being used to determine a website's accessibility. Data for each of the 100 universities was kept in a spreadsheet, available upon request. Using this data, correlations were run to determine if good responsive design tactics also rendered compliant accessibility factors.

Each website was given a score out of 20 based on responsive design, and compared to the number of total violations falling in the category of known issues using AChecker. Likely and possible problems were excluded. Effective usability and accessibility are both integral parts of responsive design. To that end, the coding strategy was developed to include equal parts best practices in accessibility and responsive design. Perfect scores will pertain to websites that use best practices from both areas. That total score provides a relevant numerical value to rate overall website competency and digital inclusiveness.

Chapter 4:

Results

The following sections detail significant results from the data analysis. Due to the large number of tests run, not all of the information will be presented in detail. All statistical tests were conducted using SPSS. The codebook with accompanying descriptions are available in Appendix A and a list of all universities and their corresponding scores are available in Appendix B. A gallery of individual, descriptive examples of the website information is available in Appendix D. Each school's total responsive web design score, as well as known AChecker violations using WCAG 2.0 and Section 508 standards, are compiled in Appendix B. Table 4.1 details the correlations for H1 and RQs 3-5.

Intercoder Reliability

Intercoder reliability was calculated by evaluating a 10% sample using Cohen's kappa (κ). Two researchers examined 10 random websites ranked between 101-200 and applied a status of all, some, or none regarding alternate text attributes. Additionally, each coder filled out the codebook criteria for each of the ten universities tested. Intercoder reliability was $\kappa=.825$, with $\kappa>.8$ considered acceptable (McHugh, 2012), and overall intercoder agreement was 97.5%.

Table 4.1 Correlations for H3 and RQ3-5

		RDS	WCAG	Section 508	Tuition	Enrollment	Acceptance Rate
Responsive Design	Pearson Correlation	1	-.076	.076	-.134	.006	.034
Total Score	Sig. (2-Tailed)		.454	.452	.182	.949	.739
	N	100	99	99	100	100	100
WCAG 2.0 Errors	Pearson Correlation	-.076	1	.695**	-.071	-.222*	.059
	Sig. (2-Tailed)	.454		.000	.484	.027	.564
	N	99	99	99	99	99	99
Section 508 Errors	Pearson Correlation	.076	.695**	1	.039	-.254*	-.040
	Sig. (2-Tailed)	.452	.000		.705	.011	.696
	N	99	99	99	99	99	99
Tuition	Pearson Correlation	-.134	-.071	.039	1	-.632**	-.507**
	Sig. (2-Tailed)	.182	.484	.705		.000	.000
	N	100	99	99	100	100	100
Enrollment	Pearson Correlation	.006	-.222*	-.254*	-.632**	1	.297**
	Sig. (2-Tailed)	.949	.027	.011	.000		.003
	N	100	99	99	100	100	100
Acceptance Rate	Pearson Correlation	.034	.059	-.040	-.507**	.297**	1
	Sig. (2-Tailed)	.739	.564	.696	.000	.003	
	N	100	99	99	100	100	100

*** Responsive Design Score

**. Correlation Is Significant At The 0.01 Level (2-Tailed).

*. Correlation Is Significant At The 0.05 Level (2-Tailed).

Responsive Design and Accessibility

RQ1 questioned to what extent top universities have adopted responsive design for their homepages. Of the 100 university websites tested, 86 (86%) had scores of 15 or higher, indicating a solid grasp of responsive web design standard The average responsive design score was 18.1, representing 90.5% of the standards. Only 14 (14%) schools had a score of 15 or below, representing sites that are clearly not responsive. By far the most common score was 19 (41%, n = 41), with the alternate text item on the codebook (item 2) being the most common error (45%, n = 45). Second most common was a perfect score (32%, n = 32), indicating a flawless focus on responsive web design.

All websites tested received a point for the correct use of tables (codebook item 3), and for containing an obvious navigation menu.

RQ2 questioned to what extent top university home pages meet federal and industry accessibility standards and guideline. Regarding accessibility scores, nine universities (9%) made a perfect score with no WCAG 2.0 errors reported by AChecker. Likewise, three universities (3%) made a perfect score using Section 508 standards. The most common WCAG 2.0 scores were zero and two, both of which were scored by nine universities. The mean WCAG 2.0 score was 24.92. The SUNY College of Environmental Sciences and Forestry had the most errors, with 537. The most common Section 508 score was three, made by ten universities, with a range of scores from zero to 67. The mean Section 508 score was 11.01. Two universities, Pittsburg and New York, received perfect scores for both WCAG 2.0 and Section 508 standards. One website, the University of St. Louis, was unable to be scored for accessibility by AChecker.

Based on prior research, H1 suggested that university websites that scored higher in responsive design would also be rated as more accessible. A Pearson's Product-Moment Correlation test was performed based upon the total responsive web design score of all 100 university websites and their respective WCAG 2.0 scores, $n = 100$, $r = .01$, $p = .95$. Findings found no statistically significant relationship between the two variables. Next, a Pearson's Product-Moment Correlation test was performed based upon the total responsive web design score of all 100 university websites and their respective Section 508 scores, $n = 100$, $r = .01$, $p = .95$. H3 was not supported based on either correlations with Section 508 standards or WCAG 2.0 guidelines.

Responsive Design and University Characteristics

RQ 3 questioned whether there would be an interplay between responsive design and a series of university characteristics. A linear regression was performed with responsive design scores as the dependent variable and using tuition, total enrollment, acceptance rate, geographic area, and public/private status as predictors. As seen in Table 4.2, none of the variables were identified as predictors of responsive design, $F(5, 94)=.773$, $p=.572$. R^2 for the model was .039 and adjusted R^2 for the model was -.012.

Table 4.2 Regression analysis predicting responsive design

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	21.897	2.342		9.349	.000
Tuition	1.172E-5	.000	.071	.165	.869
Enroll	-2.793E-5	.000	-.142	-1.082	.282
Acceptance Rate	-.007	.017	-.049	-.416	.678
Geographic Area	-.051	.113	-.047	-.450	.654
Public/Private	-1.959	2.400	-.341	-.816	.416

Pearson product moment correlations were performed between the total responsive web design score of all 100 university websites and each variable. Note that all public universities tested have lower in-state tuition than out of state tuition. All private schools tested have the same tuition rate regardless of state of residency. For this test, in-state tuition rates were used for public universities. As seen in Table 4.1, results the correlational analysis found no statistically significant relationship between the previously listed variables and responsive design scores, enrollment, $n = 100$, $r = .01$, $p = .95$; tuition, $n = 100$, $r = -.13$, $p = .18$; acceptance rate, $n = 100$, $r = .01$, $p = .95$. RQ 3

also addressed the relationship between responsive design and the university's status as a public or private institution, as well as its geographic area. Follow-up independent groups t-test revealed that private universities (M = 17.70, SD = 3.05, n = 53) and public universities (M = 18.57, SD = 2.62 n = 46) did not differ in any significant way regarding responsive web design scores, t (98) = 1.50, p = 0.58.

A one-way ANOVA test comparing responsive web design scores and geographic area were not significantly related, F (8, 91) = 0.92, p = 0.50.

Next, the relationship between the independent variables of total enrollment, tuition rates, acceptance rate, and the dependent variable "accessibility errors" was explored. The previously described regression and correlations were again conducted with the same independent variables, but using the total number of WCAG 2.0 errors as the dependent variable.

A linear regression was calculated to predict WCAG 2.0 scores using tuition, total enrollment, acceptance rate, geographic area, and public/private status as the independent variables, $F(5, 93)=3.073$, p=.013. R^2 for the model was .142 and adjusted R^2 for the model was .096. Tuition and enrollment were found to be predictive of WCAG 2.0 accessibility.

Table 4.3 Regression analysis predicting WCAG 2.0

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	68.074	48.321		1.409	.162
Tuition	-.003	.001	-.857	-2.072	.041
Enroll	-.002	.001	-.433	-3.489	.001
Acceptance Rate	.005	.343	.002	.013	.989
Geographic Area	-1.342	2.308	-.058	-.582	.562
Public/Private	63.843	49.630	.516	1.286	.202

A Pearson's bivariate correlation test comparing tuition rates and WCAG 2.0 standards (using the same in-state values for public universities) yielded no significance, $n = 99$, $r = .07$, $p = .48$. A Pearson's bivariate correlation test comparing acceptance rate and WCAG 2.0 standards also yielded no significance, $n = 99$, $r = .06$, $p = .56$.

An independent groups t-test also revealed no significant difference in private universities ($M = 22.98$, SD = 36.95 n = 53) and public universities ($M = 27.17$, SD = 82.31, $n = 46$) regarding WCAG 2.0 compliance, $t\ (98) = 0.33$, $p = 0.30$.

A one-way ANOVA test comparing WCAG 2.0 scores and geographic area were also not significantly related, $F\ (8, 90) = 1.01$, $p = 0.44$. The only significant associations between responsive design and any component of RQ2 were regarding total enrollment, which appeared to have a moderately significant association with WCAG 2.0 standards.

Section 508 Tests

Finally, Research Question 5 was assessed. First, a linear regression was calculated using tuition, total enrollment, acceptance rate, geographic area, and

public/private status as predictors and Section 508 scores as the dependent variable, $F(5, 93) = 2.884$, $p = .018$, $R^2 = .134$, adjusted $R^2 = .088$. Reflecting the previous findings for WCAG 2.0 accessibility, tuition and enrollment were predictive of Section 508 accessibility.

Table 4.4 Regression analysis predicting Section 508

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	12.382	8.862		1.397	.166
Tuition	-.001	.000	-1.050	-2.527	.013
Enroll	.000	.000	-.365	-2.930	.004
Acceptance Rate	-.035	.063	-.063	-.552	.582
Geographic Area	-.341	.423	-.080	-.806	.422
Public/Private	18.806	9.102	.833	2.066	.042

The same tests were performed using AChecker's Section 508 known problems. A Pearson's bivariate correlation test comparing total enrollment and Section 508 standards also yielded significance at the .05 level, $n = 99$, $r = -.25$, $p = .01$. The two items were moderately negatively correlated. A negative correlation regarding both WCAG 2.0 and Section 508 standards indicates that the higher the total enrollment, the fewer accessibility errors each website contains.

A Pearson's bivariate correlation test comparing tuition rates and Section 508 standards (using the same in-state values for public universities) yielded no significance, $n = 99$, $r = .04$, $p = .71$.

An independent groups t-test revealed no significant difference in private universities (M = 11.94, SD = 11.45 n = 53) and public universities (M = 9.93, SD = 11.18, n = 46) regarding Section 508 compliance, t (98) = -0.88, p = 0.59.

A one-way ANOVA test factors comparing WCAG 2.0 scores and geographic area were not significantly related, F (8, 90) = 0.93, p = 0.50.

The only significant associations between responsive design and any component of RQ3 were regarding total enrollment, which appeared to have a moderately significant association with Section 508 standards.

Chapter 5:

Discussion

The purpose of this study was to explore the nation's top universities' current focus on responsive web design and accessibility in the context of diffusion of innovations. This research attempt to determine how well each university implemented these two concepts, and determine any connections between responsive web design, accessibility, and a number of factors that could play a role in affecting adoption of these digitally inclusive needs. This section will address each research question and discuss how it relates to the results found. It will also provide suggestions for the relevance of the content, how it can improve understanding of the current status of university websites, and ruminate upon what still needs to be improved regarding digital inclusiveness.

The Current State of Responsive Web Design and Accessibility. Results of this study suggest that most of the university websites tested are already using responsive web design. While some responsive websites used the design philosophy more effectively than others, the findings suggest that the top 100 universities are indeed on the cutting edge of website development. The overwhelming number of universities that adopt responsive web design is an indicator that these schools are concerned about mobile credibility and the appearance they have to the public on the web. By sensing the direction of web development philosophy, they embraced the responsive design approach and ultimately became the early adopters, forcing the rest of the industry to follow suit. Because of their early adoption, universities can use their website as an effective recruitment tool due to its new and interesting design concept.

Commonalities

This consistent use of responsive design allowed for a type of consistency across the field. Core components of many sites included a collapsible navigation menu that reduces in bulk the smaller the screen size. A search function was almost always built into menu module or located near the top of the sites, allowing for simple text access to any information the user required. Of note is that many universities used a Google custom search interface to serve as their primary search device. This could be due to Google's algorithm being useful for searching individual pages within a website, allowing programmers to avoid having to build a unique search interface for one particular site.

Also of note is that none of the universities tested contained a contact field of any kind on the home page. This may have been due to contact fields taking up space that can be used for advertisement, campus news, or links to different parts of the site. Another possibility is that the designers of the site wanted to bury the ability to contact people within the site in order to show the user information that may persuade the individual to visit the university. By delaying the ability to contact a representative, a university can impress a user with its responsively designed site.

The universities using responsive design adhered to this formatting with little deviation, which is beneficial because a user can investigate the website of one university before visiting the website of another with a low learning curve. This quasi-uniformity minimizes the stress on accessing information from multiple university websites despite the different branding.

Responsive design is also effective because it leaves room for creativity and university aesthetics. There was no one single path for the universities when it came to approaching designed content. For example, some universities featured their top research on the home page. Other universities allowed the user to experience the college through interactive photo galleries and campus tours. Finally, some schools highlighted their athletic teams' accomplishments. While a developer can no longer simply design for a desktop computer, responsive design allows the unique advantage of letting each user have a unique experience. These websites did that effectively for all platforms, allowing them to put their best foot forward.

While almost all universities focused on responsive web design, it seemed not as many chose to comply as thoroughly with standards of accessibility. While accessibility was certainly important to a number of websites, especially those that scored in the single digits of both WCAG 2.0 and Section 508 standards, many more sites showed disregard for getting the behind-the-scenes accessibility tasks correct. This is indicated by the lack of significant correlation between the responsive web design scores and the accessibility scores. Many of the websites that received a 20/20 or 19/20 on the responsive design scale received a poor score on the accessibility scales. The University of Miami, for instance, scored an 18/20 on the responsive web design scale, and yet had 197 WCAG 2.0 errors, 67 Section 508 errors, and had no alternate text on any homepage images. The indication is that universities are emphasizing style over accessibility, and that the things unseen are of less importance than the ones that are directly noticeable to the non-impaired consumer.

A Positive Direction for Digital Inclusiveness

The positive correlation between accessibility scores and total enrollment indicates that the universities catering to the largest number of students seem the most concerned about accessibility. None of the top ten highest enrolled universities had more than ten WCAG 2.0 accessibility errors, and only one had over ten Section 508 errors. Universities with higher enrollment likely serve a larger number of people with impairments, necessitating a closer focus on accessibility.

This finding suggests that larger universities have a greater commitment to accessibility. Digital inclusiveness requires easy information access to individuals in all situations, and it suggests high enrollment universities are demonstrating a greater sensitivity regarding students with impairment. These universities exemplify that, in at least this area, educational equality is being achieved. It also proves that practical accessible equality in education goes beyond classrooms and buildings, and into the realm of digital inclusiveness. As accessibility standards improve and technology develops, perhaps society is beginning to see the first signs of a perfectly usable device and achieving perfect digital inclusiveness.

The overwhelming adoption of responsive design by top-rated universities represents an equally positive advancement in digital inclusiveness. Institutions of higher education are not content to lag behind, but are instead improving usability and reducing frustration as the design philosophies present themselves. Beyond an attractive recruitment tool, responsive design makes life easier for anyone associated with a university. Additionally, a responsively designed site helps to improve the usability of

individuals of lower socioeconomic status, as many of them require smartphones and other bridge devices to access the web. Smaller and lower-rated university administrations should understand that a responsively designed site could only help increase credibility among people of all socioeconomic status.

While responsive design seems well adopted by the sample universities, accessibility is clearly an issue for many institutions. By far the most common error when checking for accessibility issues was the lack of valid alternate text on images. In a way, this makes sense due to the extra step a developer must take to get information to the screen. On the other hand, however, valid alternate text is important because a sight-impaired individual must rely on a screen-reader, which reads the alternate text attribute to the user, to receive the information. Miscoded or invalid information given to the user may lead to confusion, misinterpretation, or frustration. Additionally, slower internet connections rely on alternate text to convey information unattainable in image form.

The second most common error regarded responsive web design, in this case with horizontal scrolling existing on the devices tested. While all non-responsive websites contained horizontal scrolling, a few of the responsive sites also contained minor errors were the screen did not hit the proper breakpoint at the correct resolution during resizing. A more specific codebook should differentiate between scrolling based on design philosophy and accidental horizontal scrolling. One other common responsive web design error was the text not changing size while resizing. In many cases, the text simply relocated to a different portion of the screen, or was cut off to render it incomplete. The

specifications regarding the codebook criteria is available in Appendix A. The exact breakdown of universities and their scores per criteria are available upon request.

Limitations and Future Research. Because little research has been performed on this topic, this study comes with several important limitations as well as numerous opportunities for future research.

First, a true snapshot of the overall status of responsive web design and accessibility in university websites cannot be achieved until one creates a stratified sample of universities, from top universities to small private institutions, all the way down to state-run community colleges. This research focused on the early adopters regarding diffusion of innovations, but that designation is likely not the status quo for the majority of students and their respective colleges across the United States. These universities might have the most progressive websites because they have the most prestige and resources to implement development. These sites have likely undergone extensive reviews, accessibility checks, and usability testing. Future research should focus on producing a broader sample of universities around the nation. Future research needs to expand the playing field by performing both quantitative and qualitative analyses of university websites. For example, studies could demonstrate the accessibility issues individuals experience when needing information from a website that is not accessible. Additionally, studies could explore the issues users experience when using a site that is unresponsive on both a desktop and mobile device. Many research questions across an array of methodologies could explore university websites as they relate with

digital inclusiveness, each one existing to explore the expansive realm of diffusion of innovations.

Improvements in Coding

Another limitation in this research, which was not discovered until after coding, was that the codebook may tend to skew high. This is suggested by the fact that no university scored lower than a nine on the 20-point scale. Future research should work to create more of a more diverse set of results with the codebook and findings, perhaps by changing the "all-or-nothing" approach to a more scaled approach. For example, regarding point two on the codebook, if even one image did not contain an alternate text attribute, a score of zero was given. Similarly, point 18's sole purpose was to check for misuse of contact fields, however no website examined contained a contact field of any kind.

Indeed, a more specific analysis of responsive web design in university websites might yield some additional associations. Future research should work to refine the codebook into something more universally acceptable for scoring college websites. A more granular coding method is needed to capture the nuances of the sites, and while that may lead to a smaller sample size, it would allow for better interpretation of the results. One method for creating a more effective codebook is to make each criteria a scale. A scale could alleviate situations in which the university webpages only falter by a small amount. For example, if a page were only missing one alternate text attribute, it would no longer be counted as missing the entire value and receiving a score of zero. Also, sites

with only minor horizontal scrolling errors should not lose the entire quantity of the score.

One particular drawback to this research is that it coded for WCAG 2.0 AAA errors. Not all websites and accessibility guidelines observe WCAG 2.0 AAA errors, often stopping at AA. Additional research with this method can still gather WCAG 2.0 AAA violations, but it needs to be weighted in a way where these errors least affect the overall score. Alternately, a coder should consider only examining A and AA errors.

The fact that other items, such as tuition, acceptance rate, and geographic area, did not correlate with responsive web design or accessibility scores may not be an indication that those correlations are not there, but rather the sample is not correct for making discoveries on these matters. To see the difference, a researcher may need to compare the results of a sample of top universities to a sample of smaller ones. Therefore, this may not be an indication of insignificance, but rather how well each of these 100 universities in particular are doing in the realm of responsive web design and accessibility.

New Opportunities for Research

University websites are constantly changing, and that a university website on any given day may be completely different than the last time it was viewed. Turnover in information technology departments, as well as public relations departments, lead to different programmers taking the helm of the website. Studies need to involve a university's commitment from an accessibility standpoint. Valuable information can be

gained by studying the number and skill level of people in charge of making a university website digitally inclusive.

Because of the constant change, it is difficult to analyze any website with extreme accuracy by just the snapshots presented in this research. Instead, one must to set up a longitudinal study, even if the sites studied are fewer in number. Any researcher wanting to develop a more nuanced study of university websites needs to restrict his or her sample size and review the site over the long term. By doing so, a researcher can also track the advancement of technology from the perspective of diffusion of innovations.

Instead, this study viewed a multitude of sites and targeted only a few specific things. Although it does provide an overview of all universities, reducing entire schools down to a few numeric scores takes away much of the nuance that a qualitative or more in-depth analysis will provide. Regardless, this study is beneficial because it establishes benchmarks for future studies regarding responsive web design. Perhaps the methodology and findings of this study can be used to make future discoveries in the field.

The correlation between total enrollment and focus on accessibility needs to be examined more closely, perhaps in a qualitative setting. More understanding is needed regarding why universities that are smaller in enrollment may choose to delay a commitment to accessibility in favor of more visible issues. In order to accomplish this, studies could examine universities of similar size, possibly by ranking universities by total instead of by perception of quality. Interviews, as well and monitoring the themes of the website, can help provide a more personal look at the philosophies that go into the development of a site. A method like this can determine if smaller universities view their

website as more of an advertisement, seeking to bring in new students through flashy design or interesting features. Conversely, larger universities could view their website as an overarching tool for digital inclusiveness.

Other research should also look more specifically at both usability and potential accessibility issues, particularly regarding ADA Title II and state institutions and public universities. Researchers need to discuss the legal accessibility standards of these institutions, almost all of which receive federal funding and would presumably require compliance with accessibility standards discussed. Modifications to the scoring system can allow for focus on any specific legal aspect of website development, not just the accessibility standards as a whole.

Future research should also delve further into responsive design in university websites than just looking at the home pages. There needs to be a method for examining a website in its entirety, rather than just the most publicized page. An alternate coding structure could be developed to research the ease of common tasks, such as filling out an application, finding a specific piece of information, or contacting a university representative regarding admissions. A more hands-on approach, using subjects in a richer setting, can lend more qualitative research than can be found simply by running a few scoring scenarios. Finding the best methods for developing holistic and accessibly sound websites in the ever-changing world of mobile technology is increasingly difficult, but as more and more people are smartphone-dependent, it also becomes increasingly necessary. Society must continue to advance in design and ease of use for all individuals if it is to be truly digitally inclusive.

References

Accessibility Basics (2016). *Accessibility Basics*. Retrieved April 20, 2016 from http://www.usability.gov/what-and-why/accessibility.html

Achterkamp, R., Hermens, H., & Vollenbroek-Hutten, M. (2015). The influence of success experience on self-efficacy when providing feedback through technology. *Computers in Human Behavior*, *52*, 419-423.

Alshawi, S., & Alalwany, H. (2009). E-government evaluation: Citizen's perspective in developing countries. *Information Technology for Development, 15*(3), 193-208.

Anderson, M (2015a). *Technology Device Ownership: 2015*. Pew Research Center: Washington D.C. Retrieved April 19, 2016 from http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015/

Anderson, M (2015b). *The Demographics of Device Ownership*. Pew Research Center: Washington D.C. Retrieved April 19, 2016 from http://www.pewinternet.org/2015/10/29/the-demographics-of-device-ownership/

ATRC (2015). *IDI web accessibility checker: Web accessibility checker*. Retrieved April 22, 2016 from http://achecker.ca/

Bandura, A. (2006). *Self-efficacy beliefs of adolescents*. Information Age Publications: Charlotte, N.C. 307-337.

Bastedo, M. N., & Bowman, N. A. (2010). *US News & World Report* college rankings: Modeling institutional effects on organizational reputation. *American Journal of Education, 116*(2), 163-183.

Bohyun, K. (2013). Responsive web design, discoverability, and mobile challenge. *Library Technology Reports*, *49*(6), 29-30.

Bok, D. (2009). *Universities in the marketplace: The commercialization of higher education*. Princeton University Press.

Caldwell, B., Cooper, M., Reid, L., & Vanderheiden, G., ed. (2008). *Web Content Accessibility Guidelines 2.0*. Retrieved February 12, 2016 from https://www.w3.org/TR/WCAG20/

Cha, M., Haddadi, H., Benevento, F., & Gummadi, P. K. (2010). Measuring user influence in Twitter: The million follower fallacy. *ICWSM*, *10*(10-17), 30.

Chamary, J. (2015, September 12). 3D touch in iPhone 6S isn't just a gimmick. Here's how it works. *Forbes Magazine Online.* Retrieved March 15, 2016 from http://www.forbes.com/sites/jvchamary/2015/09/12/3d-touch-iphone-6s/#4333e1c2abc0

Charski, M. (2015). Beyond responsive design: Optimizing for different mobile devices. *Econtent*, *38*(7), 18-22.

Chen, S., & Lu, C. (2016). Exploring the relationships of green perceived value, the diffusion of innovations, and the technology acceptance model of green transportation. *Transportation Journal, 55*(1), 51–77.

Cipriani, J. (2012, June 18). Twelve ways to customize your Android device. *CNET.* Retrieved March 2, 2016 from http://www.cnet.com/how-to/twelve-ways-to-customize-your-android-device/

Clarke, M. (2002). Quantifying quality: What can the *US News and World Report* rankings tell us about the quality of higher education? *Education Policy Analysis Archives, 10*, 16.

Cochrane, T. D. (2014). Critical success factors for transforming pedagogy with mobile Web 2.0. *British Journal of Educational Technology*, *45*(1), 65-82.

Desruelle, H., & Gielen, F. (2015). Context-driven progressive enhancement of mobile web applications: A multicriteria decision-making approach. *Computer Journal*, *58*(8), 1732-1746.

Digital Inclusion (2016). *Digital Inclusion Survey.* Retrieved May 9, 2016 from http://digitalinclusion.umd.edu/

Easton, C. (2013). Website accessibility and the European Union: citizenship, procurement and the proposed Accessibility Act. *International Review of Law, Computers & Technology*, *27*(1/2), 187-199.

Eboli, M. (2015). Diffusion of innovations in dense and sparse networks. *Quality & Quantity*, *49*(4), 1559-1571.

Euerby, A., & Burns, C. M. (2014). Improving social connection through a communities-of-practice-inspired cognitive work analysis approach. *Human Factors*, *56*(2), 361-383.

Fagan, J. C., & Fagan, B. (2004). An accessibility study of state legislative websites.

Flavián, C., Guinalíu, M., & Gurrea, R. (2006). The role played by perceived usability, satisfaction and consumer trust on website loyalty. *Information & Management*, *43*(1), 1-14.

Fogg, B.J. (2002). *Stanford guidelines for web credibility. A Research Summary from the Stanford Persuasive Technology Lab*. Retrieved May 16, 2016 from http://credibility.stanford.edu/guidelines/index.html

Fogg, B.J., Soohoo, C., Danielson, D.R., Marable, L., Stanford, J., & Tauber, E.R. (2003). How do users evaluate the credibility of Web sites? *Proceedings of DUX '03: Designing for User Experiences* (pp 1-15). ACM.

Fuglerud, K. & Røssvoll, T. (2011). An evaluation of web-based voting usability and accessibility. *Universal Access in the Information Society International Journal* (2011), 1-15.

Gallaugher, J., & Ransbotham, S. (2010). Social media and customer dialog management at Starbucks. *MIS Quarterly Executive, 9*(4), 197-212.

Gardner, B. S. (2011). Responsive web design: Enriching the user experience. *Sigma Journal: Inside the Digital Ecosystem, 11*(1), 13-19.

Gayadeen, S. M., & Phillips, S. W. (2014). The innovation of community policing and the COPS Office: does diffusion of innovation theory hold in a manipulated environment? *International Journal of Police Science & Management*, *16*(3), 228-242.

Gilbertson, T. D., & Machin, C. H. C. (2012). Guidelines, icons and marketable skills: An accessibility evaluation of 100 web development company homepages. *Proceedings of the International Cross-Disciplinary Conference on Web Accessibility*, W4A '12, 4.

Gkanatsios, D. I., & Retalis, S. (2015). Interaction patterns for Windows 8 tablet applications. *Proceedings of the 18th European Conference on Pattern Languages of Program.* ACM.

Gkatzidou, V., Hone, K., Sutcliffe, L., Gibbs, J., Tariq Sadiq, S., Szczepura, A., & Estcourt, C. (2015). User interface design for mobile-based sexual health interventions for young people: Design recommendations from a qualitative study on an online Chlamydia clinical care pathway. *BMC Medical Informatics & Decision Making*, *15*(1), 1-13.

Government Information Quarterly, *21*(1), 65–85.

Helton, D. (2012). Bridging the digital divide in developing nations through mobile phone transaction systems. *B>Quest 2012.* 1-18.

Henry, S. L., & Abou-Zahra, S. (2010). *Web accessibility and usability working together. W3C Web Accessibility Initiative*. Retrieved April 20, 2016 from https://www.w3.org/WAI/EO/Drafts/access-use/accessibility-n-usability.html

Jaeger, P. T. (2004). Beyond Section 508: The spectrum of legal requirements for accessible e-government Web sites in the United States. *Journal of Government Information, 30*(4), 518-533.

Jaeger, P. T. (2006). Assessing Section 508 compliance on federal e-government

Jehl, S. (2014) *Responsible responsive design*. New York: A Book Apart.

Jobe, W. (2013). Native apps vs. mobile web apps. *iJIM, 7*(4), 27-32.

Kim, B. (2013). Responsive web design, discoverability, and mobile challenge. *Library Technology Reports, 49*(6), 29-39.

Kleinrock, L. (1995). Nomadic computing—an opportunity. *ACM SIGCOMM Computer Communication Review, 25*(1), 36-40.

Kushalnagar, P., Naturale, J., Paludneviciene, R., Smith, S. R., Werfel, E., Doolittle, R., & DeCaro, J. (2015). Health websites: Accessibility and usability for American Sign Language users. *Health Communication, 30*(8), 830-837.

Maatta Smith, S. L. (2014). Web Accessibility Assessment of Urban Public Library Websites. *Public Library Quarterly, 33*(3), 187-204.

Marcotte, E. (2010, May 25). *Responsive web design*. A List Apart. Retrieved February 10, 2016 from http://alistapart.com/article/responsive-web-design

Marcotte, E. (2014) *Responsive design*. New York: A Book Apart.

McCance, M. (2015). Increase in First-Generation Students Highlights Applicant Pool for Class of 2019. *UVA Today.* Retrieved May 16, 2016 from https://www.news.virginia.edu/content/increase-first-generation-students-highlights-applicant-pool-class-2019

Mohorovicic, S. (2013). Implementing responsive web design for enhanced web presence. *36th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO),* 1206-1210.

Morse, R., Brooks, E., & Mason, M. (2015). How *U.S. News* calculated the 2016 best colleges rankings. *U.S. News & World Report.* Retrieved March 12, 2016 from http://www.usnews.com/education/best-colleges/articles/how-us-news-calculated-the-rankings

Neilson, J. (1999). *Designing web usability: The practice of simplicity*. New Riders: San Francisco.

Olalere, A., & Lazar, J. (2011). Accessibility of U.S. federal government home pages: Section 508 compliance and site accessibility statements. *Government Information Quarterly, 28*(3), 303–309.

Papachristos, E., & Avouris, N. (2011). Are first impressions about websites only related to visual appeal? *Human-Computer Interaction–INTERACT 2011*, 489-496.

Park, W., & Han, S. H. (2014). An analytical approach to creating multitouch gesture vocabularies in mobile devices: A case study for mobile web browsing gestures. *International Journal of Human-Computer Interaction, 30*(2), 126-141.

Patch, K., Spellman, J., Wahlbin, K (2015). Mobile accessibility: How WCAG 2.0 and other W3C/WAI guidelines apply to mobile, W3C. Retrieved March 12, 2016 from http://www.w3.org/TR/mobile-accessibility-mapping/

Pew Research Center (2015). *Mobile Technology Fact Sheet*. Washington D.C.: Pew Research Center. Retrieved April 19, 2016 from http://www.pewinternet.org/fact-sheets/mobile-technology-fact-sheet/

Pike, G. R. (2004). Measuring quality: A comparison of *US News* rankings and NSSE benchmarks. *Research in Higher Education, 45*(2), 193-208.

Pollach, I. (2005). Corporate self-presentation on the WWW: Strategies for enhancing usability, credibility and utility. *Corporate Communications: An International Journal*, *10*(4), 285-301.

Regions and Divisions (2016). Regions and Divisions, U.S. Census Bureau. Retrieved April 20, 2016 from http://www.census.gov/econ/census/help/geography/regions_and_divisions.html

Reid, L. G., & Snow-Weaver, A. (2008). WCAG 2.0: A web accessibility standard for the evolving web. *Proceedings of the 2008 international cross-disciplinary conference on Web accessibility, W4A,* 109-115.

Rempel, G. H., & Bridges, L. (2013). That was then, this is now: Replacing the mobile-optimized site with responsive design. *Information Technology & Libraries*, *32*(4), 8-24.

Rodgers, E. (2003). *Diffusions of innovations (5th ed.)*. New York: Free Press.

Sáenz-Royo, C., Gracia-Lázaro, C., & Moreno, Y. (2015). The role of the organization structure in the diffusion of innovations. *Plos ONE, 10*(5), 1-13.

Sager, I. (2012, June 29). Before IPhone and Android Came Simon, the First Smartphone. *Bloomberg Business.* Retrieved May 16, 2016 from http://www.bloomberg.com/news/articles/2012-06-29/before-iphone-and-android-came-simon-the-first-smartphone

Seebauer, S. (2015). Why early adopters engage in interpersonal diffusion of technological innovations: An empirical study on electric bicycles and electric scooters. *Transportation Research*, *78*, 146-160.

Sepehr, B. (2014, December 19). Top 10 Large Companies Using Responsive Web Design Technology. *Uniwebb Software Blog.* Retrieved February 15, 2016 from

http://www.uniwebb.com/blog/post/top-10-large-companies-using-responsive-web-design-technology/1021/

Seymour, D. T. (1992). *On Q: Causing quality in higher education*. Riverside, NJ: Macmillan Publishing Company.

Shuguang, H., Zhen, Y., & Daqing, H. (2015). Understanding and supporting cross-device web search for exploratory tasks with mobile touch interactions. *ACM Transactions On Information Systems*, *33*(4), 1-34.

Smith, A (2015). *U.S. Smartphone Use in 2015*. Washington D.C.: Pew Research Center. Retrieved April 19, 2016 from http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/

Tierney, J. (2013, September 10). Your annual reminder to ignore the *U.S. News & World Report* college rankings. *The Atlantic.* Retrieved March 8, 2016 from http://www.theatlantic.com/education/archive/2013/09/your-annual-reminder-to-ignore-the-em-us-news-world-report-em-college-rankings/279103/

U.S. News and World Report (2015). *National universities rankings*. Retrieved April 20, 2016 from http://colleges.usnews.rankingsandreviews.com/best-colleges/rankings/national-universities?int=9ff208

University System of Georgia. (2016). *Higher Education, the Americans with Disabilities Act and Section 508*. Retrieved March 29, 2016 from http://www.usg.edu/siteinfo/higher_education_the_americans_with_disabilities_act_and_section_508

Valente, T. W., Dyal, S. R., Chu, K., Wipfli, H., & Fujimoto, K. (2015). Diffusion of innovations theory applied to global tobacco control treaty ratification. *Social Science & Medicine*, *145*, 89-97.

Vanderheiden, G. C. (1997). More than screen deep: Toward every-citizen interfaces to the nation's information infrastructure. In N. R. Council, *More than Screen Deep: Toward Every-Citizen Interface to the Nation's Information Infrastructure* (pp. 297-306). Washington, D.C.: National Academy Press.

Waheed, M., Kaur, K., Ain, N., & Sanni, S. A. (2015). Emotional attachment and multidimensional self-efficacy: extension of innovation diffusion theory in the context of eBook reader. *Behaviour & Information Technology, 34*(12), 1147-1159.

Web sites: A multi-method, user-centered evaluation of accessibility for persons

WebAIM (2015). Screen Reader User Survey #6. Retrieved April 9, 2016 from http://webaim.org/projects/screenreadersurvey6/

Wen, C., & Zhang, J. (2015). Design of a microlecture mobile learning system based on smartphone and web platforms. *IEEE Transactions On Education*, *58*(3), 203-207.

Winston, B. (1986) *Misunderstanding Media*. Cambridge: Harvard University Press.

with disabilities. *Government Information Quarterly, 23*(2), 169–190.

Wroblewski, L. (2011). *Mobile first*. New York: A Book Apart

Youngblood, N. E., & Lysaght, R. (2015). Accessibility and Use of Online Video Captions by Local Television News Websites. *Electronic News*, *9*(4), 242-256.

Youngblood, N.E (2015), The Digital Inclusiveness of State Library Websites, Accessibility for Persons with Disabilities and the Inclusive Future of Libraries. *Advances in Librarianship*, *40*(1), 193 - 211

Zakas, N. C. (2013). The evolution of web development for mobile devices. *Communications of The ACM, 56*(4), 42-48.

Zhou, T. (2013). Understanding continuance usage of mobile sites. *Industrial Management & Data Systems, 113*(9), 1286-1299.

Zichermann, G., & Cunningham, C. (2011). *Gamification by design: Implementing game mechanics in web and mobile apps*. Beijing: O'Reilly Media, Inc

Appendix A: Codebook

The following codebook was developed using combined techniques from *Responsive Design* (Marcotte, 2014) and *Responsible Responsive Design* (Jehl, 2014). Many of these design techniques were derived from Marcotte's (2010) initial article on responsive web design. The codebook also includes three components regarding WCAG 2.0 which directly affect responsive web design. The page numbers cited below act as an additional guidebook for how these concepts should be practically used.

QUESTION	YES	NO
1. **Does the website use an alternate mobile site?** Description: the goal of responsive web design is to have a singular site functioning appropriately across any device. Therefore, any site that automatically redirects or prompts mobile users to an alternate site does not hold the principles of responsive web design. **[•] Marcotte** **[•] Jehl** [] W3C	+0	+1
2. **Does the website contain appropriate alternate text attributes based on both AChecker results and a manual page examination?** Description: W3C requires alternate text for every non-text element, which includes "images, graphical representations of text (including symbols), image map regions, animations (e.g., animated gifs), applets and programmatic objects, ASCII art, frames, scripts,	+1	+0

QUESTION	YES	NO
images used as list bullets, spacers, graphical buttons, sounds (played with or without user interaction), stand-alone audio files, audio tracks of video, and video." In order to text for this, data from AChecker was examined, along with a manual inspection of the code. The coder then chose between three options regarding the status of alternate text on the site: *all*, *some*, or *none*. A home page is required to have alternate text on *all* elements to pass this qualification. [] Marcotte [] Jehl **[•] W3C (guideline 1.1)**		
3. **Does the website use tables for non-tabular data?** Description: tables often display critical information to the user, especially in the form of ordered lists with numeric data. However, using the table element to display information that does not belong in tabular format can sabotage the goal of responsive design, as only a finite number of rows and columns can exist in a given horizontal width. This inevitably causes horizontal scrolling. This codebook entry ensures that only tabular data be displayed in table format. [] Marcotte **[•] Jehl (p. 21)** [] W3C	+0	+1
4. **Does the website craft its infrastructure using proportional terms, such as percentages or em, instead of pixels?**	+1	+0

QUESTION	YES	NO
Description: this can often be observed by consistent movement when resizing the browser window. When resizing, all elements will move in conjunction with each other instead of breaking into different pieces. **[•] Marcotte (p. 28)** **[•] Jehl** [] W3C		
5. **Do all intended elements stay fully within the screen regardless of size?** Description: a common mistake in responsive web design is an image or block which does not stay fully on the screen when resizing a browser window. This will leave a section partially showing while the browser is locked from horizontal scrolling. **[•] Marcotte (p. 28)** **[•] Jehl** [] W3C	+1	+0
6. **Does the website have three or more major breakpoints when resized in a desktop browser window?** Description: a requirement of responsive web design is breakpoints for common device compatibly. This entry tests to make sure at least three exist, although more is preferred. **[•] Marcotte** **[•] Jehl (p. 19)** [] W3C	+1	+0
7. **Does horizontal scrolling exist on any device tested?**	+0	+1

QUESTION	YES	NO
Description: note, this does not include rare instances when the browser is locked from horizontal scrolling despite being a non-responsive site. The tester will use both a desktop and mobile device to confirm. **[•] Marcotte (p. 5)** **[•] Jehl (p. 25)** [] W3C		
8. **Does text change font size when the browser window is resizing?** Description: slight tweaks to font size are necessary to prevent text wrapping. Failure to adjust fonts as needed is a sign of inattentive design. During this component, the tester will attempt to identify a font size change in at least one header or body text. [] Marcotte **[•]Jehl (p. 18)** [] W3C	+1	+0
9. **Does the site use sans-serif fonts on the mobile viewport?** Description: sans-serif fonts are the standard for mobile design. The tester will ensure that all body texts are sans serif. It is okay for header texts to be serif fonts, especially because many universities use their own logo font for headers. **[•] Marcotte (p. 22)** [] Jehl [] W3C	+1	+0
10. **Do appropriate elements (such as slider captions) disappear, resize, or relocate when they are no longer practical for small screen sizes in mobile view?**	+1	+0

QUESTION	YES	NO
Description: in many cases, this takes the form of slideshow captions that become too large to be functional in the design. Once a designated size is reached, the captions will either shrink, move to a location above or below the slideshow, or disappear altogether. **[•] Marcotte (pg. 84)** **[•] Jehl** [] W3C		
11. **Is there an obvious navigation menu for all devices?** Description: a primary navigation menu in responsive web design will often fill out most of the top of a site, or links will be displayed to the left of the site. On mobile, these links will normally shrink into a selectable "hamburger menu," often displayed as an icon with lines. **[•] Marcotte (p. 65)** [] Jehl [] W3C	+1	+0
12. **Is there sufficient contrast between the text and the background?** Description: contrast will be checked using AChecker, an automated accessibility analysis tool. [] Marcotte [] Jehl **[•] W3C (guideline 1.4.1)**	+1	+0
13. **Does it use flexible images? That is, do they resize/change automatically based on screen size?**	+1	+0

QUESTION	YES	NO
Description: in order for a site to be responsive, one of two options must occur regarding flexible images. Either the image must shrink down concurrently with decreasing screen size (using the max-width directive), or the image must be swapped based on break points. A solid responsive design will utilize both features, but this component of the codebook ensures at least one form. **[•] Marcotte (p. 42)** [] Jehl [] W3C		
14. **Does the site have a flexible, tiled background or a solid-colored background?** Description: a responsibly designed site requires a flexibly tiled background. There are two methods for using flexibly tiled backgrounds. First, a site can have a simple solid colored or subtly textured background. Alternatively, a background image may have a fixed width, but only displays a portion of that background based on screen size. Either method is acceptable in responsive web design. **[•] Marcotte (p. 54)** [] Jehl [] W3C	+1	+0
15. **Does the site display three or more sentences in a row in paragraph form without spacing them out into bullets on both the desktop and mobile displays?**	+0	+1

QUESTION	YES	NO
Description: when building for the web, it is important to organize content in ways practical for all users. Content should not be hidden from users on mobile devices, so the entire website must be organized in a way to benefit everyone. Wordiness should be avoided, so any paragraph over two full sentences is a drawback to website design. [] Marcotte **[•] Jehl (pg. 20)** [] W3C		
16. **The user is allowed to pause moving text or slideshows. Alternately, the user can return to a previous slide.** Description: some people are unable to read at a fast enough speed to understand the information presented in this form. [] Marcotte [] Jehl **[•] W3C (guideline 2.2.2)**	+1	+0
17. **Can the links in the main menu be comfortably pressed on mobile?** Description: Jehl cites a need for a link to be at least 57 pixels wide, or enough space for the average index finger to be comfortably pressed. [] Marcotte **[•] Jehl (p. 28)** [] W3C	+1	+0

QUESTION	YES	NO
18. **Are the contact fields simple and easy to fill out (consist of no more than three fields), or does the home page have no contact fields?** Description: ideally, a home page for a university website will not have any contact forms. Instead, those should be relegated to a specific "contact us" page. However, if a contact form does exist on the home page, it needs to consist of no more than three fields and should be simple to understand (Wroblewski, 2011). **[•] Marcotte (p. 118)** [] Jehl [] W3C	+1	+0
19. **Does the site contain a search feature available across all devices?** Description: the site should contain a built-in search feature, and that function should be easy to locate across devices. Often, the search function is at the top of the page or contained in the navigation menu. **[•] Marcotte (p. 119)** [] Jehl [] W3C	+1	+0
20. **Does the site pass a Google mobile friendly test?** Description: the Google mobile friendliness test determines the overall viability of a website on a mobile device. [] Marcotte [] Jehl [] W3C	+1	+0

Appendix B: Scores

School	Responsiveness	WCAG 2.0	Section 508
Princeton	18	5	6
Harvard	19	7	15
Yale	19	8	7
Columbia	11	6	2
Stanford	20	16	8
University of Chicago	19	18	19
MIT	19	7	2
Duke	19	8	6
University of Pennsylvania	20	5	10
California Institute of Technology	20	5	5
Johns Hopkins	19	52	6
Dartmouth	20	5	25
Northwestern	18	1	5
Brown	19	16	9
Cornell	19	17	30
Vanderbilt	19	54	26
Washington U. in St. Louis	20	2	5
Rice	20	72	17
Notre Dame	19	22	5
UC Berkeley	19	6	13
Emory	13	12	12
Georgetown	18	3	6
Carnegie Mellon	20	0	4
UCLA	20	3	6
USC	11	0	3
Virginia	20	5	5
Tufts	19	23	9
Wake Forest	17	26	23
Michigan Ann Arbor	19	46	7
Boston College	20	2	8

School	Responsiveness	WCAG 2.0	Section 508
NC Chapel Hill	13	26	22
New York University	10	0	0
Rochester	20	0	3
Brandeis	10	85	3
William and Mary	19	15	17
Georgia Institute of Technology	20	1	1
Case Western Reserve	20	2	14
UC Santa Barbara	19	3	9
UC Irvine	19	0	6
UC San Diego	20	0	12
Boston University	11	9	6
Rensselaer Polytechnic Institute	18	37	11
Tulane	20	13	13
UC Davis	20	1	3
Illinois Urbana-Champaign	20	0	24
Wisconsin-Madison	19	4	7
Lehigh	19	3	9
Northeastern	20	1	9
Penn State	20	2	3
Florida	19	0	8
Miami	18	197	67
Ohio State	19	2	2
Pepperdine	20	3	20
Texas	19	6	14
Washington	19	6	0
Yeshiva	19	7	20
George Washington	14	5	3
UCONN	19	14	14
Maryland- College Park	10	2	8
Worcester Polytechnic Institute	19	9	8
Clemson	18	15	9
Purdue	20	25	4

School	Responsiveness	WCAG 2.0	Section 508
Southern Methodist	18	147	18
Syracuse	14	32	3
Georgia	20	8	8
BYU	19	6	7
Fordham	18	22	18
Pittsburg	19	0	0
Minnesota - Twin Cities	19	2	2
Texas A&M	19	5	9
Virginia Tech	19	77	19
American	19	7	17
Baylor	18	6	1
Rutgers	20	6	3
Clark	20	3	6
Colorado School of Mines	9	93	14
Indiana	20	1	9
Michigan State	19	10	8
Stevens Institute of Technology	19	63	30
Delaware	10	9	5
University of Massachusetts	19	12	4
Miami Ohio	20	3	2
TCU	11	16	7
UC Santa Cruz	20	5	2
Iowa	20	9	3
Marquette	20	7	2
Denver	17	2	2
Tulsa	19	58	11
Binghampton	20	51	19
NC State	19	1	11
Stony Brook	19	23	34
SUNY College of Environmental Science and Forestry	18	537	67
Colorado Boulder	20	13	1

School	Responsiveness	WCAG 2.0	Section 508
San Diego	19	21	15
Vermont	19	3	3
Florida State	19	22	16
St. Louis	12	N/A	N/A
Alabama	18	165	15
Drexel	20	2	7
Loyola	19	76	39

Appendix C: Geographic Areas by State

Northeast Region

New England (NE): Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont

Middle Atlantic (MA): New Jersey, New York and Pennsylvania

Midwest Region

East North Central (ENC): Illinois, Indiana, Michigan, Ohio and Wisconsin

West North Central (WNC): Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota

South Region

South Atlantic (SA): Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia

East South Central (ENC): Alabama, Kentucky, Mississippi and Tennessee

West South Central (WSD): Arkansas, Louisiana, Oklahoma and Texas

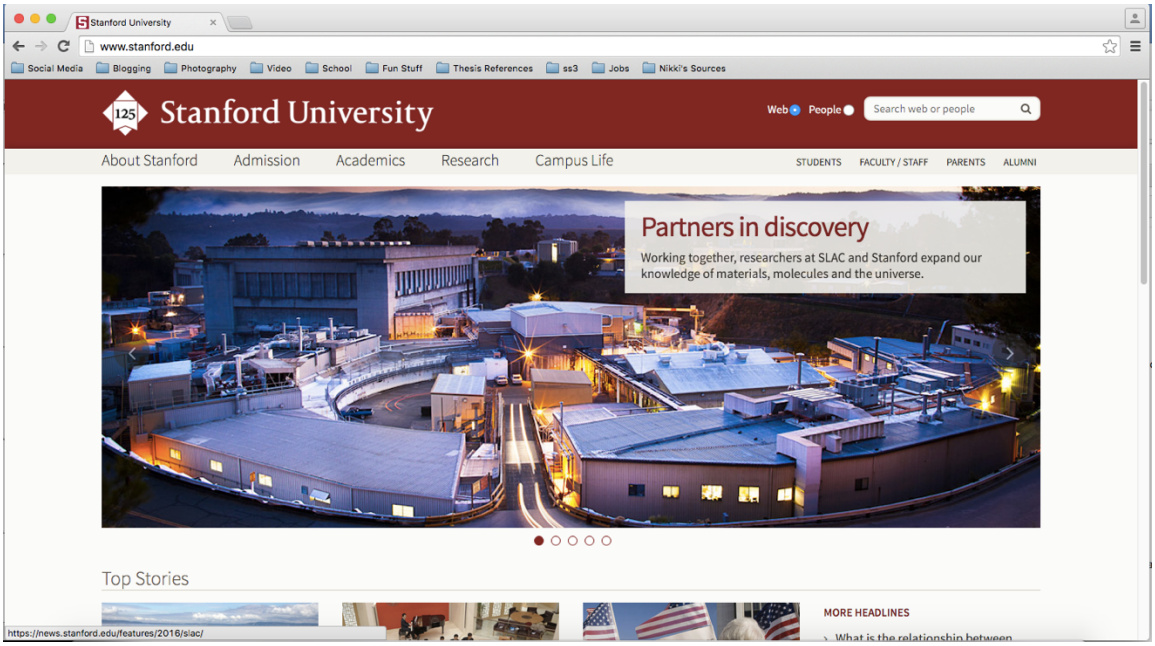
West Region

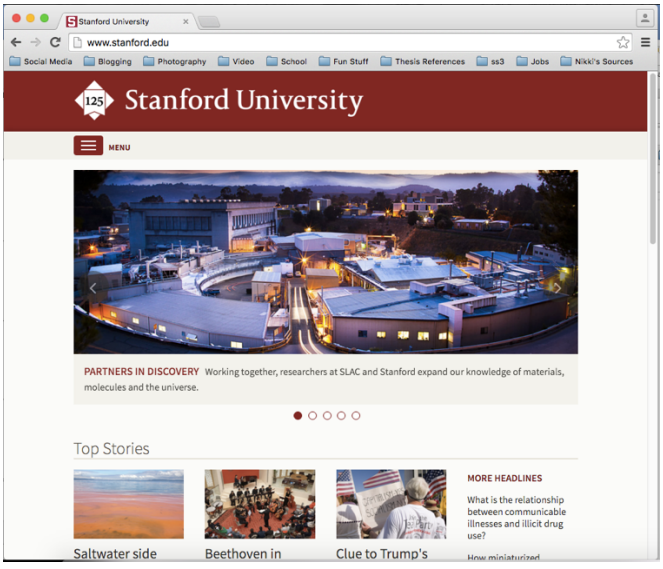
Mountain Division (MD): Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming

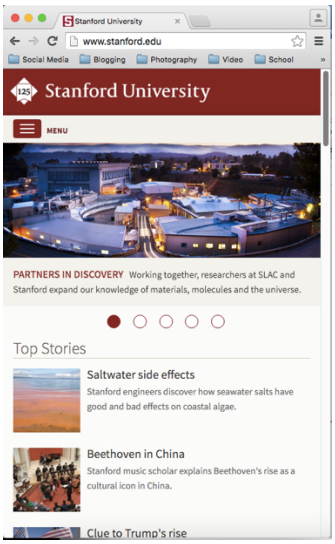
Pacific Division (PD): Alaska, California, Hawaii, Oregon and Washington

Appendix D: Visual Gallery

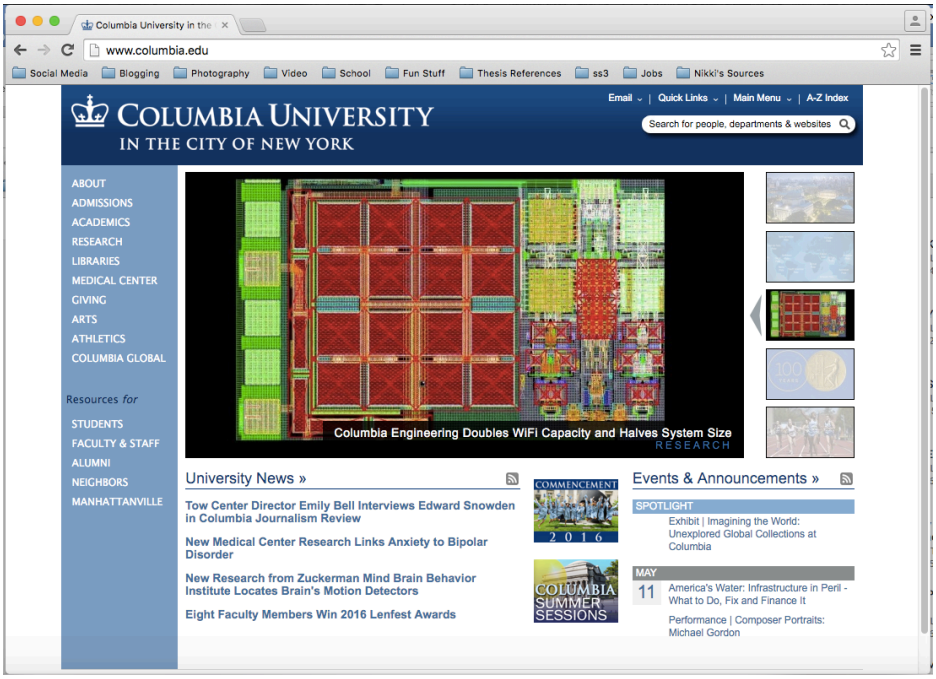
The website for Stanford University contains three different breakpoints.



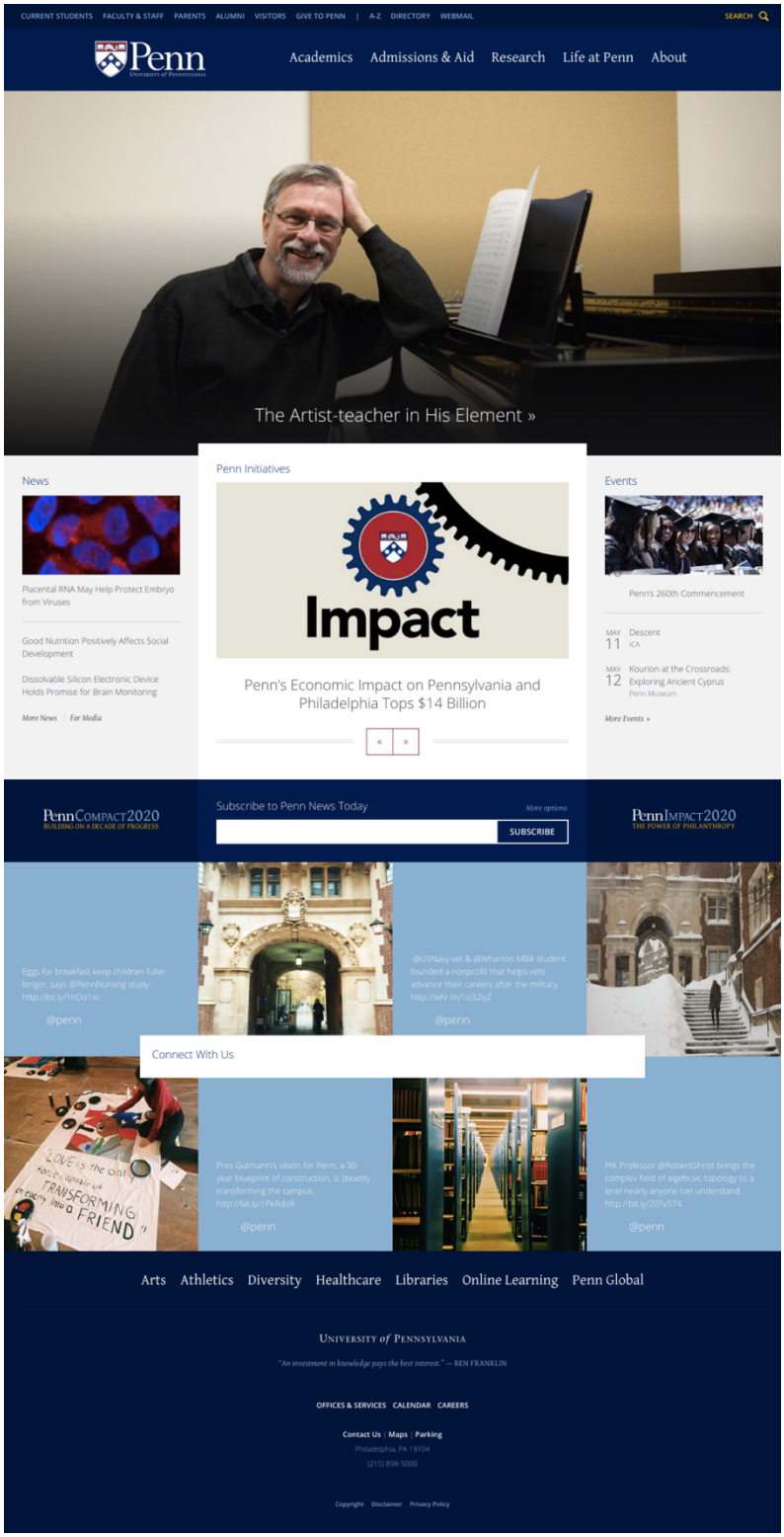




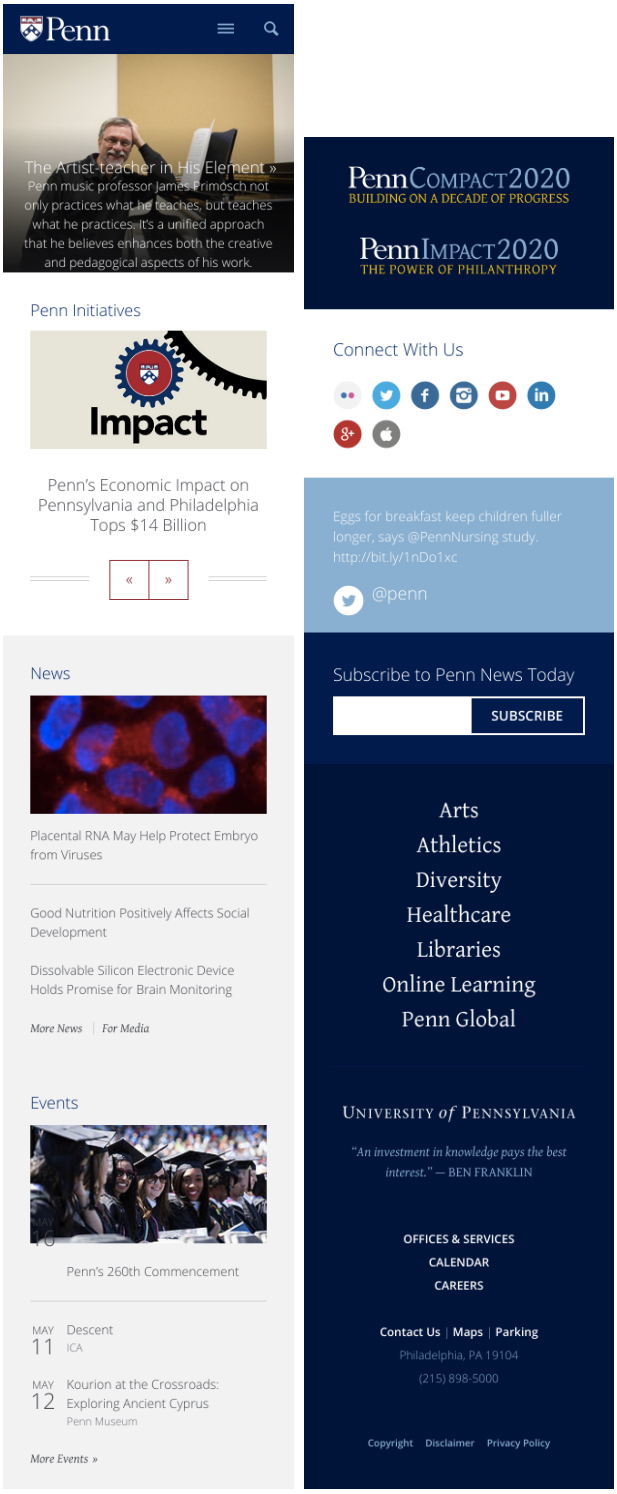
Columbia University's non-responsive website contains horizontal scrolling.



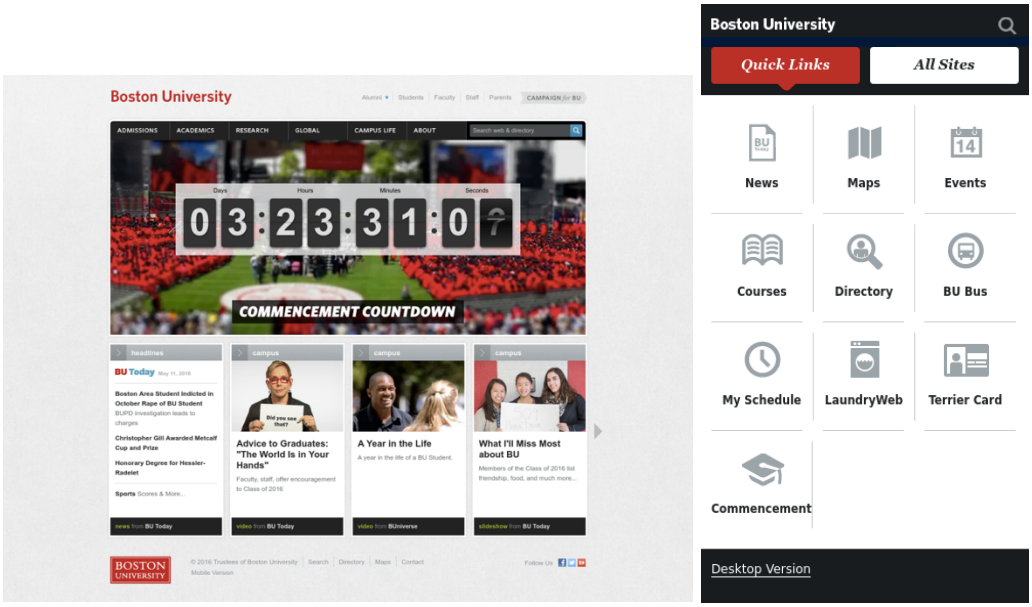
This is the University of Pennsylvania's responsive website in desktop layout.



This is the University of Pennsylvania's responsive website in mobile layout.



Some websites use an alternate mobile site.



Yale contains eight known WCAG 2.0 (A-AAA) errors according to ATRC AChecker.