Evaluation of Accessibility for the Visually Impaired- The Case of Higher Education Institutions' Websites in Ghana*

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Abstract

Globally, the use of web-based resources has increased tremendously among Higher Education Institutions (HEIs). Most HEIs have websites which serve as a virtual gateway to accessing information and services for students. As a result, the demand for website accessibility in HEIs continues to upsurge. The accessibility of a website means that everyone regardless of disabilities can perceive, understand and interact with the website. While web-based resources of HEIs offer convenience for most students; those with disabilities risk being excluded particularly the visually impaired who use assistive technologies if websites are not designed to be technically accessible. Yet web accessibility is under-explored in Ghana. In this study, we evaluate using aDesigner, the accessibility of 15 HEIs' websites in Ghana to determine their adherence to the Web Content Accessibility Guidelines (WCAG 2.0) published by the World Wide Web Consortium (W3C). The findings show that none of the websites examined conform to the acceptable web accessibility level of compliance. The results indicate that most HEIs websites were not perceivable and operable hence the visually impaired would experience barriers accessing them. The results also identified critical accessibility errors on the websites. We suggest guidelines to address these critical errors and develop a prototype of an accessible website. This study, therefore, raises awareness about web accessibility in Ghana and provides some recommendations to improve web accessibility for the visually impaired and persons with disabilities at large in the web-learning environment.

Keywords: Web Accessibility, Higher Education Institutions, Students with Disabilities, Visually Impaired

1 Introduction

Worldwide over one billion people live with disabilities including an estimated 285 million visually impaired (Boussarhan and Daoudi, 2014). Africa the second largest continent and second most populous in the world has 10% of its population disabled (Rorissa and Demissie, 2010). Several studies (Mitra *et al.,* 2011; Kurt, 2011; Ratliffe *et al.,*2012) in the past have shown that education among persons with disabilities (PWDs) in many developing countries is low due to marginalisation and stigmatisation. Hence the web presents an opportunity for PWDs to undertake tasks that would otherwise be difficult or impossible. For example, learners with disabilities can take courses in the comfort of their homes and access urgent information from institutions' websites. However, this is only possible when web contents are designed with necessary accessibility features making them compatible with assistive technologies. Assistive technologies such as screen readers, embossers, magnifiers refer to any software or hardware that compensate and enhance functional capabilities of PWDs (Kurt, 2011; Boussarhan and Daoudi, 2014)

The web is a major source of information. Many activities which previously required a lot of time to accomplish can now be done by just a click of a button. This has made access to information more convenient and easier for most people. However, while providing this benefit, there are dangers that some categories of people would be excluded because they require other supporting technologies for access. In the context of Higher Education Institutions (HEIs), Students with Disabilities (SWDs) are most at risk of being excluded from access, and in particular the visually impaired who use assistive technologies such as screen magnifiers and screen readers. Although there are other forms of disabilities such as mobility, speech, cognitive among others, studies have shown that visual impairment is the most restrictive type of disability (Venter and Lotriet, 2005; Boussarhan and Daoudi, 2014).

World Wide Web is increasingly playing a pivotal role in higher education in the provision of administrative, academic and student services. Websites of HEIs are very crucial as they serve as a virtual gateway; providing timely and vital information to students and therefore should be accessible. For a website to be accessible; it should be interactive, easy to navigate and use regardless of device or disabilities (Habit *et al.,* 2014; Boateng, 2015). Today, the use of the web is required as part of student life since most of the information needed for day-to-day activities on campus can be found on the institutions' websites. With most physical classrooms now transforming into virtual with the help of the web, access to the web becomes even more crucial. However, web accessibility in HEIs remains a challenge for SWDs

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(Harper and DeWaters, 2008; Pino and Mortari, 2014; da Silva and Alturas, 2015).

Many research studies that have examined the accessibility of HEIs websites focus on developed countries and identified critical accessibility barriers. For instance, Harper and DeWaters (2008), reported that 98% of Australian university websites fail to meet the minimum criteria required for accessibility. Similar findings were reported in several other studies in (Kurt, 2011; Michailidou, Mavrou and Zaphiris, 2012; van Rooij and Zirkle, 2016; Işeri *et al.,* 2017). On the African continent, few studies on web accessibility have been conducted. This study focuses on one African country, Ghana. Ghana is located in West Africa with an estimated 10% of its population living with disabilities (Ametepee and Anastasiou, 2015). In recent times, many HEIs in Ghana are moving their resources online as distance education, and e-learning is becoming popular by the day (Boateng, 2015). Although inclusive education policy was promulgated in 2012 to ensure the integration of individuals with disabilities into mainstream institutions; its implementation has been slow (Ametepee and Anastasiou, 2015).

Given that, the web has transformed learning in several ways, for instance, electronic learning (e-learning), online learning, blended learning among others; it is imperative to examine the accessibility of websites of HEIs to ensure equal access for the visually impaired. Against this background, this study seeks to: (1) examine web accessibility in 15 HEIs; (2) design a prototype of an accessible website; (3) and raise awareness on the importance of accessibility in the web-based learning environment.

2 Resources and Methods Used

2.1 Web Content Accessibility Guidelines

Web Content Accessibility Guidelines (WCAG) was developed by the Web Accessibility Initiative (WAI) to guide developers of websites. These guidelines are meant to improve web accessibility for people with disabilities who often face barriers accessing online services (Brewer, 2004; Işeri *et al.,* 2017). WCAG provides information on how to make a web page or web application more accessible to a wide range of disabilities. WCAG provides 14 guidelines and 65 checkpoints categorised into three priority levels of accessibility: Priority 1 (16 checkpoints), Priority 2 (30 checkpoints) and Priority 3 (19 checkpoints). Each of these priorities conforms to an accessibility criterion: Level A (Priority 1), Level AA (Priority 2) and Level AAA (Priority 3). Website conformance to Level A means all problems relating to Priority 1 have been fixed. For a website to achieve Level AA implies accessibility issues in Priorities 1 and 2 have been fixed. Website conformance to Level AAA means all problems relating to Priorities 1, 2 and 3 have been resolved. Level AA criteria are set by WCAG as the minimum for a website to be accessible to PWDs. In line with these guidelines, several countries have established contextual web guidelines (Boussarhan and Daoudi, 2014); however, many developing countries like Ghana lack such web accessibility guidelines (Yaokumah *et al.,* 2015)

2.2 Choice of Diagnostic Tool

WCAG has defined four requirements for an accessible website: it should be perceivable, operable, understandable and robust (Boussarhan and Daoudi, 2014). These requirements are evaluated using web diagnostic tools. A web diagnostic tool is a software that aids in analysing web pages by comparing the written codes on the webpage to WCAG guidelines (Brewer, 2004). Diagnostic tools are efficient and save timing in detecting accessibility errors (Bradbard and Peters, 2010; Yaokumah *et al.,* 2015). Examples of diagnostic tools include WAVE, Achecker, Lift, Aprompt, aDesigner and TAW. This study employed aDesigner, a diagnostic tool developed by IBM for two major reasons. First, aDesigner is a disability simulator which detects accessibility flaws in websites specifically for the visually impaired (Takagi *et al.,* 2004; Michalska *et al.,* 2014). Secondly, it is an open source software which makes it easily accessible. There are two types of extensible visualisation engines in aDesigner which are: blind usability simulation engine for simulating the case of blind usage of the website under evaluation; and low-vision simulation engine for simulating the case of low-vision usage of the website under evaluation.
The following procedures were followed to evaluate the websites:

(i) aDesigner was installed and launched.
(ii) HTML accessibility tab was selected
(iii) URLs for websites were entered one at a time
(iv) Simulation was conducted in two modes: blind and low vision
(v) Results were generated for analysis

2.3 Selection of Websites

The study selected 15 websites of HEIs in Ghana. aDesigner was then used to determine their compliance with WCAG 2.0. Only the homepages of the websites were evaluated since errors on the homepage mostly run through the rest of the websites (Kurt, 2011). Also, students are likely to visit the homepage first before linking up to other pages. Test evaluation was conducted in two

stimulation modes: low vision (L) and blindness (B) for each website. Each homepage was evaluated to check its compliance with WCAG 2.0. Results on adherence to WCAG principles (Perceivable, Operable, Understandable and Robust) were recorded for each case. aDesigner rated each website's performance in terms of accessibility. Ratings ranged from 0 to 3 where 0 is the poorest performance while 3 indicates the highest performance in terms of accessibility. For the sake of anonymity, each website was coded with a number.

3 Results and Discussion

3.1 Results

After evaluating each website, aDesigner reported the number of critical errors found on each homepage and the WCAG principles (Perceivable, Operable, Understandable, Robust) violated. The results of compliance with WCAG principles are shown in Table 1. The results show that most websites violated the 'Perceivable and Operable' principles. However, websites were quite understandable and robust. Table 2 indicates the accessibility errors that should be fixed. A further detailed report was generated by aDesigner indicating the guidelines violated.

Table 1: Results of WCAG principles

Website	Perceivable (%)	Operable (%)	Understandable (%)	Robust (%)
No. 1	0	31	95	85
No. 2	19	16	90	80
No. 3	0	78	93	91
No. 4	72	47	93	93
No. 5	0	10	86	73
No. 6	58	82	100	100
No. 7	0	79	89	83
No. 8	36	71	95	100
No. 9	0	84	95	100
No.10	42	0	86	88
No.11	22	11	81	78
No.12	7	18	84	87
No.13	0	73	90	88
No.14	0	55	100	85
No.15	52	61	83	95
Average	**20.5**	**47.7**	**90.7**	**88.4**

The analysis shows that most websites have a large number of problems relating to the perceivable principle. This is followed by the violation of the operable principle. Websites are quite robust, and the understandable principle was the least violated. The low scores in principles "Perceivable and Operable" mean that these websites will be less usable for the visually impaired since they will have difficulty operating the interface to retrieve content. Additionally, websites may not be compatible with some web browsers (Abu-doush *et al.,* 2013).

Critical accessibility errors were identified on all homepages for both low vision and blind simulation modes. Results of ratings show that only one website (see Table 2; No. 9) was accessible for users with low vision. The is because website No. 9 though had a very poor rating for blind users, obtained a good rating for low vision users. Notable errors reported by aDesigner include missing table headers and tags; lack of intra-page linking; lack of alternative text for images; missing table indices to help navigate keyboard; missing titles on frames; fixed font size; poor contrast of image; and poor text colour.

Table 2: Results of critical accessibility errors

Website	Rating	Critical Errors
No. 1	0(L), 0(B)	215(L),46(B)
No. 2	0(L), 0(B)	79(L),28(B)
No. 3	0(L), 0(B)	51(L), 37(B)
No. 4	0(L), 0(B)	24(L),5(B)
No. 5	0(L), 0(B)	57(L),33(B)
No. 6	0(L), 1(B)	91(L),8(B)
No. 7	0(L), 0(B)	57(L),20(B)
No. 8	0(L), 0(B)	65(L),7(B)
No. 9	2(L), 0(B)	22(L),30(B)
No. 10	0(L), 0(B)	160(L),25(B)
No. 11	0(L), 0(B)	112(L),34(B)
No. 12	0(L), 1(B)	143(L),36(B)
No. 13	0(L), 0(B)	132(L),33(B)
No. 14	1(L), 1(B)	110(L),33(B)
No. 15	0(L), 0(B)	76(L),2(B)

Key: L = Result for low vision test; B = Result for blind test.
Ratings: 0= Very Poor; 1 = Poor; 2 = Good; 3= Very Good

The findings indicate that most websites are not accessible to the visually impaired. Most of the websites had images and graphics without descriptions hence cannot be read by screen readers. Appropriate alternative text should, therefore, be used to describe images for users with screen readers. An empty string (" ") could also be used as alternative text in cases where images may not really matter to the blind user. Several tables also lacked tags making it difficult for a blind user to understand their contents. Tables need to be well structured and tagged to make them accessible.

Websites also lacked intra-page links to facilitate navigation and linking from one page to the other. Options for font sizes are missing from most websites; this could affect low vision users. The use of absolute-size keywords (An example is “large"), relative-size keywords (An example, "larger") will enable low vision users to enlarge fonts. Many forms lacked titles, shielding blind users from knowing which input details are required making the webpage less perceivable. Poor foreground and background colour contrast were identified on many of the websites. The use of sharp contrasting colours for the foreground and background is recommended to help improve accessibility.

3.2 Prototype Design

To develop the prototype, critical accessibility errors reported by aDesigner were meticulously studied together with the suggested recommendations before concluding on a design approach. The design considered the following factors:

(i) website compatibility with diverse assistive technologies such as screen readers, voice recognition software and screen magnifiers;
(ii) the consistency of page layout of the website for all web pages;
(iii) implementation of asynchronous automation for each webpage to enable the visually impaired perceive content, navigate and gain control over the webpage.

The prototype design was implemented using AJAX (Asynchronous JavaScript and XML). The prototype was developed by adhering to WCAG guidelines to ensure maximum accessibility for the visually impaired and the design evaluated in the end to compare earlier results. Fig. 1 and 2 illustrate the snapshots of Login and Course registration pages from the prototype design respectively.

3.3 Prototype Evaluation

The evaluation was conducted for four web pages in the prototype website: Home, Login, Registration and Sitemap. Results on WCAG principles (Table 3) show that the prototype conformed fully to all four principles. aDesigner found few critical errors on all pages both for low vision and blind simulations; these errors, however, are negligible. Rating performance (Table 4) for each page was high with the ‘Login and Registration’ pages having the highest scores. Fig. 3 snapshot of aDesigner simulation for the Homepage of the prototype design. The results imply that the visually impaired can use the prototype website with fewer barriers even though the website had a combination of many colours, different web elements (forms, tables, divs, img etc.), pictures and implemented several web technologies like Jquery, JavaScript, CSS. Achieving such a high accessibility rating for the prototype website is as a result of the careful implementation of the various considerations made during the design process.

3.4. Result from Prototype

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Table 3 Results on WCAG Principles for the Prototype

Page	Perceivable %	Operable %	Understandable %	Robust %
Home	98	100	98	100
Login	98	100	98	100
Registration	98	98	98	100
Sitemap	98	100	98	100
Average	**98**	**99.5**	**98**	**100**

Table 4 Results on Rating and Critical Errors for the Prototype

Rating %	Critical %
2(L), 2(B)	0(L), 0(B)
3(L), 2(B)	0(L), 0(B)
3(L), 2(B)	0(L), 0(B)
2(L), 2(B)	0(L), 0(B)

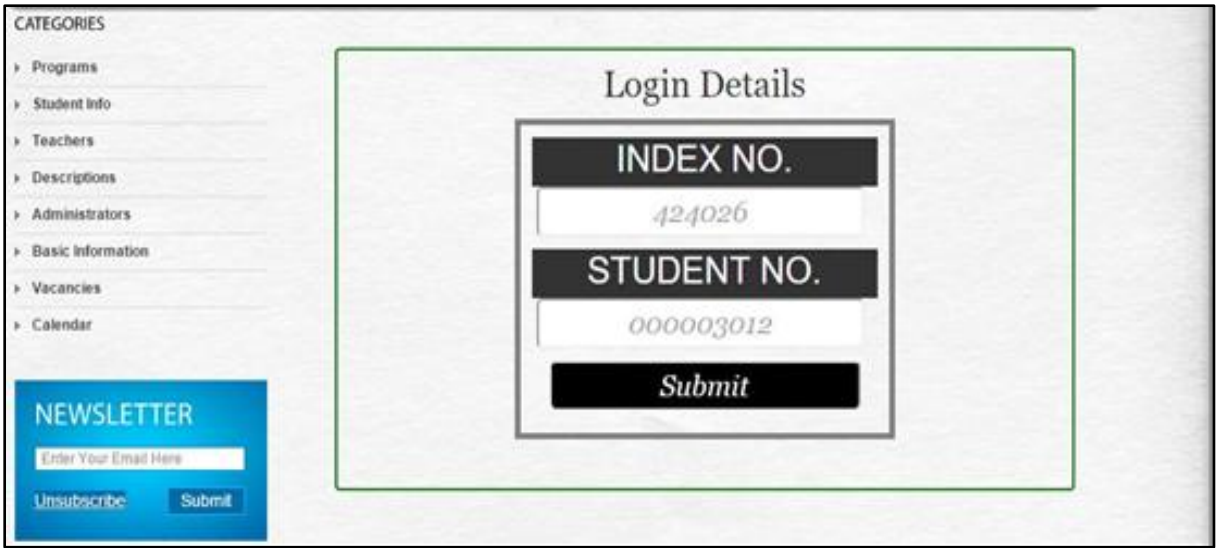

Fig. 1 Snapshot of the prototype (Login page)

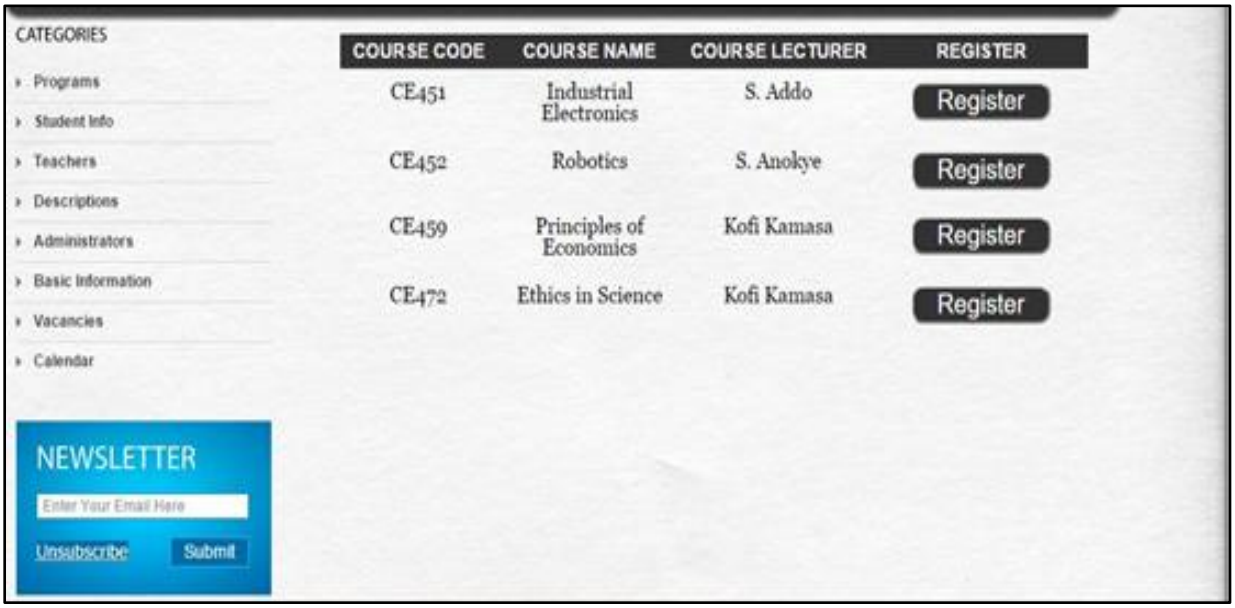

Fig. 2 Snapshot of the prototype (Course registration page)

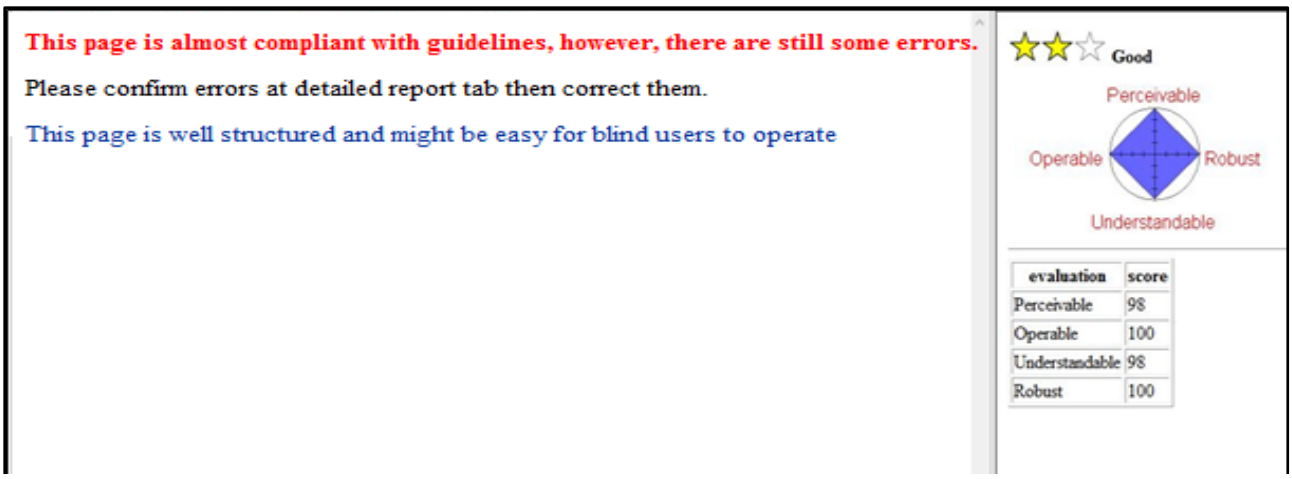

Fig. 3 Snapshot of results of the Homepage of the prototype

3.5 Discussion

The internet serves as a platform for providing a wide range of resources for various aspects of human endeavour. For this reason, it is very important that websites are designed with persons with disabilities in mind, especially for assistive technology users. For instance, the visually impaired use assistive technologies for accessing resources on the internet. Assistive technologies are tools which have the potential of magnifying or interpreting the content of a webpage to enable people with either low vision or total blindness to navigate it. When a webpage is not properly structured, assistive technologies are not able to interpret its content properly; thereby putting the visually impaired at a disadvantage which could lead to them becoming digitally excluded. In the context of HEIs, where most academic resources are placed on improperly structured websites, visually impaired students cannot be academically efficient.

Results of the evaluation is an indication that even though a good number of HEIs in Ghana have academic resources online, their websites are not accessible to assistive technologies. This may be because web developers do not have enough knowledge of the concept of web accessibility. It could also be that developers lack awareness of the fact that, the visually impaired also use computers.

4. Conclusions and Recommendations

Web accessibility is a critical requirement for the visually impaired to have easy access to web content. In this study, evaluation of fifteen websites of HEIs in Ghana revealed that the visually impaired students would encounter several challenges accessing these websites. For example, the findings show that none of the websites is accessible to the visually impaired. However, the prototype design with the necessary design considerations shows high performance in accessibility with negligible errors. We, therefore, advocate the need to create more awareness by incorporating accessibility into the curriculum of educational institutions to help sensitise people in society. We also recommend that the government implement a web accessibility policy to guide the development of online resources.

There is a need to train web developers on accessibility requirements for persons with disabilities who employ assistive technologies. Disability oriented organisations should help to champion the creation of awareness on web accessibility in digital society. The findings of this study are significant in several ways. The study is the first of its kind examining web accessibility in Ghanaian universities thereby raising contextual awareness. The findings also provide insights into how to develop and improve HEIs websites to be more accessible to all students, and particularly students with visual impairment.

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