ACCESSIBILITY FACTORS FOR TOTALLY BLIND USERS OF PALESTINIAN UNIVERSITIES WEBSITES

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ABSTRACT. The World Wide Web (Web) is considered to be one of the sources of information and services. Universities use their webpages to communicate with stakeholders. Most of the related researchers have discovered significant faults with respect to accessibility of university websites, especially for blind users. In order to determine the totally blind requirements for designing websites, this study conducted a comprehensive literature review and based it on the Web Content Accessibility Guidelines, WCAG 2.0. The study revealed important factors in designing an accessible university webpage prototype. An online questionnaire was constructed to evaluate the accessibility of the prototype from blind users' perspective. From the evaluation of 16 visually impaired participants, it was found that the prototype was highly accessible among the totally blind where the mean score was 4.19. A regression analysis test was also utilized to determine the relationship between the items of the questionnaire and the main principles of accessibility. The results showed that there were statistically significant differences between these items. In conclusion, the accessibility factors are indirectly validated, and could be used to develop an accessible university website for blind users.

Keywords: totally blind, WCAG 2.0, evaluation, regression analysis

INTRODUCTION

The World Wide Web (Web) is a source of information. Proper access to this network is necessary for all groups in a society (Kurt, 2011; Wanniarachchi & Jayathilake, 2012). Higher education institutions employ the Web for many purposes such as providing services and information through their websites. Therefore, the university websites must be accessible to all users (Kurt, 2011) including people with or without impairments. The United Nations Convention on the Rights of Persons with Disabilities encourages information providers on the Web to make their services accessible to persons with disabilities.

Accessibility is the degree of ability to access a product, device, service, or environment and their availability for all individuals, in particular for those with disabilities or special needs. Of concern is how people with disability can access, navigate, understand, and react to the Web (Henry, 2005). The World Wide Web Consortium (W3C) provides the most important guidelines for Web accessibility known as the Web Content Accessibility Guidelines (WCAG). These guidelines could increase the accessibility level of Web content to make websites available to a wider range of disabled people including those with visual disabilities (Caldwell et al. 2008). Disabled individuals use assistive tools to access the Web (Kurt,

2011). The use of these tools vary according to the level of visual disability. For example, Totally Blind (TB) users usually use screen reader programs. A Web page should be designed to support compatibility with these tools so that handicapped people could also access these pages (Abanumy et al., 2005).

According to the World Health Organization (WHO) statistics, about 90% of individuals who have a visual disability live in developing countries (WHO, 2014) and this includes Palestine. In Palestine, a disabled individual's survey conducted in 2011 reveals that 2.7% of the Palestinian population have a disability and 0.6% of them are visually handicapped (BCBS & MoSA, 2011).

Many researchers such as Forgione-Barkas (2012) and Brajnik (2009) filtered the WCAG guidelines and only determined the guidelines related to visual disabilities. Early study by Hassouna and Sahari (2014) concluded that Palestinian universities' websites have significant accessibility weaknesses that may present many obstacles for disabled persons especially for the visually handicapped. Thus, many users with visual impairment especially totally blind users could not access these sites effectively.

In this study, accessibility factors for TB is determined and based on these factors, a website prototype that is accessible to TB users is constructed. This paper discusses the development of both the accessibility factors and prototype for TB users. Finally, the prototype evaluation and validation of factors are discussed.

METHODOLOGY

The study was conducted in two phases as shown in Figure 1. The two phases were utilized to reveal the accessibility factors for TB users, and then to validate the revealed factors using blind users. The following sections explain the two phases in more detail.

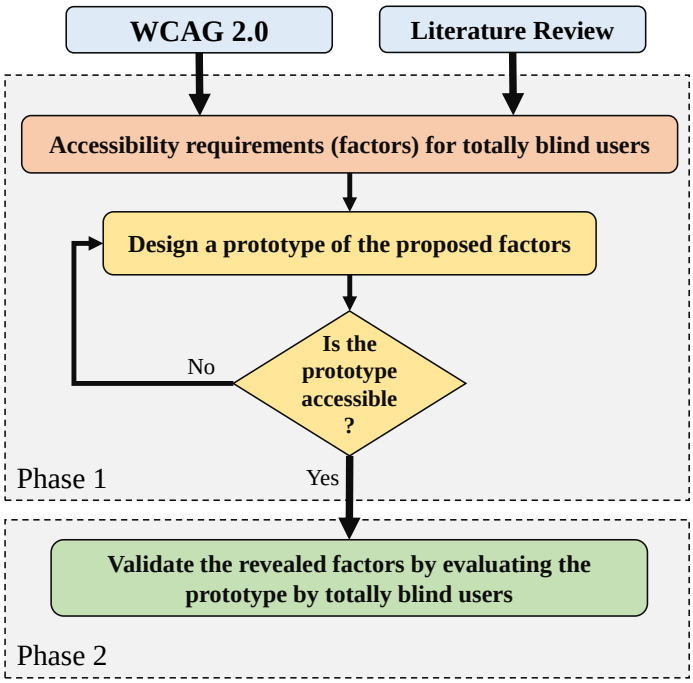

Figure 1. Study Workflow

Firstly, Phase 1 determines the accessibility factors for TB users from literature studies in light of WCAG 2.0 guidelines. Then, the study develops an accessible prototype based on

these factors. After that, the prototype is evaluated using different accessibility evaluation methods to ensure it conforms to these factors. Thus, if the prototype fails in any of the proposed factors, it is returned to the design stage where problems are repaired. The prototype is then retested. The study utilized the CynthiaSays automatic evaluation tool and manual assessment using expert judgment.

After the accessible university prototype is designed, the prototype is presented to the Assistive Technology Center (ATC) staffs at the Islamic University of Gaza (IUG) who have good experience in handling the needs of visually disabled people. They have real-life experience in this field and have good working knowledge of the problems faced by visually disabled users when surfing the Web. The feedback and evaluation results are then used to refine the prototype to make sure it is really accessible.

The second phase is to have real TB users evaluate the website and validate the proposed factors. Totally blind users were asked to try the prototype and provide feedback regarding its accessibility. The quantitative approach was utilized to evaluate each factor and to determine the relationship between these factors and that of the main principles of accessibility from the TB perspective. They were asked to perform browse-related tasks and other general tasks involving the prototype.

Study Sampling

The purposive cluster sampling was employed, which targets blind participants from the ATC center at the Islamic University of Gaza (IUG) in Palestine. The ATC center was established in the year 2000. It is considered the first university center in Palestine that is concerned with visually disabled persons, and aims to enable these people to fully participate in education (Elaydi & Shehada, 2013). To measure the factors of accessibility from the perspective of TB persons, a questionnaire survey was conducted with 16 TB respondents participated.

Instrument Design

The study utilizes a questionnaire to measure the accessibility of the prototype. The questionnaire is designed based on accessibility factors that have been retrieved from literature review, and then translated into items. There are seven accessibility factors related to TB users. Fourteen items are constructed based on the WCAG2.0 criteria. People with visual disability prefer to use a Web-based survey instead of the paper-based survey (Lazar et al., 2010). Consequently, the study employed an online questionnaire approach using Google drive as the tool to design the questionnaire. In addition, the study took into consideration accessibility issues for visually disabled persons when an online questionnaire tool was selected. Thus, a NVDA screen reader program was used to manually test the accessibility of the questionnaire.

The questionnaire adopts the 5-point Likert scale which are; 1- strongly disagree, 2- disagree, 3- somewhat agree, 4- agree, 5- strongly agree. In brief, the questionnaire was designed and refined through five major steps in which amendment and updating were performed after each step. First, the design of the questionnaire starts with the translation of factors into items. Second, three experts from related areas validate the questionnaire. Third, the questionnaire is translated into the Arabic language, which is then proofread. Fourth, the questionnaire is converted into a Web-based format using Google drive. Lastly, the accessibility of the Web-based survey tool is tested.

Data Analysis

The data analysis was done using the SPSS 21. The study employed statistical analysis methods including the Cronbach's Alpha for reliability, descriptive analysis, and a multiple

Regression Analysis was utilized to analyze the relationship between the questionnaire items and the dependent variables, which are the main accessibility principles, after the normality assumption is satisfied.

RESULTS

Since the study's framework consists of two phases, the results are presented accordingly. The next sections explain the results in further detail.

Phase 1 resulted in a prototype design used to validate the proposed factors. The prototype was developed based on these factors. The researcher decided to develop a high fidelity prototype to increase interactivity and to facilitate visually disabled user evaluation. The following techniques were included in the design to comply with the proposed model's factors:

a. The prototype page provided the correct language declaration to make the webpage more compatible with assistive technologies.
b. The prototype provided an ALT text for each visual element in the page to make it readable and accessible to screen readers. The prototype provided adequate ALT text for image presenting content or image presenting function such as the image button. For decorative images it provided null ALT (alt="").
c. The prototype had skip navigation links. Most of the universities' websites had long lists of links. This technique will benefit TB users during their navigation by bypassing these links into the main contents directly.
d. The prototype contained links to friendly text-only page with simpler layouts for screen reader users.
e. All prototype functionalities were developed to be accessible by keyboard only, especially the main menu.
f. The prototype used semantic markup by including headings (such as H1, H2, H3) to structure its text contents correctly. This technique will support meaningful structure, provide correct navigation order, and increase the adaptation ability of the webpage.
g. The layout of the prototype webpage utilized the ARIA landmark to identify the webpage sections. This will assist screen reader users to orient themselves and facilitate navigation in various regions of the Web page.
h. The contact us form in the prototype provided adequate labels for the input fields, indicated the required fields, and helped users to identify the input errors. The form moved the cursor automatically to problematic fields.
i. Data tables in the prototype will have a summary abstract of the tables and its contents, where the table content is identified by its headers, columns, and rows. This technique will make the tables more accessible for screen reader users particularly.

After the prototype was developed, it was evaluated and the results of automatic and manual evaluations proved that the prototype was highly accessible. As a result, the prototype of the proposed model was developed.

The results from Phase 2 are obtained from the evaluation of the proposed model. The evaluation was done via a survey on the developed prototype of a university webpage.. The Cronbach's alpha (α) reliability of the TB subscale consisted of 18 items is 0.73. Since the five-point Likert scale was used in the questionnaire items, the researcher divided the mean score into three levels, low (0 to 1.67), medium (1.68 to 3.33) and high (3.34 to 5). The questionnaire results were tabulated and analyzed using SPSS and are presented in the following sections.

Accessibility Score of the Prototype

This section presents the findings of descriptive analysis from the survey. Table 1 shows the mean range of prototype accessibility from the TB users' perspective. Generally, the evaluation findings of these users show that the prototype was accessible and they highly agreed with its accessibility items. The mean of the 14 items ranged from 3.56 to 4.56. Therefore, all of these items' results were categorized as high level.

Table 1. Mean Score of Items

No.	Item	Mean
	Perceivability	
C1	The webpage provides alternative text for images and buttons.	4.00
C2	Text headings and labels of input fields give clear understanding of their purpose.	4.13
C3	The webpage provides a summary information about tables.	4.31
C11	The text-only page is a comfortable way to surf the webpage.	4.25
C14	The webpage is presented in different ways without losing any information and/or structure (e.g. simpler layout like Text-only page).	4.44
	Perceivability Mean Score	**4.23**
	Understandability	
C8	The name of input fields describes it properly.	3.56
C9	The webpage identifies the required field in the forms.	3.81
C10	In the forms, the webpage alerts users to identify the errors.	4.19
	Understandability Mean Score	**3.85**
	Operability	
C4	The webpage is accessible by keyboard only.	4.31
C5	The webpage preserves the visual sequence when using the tab key to navigate.	4.13
C6	The webpage provides different ways to navigate and to browse its contents (such as headings, landmarks, and skip navigation links).	4.13
C7	The webpage title is meaningful.	4.31
C12	The skip navigation links allow easy navigation of the site.	3.81
	Operability Mean Score	**4.14**
	Interactivity	
C13	The screen reader program is compatible with the webpage.	4.56
	Interactivity Mean Score	**4.56**
	Accessibility Mean Score for TB	**4.19**

Model Validation

Table 2 shows the summary of multiple regression analysis output. The model of perceivability, understandability, operability, and interactivity was significant ($P < 0.05$). The adjusted determination factor (R^2) equals 0.942, which means about 94.2% of the TB perceivability are predicted and determined by C1, C2, C3, C11, and C14 and similar explanation for understandability, operability and interactivity factors.

Table 2. Summary of Regression Analysis

Accessibility Principles	Regression Equation	Sign	R^2 Adjusted
Perceivable	TB perceivability = - 0.932+ (0.396 * C1) + (0.360* C2) + (0.328 * C3) + (0.320 * C11) + (0.305 * C14)	<0.05	0.942
Understandable	TB understandability = -1.249 + (0.824* C10) + (0.511* C9) + (0.432* C8)	<0.05	0.937
Operable	TB operability = -0.537 + (0.389* C4) + (0.375* C6) + (0.432* C5) + (0.256* C7) + (0.245* C12).	<0.05	0.949
Interactive	TB interactivity = 0.277 + (0.832* C13)	<0.05	0.692

CONCLUSION AND FUTURE WORKS

Inaccessible websites could severely limit users' interaction with them. TB users are considered one of the groups that are most hindered by inaccessible websites. In order to determine TB requirements for designing websites, this study conducted a comprehensive literature review and based it on the WCAG 2.0. The revealed factors were used to design a prototype, and an online survey was conducted on TB users to evaluate the accessibility of this prototype. From the evaluation of TB participants, it was found that the prototype was highly accessible. The regression analysis results showed that there were statistically significant differences between the respective items for each main accessibility principles. In conclusion, the accessibility factors are indirectly validated, and could be used to develop an accessible university website for blind users. Further studies could be done to determine the factors for other visual disability levels such as the partially blind and color blind users.

ACKNOWLEDGMENTS

This work was supported by Universiti Kebangsaan Malaysia, Multimedia Software and Usability Research Group and ERGS/1/2013/ICT05/UKM/02/3 research grant.

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