

Ergonomic Evaluation of Websites Focusing on the Human-Computer Interface so as to Improve Access to the Web Especially by People with Visual Disabilities

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Abstract. This study sets out to contribute to making web pages more accessible especially with reference to people with visual impairments. Ways of evaluating of the interfaces of web sites and systems were investigated resulting in new, interim proposals which make use of W3C and Electronic Government tools combined with heuristics and. Thus, an assessment with greater emphasis on ergonomic criteria in terms of the human-computer interface is provided. A case study was used to evaluate three interfaces using the W3C validation tools HTML/ CSS validator and DaSilva. Thereafter, Jakob Nielsen's heuristics were applied using a screen reader. The outcome was comparative charts and tables that illustrate the possibility of outside experts applying the methods together to achieve a substantially higher level of detailed information on errors. This would provide improvements in correcting errors on interfaces with a view to minimizing ergonomic problems and usability. These are problems that hinder the visually impaired from having full access to websites and systems.

Keywords: Human-computer interface, accessibility, usability, universal design, visual impairment, ergonomic evaluation.

1 Introduction

Among many other technological advances, the Web has stood out and is being used by millions of people worldwide, and is thus regarded as an important means of communication, expression, publication, entertainment etc. For this reason and others it should be a democratic environment and promote accessibility but this is not happening because the lack of knowledge and interest by governments, society and people who create and develop means to use the web put the precepts of universal design on the back boiler whereas this could and should be otherwise.

The mission of entities such as W3C (World Wide Web Consortium) [9], an international community with more than 400 members, amongst which there are technology

companies, government agencies and other types of organization, is to develop the Web to its full potential. Since its foundation in 1994 by Tim Berners-Lee (creator of the World Wide Web) and other, W3C has published more than 110 standards for technology and languages for the Internet, called "W3C Recommendations", with the objective of unify the web and its markets, thus avoiding fragmentation.

Within the mission of "Leading the World Wide Web to reach its potential by developing protocols and guidelines that ensure its long-term growth," one of the goals that W3C has set itself is to create a "web for all". Making sharing knowledge and communication viable for all-comers, regardless of culture, equipment, software, language, or physical or mental ability. By means of the WAI (Web Accessibility Initiative) access to websites by different and very varied groups of users is fostered, and by so doing lives up to the words of its founder and director Tim Berners-Lee.

"We are providers and responsible for accessibility, since we make use of tools, technologies and recommendations which have a universal design (access for all) in mind".

The application of heuristic principles applied by using appropriate assistive technology and making use of specialists who have appropriate knowledge contribute significantly and bring, in the union of technology, from people's knowledge and different disciplines of knowledge, the power required to break down barriers of prejudice and exclusion imposed on people with whatever form of disability. Its main focus is to work on assessing accessibility for the blind. These matters are reported on in this study as they inform its theme. It should be made clear that the contributions offered to people with visual impairments, directly and indirectly, benefit other people, whether or not they have some type of special need.

From the literature surveyed as a theoretical reference for this study, much has already been said and dealt with on various aspects different points of view and a focus on the blind user and on other related issues. But very little is related to investigating the relevant points that comprise an ergonomic evaluation of websites. Thus this paper sought, within the contributions brought up in the state of the art of this research, the foundations needed so that the authors might act with agents who foster a Web, the objective of which is access for all. This is because in the conception of this study the problem is not found in blind users nor in the means that they use to access the Internet. The problem addressed here is from the perspective of misusing or improperly applying the evaluation of the accessibility of web sites and systems.

According to KERLINGER [2], a problem "is an issue that shows a situation which needs to be discussed, investigated, decided on or solved." In this case, the issue in question revolves around a form of questioning that is common to other areas of knowledge: the lack of accessibility. In order to restrict the scope of investigation, this study is limited to working on the inaccessibility of websites so that they can be used by people with varying degrees of visual impairment.

This research puts forward proposals for improving the ways that websites are evaluated. Therefore, issues related to evaluating these will be addressed, more specifically by making an ergonomic evaluation with a view to proposing improvements in how they are used. To that end, the field research will be targeted and concentrated on the knowledge areas of Design and Ergonomics.

This study investigated factors that contribute to and collaborate with minimizing access problems to websites, which, hypothetically, is related to improvements in the instruments and forms of assessment in order to facilitate diagnosis of the problems of usability, accessibility, browsability and ergonomics, thus obtaining solutions which are simpler and more obvious in order to correct such problems.

Starting out from the principle that there are ergonomic and usability problems that make access to web sites difficult for the visually impaired, the other hypothesis was reached which addresses adapting and applying existing principles of human-computer interaction possibly to minimize these problems of access to web pages.

2 Methodology Adopted for the Research

For GIL [3], research has a pragmatic character. It is a "formal and systematic development process of the scientific method. The fundamental objective of research is to discover answers to problems by using scientific procedures".

The research to be tackled is of an applied nature, has exploratory objectives and is informed by review of the literature procedures. It is divided into the following steps:

- In the first step, the procedure adopted was that of conducting a bibliographical survey (review of the literature). This is in order to check books, magazines, articles, monographs, dissertations, PhD theses, specialized reference sites etc. In short, any material that could serve as a base reference for the study in question. The intention in this stage was to identify what has been written, who wrote it and that it was published on ergonomic evaluation of a web interface. These are the matters that characterize the state of the art in this study;
- In the second, all findings targeted in the review of the literature were put into practice and tools that check compliance with the standards and recommendations set out by W3C and e-MAG were applied. These were W3C automated tools such as DASILVA, HTML and Validator and CSS Validator. After these websites were sent for appreciation to evaluators (Designers) trained and instructed to apply the 10 heuristics of Jakob Nielsen [7], as per their repertoire of knowledge and making use of screen reader software. The results of the different evaluation methods were compared with a view to showing that the evaluation of automated accessibility plus the assessment of a designer based on heuristic tools which make use of assistive technology lead to a much richer result in terms of detail and consequently offer better solutions with respect to the errors found in the interfaces, regarding the ergonomic evaluation of websites.

3 Recommendations for the Ergonomic Evaluation of Websites

The ergonomic evaluation of websites deals with every aspect of human-computer interaction and involves interdisciplinary and multidisciplinary issues and acts as an agent to promote accessibility to web pages for people with special needs.

The prospect that will be observed and tackled in this chapter is focused on analyzing and evaluating the interface by using non-empirical methods, with a view to seeking to enhance methods and techniques that benefit most people.

Brandão [1], based on Jordan [8] says that some interface assessment methods do not make of use participants, i.e. they do not use users in the tests. In this case, the opinions are issued by one or more experts.

This paper uses methodologies and methods developed by W3C, the Electronic Government and Nielsen's 10 heuristic principles because they are simple to learn and apply, are practical and quick, come at low cost and because they are not empirical methods, i.e. user participation is not needed for a formal opinion to be issued.

3.1 W3C/WAI Recommendations

The World Wide Web Consortium (W3C) was created in 1994 by Tim Berners-Lee. W3C is a consortium of technology companies to raise the web to its full development by creating protocols, standards and languages. W3C was responsible for creating languages such as HTML, CSS and XML.

W3C's mission is to lift the World Wide Web to its full potential by developing protocols and guidelines that ensure its long-term growth. W3C [12].

The WAI (Web Accessibility Initiative) is the part of W3C responsible for developing strategies, guidelines, and every kind of resource to help make the Web more accessible to people with disabilities.

To make the web accessible, WAI created several guidelines for three components involved in the processes of web development. Web accessibility depends on the integration of these components. On one hand, there are developers who rely on authoring tools and assessment tools. From another perspective, there are users who use browsers, media players, and assistive technologies. Thus, in this process, users, developers and content interact.

There are three guidelines [10-13]:

- Authoring Tool Accessibility Guidelines (ATAG) concern authoring tools;
- Web Content Accessibility Guidelines (WCAG) are about Web content and are used by developers, authoring tools and enhancements;
- User Agent Accessibility Guidelines (UCAG) relate to web browsers and media players, including some aspects of assistive technologies.

3.2 Recommendations for Accessibility

The recommendations for web content are general recommendations where each recommendation groups together check points that address how they should be met so as

to offer content that is accessible to users who have some kind of disability. In total there are 14 in WCAG 1.0. They are:

- Offer alternatives to auditory and visual content;
- Do not use just color;
- Use markup and style sheets correctly;
- Clearly indicate which language is used;
- Create tables that can be harmoniously transformed;
- Ensure that pages featuring new technologies are harmoniously transformed;
- Ensure user control over the time changes of content;
- Ensure user's direct accessibility to (embedded) integrated interfaces;
- Design pages by taking the independence of devices into consideration;
- Use interim solutions;
- Use W3C technologies and recommendations;
- Offer context and guidance information;
- Offer clear browsing mechanisms;
- Ensure the clarity and simplicity of documents.

4 Case Study with the Ergonomic Evaluation of Websites

To conduct the case study, three websites were used, two of which do not consider accessibility while the third does. The first site used for the evaluation was that of UFRPE (Universidade Federal Rural de Pernambuco). It covers the entire range of the site. In the middle, there is an image of the façade of the Office of the Rector of the University sectioned into 12 rectangles arranged in three rows. On the second line in the first two rectangles there is a vertical menu with links to university information and processes. At its side, in the rectangles numbered 8 and 12 there is a box with links and advance snippets of news related to the institution. In rectangle 10 there is a box with events related to the institution. At the top of the site there is the logo of the institution on the left and on the right there is a horizontal menu, useful links and a search utility. At the bottom, a ComboBox is shown of links for quick access to contents, some banners with tools which teachers, students and other members of the institution may use and on the last line there is copyright information, the address and telephone number.

The objective of this case study is to point up by means of evaluating the interface by different methods, problems regarding how the interfaces are evaluated in order to meet the needs of the visually impaired. Therefore, tests were conducted using semi-automatic tools of online assessment, which are based on the recommendations of W3C/WAI and Electronic Government. Finally the application of two heuristic evaluations by two different means, one not using screen reader software and the other doing so. These methods were chosen because: it is quick to learn and manipulate them; they are not stressful and boring; they are quick to apply, they cost very little to implement and their efficiency, effectiveness and safety have been proved. They are widely used and recognized internationally because of their good results in solving interface and accessibility problems.

When a start was made on evaluating these interfaces, use was then made of the heuristics developed by Nielsen [4-7] for this purpose. Issues were come across that a semi-automatic validation tool was not able to detect, something that only an expert having a vast repertoire of knowledge might be able to point out. As examples, mention should be made of:

- Issues related to the different levels of visual, motor, cognitive impairment, etc.;
- Colors for the degrees of color blindness;
- Font sizes suitable for people with difficulty seeing;
- Semantics in code structuring for easy browsing via the keyboard;
- Structuring the graphical network to facilitate the generation of mind models for both the visually impaired and the sighted;
- Making use of the resources of audio description;

Working on the complementarity and supplementarity of images, not just treating them as decorations.

There are many other issues that can be added to the list mentioned, but what this paper really wishes to show evidence of is that the intervention of a specialist is needed who has appropriate tools and support so that there is the perception that a site, website or web system is really accessible. It is this perception that can bring a wealth of contributions that a simple automated mechanism still cannot.

From the moment that the self-same heuristic evaluation is submitted to the interface, only this time with the evaluators making use of a software screen reader (Non-Visual Desktop Access - NVDA) during their browsing, it was noted with surprise that there was a wealth of detail that was not detected when the heuristic evaluation was applied in the conventional manner.

- In the heuristic evaluation applied using the screen reader for browsing, common problems cited by the three evaluators were found, such as:
- Problems with content headers;
- Lack of shortcuts for browsing;
- Leap zones;
- Access keys (quick access via keyboard shortcuts);
- Description of buttons and images;
- Description of menu links;
- Best description of what the page is, of what content or information that website is about;
- A textual description for images, banners, flash;
- A profound lack of knowledge and concern with audio description.

From the results, it once again became evident that the site which set out to implement accessibility features obtained a lower incidence of errors.

Some considerations can be attributed to this case study. The simple fact of some of the ways of assessment described in isolation being used does not guarantee accessibility.

The acquisition of a seal from a validator is not a warranty or guarantee that this site, website or web system is accessible. Compliance levels will be much fuller when the recommendations laid down are followed and applied correctly.

The application of these different forms of assessment taken together is what really makes a difference in evaluating whether the pages are really accessible.

This case study was extremely important for verifying and pointing up that there are many problems in the way that web interfaces are evaluated and that there are ergonomic concerns, of usability and applying in a non-separate way the HCI principles and universal design that already exist. The problems of accessing the Web that are faced by people with visual impairment can be minimized. This will also enable people with other types of disabilities to access it because assistive technologies are being dealing with that can be used by the different groups in question.

There is still a lot to do, even if the result hoped for from the research is achieved, the authors are not fully satisfied with the rules for applying Jakob Nielsen's usability heuristics. It may be that the authors could have achieved a more expressive result, if they had used a larger number of evaluators than that recommended. This might have led to a more comprehensive classification, categorization and leveling of knowledge with a view to obtaining results that would be richer in detail. This might well enable work to be done not only on issues of accessibility and ergonomics but might obtain an understanding of the social context of such evaluators and how this influences their work.

First and foremost, the authors' contribution to the three interfaces evaluated takes the form of the following recommendations, which can be applied in common to all three.

Interface designers need to address the problem of disability other than from a perspective that excludes. This has been worked on for years in Brazil and worldwide for many years. Exclusion begins from the moment an attempt is made to isolate the problem rather than to solve it. For example, there are developers that create different interfaces for individuals with visual impairments. This act is flawed and prejudiced because the problem is thereby being isolated. The problem does not lie in blind people but rather the way in which access is offered to them.

5 Conclusion

Given the hypotheses raised, of the theoretical reference base surveyed, by means of the theoretical foundation and the results presented in the case study, important conclusions can be drawn about the issue of Ergonomic Evaluation of Websites for use by People with Visual Impairment, using the Human-Computer Interface.

The hypothesis was raised that if existing HCI principles are adopted, the problems that blind people have in accessing interfaces can be reduced. This hypothesis was proved by comparing the results obtained by semi-automatic evaluation mechanisms and applying heuristic evaluation, in which the interface that met HCI principles, in this case the APADA site, was better assessed.

It has been shown throughout the sections above and especially in the case study, that, if websites are evaluated on different aspects and techniques, it is possible to detect why they are not accessible.

It was noted that mechanisms of semi-automatic evaluation are not useful if used simply to meet compliance rules, and that there are many forms of incompatibility from one tool to another, evidenced in the results from the assessments, in which there was a large difference of the errors found on the same page by different tools.

Good contributions were made when Nielsen's heuristics were adapted, using the interpretation of experts and the assistive tool, the NVDA screen reader. This was interesting because the evaluation was very much richer.

It can be concluded that there is still much to be done, because the barriers are not technological but rather cultural ones. We are part of a society that excludes which, even when the issue is "accessibility", acts so as to exclude those who need special attention. Accessibility and universal design should be dealt with as top priority matters and not as something that must be done to comply with the law or a requirement. Something should be done for the sake of loving one's neighbor.

It is hoped that the results of this research may contribute to the academic and scientific community, and serve as a basis for enhancing ways of assessment methods and the appropriateness of projects that help not only the visually impaired but may also contribute to access by other people who may also have a special need.

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