Web Accessibility: Design of an Educational System to Support Guidelines Learning

Christos Katsanos, Athanasios Tsakoumis, and Nikolaos Avouris

Human-Computer Interaction Group, Electrical and Computer Engineering Dept.,
University of Patras, GR-26500 Rio Patras, Greece

Abstract — Many websites remain inaccessible for people with disabilities, despite the availability of relevant guidelines and tools. This is mainly due to lack of training of Web designers on accessibility technology. This need is addressed, by ESALP, presented in this paper, a web-based application that is meant to be used as a tool to disseminate and teach Web accessibility guidelines and good design practices. The tool adopts an example-based teaching approach. First, it exposes people to the accessibility impasses that arise when certain, established guidelines are violated, and then provides concise advice on how to avoid or resolve them. These examples were derived from an in-depth, Web accessibility evaluation study of 50 Greek websites. The results of this study, in agreement to similar studies, also indicated that the accessibility of the Greek Web is rather low. We argue that the presented tool could help in improving the accessibility of websites by increasing awareness, motivating and educating Web development stakeholders on the subject of accessibility.

Index Terms — Human-computer interaction, Web accessibility, educational tool, example-based learning, accessibility study

I. INTRODUCTION

In today’s information society the Web has become an invaluable way to access information, exchange ideas and do business. The Web is used by a constantly growing number of people of different ages, cultures, education, and with different physical and cognitive abilities. It is therefore essential to ensure equal access to the Web and provide the same opportunities for all people [1]. As T. Berners-Lee, inventor of the Web, eloquently stated: “The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect.”

Web accessibility refers to the practice of making websites usable by people of all abilities and disabilities [2]. The following excerpt from [19] stresses the importance of ensuring accessibility of websites for people with disabilities.

“This is the author's version of the work.
You can quote this paper as:
their rationale hard to understand. Furthermore, guidelines usually come into long documents that can discourage practitioners from investing time and effort to read them.

Automated software tools have been proposed as an efficient and easy way to evaluate and remedy accessibility problems. These tools typically inspect the source code of webpages and report potential accessibility problems. Representative examples of such tools are IBM-RPT (former WebExact), and AChecker (www.atautor.ca/achecker). However, not all guidelines can be evaluated in an automated way. But even if they could, automated tools would still require a fully functional version of a website to run. Such a version is only available at the final stage of the development process, in which the cost of resolving accessibility problems is usually very high.

Therefore, it is important to integrate the accessibility requirements in the early stages of development. New versions of Web development tools, such as Dreamweaver and FrontPage, reflect this need by providing integrated accessibility-related support. However, websites continue to have low accessibility [4]–[8]. Therefore, new ways to communicate the value of Web accessibility to Web development stakeholders and train them on good accessibility practices are required.

In this paper, we present ESALP, a learn-by-example tool that aims to increase awareness, motivate and educate Web development stakeholders on Web accessibility. The remaining of this paper is structured as follows. First, the requirements and rationale of the design choices of the proposed tool are delineated. Next, the details of the Web accessibility study that was conducted to collect real-world examples for the tool are described. Subsequently, the interface and interaction design of the tool is presented, followed by conclusions and directions for future work.

II. DESIGNING AN EDUCATIONAL SYSTEM TO SUPPORT ACCESSIBILITY LEARNING THROUGH PARADIGMS (ESALP)

A. Requirements and Typical Users of the Tool

The goal of the proposed tool is to increase awareness and educate people on Web accessibility. The tool is addressed to both Web practitioners and students, who currently shape their future Web development practices. Web practitioners can also use the tool to communicate in an easy way the need for accessibility to clients and managers. If all stakeholders become convinced of the value of Web accessibility, then it is more likely that an accessible website will be developed [10]. In addition, educators and professors can also use the tool as accompanying material in their accessibility courses or training modules.

Based on these goals and the typical users identified, the following high-level requirements were formulated for the proposed tool:

1) It should cover at least the most widely used set of available Web accessibility guidelines;
2) It should expose its users to the accessibility impasses that arise when certain guidelines are violated. In this way, they can have a clear picture and long-lasting impression of the problematic situations that occur, and get motivated to develop good accessibility practices;
3) It should provide concise advice on how to avoid or resolve each problem. Long documents describing solutions in an abstract and context-independent way do not seem to fit to the busy schedules and problem-oriented thinking of Web practitioners;
4) It should organize the provided material in a structured and flexible way so that the users of the tool can follow their own learning paths. Additional links to external resources should be also provided for further exploration;
5) It should require minimal effort to install and run on as many computer platforms as possible;

B. Design Choices and Rationale

An example-based learning approach accompanied by concise advice on how to avoid or remedy the problem was deemed as an appropriate vehicle to achieve the goals of the proposed tool. Examples are often used for teaching good design practices and guidelines in both Human-Computer Interaction (HCI) and Software Engineering (SE) fields.

For instance, [15] is an entire book that illustrates good and bad Web design practices with heavy emphasis on real-world examples. In addition, there are various sites presenting examples of bad designs in an attempt to communicate good design practices, such as “Webpages that Suck” (www.webpagessucksuck.com), and “Worst of the Web” (www.worstoftheweb.com).

Patterns have been also proposed as a useful tool to communicate design knowledge and teach good design practices [11]–[13]. A pattern is defined as “a structured description of an invariant solution to a recurrent problem within a context” [13]. Two other closely related concepts are anti-patterns and amelioration patterns. Anti-patterns present a “specific piece of negative advice or an example of bad practice” [14], whereas amelioration patterns combine anti-patterns with advice on how to correct the problem [14]. All types of patterns are grounded in presenting concrete examples, either in a positive or a negative way. Study results [14] indicate that the examples presented with each pattern or guideline capture students’ attention and interest, and support better understanding of its rationale and application. The approach we adopted is close in principle, but at the same time quite different from the concept of amelioration patterns, since the latter are potentially more general and typically refer to multiple contexts [13].

The set of guidelines selected for the proposed tool was the first version of WCAG [16], which is a widely-known and
used set of guidelines. The Web accessibility study that identified representative examples of guidelines violations for the content of the tool started on September 2008 – details of the study are described in the following section. At this time the second final version of the WCAG guidelines [17] was not yet available. However, future work includes integrating bad design examples of this and other sets of guidelines.

WCAG v1.0 includes 14 broadly-expressed guidelines, each of which has to meet a certain number of checkpoints. Table I presents these 14 guidelines. Each checkpoint explains how the guideline applies in typical content development scenarios. All 64 checkpoints are divided into three levels of priority. Priority 1 checkpoints must be satisfied or otherwise the website is characterized as inaccessible for one or more groups. Priority 2 checkpoints should be satisfied in order to remove significant accessibility impasses. Priority 3 checkpoints may be addressed to improve access to the website. Based on the priority level of checkpoints satisfied, a website is characterized as having A, AA or AAA level of conformance correspondingly.

TABLE I

<table>
<thead>
<tr>
<th>Number</th>
<th>WCAG 1.0 Accessibility Guidelines [16]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provide equivalent alternatives to auditory and visual content.</td>
</tr>
<tr>
<td>2</td>
<td>Don't rely on color alone.</td>
</tr>
<tr>
<td>3</td>
<td>Use markup and style sheets and do so properly.</td>
</tr>
<tr>
<td>4</td>
<td>Clarify natural language usage</td>
</tr>
<tr>
<td>5</td>
<td>Create tables that transform gracefully.</td>
</tr>
<tr>
<td>6</td>
<td>Ensure that pages featuring new technologies transform gracefully.</td>
</tr>
<tr>
<td>7</td>
<td>Ensure user control of time-sensitive content changes.</td>
</tr>
<tr>
<td>8</td>
<td>Ensure direct accessibility of embedded user interfaces.</td>
</tr>
<tr>
<td>9</td>
<td>Design for device-independence.</td>
</tr>
<tr>
<td>10</td>
<td>Use interim solutions.</td>
</tr>
<tr>
<td>11</td>
<td>Use W3C technologies and guidelines.</td>
</tr>
<tr>
<td>12</td>
<td>Provide context and orientation information.</td>
</tr>
<tr>
<td>13</td>
<td>Provide clear navigation mechanisms.</td>
</tr>
<tr>
<td>14</td>
<td>Ensure that documents are clear and simple.</td>
</tr>
</tbody>
</table>

C. A Study to Collect Examples of Guidelines Violations

A Web accessibility study was conducted in order to identify representative examples of accessibility guidelines violations for the content of the proposed tool.

A total of 50 Greek websites was evaluated against all WCAG 1.0 checkpoints. The evaluated websites were selected from seven different domains based on: a) their popularity ranking according to Alexa (www.alexa.com), and b) their coverage of typical everyday online activities and interests. Table II presents the total number of websites evaluated per domain along with a representative example of each category.

The study was supported by a combination of tools. First, the IBM Rational Policy Tester Accessibility Edition (RPT) 5.5, a commercial, automated accessibility evaluation tool was used to evaluate each of the selected websites against WCAG 1.0. Next, the freely-available Web Accessibility Toolbar 2.0 (WAT) was used to further investigate some of the warnings of potential problems produced by IBM-RPT. This was necessary in order to identify examples of checkpoints that require manual inspection (e.g. 14.1 “Use the clearest and simplest language appropriate for a site's content”).

Despite the relatively small number of websites evaluated, the results of the study also provide a useful indicator of the Greek Web accessibility. Table II presents the number of different guidelines violated and the total number of problems found (i.e. instances of violations) per domain of the websites evaluated. Only the problems that could be automatically identified by IBM-RPT are included (i.e. known-issues). The distribution of the total number of known-issues found was significantly skewed for most categories (p<0.05) and thus the median was used as a measure of central tendency.

All of the evaluated websites were found to be inaccessible according to the WCAG levels of compliance. The websites violated on average 2.8 guidelines of priority 1, 8 guidelines of priority 2, and 3.6 guidelines of priority 3. The average of guidelines violated across the different domains was approximately the same. Some categories (e.g. News) had substantially larger numbers of total violation-instances, but this can be attributed to their relatively higher complexity.

These results further strengthen our point that additional, complementary approaches to increase awareness and educate people on Web accessibility are required.

D. Interface and Interaction Design of the Tool

Fig. 1 presents an example of the interface of the proposed tool. The tool presents a short description of each guideline (Fig. 1b), representative examples of the problematic situations that occur when accessibility guidelines are violated in real-world websites (Fig. 1c) and concise advice on how the problem can be avoided or resolved (Fig. 1d).

Although a single webpage can break many guidelines at the same time, each example focuses on only one guideline violation to simplify the message and make the content easier to understand. The examples contain pictures that contrast how the presented webpage is viewed by people with and without disabilities, and a brief textual description of the accessibility problem (Fig. 1c). Each example is accompanied by a title that communicates the domain (e.g. “hospital”) and the name of the actual website in order to underline the fact that these examples refer to existing websites.

In addition, concise, practical advice on how to ensure compliance with the presented guideline and how to avoid or resolve the problem is also provided (Fig. 1d). This advice was derived by summarizing the information contained in the WCAG 1.0 guidelines. Such a summarization was made possible by the contextualization of the guideline in an exemplary situation. A link to additional resources about each guideline is also provided to allow further exploration.
### TABLE II
**Domains of Websites Evaluated and Accessibility Problems Found by WCAG 1.0 Priority.**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Total Sites</th>
<th>Representative Example</th>
<th>Priority 1 Known-Issues&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Priority 2 Known-Issues&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Priority 3 Known-Issues&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Guidelines Violated (Average)</td>
<td>Total Instances (Median)</td>
<td>Guidelines Violated (Average)</td>
</tr>
<tr>
<td>News</td>
<td>8</td>
<td><a href="http://www.in.gr">www.in.gr</a></td>
<td>3.3</td>
<td>8701</td>
<td>9.9</td>
</tr>
<tr>
<td>Education</td>
<td>8</td>
<td><a href="http://www.upatras.gr">www.upatras.gr</a></td>
<td>3.1</td>
<td>3375</td>
<td>9.0</td>
</tr>
<tr>
<td>Commerce</td>
<td>7</td>
<td><a href="http://www.plaisio.gr">www.plaisio.gr</a></td>
<td>2.9</td>
<td>2674</td>
<td>7.3</td>
</tr>
<tr>
<td>Public Transportation</td>
<td>8</td>
<td><a href="http://www.aia.gr">www.aia.gr</a></td>
<td>2.8</td>
<td>499</td>
<td>7.3</td>
</tr>
<tr>
<td>Tourism &amp; Travel</td>
<td>4</td>
<td><a href="http://www.travelforall.gr">www.travelforall.gr</a></td>
<td>2.8</td>
<td>3783</td>
<td>8.5</td>
</tr>
<tr>
<td>Health</td>
<td>8</td>
<td><a href="http://www.ippokratio.gr">www.ippokratio.gr</a></td>
<td>2.5</td>
<td>1633</td>
<td>7.4</td>
</tr>
<tr>
<td>Social &amp; Non-Profit Organizations</td>
<td>7</td>
<td><a href="http://www.unicef.gr">www.unicef.gr</a></td>
<td>2.6</td>
<td>306</td>
<td>7.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>“Known-Issues” is used to refer only to problems that can be automatically identified by accessibility evaluation tools.

The provided material is organized under different facets [18] to allow personalization of the user’s learning path. The available options (Fig. 1a) allow the user to easily navigate the information space by progressively narrowing the choices in each dimension. Alternatively, typical keyword search can be used.

The number of items in each facet is presented in parentheses next to each link-option. Multiple filters can be applied at the same time and each one can be easily removed with a single click. Currently the following facets have been specified:

1. WCAG number of guideline (e.g. guideline 1);
2. WCAG number of specific checkpoint (e.g. checkpoint 1.1);
3. Priority category of guideline (e.g. priority 1);
4. Elements of a page (e.g. forms, tables);
5. Type of disability (e.g. blindness).

---

**Educational System for Accessibility Learning through Paradigms**

These terms define your current search. To remove a category filter click the ▼

**BY WCAG 1.0 CHECKPOINT: all > 1.1 > Example 1**

**BY WCAG 1.0 GUIDELINE [18]**

- **GUIDELINE 1 [5]**
- **GUIDELINE 2 [2]**
- **GUIDELINE 3 [7]**
- **GUIDELINE 4 [3]**

**BY PRIORITY [3]**

- **PRIORITY 1 [16]**
- **PRIORITY 2 [18]**
- **PRIORITY 3 [30]**

**BY PAGE ELEMENTS [18]**

- **LISTS [2]**
- **TABLES [7]**
- **LINKS [7]**
- **IMAGES [6]**

**BY DISABILITY [5]**

- **BLINDNESS [17]**
- **DEAFNESS [5]**

---

Fig. 1. Interface of the proposed Educational Tool for Accessibility Learning through Paradigms (ESALP): (a) Navigation mechanisms, (b) Short description of the guideline, (c) Example of its violation, (d) Concise advice on how to avoid or resolve the problem.
III. CONCLUSIONS AND FUTURE WORK

Despite the importance of accessibility and the availability of guidelines and tools that support the design of accessible websites, study results [4]–[8], indicate that a large percentage of websites is still characterized by low accessibility. In agreement with these studies, we found that all of the 50 Greek websites evaluated were inaccessible according to the WCAG levels of conformance. A study [10], involving 175 webmasters, identifies lack of training, lack of managerial support, lack of client support and confusing guidelines as some of the major obstacles to developing more accessible websites.

In an attempt to address these issues, we have presented the design of a web-based tool that is meant to be used as a way to disseminate and teach Web accessibility guidelines and good design practices. The tool uses an example-based approach to expose Web development stakeholders, such as developers, managers, and clients, to the problematic situations that occur when established accessibility guidelines are violated. After the users of the tool are exposed to these problems, they are provided with concise advice on how to avoid or resolve them. The concept adopted is similar in principle to that of amelioration patterns [14].

The tool is planned to be made freely available online at http://hci.ece.upatras.gr. Our aims are to increase awareness, motivate, and educate stakeholders in Web development on Web accessibility. Furthermore, the tool can be a valuable asset to educators teaching, and students learning about Web accessibility. In agreement to [10], it is argued that if more people that are involved in the development of a website become familiar and embrace Web accessibility ideas, then it is more likely that accessible websites will be developed. Initial presentations of the tool to colleagues involved in Web development and students of an Electrical and Computer Engineering department received very positive feedback.

Future work involves integration of the proposed approach in two University courses that include modules on Web accessibility in order to investigate its contribution to the educational process. In addition, the coverage and interrelations with sets of guidelines other than WCAG 1.0, such as Section 508 and WCAG 2.0, is envisaged as a future direction.

As a footnote, it should be stressed that this paper does not suggest that the proposed tool is a substitute to studying Web accessibility guidelines or any other type of related material. Instead, it is proposed as a complementary way to disseminate and teach good accessibility practices, in conjunction with existing approaches.

IV. REFERENCES