Exploring the accessibility evaluation of city council websites by computer science students using a service-learning approach

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ABSTRACT

Web content accessibility guidelines (WCAG) have been the de facto standard for web accessibility evaluation for more than two decades and therefore have been introduced into legislation and university curricula in Computer Science. The usefulness of using WCAG to evaluate web accessibility in educational contexts is clear but the reality is that both teaching and learning how to apply WCAG is complex, and the challenge is even greater if students do not have the technical skills expected for WCAG's applicability. Accessibility is not an easy topic to teach and learn since it involves complex terminology and methodologies, and besides, students at the National Distance Education University (UNED) are adults with less time to share knowledge among others. In this research, we have tried a humanistic approach, more precisely, a philosophical-educational approach, as is the case of service-learning (SL) that might connect our students with the reality they are into, assessing the accessibility of their city council's webpages. We propose SL as a practical philosophical-educational approach, also part of the ethical formation that is needed in engineering students, which helps to respond to the questions and challenges of the European Higher Education Area and UNESCO´s Sustainable Development Goals.

KEYWORDS

Web accessibility, Accessibility evaluation, Service-learning approach

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1 INTRODUCTION

Web Content Accessibility Guidelines (WCAG) is an international standard for Web accessibility evaluation; legislation and policies across the world refer to WCAG compliance as their reference standard [4]. There are several coexisting versions of WCAG: 1.0, 2.0, 2.1 and 2.2 and 3.0 is a working draft. WCAG 2.1, were released in June 2018, the updated guidelines include specific criteria for users with cognitive or learning disabilities and with low vision, and access from mobile devices is included. WCAG 2.1 guidelines have 13 guidelines and 78 success criteria which are written as testable statements that are not technology specific. Teaching and learning how to apply WCAG is complex, and the challenge is even greater if students do not have the technical skills expected for WCAG's applicability [5]. Computer scientists need to apply accessibility in terms of not only complying with legislation in their industry roles but should learn them as part of their curriculum when studying for their university degrees [6]. However, accessibility is not an easy topic to teach and learn since it involves complex terminology and methodologies, as well, it is usually embedded in dedicated courses instead of including it across the whole curriculum [7] [8]. Therefore, there exists a need to better integrate accessibility into the Computer Science curriculum [9]. Accessibility education in Computing Science presents challenging characteristics for those engaged in accessibility capacity building [10]. That is related to the fact that not all Computer Science faculty know enough about accessibility; they may not have had the professional development to teach accessibility [11]. Some of the best practices for teaching accessibility within the Computer Science curriculum include simulating disabilities to understand the reality of those with accessibility needs, the use of videos or alternative formats that can be combined with the textbook and include other types of resources like research papers or online resources [12].

1.1 Service-Learning

Literature indicates that the use of a variety of methods is helpful in learning processes, such as mixing traditional lectures, collaborative learning sessions, exercises on website evaluation and the development of accessible websites [13]. In our specific context of Higher Education delivery at a distance education university, where students are adults who have professional and personal duties and have less time to conduct collaborative learning activities, we looked for a user-centric methodology. In this work, we propose the use of service-learning (SL) as a practical philosophical-educational approach, part of the ethical formation that is needed in engineering students, which helps to respond to the questions and challenges of the European Higher Education Area (EHEA). In [14], authors support the theory that SL may form a philosophy of higher education and thus shed light on the sense and scope of the University at present. As a professional, citizen and person: will our students know how to integrate into the context that they will find themselves in? Will they know how to contribute their knowledge to the reality that they must fit into? Will they act with

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a commitment to ethics? Will they have a sense of community in society?

In this respect, we believe that it is more important to offer education in soft skills, which will prepare our students to face future situations, and to look up information and new techniques to deal with them. Our goal is to "*(. . .) educate independent individuals whose exercise of civic responsibility indeed improves the communities in which they live together with others*" [15]. SL drives our work towards an enriched and augmented education, falling within a practical philosophical-educational approach [16] [17] which implies an ethical theory of human formation [18].

After some years of developing other strategies based on andragogy [19] in the year 2019 we decided to try a new methodology that prepares our students to act and commit themselves as active, critical and responsible citizens, giving them opportunities to learn throughout their whole life, supporting them in their social role [20], encouraging students to be independent and promote constructive research, the setting of objectives, collaboration, communication and reflection within practices in real contexts [15].

This social dimension of the EHEA is linked to the need for an ethical-civic education and the social responsibility of universities [21] [22]. Collaborate to go beyond the immediate (urgent problems faced) and the instrumental (training graduates in their specialisation for professional insertion) to make our future possible by knowing, deep down and being critical, where we come from to know where we should go as a society, as a person and as a professional in the area of work in which they specialise [23]. This requires the training of human capabilities understood as potentialities that enable us to learn and, from that learning, to acquire the skills to be, to do, to try and to behave.

The theoretical framework of SL is being influenced by an extensive and varied group of pedagogical authors and movements, including diversity as a clue aspect of its theoretical origins. SL demonstrates can act as a catalyst for generating a homogeneous philosophical-educational approach as it has been accepted in the Canary Islands Declaration on SL in higher education [24].

Some components of SL are emphasised by influences such as learning by doing and the socialist pedagogy or the scouting movement [25]. In this work, we try to focus the practical activity in the prominent role of students, in a user-centric approach. We linked their concern about the social reality around them with assessing the accessibility of their city council's web pages, bringing some of their interests closer to the reality which takes place outside the learning environment, and trying to get closer to their learning and social needs. As teachers, the practical assessment links the relationship of our educational institution with the social reality of our country, identifying social and civic educational goals or objectives that can help people reach their full potential.

2 METHODOLOGY

The context of this study is the "Usability and Accessibility" course which is part of the Computer Engineering and Information Technology Engineering degrees at the National Distance Education University (UNED), in which third-year Computer Science undergraduates are introduced to the guidelines for designing and implementing accessible graphical user interfaces, developing accessible webpages and the use of automatic and manual tools in methodologies for assessing Web accessibility (i.e., the use of W3C standards). An adaptation of accessibility evaluation protocols with WCAG 2.X was used in this study to evaluate an online resource and to understand students' experiences and perceptions while evaluating WCAG.

The course has two assignments focused on the same web page, selected by the students themselves. The first one is an assignment to understand the multiple accessibility barriers for users using the Web, and the second one is an in-depth study of WCAG guidelines including an accessibility evaluation, both automatically and manually (i.e., applying heuristic evaluations). The second assignment was redesigned in the last six years trying to better engage the student with the practical activity [19] [26].

Following a procedure for accessibility evaluation [27], the evaluation on the websites was sampled including:

- The homepage.
- A page including a video.
- A page including a question/answer thread, blog, or online chat.
- A page including a web form.

For the evaluation of each criterion the following rating method was applied:

- NA (Not achieved): The feature to test is missing.
- PA (Partially achieved): The feature to test is available but not integrated.
- If the criterion is not applicable, "Not Applicable" is added to the comments.
- LA (Largely achieved): The feature to test is available and partially integrated.
- FA (Fully achieved): The feature to test is available and fully integrated.

2.1 Research questions

The objective of this research was to assess the benefits of including SL as a new learning methodology to improve the understanding of the students, whilst connecting the students with their social reality, as well as to understand the state of web accessibility in city web sites around the country. The research questions addressed were:

- RQ1. What are the most common WCAG errors and successes when evaluating city council websites?
- RQ2. What is the perception of the students of using a SL approach?

Students first mark the values associated with WCAG which are collected automatically on the checklist sheet and then perform the required manual evaluation. For the automatic evaluation, students used WAVE (with the added benefit of having a plugin extension for Chrome or Firefox browsers). Complementary tools included NVDA, Voiceover, Contrast Checker and HTML validator along with several plugins for Chrome and Firefox Web browsers. A quantitative method approach has been used for this research [28]. For the analysis of RQ1 evaluations of students were considered as a Likert scale, when examining Likert scale data, we treated it as interval data, wherein the mean and standard deviation serve as the

Table 1: Student demographic data

		Gender		Age			
Year	**Students (Total)**	**Male**	**Female**	**<= 25**	**26 - 35**	**36 - 45**	**>46**
2019-2020	30 (15)	90%	10%	16.67%	33.33%	40%	10%
2020-2021	56 (36)	71.42%	28.58%	13.21%	43.40%	16.98%	26.42%
2021-2022	59 (43)	86.44%	13.56%	22.64%	28.30%	33.96%	15.09%

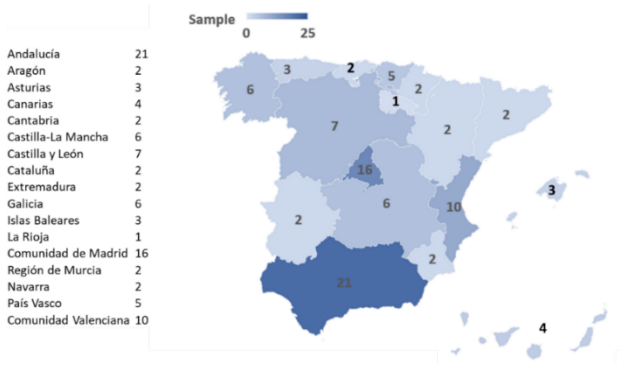

Figure 1: City Council websites distribution

most suitable measure of central tendency, evaluations have been clustered by levels (A and AA) instead of principles to check the level of accessibility following international legislation on web accessibility. For RQ2 data from university satisfaction questionnaires within the sample have been included.

2.2 Sample

The sample in this study included students in academic courses 2019-2020, 2020-2021 and 2021-2022 with a total of 145 students enrolled in the courses. Students were mainly male and adult learners with ages between 26 and 45. See Table 1 for disclosed data. Students, at the time of registering, consented to the use of anonymised data from their educational interactions for research purposes.

From those registered 109 completed the assignment. To see the diversity of evaluations and remove redundancy evaluations of the same city council websites were removed, keeping the most up to date. The following cities had redundancies: Madrid (7), Sevilla (3), Malaga (3), Alicante (1), Valencia (1). The final sample, therefore, included a total of 94 evaluations which can be seen distributed in Autonomous Communities in Figure 1.

3 ANALYSIS AND RESULTS

3.1 WCAG student's accessibility analysis

The results of students' WCAG evaluation (RQ1) have been divided by levels and criteria. For the evaluations for level A which involve critical aspects of accessibility, errors include aspects such as the lack of options for navigation for those with visual impairments (1.1.1, 2.4.1), or those which can affect mobility aspects of users (2.1.4, 2.5.4), and stopping unnecessary information from appearing (2.2.2). Problems with recorded videos include a lack of audio and video-only options and captions, audio descriptions or text alternatives (1.2.1, 1.2.2, 1.2.3).

Successes include the sequence of information, relationships, and order (1.3.1 – 1.3.2, 2.4.3, 2.4.4), correctness in the title, labels, and language (2.4.2, 2.5.3, 3.1.1, 4.1.1, 4.1.2), appropriate use of colour (1.4.1) and keyboard (2.1.1, 2.2.2). As well as use of pointer (2.5.1, 2.5.2) and focus and instructions (3.2.1 – 3.2.2, 3.3.1, 3.3.2). For level AA the low results of some criteria are aligned with level A, in those when videos are present like the lack of lack of audio description (1.2.5) and the absence of captions in live events (1.2.4). Other errors can affect the access of users with accessibility needs to key information such as the correct use of contrast (1.4.3) or when accessing forms which is something common in public administration (3.3.4, 4.1.3). Those criteria that are better achieved are related to the orientation, purpose, and navigation (1.3.4, 1.3.5, 3.2.3, 3.2.4) text resize and use in images (1.4.4, 1.4.5, 1.4.10 – 1.4.13), and information and labelling (2.4.5 – 2.4.7).

Level A errors are 30%, those types of errors imply users might not be able to use the website with key criteria such as 1.1.1 or 2.1.4. Most errors belong to the perceivable principle (11, 55%) with 4 Level A, this principle is crucial for accessibility because it ensures that digital content is presented in a way that can be perceived by all users taking care of aspects that are common on public administration websites such as text, images, multimedia, and user interface components. While the 20 most common accessibility successes are included with a mean value higher than 4.02. In this case, is good to see level A criteria cover 35% while level AA is 40%. Most successes in this case belong to the operable principle (9, 45%), this principle is vital for accessibility because it focuses on ensuring that web content is designed and presented in a way that allows all users to interact with it effectively and efficiently.

3.2 Student's perception

Regarding RQ2, the quantitative satisfaction of students shows a positive indicator through the years as seen in Table 2, considering the difficulties arising in 2018 with the publication of WCAG 2.1 and its implementation in the practical activities of the course. Student satisfaction has increased steadily since this new SL method started to be applied and the difference in overall degrees satisfaction is also substantial.

4 CONCLUSIONS

WCAG evaluations are complex and difficult, even with current automatic tools, and better evaluation protocols and training methods are needed. Students, despite undergoing a one-month training program in WCAG heuristic evaluation and the utilisation of automated tools, lack sufficient expertise in the assessment of accessibility and

Table 2: Student satisfaction of the course

	Degree in Information Technology Engineering			Degree in Computer Engineering		
Year	**Course satisfaction**	**Degree satisfaction**	**Diff.**	**Course satisfaction**	**Degree satisfaction**	**Diff.**
2016-2017	83,08	65,18	17,9	75,69	66,12	9,57
2017-2018	78	67,45	10,55	68,22	66,93	1,29
2018-2019	22,67	65,24	-42,57	68,89	66,53	2,36
2019-2020	74,15	67,61	6,54	88,1	69,63	18,47
2020-2021	87,86	70,03	17,83	64,43	68,5	-4,07
2021-2022	98,57	69,81	28,76	86,49	71,01	15,48
2022-2023	87,14	71,88	15,26	78,61	70,58	8,027

they cannot be classified as experts in this field. This research is an effort to better integrate accessibility evaluation into the Computer Science curriculum by considering the pedagogy of SL that helps us, the lecturers, to carry out actions of knowledge transfer with social value. From this viewpoint, SL brings together the social responsibility actions of the University itself, thus bringing its three mainstays into line in the same direction: teaching, research, and knowledge transfer. The variety of students coming from different parts of the country has given this work a holistic state-of-the-art level of accessibility on the main city council's websites. More analysis needs to be carried out, to compare the accessibility state by gross domestic product and population. Moreover, a deeper analysis of the impact of the proposal and the link to the SL theories must also be performed, in that sense qualitative feedback considering students' suggestions and comments about their experience is required.

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