Improving Accessibility in Virtual Learning Environments and Educational Resources: A Practical Case and Future Challenges

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Abstract: A system is considered accessible if it allows different users to access its features, even if these users have physical, visual, auditory or any other type of disabilities. Accessibility has become crucial in Virtual Learning Environment (VLE) since these deliver the educational contents as online activities and electronic courses. Despite such importance, one of the most consistent problems with modern learning management systems is their failure to comply with standards for accessibility. Also, those that manage to meet accessibility criteria still receive negative reviews from disabled users. As a result, accessibility issues act as a barrier in the growth of VLEs. In this paper, we intend to reduce this barrier by providing a practical example of how educational institutions can improve their VLEs and their educational resources. We proposed and applied a process for identifying accessibility requirements and implemented these requirements, testing the redesigned VLEs and educational resources with end users. Obtained results are discussed to provide insights on how software engineering teams can improve the accessibility of VLEs and educational resources.

1 INTRODUCTION

The use of virtual learning environments (VLE) and online educational resources is one of the proposals for popularizing and democratizing learning by promoting access and inclusion of all types of users. However, the use of such technologies still presents barriers for the access and permanence of all students, which include People with Disabilities (PwD) (Brito and Dias, 2020). The latest World Report on Disability of the World Health Organization shows that around 15% of the world's population lives with some degree of disability issues (Organization et al., 2011).

The lack of technological resources, specialized practitioners and lack of accessibility in the architecture of VLE are considered challenges to the permanence of students (Cinquin et al., 2021). Studies in the Distance Education area point to the need to adapt VLE, as well as the proposed curriculum and didactic resources (Lee, 2017; Brito and Dias, 2020).

Considering the above, Assisting Technologies (AT) emerge with the goal of promoting equity, enabling emerging barriers to be overcome or excluded, as well as, reduce disadvantages in the learning of PwD when compared to the other students. With the rise of distance education (Lee, 2017) and the increase in the number of PwD (Organization et al., 2011), education institutions face the challenge of promoting the accessibility of offered courses, ensuring the quality of content and educational solutions, as well as the strategies for student permanence until the completion of the course.

This position paper aims to present Federal University of Maranhão's path towards the inclusion of accessibility aspects in its VLE and its educational resources. Initially, we conducted a survey of the most needed accessibility items for environments and resources. Then implementations in the environment

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and objects were executed. Finally, the pedagogical production team created the content with accessibility. After preparing the course, we made it available to the general public in November 2021. To this day, 50 students with disabilities have already joined the course, and they have to perform 28 activities.

The remainder of this paper is organized as follows: Section 2 presents the background and related work regarding accessibility and VLEs. Section 3 describes our methodology for enabling accessibility in our online educational resources and VLE. Then, Section 4 presents the analysis and results regarding the improvements and current use of our online educational resources and VLE. Finally, Section 5 presents our conclusion and future work.

2 ACCESSIBILITY IN VIRTUAL LEARNING ENVIRONMENTS

VLEs are tools aimed at providing learning opportunities through knowledge sharing and social interaction (Dillenbourg et al., 2002). The literature presents a series of environments that are currently used by educational institutions, for example: Moodle[1], Blackboard[2], and Edmodo[3]. Although these environments offer some kind of support for accessibility, PwD still highlight the absence of elements to help them achieve learning goals (Lee, 2017; Bozza et al., 2010).

Accessibility is the concept that represents the ability to access computers, mobile devices and the internet by people with various types of disabilities (visual, auditory, physical and others) (Carter and Markel, 2001). According to (Paiva et al., 2021), the importance of accessibility and its evaluation has grown in recent years, as the use of software has become increasingly essential in the modern world (Buendía et al., 2012).

Accessibility in VLE has also been the goal of study in recent years. Nascimento et al. (2019) presented a LMS created from accessibility guidelines. During development, PwD carried out part of the validation of the LMS. Finally, the authors described that the environment was well accepted by people with and without disabilities (Nascimento et al., 2019). In another study, (Alturki et al., 2016) present an accessibility assessment of the VLE Blackboard at King Saud University. The results showed that Blackboard was an accessible tool for different types of teachers .

In their research, Brito and Dias (2020) present a focus group describing expert opinions about the accessibility of a LMS. As a result, they identified that the use of third-party tools increases the flexibility of people with different types of disabilities and makes the solution (development of the LMS) cheaper. However, there is incompatibility of the external tools with the developed solution (Brito and Dias, 2020).

Considering the above results, it is clear that here is an interest from researchers and practitioners in the field of VLE' accessibility. Although the analysis of popular VLE is being performed to verify to what extent they support people with disabilities, there is still the need to further analyze the impact of implemented changes in real use scenarios. Our goal is to provide such type of analysis showing the impact of meeting accessibility requirements in our MLS and its educational resources. In the following section, we present the methodology we followed within this research.

3 METHODOLOGY

At Directorate of Technologies in Education (DTED/UNA-SUS) from Federal University of Maranhão (UFMA), we use a Moodle-based VLE. In September 2020, we identified the need to support PwD when a specific online course had disabled students. The course dealt with teaching accessibility in physical spaces in police stations. Up until this point, our environment was not properly prepared to contain accessible resources. Therefore, our objective was the inclusion and evaluation of accessibility in digital educational websites of UNA-SUS/DTED/UFMA. Then, we developed a process containing the activities described below: (1) technological suitability for accessibility; (2) creating content for accessibility; and (3) tracking students' progress through the course. The process was proposed based on common activities regarding accessibility evaluation and our internal process. Figure 1 present our process.

3.1 Technology Adaptations for Meeting Accessibility Criteria

3.1.1 Analysis of Accessibility Recommendations

For the inclusion and evaluation of accessibility, it was essential to identify requirements from the perspective of accessibility, using parameters that could be followed in the development of an online environment. In such context, the World Wide Web

[1]Avaliable at: https://moodle.org/?lang=en_us
[2]Avaliable at: https:/ /www.blackboard.com/
[3]Evaluable at: https://new.edmodo.com/

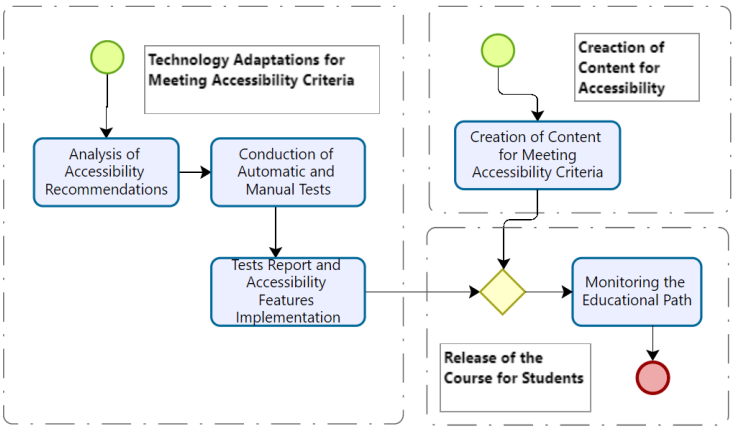

Figure 1: Process for enabling and evaluating the accessibility at UNA-SUS/DTED/UFMA.

Consortium (W3C[4]) is an international consortium of companies, government agencies and independent organizations, which aims to develop a set of standards for the creation and interpretation of content for the web. Through the Web Accessibility Initiative (WAI[5]), which is the organization responsible for developing guidelines, strategies and resources for web accessibility, the W3C created the Web Content Accessibility Guidelines (WCAG[6]). WCAG is a document that presents some accessibility guidelines for web content. These guidelines are related to intellectual impairments and aim to reduce barriers for people with different disabilities to access the internet.

For inclusion and evaluation of web accessibility, in addition to WCAG, we also used the Digital Accessibility Model in Electronic Government of our Country (e-MAG). Throughout the document, several recommendations are presented for the construction of an accessible website, such as: (i) follow the web language standards, in order to guarantee the website's compatibility with all types of browsers, software and mobile devices; (ii) Accessibility recommendations in the organization of HTML (HyperText Markup Language) code in order of development and features; and (iii) Accessibility assessment, which can be automatically performed by software, or manually through human validation checklists.

3.1.2 Conduction of Automatic & Manual Tests

Accessibility validators are automatic tools that search the code of a page, issuing reports that indicate accessibility errors according to the priorities suggested in WCAG. Therefore, in order to increase the degree of confidence in the automatic validation results, the tests were performed using the Cynthia Says[7], Lighthouse[8] and Accessibility Scanner[9] tools.

The Criptzone Cynthia Says portal is an automated accessibility validator that was developed by Criptzone Inc. together with The International Center for Disability Resources on the Internet – ICDRI and the Internet Society. This tool allows users to test individual pages on their websites by providing feedback in report format.

Lighthouse is an open source automated tool that analyzes the quality of web applications. It can be run as a Chrome extension (only browser extension available) or from the command line. When informing the URL to be audited, the tool runs a series of tests on the page and generates a report on its performance, with a specific section on accessibility-related failures.

The Accessibility Scanner is a tool that suggests accessibility improvements in mobile applications, such as increasing small touch targets, increasing contrast and providing content descriptions so that the website can be more easily used by PwD.

Since automatic validators are not able to detect all accessibility issues on a website, manual validation becomes an essential step in the evaluation process, as many aspects require human judgment. For this step of the process, we used the NonVisual Desktop Access (NVDA) screen reader, a tool that allows blind or visually impaired users to access and interact with websites. During manual validation, we scrolled all pages using only the keyboard, checking behaviors, shortcuts, alternative contrast sheets, if the alternative texts were described according to the image and its context, among others.

[4]https://www.w3.org/
[5]https://www.w3.org/WAI/
[6]https://www.w3.org/WAI/standards-guidelines/wcag/
[7]https://bit.ly/3HkTDRa
[8]https://bit.ly/3HbX8JG
[9]https://bit.ly/3r4Krei

3.1.3 Tests Report and Accessibility Features Implementation

After performing the automatic and manual tests, all identified improvement opportunities were registered in a single document. Then, we presented the general report to the development team for the implementation stage, where the suggested corrections were made. Finally, after completion of the implementation, the site returned to the evaluation team, who analyzed whether all the items described in the general report were covered after the development process. In this last assessment, we had a visually impaired programmer perform the assessment.

3.2 Creation of Content for Meeting Accessibility Criteria

Despite all the technological work carried out, there was a need to create content to promote accessibility, such as: translation into LIBRAS (Brazilian Sign Language) by a qualified person and descriptive text of images and videos for audio description. Additionally, other activities were carried out by the educational content creation team, such as: (1) Study on accessibility criteria, specific for all types of disabilities; and (2) development of an internal reference pedagogical document to meet accessibility criteria considering the different media.

3.3 Release of the Course & Monitoring of the Educational Path

In September 2021, UNA-SUS/DTED/UFMA released the course with the implemented accessibility requirements. From that moment on, the information technology team monitored the entry of students into the courses and specifically analyzed data related to students who declared themselves to be disabled. All students, upon joining the course, signed a consent form. Thus, the presentation of the data within this paper is authorized by the students.

4 RESULTS

In this section, we present the results in two parts: (1) technological results for enabling accessibility; and (2) use of the course by people with disabilities.

4.1 Technological Results

At all, eight online educational resources (e-book, info-graphic, video, podcast, forum, glossary, quiz and form) and a VLE were evaluated. We have incorporated seven accessibility features, namely: audio description, markup, behavior, content/information, presentation/design, multimedia and form.

Regarding audio description, our main resources (e-book and info graphic) received audio description of images. Pedagogical production teams prepared all course material and also an adequate description of the images to be read by screen readers (see Subsection 3.2). Our educational resources can be read by screen readers on the market and by readers developed by the development team at UNA-SUS/DTED/UFMA. This adaptation for the description of the images is being carried out by a team specialized in the production of accessible content. This accessible audio description impacts other aspects of accessibility, such as multimedia. Currently, our screen reader is exclusively intended for our e-books and info-graphics and has several speed options.

Markup, behavior, content/information, and presentation aspects are following the accessibility guidelines described above. Figure 2 presents an example image of our e-book model where accessibility innovations have been added. At the top left of the image, it can be seen our unique screen reader activation options, playback speed and contrast settings.

In the VLE, we have incorporated five features listed by e-MAG (see Figure 3): accessibility bar; hotkeys; contrast sheet; presentation of the site map; and page with the description of accessibility features.

4.2 Results on the Course usage by PwD

The course and VLE with accessibility requirements were made available for students in September 2021 and will be available until March 31, 2022. The course is made available for both people with and without disabilities. At the moment of the submission of this paper, we registered 50 students with some type of disability. The deficiencies reported by the

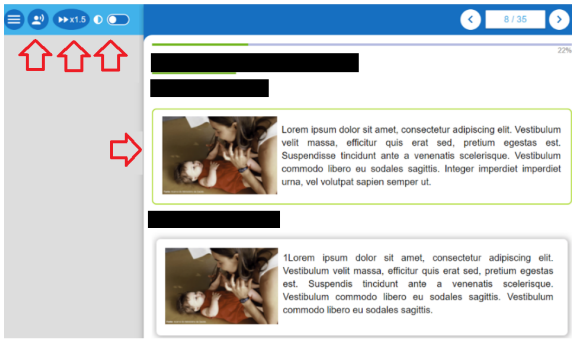

Figure 2: E-book with accessibility tools (screen reader, playback speed, and high contrast screen.

Figure 3: Homepage of our VLE with accessibility features (In Brazilian Portuguese Language).

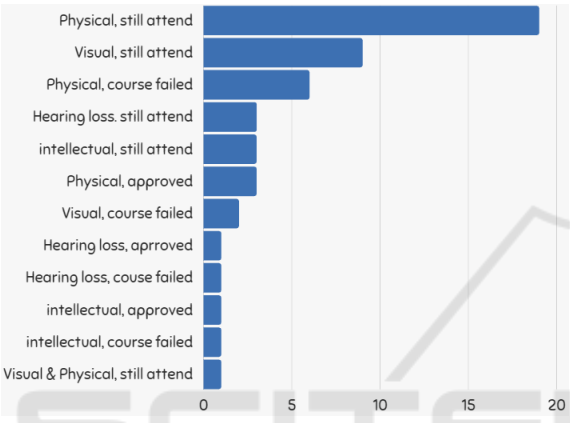

Figure 4: Status of the PwD within the course.

students were: physical (28 students), visual (11 students), intellectual (5 students) and hearing (5 students). We highlight that only one student indicated having more than one deficiency, which in this case were both visual and physical impairments.

Regarding the course progress, we identified that only five students completed the course. Students who have concluded have the following disabilities: physical (3 students); hearing (1 student); and intellectual (1 student). On the other hand, we have 10 students who failed (i.e. they finished the course but failed due to unsatisfactory grades). The remaining 35 students are still taking the course. Our result is an initial indication that it is possible to complete the course proposed in our VLE for people with the following disabilities: physical, hearing and intellectual. Figure 4 presents a detailed chart of the status of students in courses by type of disability.

By carrying out a detailed analysis of the students who are still taking the course, we observed that the course and the implemented VLE can be used by PwD. However, we need to wait until the course's ending for more data to confirm our observations. Moreover, there is no guarantee that the students find the online resources easy to carry out the activities. Figure 5 presents an overview of the current performance of students in the course, considering which activities they managed to finish until this paper submission.

Considering the current state of these students, although they are able to access all educational resources, when reaching activity 6 (which is an e-book), only visually impaired users are able to complete this and later activities. Nevertheless, not finishing the activities may not be related to the difficulty of the activities nor lack of accessibility (since 5 students with different disabilities have already finished all activities). Also, the students have two more months to finish the activities, which can cause students to pause the course and continue whenever they can dedicate further time. These data, however, allowed us to identify that students with disabilities take longer to attend the course than students without disabilities. Since we do not have an average time yet of how long it takes students with and without disabilities to finish the course, we need more time to reach a conclusion whether there is a significant statistical difference on the conclusion time. Also, in this analysis, it is necessary to verify the reasons behind using more time to finish the activities, and verify if further accessibility requirements need to be met. Finally, the development of accessibility features, such as an internal screen reader for the e-book and an info-graphic, were also seen as facilitators of the student-VLE interaction from the point of view of the visually impaired evaluator inside the development team.

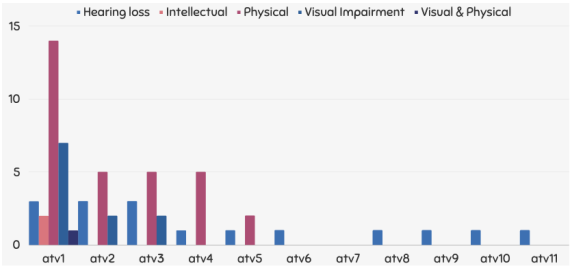

Figure 5: Student with disabilities per activity performed.

5 CONCLUSIONS

The inclusion of accessibility is important to provide access of educational resources and systems to all user profiles. However, including accessibility attributes in VLEs and educational resources is still a challenge, as it is necessary to consider the different types of disabilities.

In this paper, we proposed a process for inclusion and evaluation of accessibility in educational resources and VLE considering the context of UNA-SUS/DTED/UFMA. Besides monitoring the use of resources and our VLE by people with disabilities, we carry out a survey of the main techniques and standards for accessibility implementation and then carried out various activities to include the identified accessibility attributes in our VLE, such as: performing manual and automated tests; implementation of accessibility features; and creating content for accessibility. Within this experience, we managed to adequate eight educational resources and a VLE. In these resources and VLEs, we have incorporated seven accessibility features. The resources and VLE are currently made available to students with and without disabilities. At all, at least 50 students with disabilities are attending the courses.

As a limitation of this work, there is a reduced number of educational resources with accessibility. Additionally, we did not carry out a more in-depth analysis to consider the specifics of intellectual disabilities. These limitations can prevent students from completing the course. As future research perspectives, we intend to further analyzed the data after the course offering period. In addition, we intend to analyze other types of disabilities, such as intellectual disability and their variations, while proposing mechanisms to improve access to the VLE and its educational resources. With this real success case of improving the accessibility of VLE and educational resources, we intend to encourage other educational institutions to improve educational systems and provide further access to different user profiles, reducing the barriers to high quality education.

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