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Training Engineering Educators on Accessible and Inclusive Learning Design*

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The adoption of new technologies for education is changing, and it is reflected for instance, in the use of cloud-based applications for experimental practices in engineering courses and the inclusion of virtual courses in the educational process. Additionally, Educational Institutions are preparing Massive Open Online Courses (MOOCs) as a tool to offer education to students from all over the world. However, Accessibility in cloud-based applications, virtual platforms and MOOCs has not been widely taken into account in the design process that involves educators, especially in the tasks related to the production of educational resources.

The purpose of this study is twofold. On one hand, it aims to promote the inclusion of accessibility features in all phases involved in the online educational process. For this purpose, an open online course was prepared to train teachers on how to design accessible virtual courses. On the other hand, the goal is to identify the competences for educators involved in the creation of accessible digital educational contents in order to suggest a basic curriculum that can be used for Educational Institutions.

This work presents the accessibility experiences with engineering courses involving a strong component of scientific content and simulations. This work presents the proposed competences for engineering educators involved in the creation of accessible digital educational contents, with the purpose of implementing a basic curriculum that can be used for Educational Institutions to train their teachers on accessibility from the perspective of a student with disability. It is to be hoped that in some way in the future, the engineering educators will be able to transmit the accessibility awareness to their students, in order to have future engineers that will produce changes for the benefit of all.

Keywords: web content accessibility; usability; disability; WCAG 2.0; learning design; MOOC

1. Introduction

In a broad sense, Accessibility can be considered as the condition that environments, products, and services must meet to be understandable, usable and practical for all people, including those with disabilities. In this sense, there is a wide range of diversity of people and abilities, this is why in some terms, engineering educators should be aware on how students with disabilities interact with computers and especially with the educational resources that educators are producing for them. In this regard, there are many reasons why people may be experiencing accessibility barriers. The diversity of disabilities can be summarized in six groups: auditory, cognitive, neurological, physical, speech and visual disabilities [1]. Nevertheless, the inclusion of accessibility features for online applications and digital content represents a very important benefit for all people, including people with age-related impairments, temporary disabilities or technological limitations.

In the context of education, the analysis of accessibility is object of continuous study. As it is intended to be presented from the perspective of an observatory on accessibility on virtual education and society [2]. Some researches analyze the accessibility with a global perspective, and their findings show differences in the accessibility of the web pages of the universities [3, 4]. Other studies have their focus in the accessibility of the learning management system and the most recent studies are debating about the accessibility of the MOOC platforms [5–7]. However, even though a cloud-application or a virtual platform complies with all the accessibility requirements, the educator publishing new content should know how to create accessible content. Based on that, for this study an open online training course for engineering educators was prepared with the goal of teaching how to design accessible virtual courses from the very beginning. As an example, educators were taught the building blocks on how to provide alternative descriptions to images or how to evaluate the accessibility of a simple document taking into account the perspective of a student with a disability. In this sense, teachers, tutors,

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and instructional designers, should be encouraged to understand the needs of a diverse population of students in order to create accessible content, improve alternative teaching methods and evaluate different strategies for evaluation.

The open online training course to design accessible virtual courses was supported by the observatory on accessibility in virtual education and society ESVI-AL [2] and based on a methodological framework based on the standard ISO/IEC 19796 [8]. This is a common and generic framework used to describe, specify, understand and compare the components of the lifecycle of an e-learning project. This framework harmonizes existing and future approaches, components, terms, and definitions related to projects for learning, education, and training [9]. The proposed methodological framework is described with seven components categories: processes, activities, tasks, products, methods, metrics and participants. The seven processes that explore on accessibility features in the phases of the life cycle for a virtual course are the following: Needs Analysis, Framework Analysis, Conception and Design, Development and Production, Implementation, Learning Process, Evaluation, and Optimization. In this online training course, there is a special dedication to the processes with a strong involvement of teachers while taking into account accessibility for their courses: (1) Conception and Design; (3) Learning Process; (4) Evaluation and Optimization.

The work identifies the competencies that a teacher must know to create accessible digital educational content. It is concluded detailing the results of 17 editions given for the training courses in Ecuador (3), Colombia (1), El Salvador (1), Guatemala (3), Paraguay (1), Finland (1), Uruguay (1), Peru (1), Spain (2), and online (3). In total, 991 teachers have been admitted, with a total of 464 teachers that approved the training (175 men and 289 women). The participants in the experience provided comments and suggestions for further improvement. It is important to notice that this is an ongoing endeavor with an active edition of the courses being taught for teachers at the University of Alcalá (Spain).

This paper is organized as follows: First, a state of the art is presented with the main accessibility requirements and guidelines that a web-based platform should follow. This section is complemented with a literature review of related works on recent studies about accessibility in technical courses with a special focus on engineering courses, involving a strong component of scientific content and simulations. Then, in section 3, the purpose of the study and objectives are presented with the details of the open online training course designed for this experience, which includes techniques using automatic tools, disability simulation tools, testing tools and personal analysis of the educational contents and the pedagogical aspects. Section 4 presents the results of the study, overall this work presents the proposed competencies for engineering educators involved in the creation of accessible digital educational contents, with the purpose to implement a basic curriculum that can be used for Educational Institutions to train their teachers on accessibility from the perspective of a student with a disability. Finally a discussion and conclusions are presented.

2. Literature review

2.1 Accessibility requirements and guidelines

Accessibility can be considered as the condition that environments, products, and services must meet to be understandable, usable and practical for all people, including people with disabilities. Moreover, as digital education is related to web content, it is important to mention that accessibility of a website means the condition that a website must comply in order to be understandable, usable and practical by all people, including those who have a disability. Related to this definition, Tim Berners-Lee [10], states: ''Accessibility is the art of ensuring that, to as large an extent as possible, facilities (such as, for example, web access) are available to people whether or not they have impairments of one sort or another''.

The right to equality of opportunity and treatment through the promotion of, among other things, universal accessibility is a right depicted in the legislation of many countries, especially in those that have ratified the Convention on the Rights of Persons with Disabilities (CRPD) promoted by the United Nations [11]. The 173 countries that have ratified the UN Convention on the Rights of Persons with Disabilities are committed to promoting access to the Internet for people with disabilities (Article 9.g of the Convention). The current interest in evaluating the accessibility of websites and web-content is increasing. This interest is driven by current national and international legislation, which requires websites of companies and Public Administrations to be complaint with certain accessibility requirements. In this scenario, support tools are needed for website developers and auditors to adapt to existing regulations in each case.

In this regard, on October 2016, the European Union adopted Directive 2016/2102 [12] on the accessibility of the websites and mobile applications of public sector bodies. This Directive should be transposed into the legislation of each EU country, and tools will be needed to help to comply with future legislation, facilitating the

assessment of the accessibility of websites. The need for companies and institutions to make their web pages and applications accessible to comply with new legislation or those already in force in Europe and other territories makes it necessary to use automatic accessibility assessment tools that facilitate the work of developers and website auditors. However, there is a great disparity of these assessment tools. They apply different evaluation criteria and generate heterogeneous reports, with different types of formats, and with various forms of structuring the information contained. In addition to that, the results do not always coincide, with tools that are more ''intelligent'' than others; That is, some are able to detect accessibility problems and others cannot, or some of these tools are specialized in specific types of errors or they pay more attention to a subset of problems compared to other tools.

The accessibility of a website, but especially the accessibility of the content that is published on a website, is essential to make it perceptible, operable and understandable for all users, including people with disabilities. To help determine the accessibility of a website and its content, the World Wide Web Consortium (W3C) has developed the Web Content Accessibility Guidelines (WCAG 2.0) [13], which have been adopted as an international ISO (2012) standard [14]. This standard establishes the minimum requirements for a web content to be accessible, overcoming the barriers of access to any type of user.

Other organizations have published their own web accessibility requirements, such as the well-known Section 508 of the Rehabilitation Act of the United States Government [15], the German government's BITV standard [16], Italy [17], UNE 139803 in Spain [18], or the European standard EN 301549 [19], among others. There are, on well-known websites, lists with the current legal norms or requirements on web accessibility in different countries of the world [20–22]. In general, the requirements established in each country usually have much in common with the WCAG 2.0 standard [13], which defines 61 compliance criteria or criteria of success that must be satisfied by applications or websites. WCAG 2.0 components are principles, guidelines and success criteria. Based on the four principles of web accessibility (perceivable, operable, understandable, and robust), there are twelve guidelines that provide basic goals in form of a total amount of 61 success criteria (Table 1). In addition, three levels of conformance are established (A, AA and AAA) for websites, depending on their success criteria. To get level A, 25 criteria have to be met. To get level AA, besides the aforementioned, 13 more criteria have to be met. Level AAA is obtained when all 61 criteria are met.

In order to verify the fulfillment of the requirements of accessibility of a web information system, a developer or an auditor may use self-evaluation tools; although a manual ratification of the results provided by these tools will always be necessary. In addition, it is important to count on the collaboration of users—beneficiaries with different disabilities, to verify that the final system is accessible and functional.

There are many types of automatic evaluation tools. The W3C maintains a web page with a list of tools [23]. The most used are online evaluation tools. These are applications or web services that allow the user to indicate the address (URL) of the website to be reviewed, obtaining an evaluation report, which includes verified accessibility requirements, found errors and warnings. However, not all tools are equally effective, so the execution of different tools to complement the results is necessary [24].

While it is not easy for an educator to choose the most appropriate evaluation tool, it is important that the administrators and developers of a virtual learning environment pre-select a sub-set of tools

Table 1. Accessibility principles, guidelines and success criteria established in WCAG 2.0

Principles (4)	Guidelines (12)	Success Criteria (61)
1. Perceivable	1.1 Provide text alternatives	1
	1.2 Provide alternatives for time-based media	9
	1.3 Create adaptable content	3
	1.4 Make content distinguishable	9
2. Operable	2.1 Make all functionality available from a keyboard	3
	2.2 Provide users enough time to read and use content	5
	2.3 Do not design content in a way that cause seizures	2
	2.4 Provide ways to help users navigate	10
3. Understandable	3.1 Make text content readable and understandable	6
	3.2 Make Web pages appear and operate in predictable ways	5
	3.3 Help users avoid and correct mistakes	6
4. Robust	4.1 Maximize compatibility with user agents	2

to help educators choose which one should complement the educational content production process. In literature, there are few published papers that offer comparative studies of tools. One of them is that of Vigo et al. [25], which compares the results obtained by six different tools in the evaluation of three websites, and a comparative study of 126 tools [26], in which twelve criteria of comparison have been used, such as the norms or guidelines of accessibility applied by each tool, the permissiveness for options of configuration, language used, coverage, whether it offers repair recommendations, the level of detail and format of the reports, whether it supports HTML5 and DOM page revisions, whether it offers an API interface, and if it scores the level of accessibility of the page or website analyzed. The study also proposes a possible classification of these tools based on two properties: its functionality and its mode of use.

In terms of functionality, it is possible to identify seven main functions that an automatic accessibility tool should provide in order to help web-content producers. The first is the function of assessing the accessibility of a page or website. Another function can be the verification of the accessibility of documents (in pdf, docx, or another format). Tools that measure the readability of text are also useful, considering that a condition for a digital resource to be accessible is that its content is easily understood. Some tools also allow checking whether the contrast in the images or text is enough, or if a moving image includes flashes that can cause epilepsy problems. Finally, although the vast majority focus on the evaluation of pages or web applications, there are a small number of tools available for automatic evaluation of the accessibility of other types of applications, such as native applications for mobile devices (phones and tablets), and desktop applications.

Regarding its mode of use, there are tools that offer their functionality as an online service with a web form interface, so that the tool has an associated URL that the user accesses through a web browser. There is a form on the main page of the tool where the user enters the necessary data for the evaluation. These data are received by a web server and returns results that are displayed on the web browser. There are also tools that offer their functionality in the form of remote web services, such as an API (Application Program Interface), which must be invoked using the appropriate protocol, usually HTTP.

Other tools can be integrated directly into web browsers, such as extensions or add-ons. There are also extensions for development environments (for instance, Visual Studio or Eclipse) and for text editors (for instance, Microsoft Word). Additionally, there are evaluation tools that can be installed as desktop applications, or as applications on mobile devices, or as a web application for installation on a local server. There are tools that are used from the command line of an operating system, and others that do not respond to the traditional concept of a program, but consist of software libraries that offer evaluation functionality through an API for a programming language in particular. Finally, there are the so-called meta-tools or tools that what they actually do is reusing the functionality of one or more tools simultaneously.

In addition to the automatic evaluation tools, there are also market-based website accessibility evaluation services by companies and organizations that rely on the same idea of providing the URL of a website and obtaining a report. But in this case, it is not immediately, but the report is subsequently received, for example: by email, since the evaluation performed by the entity may also include manual reviews. In general, these are payment services, although in Spain there is a service of this type that is free in order to evaluate the accessibility of Public Administration websites, including Universities [27].

After analyzing and testing 126 tools, from the comparative study [26], it can be concluded that one tool is not enough to evaluate the accessibility of a page or website, since there are cases in which errors on a web page are detected by one tool, but not by another, because each one focuses on accessibility evaluation cases. The study in [26], made a selection of the 18 most important tools, which were subjected to a thorough review, creating an extensive battery of cases, and a test with simulated accessibility errors. Only the Tenon tool [28] managed to detect 40% of accessibility problems. However, if the results of this tool are combined with the others as AccessMonitor [29], TAW [30] and OAW [31], the percentage of errors detected is increased up to 80%. Therefore, combining the results of more than one tool is essential.

Overall, this kind of tools should be easily available for educators that are publishing educational content in e-learning or MOOC frameworks, but especially they should be trained on what is the importance of accessibility for web-content in order to raise awareness of the importance to include basic features for a benefit to students with disabilities. Moreover, it is important that the technical team that is leading the virtual learning environment guarantees that the system is accessible, in that way, the educators and educational content creators just need to check on the accessibility of the new content that will be uploaded to the system.

2.2 Related work on accessibility in technical courses

In 2014, the International Day of Persons with Disabilities [32] focused on the theme, ''sustainable development: the promise of technology''. It is a fact that technology has changed the world, bringing knowledge within reach and expanding a range of opportunities. People with disabilities can benefit enormously from such advances, yet too many lack access to these essential tools. In this sense, Ban Ki-moon declared: ''Let us spare no effort to ensure that policies, programs, guidelines and 21st century technologies are accessible to persons with disabilities and sensitive to their perspectives and experiences. Together, let us work for a better future that is inclusive, equitable and sustainable for all.'' This message is an open invitation to explore and guarantee the inclusion of people with disabilities in all contexts of life. In terms on legislation related to students with disabilities in online distance education, Edmonds (2004) explored the different laws available and highlights the legal and technical concerns for education institutions. International legislation in terms of technological evolution related to Cloud Applications is reflected on the Convention on the Rights of Persons with Disabilities (CRPD) in Article 9 (points 2.g an 2.h) [11]. The CRPD highlights the importance of promoting access to Information and Communications Technology (ICT) for People with Disabilities (PWD) and specially producing accessible content in early stages at minimum costs. Related to education, the (CRPD) in Article 24 recognizes the right to an education. Countries that signed the CRPD must make sure that people with disabilities are able to get access not only to general education but also to tertiary education, vocational training, adult education and lifelong learning without discrimination and on an equal basis with others.

For engineering courses, the courses in STEM disciplines (Science, Technology, Engineering and Mathematics) are a basic stone for every curricula and it is important to raise awareness on the importance of accessibility of virtual courses in these specific disciplines. In this sense, as stated by authors Breiner, et al. [33], STEM education replaces the traditional lecture-style teaching approaches with other strategies as inquiry and project-based activities, eliciting that the students can understand problems bridging all the concepts related to STEM disciplines. But there are still open questions as: (1) Is it possible to define these kind of activities as e-tivities [34] using cloud applications including accessibility to all the students, including students with disabilities? (2) What happens when a teacher wants to use Cloud Applications to improve the learning experience and needs to assess the accessibility of the applications to be sure the students will be able to use the proposed tools?

The inclusion of STEM disciplines in virtual learning environments has been a challenge for educators, but especially this topic has not been widely explored for students with disabilities. It is possible to identify some studies that have explored accessibility issues when teaching some of the STEM disciplines [35–37, 48–50, 53, 54]. Burgstahler et al. [38], presented a case study to prepare distance learning courses to be accessible to students and instructors with disabilities and Power et al. [39] introduced the barriers that students with disabilities could face in virtual learning environments. Authors in [40–42, 47] presented recommendations on accessibility when teaching computer sciences. Ferreira and Freitas [43], Karshmer et al. [44] and Namdev [46] provided recommendations for mathematics accessibility for blind people, being mathematics one of the basis of STEM subjects. In addition to that, it is possible to identify a study describing the relationship among the Universal Design for Learning and STEM students with disabilities [45]. Moreover, Peng et al. [51] and Gwordz et al. [52] explored on the impact of augmented virtual reality for practical experiences within STEM disciplines.

Recent studies were also published about accessibility courses, showing the analysis of a specific knowledge and focused on a kind of student limitation. Sanchez-Gordon and Luján-Mora [55] showed a specific study about engineering in MOOC, and presented the base for establishing criteria for a preliminary selection of MOOCs as creditable courses in engineering programs at a Polytechnic School for non-native speakers. If a MOOC platform has accessibility conflicts, it becomes a barrier for disabled students when they try to take any course: common tasks as login, search, forums, content navigation, etc. can be complex and even impossible for these students. In this sense, it is possible to identify the studies [7, 5, 56–57] related to accessibility in MOOC frameworks.

In terms of training for educators on Learning Design it is possible to identify the work from [65, 67], there is an initiative to teach accessibility in MOOC courses [66], and exploration of the importance of accessibility in computer science pedagogy [68] and proposals for professional certifications related to accessibility professionals [69-70] but there is a lack of training proposals for educators on how to create accessible content based on the perspective from students with disabilities.

3. Method

3.1 Purpose of the study and objectives

The purpose of this study is twofold. On one hand, the aim is to promote the inclusion of accessibility features in all phases involved in the online educational process. On the other hand, the goal is to identify the competences for educators involved in the creation of accessible digital educational contents, in order to suggest a basic curriculum that can be used for educational institutions.

3.2 Procedure

In this work, an open online training course for engineering educators was prepared with the goal of teaching how to design accessible virtual courses from the very beginning. As an example, educators are trained with the building blocks on how to provide alternative descriptions to images or how to evaluate the accessibility of a simple document taking into account the perspective of a student with a disability. In this sense, teachers, tutors and instructional designers, should be encouraged to understand the needs of a diverse population of students in order to create accessible content, improve alternative teaching methods and evaluate different strategies for evaluation.

The open online training course to design accessible virtual courses was based on a methodological framework based on the standard ISO/IEC 19796 [8]. This is a common and generic framework used to describe, specify, understand and compare the components of the lifecycle of an e-learning project. This framework harmonizes existing and future approaches, components, terms, and definitions related to projects for learning, education and training [9]. The proposed methodological framework is described with seven components categories: processes, activities, tasks, products, methods, metrics and participants. The seven processes that explore on accessibility features in the phases of the life cycle for a virtual course are the following: Needs Analysis, Framework Analysis, Conception and Design, Development and Production, Implementation, Learning Process, Evaluation and Optimization. In this online training course there is a special dedication to the processes with a strong involvement of teachers while taking into account accessibility for their courses: (1) Conception and Design; (3) Learning Process; (4) Evaluation and Optimization.

Among the difficulties that the teacher faces when preparing learning content in digital format is the diversity of authoring tools available. In [58] a compilation of the basic recommendations to take into account to find accessibility in teaching documents, recommendations based on the ADOD project [59] is presented. The ADOD project for creating accessible digital documents describes a number of recommended techniques for preparing accessible content documents, but a special focus on scientific and practical content, inherent for engineering courses should be taken into account. The recommendations are based on the guidelines of WCAG 2.0 for the different types of office tools. The recommendations applicable to office automation tools also apply to PDF documents. Among the applicable accessibility checks in PDF documents and the recommendations of PDF accessibility techniques WCAG 2.0 are the following:

1. All non-text elements must include alternative text
2. Check background color and foreground
3. Specify the language of the text
4. Review hyperlinks
5. Review the labeling and headings
6. Alternative texts in links
7. Explain abbreviations and acronyms
8. Review the language changes in the text
9. Identify decorative elements: headers and footers
10. Add bookmarks that allow you to jump to certain parts of the document
11. Verify that the default reading order according to the label structure makes sense and is consistent
12. Check the security settings
13. If the PDF contains an image, from a scanned document, it will be necessary to use an OCR procedure.
14. In the case that the PDF includes a form, in the properties of each field a description of the requested data must be specified.

In addition to the ADOD project, there are other initiatives and guides for the creation of accessible electronic documents, including [60–62].

In this work, there is a repertoire of competences on accessibility that any educator who uses technology to prepare educational content should have. The catalog of competencies has been organized hierarchically, with five general competencies that are broken down into specific competencies. Table 3 shows the five general competencies.

The competencies identified as DOC#, PRE# and PDF # are considered to be fundamental to the work of any educator, so they refer to the fact that documents and presentations they use in their classes can be used by students with disabilities. The AUD# competence is complementary, and must be acquired by teachers who use videos or audios in their teaching, which is becoming more common nowadays. WEB # competition is applicable to

recommendations by the students to be sure that they will be able to follow the contents inside the proposed webs or external cloud applications used for learning activities. Table 2 identifies the description of the core competencies to be achieved by the educator, the type of competence and the number of specific skills that constructs the general competence. For instance, for the core competence DOC#, it is possible to identify twelve basic skills, among others. It is worth to mention the following four as an example:

- How to correct the accessibility problems presented by a document
- How to set the language of a document in different parts of itself
- Read and test a document using a supporting tool (e.g., screen reader)
- Properly structure a document, formatting using styles for further navigation

3.3 Tools and proposed curriculum

To acquire the competencies described in the previous sections, this work proposes a curriculum design composed of five learning modules, one for each of the competences (Table 2). Each module is divided into two didactic units: a first one to learn the accessibility guidelines applicable in the creation of the educational material (document, presentation, audiovisual, web page), and a second unit for the application of accessibility testing techniques in educational materials already available.

With the support of the ALFA III program of the European Union [63] and the Observatory on Accessibility in Virtual Education and Society [72], seven Latin American universities, three universities in Europe and two international organizations of people with disabilities: the World Organization of Persons with Disabilities (DPI) and the Latin American Union of Blind (ULAC); A course with a duration of 75 hours (3 credits of the European ECTS system) was designed. The courses were prepared using an accessible virtual learning environment.

The structure of the five teaching modules is the following, including documents and subtitled videos. In all cases, a module is composed of the following evaluation resources and activities:

- Presentation video of the module.
- Theoretical contents of the module, available in doc, pdf and html format.
- Module self-evaluation test.
- Practical exercise solved, with a statement, a solution, and a video explaining the solution. It basically consists of correcting the problems of accessibility in a digital educational material.
- Assessment activity 1: Knowledge assessment test.
- Assessment activity 2: Unit discussion forum. Includes a video explaining the topic.
- Assessment activity 3: Proposed practical exercise. Similar to the practical exercise solved.

The expected dedication for the study and execution of the activities of each module is approximately 15 hours. Moreover, for the blended learning courses, including face-to-face meetings, collaborators from the organizations of people with disabilities were invited to teach the participants the main problems that they face while learning with educational content with accessibility issues. These demonstrations were recorded and offered for the full online sessions.

4. Results and Discussion

The contents of the course have been reviewed by a team of five visual impairment evaluators, one reviewer for each of the five course modules selected by the Latin American Blind Union (ULAC). In [64] the main problems detected by the reviewers are described, which have been taken into account to improve the accessibility of the contents of the course. Experts have reviewed the course using different browsers and screen readers, and following the following steps in each module:

1. Review of the presentation videos of the module
2. Review of the contents of the module
3. Review of the module self-assessment test
4. Review of the practical exercise solved of the module
5. Review of the module evaluation test
6. Review of the module discussion forums
7. Review of the proposed practical exercise in the module

Table 2. General competencies for engineering educators with accessibility awareness

General Competence	Description	Type	Related Skills
DOC#	Creation of accessible digital documents	Basic	12
PRE#	Creation of accessible presentations	Basic	14
PDF#	Creation of accessible portable documents (pdf)	Basic	4
AUD#	Foundations of accessible multimedia content	Complementary	6
WEB#	Foundations of accessible web pages	Complementary	18

8. Preparation of an evaluation report

In general, in the opinion of the reviewers, the virtual campus in which the course is taught is accessible and has a good distribution of fields and spaces for each section. There is no inconvenience for entering the platform, as it can be accessed with a screen reader; likewise, its contrasts are suitable for users with low vision. The contents of the course are accessible and this has been verified using several browsers and screen readers, obtaining the best results with the combination of the Firefox browser and the JAWS reader. There have been tests of reading the content in each web page, of each page's route with navigation keys, use of fast addressing links, and route of each URL by lists, use of links to skip sections, and download files, among others.

Among the reviewers' recommendations, regarding the organization of course materials, the course offers several formats for the same resource (Word, PDF, Web, Audio/Video), and this allows students to choose the one that interests them the most; a large amount of repeated resources can make it difficult to select the right material for the users. It would help if they are grouped in folders that indicate the type of format. Or if some mechanism of automatic adaptation of the resources to the preferences of the users will be used.

Another recommendation refers to the use of forums, which has been the only section of the course that presents major issues of accessibility. A revision of the design of this virtual campus service is necessary, so that all students can participate in the debates and, above all, because there are evaluation activities in which it is mandatory to use the forum. If it were not possible to redesign this section of the platform, it would be necessary to use external forum systems to ensure an inclusive participation in the course discussions.

Following the initial review of the course's modules and once the improvements were prepared, a total of 17 editions were performed in Ecuador (3), Colombia (1), El Salvador (1), Guatemala (3), Paraguay (1), Finland (1), Uruguay (1), Peru (1), Spain (2), and online (3). The training editions were prepared as blended sessions or full online training sessions in order to reach a greater audience. In total, 991 teachers have been admitted, with a total of 464 teachers that approved the training (175 men and 289 women), Table 3 presents the participants' distribution based on country of origin, with a great participation from 19 different countries representing more than 150 higher education institutions. The participants in the experience provided comments and suggestions for further improvement. It is important to notice that this is an ongoing endeavor with an active edition of the courses being taught for teachers in the University of Alcalá (Spain).

Overall, it is possible to highlight the achievement of the first objective of this work, to promote the inclusion of accessibility features in all phases involved in the online educational process and increase the awareness of the importance of accessibility for students with disabilities. In this sense, it is possible to identify the increased interest from educators that were enrolled in any of the 17 editions of the course that were performed in blended and full-online modality. A total of 991

Table 3. Educators enrolled in the training course from 19 countries representing more than 150 different higher education institutions

Country	Enrolled	Approved 3 modules	Approved 5 modules
Argentina	76	49 (64%)	34 (45%)
Bolivia	23	16 (70%)	5 (22%)
Brazil	5	4 (80%)	2 (40%)
Chile	24	18 (75%)	12 (50%)
Colombia	149	102 (68%)	58 (39%)
Costa Rica	12	7 (58%)	5 (42%)
Cuba	1	1 (100%)	1 (100%)
Ecuador	121	88 (73%)	65 (54%)
El Salvador	44	35 (80%)	21 (48%)
Spain	33	29 (88%)	27 (82%)
Finland	15	13 (87%)	13 (87%)
Guatemala	81	51 (63%)	23 (28%)
Honduras	5	3 (60%)	3 (60%)
Mexico	39	27 (69%)	21 (54%)
Nicaragua	6	4 (67%)	2 (33%)
Panamá	5	4 (80%)	4 (80%)
Paraguay	114	89 (78%)	51 (45%)
Peru	111	62 (56%)	36 (32%)
Dominican Republic	5	3 (60%)	0 (0%)
Uruguay	76	46 (61%)	34 (45%)
Venezuela	46	23 (50%)	15 (33%)
Total	**991**	**674 (68%)**	**432 (44%)**

educators expressed interest in learn about the importance accessibility through the action of enrolling in the course. The training, composed by five competences, three of them considered as basic and two complementary (see section 3.2), had an important participation from enrolled educators with 68% of the participants finishing the three basic modules and 44% of them completing the five modules proposed in this basic curriculum (see Table 3). Based on this, it is possible to affirm the fulfilling of the second objective of this work: to identify the competences for educators involved in the creation of accessible digital educational contents in order to suggest a basic curriculum that can be used for educational institutions.

Finally, it is necessary to emphasize the importance of accessible virtual learning models, since they not only generate greater educational inclusion, but also increase the opportunities for training, thus contributing to greater autonomy for people with disabilities. In this sense, guiding resources and summarizing them in a formative instance for teachers, such as the course analyzed in this work, is a previous but indispensable link to train future professionals with an awareness of accessibility and inclusion.

5. Future work

As a future work, the validated modules will be submitted to centers of standardization, for example: as a CEN Workshop Agreement [65] or as a professional level certification center [70] in order to increase the scope of dissemination. Meanwhile the proposed curriculum and modules will be constantly updated, improved and publicly available through the ESVI-AL Network [63], ACAI-LA project [58], as well as the observatory for education and the virtual society ESVI-AL [71, 72], with the purpose that any educational institution can train their teachers to increase the awareness of the importance of accessibility.

6. Conclusions

The Engineers Educators of the Future must be able to provide education to all students, including students with disabilities. This work proposed and validated five general competences for educators involved in the creation of accessible digital educational contents with the purpose to implement a basic curriculum that can be used for educational institutions to train their educators on accessibility from the perspective of a student with disability. The five general competences are: (1) Creation of accessible digital documents, (2) Creation of accessible presentations, (3) Creation of accessible portable documents (pdf), (4) Foundations of accessible multimedia content, and (5) Foundations of accessible web pages.

It is important to highlight that the inclusion of accessibility features in a virtual education environment is a complex endeavor that involves different stakeholders, being the most important one the technical staff that must assure that the systems complies with international standards related to accessibility. But it is also true that all participants must contribute with their work, and in the case of the educators, they should have the basic competences to prepare accessible digital educational content. In this sense, this work prepared an online training composed of five modules. A total of 17 editions of the training sessions were performed with 991 participants from 150 different education institutions with the support of international networks.

It is to be hoped that in some way in the future, the educators can transmit the accessibility awareness to their students, in order to have future engineers that will produce changes for the benefit of all.

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