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Analysis of Compliance and Gaps in Web Accessibility on Spanish University Websites

Análisis de cumplimiento y carencias en la accesibilidad web de los sitios web de las universidades españolas

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ABSTRACT

Web accessibility in higher education is crucial for ensuring equal opportunities for students with disabilities. Pre-COVID-19 studies revealed many challenges in this area, and legal regulations require public institutions, including universities, to meet specific standards.

This study assesses web accessibility in Spanish universities by analysing a representative sample of their websites using automated tools and manual reviews. The findings show the extent of compliance with accessibility guidelines and identify areas needing improvement.

Additionally, the study explores how factors like university size, technological resources, and institutional commitment to inclusion affect accessibility levels. The results provide an overview of web accessibility in Spain's higher education, offering recommendations to enhance the experience for students with disabilities and promote educational equality.

RESUMEN

La accesibilidad web en la educación superior es fundamental para garantizar la igualdad de oportunidades para los estudiantes con discapacidades. Estudios previos a la COVID-19 revelaron numerosos desafíos en este ámbito, y las normativas legales exigen que las instituciones públicas, incluidas las universidades, cumplan con estándares específicos.

Este estudio evalúa la accesibilidad web en las universidades españolas mediante el análisis de una muestra representativa de sus sitios web, utilizando herramientas automatizadas y revisiones manuales. Los hallazgos muestran el grado de cumplimiento con las pautas de accesibilidad y señalan las áreas que requieren mejoras. Además, el estudio analiza cómo factores como el tamaño de la universidad, los recursos tecnológicos y el compromiso institucional con la inclusión influyen en los niveles de accesibilidad. Los resultados ofrecen una visión general de la accesibilidad web en la educación superior en España, proporcionando recomendaciones para mejorar la experiencia de los estudiantes con discapacidades y promover la igualdad educativa.

KEYWORDS - *PALABRAS CLAVE*

E-Learning, distributed learning environments, human-machine interface, web accessibility, higher education

E-Learning, entornos de aprendizaje distribuido, interfaz hombre-máquina, accesibilidad web, educación superior

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1. INTRODUCTION

Web Accessibility is defined as a characteristic of web pages, referring to the creation of web pages with design and content accessible to all individuals, regardless of their disability status. This disability can be either temporary or permanent and may result from personal factors (e.g., a disability) or external factors (e.g., technical issues).

The World Wide Web Consortium (W3C) is an international organization that endeavors to create an accessible web for everyone. To achieve this objective, it has established guidelines and design recommendations for the development of accessible websites. The first guideline, WCAG 1.0, was compiled in 1999. The second version, WCAG 2.0, was released in 2008, and WCAG 2.1 was defined in 2018. Since 2012, the W3C has been working on WCAG 3.0.

The W3C delineates three levels of accessibility, ranging from basic accessibility (A) to full accessibility (AAA). These levels are achieved by adhering to design recommendations known as Success Criteria.

Accessible web design provides benefits to all individuals, including those without disabilities. These benefits are evident in all areas where the web is utilized, particularly in education. Notably, since the COVID-19 pandemic, there has been an increase in the use of the web for educational purposes.

Various studies by different authors have demonstrated deficiencies in the levels of web accessibility of university websites concerning compliance with W3C guidelines. The design and content of these websites are not adequately tailored for use by individuals with disabilities. Accessibility levels have not improved since the onset of the COVID-19 pandemic.

The Spanish university system comprises two types of universities: publicly funded and privately funded. In all cases, both public and private universities must adhere to W3C recommendations regarding web accessibility in the design of their websites.

This study presents the results of a web accessibility diagnosis conducted on a sample of Spanish universities included in a university ranking. The findings establish a comparison between public and private universities, as well as a correlation between web accessibility levels and quality variables in university teaching.

2. CONTEXT

2.1. Web accessibility

Web accessibility, an essential aspect of website and web application design and development, ensures that all users, including those with disabilities, can access and interact with online content effectively. Its goal is to remove barriers that prevent people with disabilities from fully participating in the digital sphere. In today's digital landscape, web accessibility plays a fundamental role in promoting equal opportunities, encouraging inclusion and defending fundamental human rights (W3C, 2018).

To address the need for accessibility, the World Wide Web Consortium (W3C), established in 1994, takes a central role in shaping web accessibility guidelines. By collaborating with industry experts, disability advocacy groups, and technology leaders, W3C develops open standards that drive long-term growth and improvement in web accessibility (Chisholm et al., 1999).

The Web Content Accessibility Guidelines (WCAG), developed by the W3C, provide a comprehensive framework for achieving web accessibility. The globally recognized and widely adopted WCAG guidelines establish standards and techniques to improve the accessibility of digital content. These guidelines address several aspects, including perception (information and UI components should be perceived by users), operability (UI components and navigation should be operable from a keyboard, with time sufficient to read the contents and with the appropriate size), comprehensibility (the text content must be readable and understandable and web pages must appear in a predictable way) and robustness (the content must be able to be interpreted by a wide variety of agents of user). These can ensure that people with disabilities can access and use online information and services effectively. The WCAG guidelines are structured into three conformance levels: A, AA, and AAA, with each level representing increasing levels of accessibility. Level A focuses on addressing the most fundamental accessibility requirements, while Level AA incorporates more comprehensive guidelines to accommodate a broader range of disabilities. Level AAA represents the highest level of accessibility and provides an enhanced user experience for people with disabilities (Caldwell et al., 2008; Campoverde et al., 2021; Chisholm et al., 1999).

Web accessibility offers numerous benefits for people with disabilities and society. It guarantees equal access to information and services, promoting inclusion and empowerment. Accessible websites and applications improve usability not only for people with disabilities but also for older adults and those with temporary disabilities: people without disabilities may have limitations (temporary or not) that are similar to the limitations imposed by disabilities. Prioritizing web accessibility contributes to creating inclusive learning environments within educational institutions (Burgstahler & Moore, 2015; Fraiz, 2008; Slater et al., 2015).

Errors in web accessibility success criteria can be classified into two types. The first type includes errors that can be automatically detected by software (some computer applications and websites are available to assess accessibility levels). The second type involves errors that require manual detection, which requires the participation of accessibility specialists (Serrano, 2009).

Automatically detectable errors allow the use of computer tools for their detection and correction. A notable tool that exemplifies automated accessibility analysis is the Web Accessibility Test (TAW). Aimed primarily at web design and development professionals, it facilitates the analysis and detection of errors in the design of accessible web pages. In addition, it generates a list of possible problems that may require manual confirmation or dismissal by the evaluator (Alim, 2021; Serrano, 2009).

Automatic tools have the ability to quickly review a web page in a matter of seconds, allowing you to evaluate large groups of pages from numerous sites relatively quickly. However, the use of a tool is not enough, since it must be complemented with the evaluation of expert users (Aizpurua et al., 2016; Brewer, 2019; Campoverde et al., 2021; Serrano, 2009).

2.2. Web accessibility in Spanish university education

The Spanish university system is made up of 50 public and 36 private universities, with more than 1.5 million students. These students represent 32% of the Spanish population between 18 and 24 years old (Ministerio de Universidades, 2023).

The Internet plays a fundamental role in education: it provides information and an environment for creativity and provides instruction. Universities have welcomed the existence, incorporation and use of new technologies, which has led to the emergence of new communication methods and organizational and pedagogical models, based totally or partially on digital networks. Information and Communications Technologies (ICT) allow an educational model aimed at addressing the shortcomings of traditional teaching methods. They provide the flexibility to adapt to various learning styles and paces (Dinc, 2017; Mogollon de Lugo, 2017).

The importance of guaranteeing access to higher education for people with disabilities lies in their integration into the knowledge society. Accessibility to Internet, ICT and communication services is a fundamental right for them. Universities must facilitate this access by providing resources that promote the continuity of studies and adapt to various social situations (Jaume-Mayol et al., 2019; Muntaner et al., 2008; Pastor & Antón, 2008).

Addressing the needs of university students with disabilities must go beyond individual responses and offer contextual and social solutions to defend equal opportunities. Neglecting this responsibility can result in direct or indirect discrimination, creating disadvantages for certain groups. Furthermore, web accessibility in university education improves the learning process (Jaume-Mayol et al., 2019; Luque et al., 2005).

Regarding the inclusion of people with disabilities in education, it is essential to ensure that content is accessible not only through the web, but also to promote universal accessibility, regardless of the device or format of the content (Chicaiza et al., 2014; Colomé, 2019; Hilera & Campo, 2015).

Technology is a valuable resource that facilitates the education of people with various disabilities, offering new alternatives through virtual classes and innovative methods. Universal education must be promoted through technology, with the collaboration of web designers, educators and teachers, who play a crucial role in improving web accessibility in educational environments (Dinc, 2017; Saldarriaga, 2014).

Several studies have been carried out on the Web Accessibility of Spanish universities, with results that show that universities that have websites do not comply with web accessibility guidelines (Casasola et al., 2017; Chacón et al., 2013; Hilera et al., 2013; Guasch & Hernández, 2010; Toledo et al., 2013).

Some authors have shown that, in general, web accessibility levels in universities in various countries are not adequate to effectively support the learning experiences of people with disabilities. This deficiency manifests itself in several key areas of digital accessibility, limiting the ability of these students to access educational resources on equal terms. For example, a study focused on universities in the United Kingdom specifically identified the Web Content Accessibility Guidelines (WCAG) Success Criteria that had the highest number of errors. These

errors encompass a variety of technical and design aspects that are critical to the navigability and usability of university websites for people with disabilities. Such studies underscore the urgent need for educational institutions to make significant improvements to their web accessibility practices to ensure that all students can fully participate in the digital academic environment. The most common web accessibility errors that have been detected in such studies can be seen in table 1 (Alim, 2021; Simonson et al., 2008).

Table 1

Most common web accessibility errors that have been detected (Alim, 2021)

Error type	WCAG 2.0 Success Criteria	Access. level
Contrast errors	1.4.3 (Minimum Contrast)	AA
Form labels	1.1.1 (Non-text content)	A
Form labels	1.3.1 (Info and relationships)	A
Form labels	2.4.6 (Headings and labels)	AA
Form labels	3.3.2 (Labels or instructions)	A
Empty headings	1.3.1 (Info and relationships)	A
Empty headings	2.4.1 (Bypass blocks)	A
Empty headings	2.4.6 (Headings and labels)	AA
Empty links	2.4.4 (Link purpose in context)	A
Unique ID for elements and correct element attributes	4.1.1 (Parsing)	A
Titles for links	4.1.2 (Name, role, value)	A
Language	3.1.1 (Language of page)	A
Changing the setting of the user interface component	3.2.2 (On input)	A

Web accessibility allows for the efficient use of assistive devices necessary to access web content. Accessibility, conceived as equal opportunities, should be present in all areas, including the accessibility of websites and academic content (Térmens et al., 2008; Zubillaga, 2010).

In Spain there are regulations on web accessibility in university studies. The Organic Law 4/2007, the Royal Decree 1791/2010 and the Organic Law of the University System of 2023 can be highlighted. At the level of general regulations on web accessibility, the UNE 139803 standard (years 2004, 2021, 2015 and 2019), Royal Decree 1494/2007, Royal Decree 1112/2018 (on accessibility of websites and mobile applications in the public sector). Decree 1112/2018 establishes that entities responsible for websites and mobile applications must provide a detailed accessibility statement regarding the compliance of their respective websites and mobile applications. This accessibility statement must be updated at least once a year and published on the website itself, accessible from all pages of the website through a link called "Accessibility" (BOE, 2007, 2010, 2023; PAE, 2023).

Analysing the content of the previous regulations and laws, it can be stated that web accessibility has been an obligation for Spanish universities since 2007.

3. METHOD

3.1. Goals

The objectives of the study are:

- Analyse the web accessibility levels of the main pages of the websites of Spanish universities.
- Analyse a possible relationship between certain classifications of universities according to certain quality parameters and the web accessibility levels of the sites.
- Analyse and discuss the degree of compliance with legal web accessibility standards on the websites of Spanish universities.

Based on the achievement of the objectives, a general evaluation of web accessibility in Spanish universities can be carried out. This evaluation will allow us to design specific action plans to improve web accessibility levels.

The following working hypothesis is proposed: There is a relationship between the university quality classification variables and the levels of web accessibility, which indicates that universities with higher ranking scores exhibit better levels of web accessibility.

To achieve the proposed objectives and verify the validity of the working hypothesis, a study has been conducted on the level of compliance with the WCAG 2.1 Success Criteria that can be analysed through automated procedures.

3.2. Methodology

The study was carried out following the following stages:

- Create a database with the URLs of the home pages of the websites of the universities in the university classification.
- For each URL in the database, using the TAW tool, examine the home pages to determine compliance with the WCAG 2.1 success criteria.
- Check that Spanish universities comply with Spanish regulations on web accessibility issues.
- Analyse the results obtained and draw conclusions.

The list of Success Criteria analysed is shown in table 2, with a description of each one. A full description of the Success Criteria can be found on the World Wide Web Consortium website (W3C, 2018).

Table 2

Description of Analysed Success Criteria Checkpoint Description Level Principle (W3C, 2018)

Success Criteria	Description	Level	Principle	Guideline
1.1.1	Non-text Content	A	Perceivable	Text Alternatives
1.3.1	Info and Relationships	A	Perceivable	Adaptable
1.4.4	Resize text	AA	Perceivable	Distinguishable
2.1.1	Keyboard	A	Operable	Keyboard Accessible
2.1.3	Keyboard (No Exception)	AAA	Operable	Keyboard Accessible
2.2.1	Timing Adjustable	A	Operable	Enough Time
2.2.4	Interruptions	AAA	Operable	Enough Time
2.4.4	Link Purpose (In Context)	A	Operable	Navigable
2.4.7	Focus Visible	AA	Operable	Navigable
2.4.9	Link Purpose (Link Only)	AAA	Operable	Navigable
2.4.10	Section Headings	AAA	Operable	Navigable
3.1.1	Language of Page	A	Understandable	Readable
3.1.4	Abbreviations	AAA	Understandable	Readable
3.2.2	On Input	A	Understandable	Predictable
3.2.5	Change on Request	AAA	Understandable	Predictable
3.3.2	Labels or Instructions	A	Understandable	Input Assistance
4.1.1	Parsing	A	Robust	Compatible
4.1.2	Name, Role, Value	A	Robust	Compatible

3.1. Sample description and limitations

The sample is made up of the universities included in the university classification according to certain quality parameters published annually by the BBVA Foundation (BVA Bank). This ranking is based on the study of the activities of universities in teaching, research and innovation. The first edition was published in 2013 with information from public universities. The 2023 ranking offers information from both public and private universities (Pérez et al., 2023).

A database has been designed and created with the following information: Geographic location of the universities and the type of teaching they offer (face-to-face or online), data related to the variables described in the classification of universities and data related to compliance with the accessibility criteria analysed. These data are obtained through an automated analysis of criteria that can be analysed using the TAW analysis tool.

To determine the level of compliance with the WCAG 2.1 accessibility criteria, an algorithm has been developed that connects to the online web analysis tool TAW. The algorithm, developed in the Python programming language, makes a request to the online tool TAWDIS.net for each of the URLs of the universities analysed. Once the report is retrieved using web scraping techniques, the text is analysed according to a predefined content pattern to extract the evaluation of each Success Criterion. With the database fully populated, the data analysis was conducted using a spreadsheet and the R statistical software.

To assess web accessibility, the TAW tool was used to automatically identify errors and generate a list of necessary manual checks. TAW detects issues at the code level. However, since certain design errors can only be identified manually, a complementary manual analysis is recommended. Therefore, this study focused solely on errors that can be detected through

automated web accessibility evaluation tools, while also serving as a starting point for identifying design flaws and addressing them later.

4. RESULTS AND DISCUSSION

4.1. Total Results

A total of 4981 errors have been identified in the analysed Success Criteria, considering that a single success criterion can present multiple errors on the same web page:

- The arithmetic average is 70.1 errors per web page.
- Most errors (57.5%) are attributed to Level A criteria.
- No errors have been detected at Level AA, while 42.5% of errors are related to Level AAA criteria. The lack of errors at Level AA is due to two main factors: the limited number of criteria analysed, as the TAW tool only evaluates two automatic criteria for this level of compliance, and the fact that these criteria are usually managed through web design programs.

According to the result:

- In no case has the minimum accessibility level A been detected.
- A total of 2 universities has 1 error that prevents them from obtaining level A and another has 4 errors at said level.
- In all cases these are universities in which public education is provided. They are the universities with websites closest to obtaining the A level.
- The rest of the universities have websites with errors regarding A and AAA level criteria.

Considering the errors based on the Conformity Criteria, the highest occurrence is observed in Criterion 2.4.9 (Level AAA). Success Criteria 2.4.9 refers to allowing the purpose of each link to be identified solely from the link text. This error is present in 90.1% of the websites analysed (89.8% in public universities and 90.9% in private universities). Likewise, the high incidence of error 1.1.1 (Level A) stands out, which occurs in 85.9% of websites (81.6% in public universities and 95.5% in private universities). According to Success Criterion 1.1.1, all non-text content must have a textual alternative that serves an equivalent purpose. In relation to errors by accessibility level, the Success Criteria with the highest number of websites that commit them correspond to the Level A criteria (that is, Success Criteria 1.1.1, 1.3.1, 2.4.4 and 4.1.2). In all cases, more than 60% of websites have these errors. The table 3 shows the percentages of errors in WCAG 2.1 success criteria.

Table 3

Accessibility Errors in Success Criteria

Success Criteria	Level	Webs with Errors	Errors in Public Univ.	Errors in Private Univ.	% webs with error	% Publics with error	% Privates with error
2.4.9	AAA	64	44	20	90,1%	89,8%	90,9%
1.1.1	A	61	40	21	85,9%	81,6%	95,5%
1.3.1	A	56	35	21	78,9%	71,4%	95,5%
2.4.4	A	55	34	21	77,5%	69,4%	95,5%
4.1.2	A	43	25	18	60,6%	51,0%	81,8%
2.4.10	AAA	41	27	14	57,7%	55,1%	63,6%
3.3.2	A	34	19	15	47,9%	38,8%	68,2%
3.2.2	A	21	11	10	29,6%	22,4%	45,5%
2.1.3	AAA	14	6	8	19,7%	12,2%	36,4%
3.1.1	A	7	5	2	9,9%	10,2%	9,1%
4.1.1	A	1	1	0	1,4%	2,0%	0,0%

Public universities obtain better results compared to private ones. When analysing the five Success Criteria with the highest percentage of errors on the websites, it is observed that in all cases the percentage of errors is higher in private universities.

4.2. Relationship between quality and web accessibility parameters

The correlation values have been calculated between the quality parameters used to establish the classification of Spanish universities and the accessibility levels. The values obtained are the following:

- In relation to teaching, a correlation of 0.01 has been observed, which suggests that there is no significant relationship between the quality of teaching and levels of web accessibility. Breaking down by type of university, the correlation for public universities is 0.09, while for private universities it is 0.24. On the other hand, universities with non-face-to-face teaching present a correlation that remains at 0.09.
- Regarding the volume of teaching, measured by the number of university courses, the correlation is 0.39, which suggests that a greater volume of teaching is associated with better web accessibility. However, when broken down by type of university, it is observed that private universities present a correlation of 0.12, indicating that there is almost no relationship in this case. In contrast, public universities show a correlation of 0.28, which indicates a moderate relationship between the volume of teaching and web accessibility
- The correlation value between web accessibility and Research and Innovation parameters is 0.42, indicating a weak correlation
- For the general university qualification, which covers Teaching and Research and Innovation, the correlation with web accessibility is 0.37. Specifically, the correlation is 0.1 for public universities and 0.38 for private universities.

No significant correlation is observed between the university classification variables according to quality parameters and the web accessibility of their websites. Therefore, the highest-ranked

universities do not necessarily achieve the best results in web accessibility.

4.3.Web Accessibility Compliance Statements

Royal Decree 1112/2018, on the accessibility of public sector websites and mobile applications, indicates that it is necessary to include a link with the text Accessibility that contains a declaration of web accessibility conformity that must be updated annually. The websites of the universities have been analysed (considering that only public ones are obliged to comply with the decree) to check if they have the aforementioned link with the declaration of web accessibility conformity. The result is that 83.67% of public universities include this link. In the case of private universities, the proportion of those universities that incorporate the link is reduced to 4.55%.

Regarding the content of the declaration of conformity pages, 78% of the 42 universities that include the link have some document that complies with the standard declaration included in the Royal Decree.

Among the declarations of conformity that adhere to the standard, 5 declarations claim to have achieved a specific level of accessibility (1 at level A, 3 at level AA and 1 at level AAA). In all cases, these are web pages that, according to the accessibility analysis carried out with the TAW tool, do not meet the minimum level A.

Declarations of partial conformity follow a similar structure: in addition to citing the reference regulations, they specify that the website has partial accessibility, describing all accessibility errors on the website and providing contact information for suggestions to improve web accessibility.

Legal regulations indicate that updates and revisions to the document must be made, with at least an annual review. The revision date is indicated in 81% of websites. However, in 67.65% of cases these are review dates that have passed more than 1 year since the date of the last review of the declaration of conformity. Most of dates that have passed the 1-year deadline are more than 3 years since the last review (56.5%): the oldest date is March 1, 2013.

5. CONCLUSIONS

Web accessibility offers benefits for people with disabilities and society. It guarantees equal access to information and services, promoting inclusion and empowerment. In the academic sector, universal access allows all people to access higher education.

Several studies have shown that web accessibility levels prior to the COVID-19 pandemic, of Spanish and non-Spanish university websites, did not provide access to people with disabilities. The study presented demonstrates that these levels have not improved significantly in Spanish universities after the end of the pandemic. Furthermore, it is confirmed that the errors in the Success Criteria detected in previous studies persist in the present.

A comparison has been made between the results of public and private universities. It has been proven that public universities obtain better results. Therefore, private universities should

make efforts to reach the web accessibility levels of public universities.

An attempt has been made to establish a relationship between various variables used to classify Spanish universities and web accessibility levels. Weak relationships have been detected between accessibility levels and the Research and Innovation variable and the volume of Teaching. However, no relationship has been found with the quality of Teaching. Therefore, it can be concluded that the hypothesis is not supported: the universities best ranked according to quality parameters do not obtain the best results in web accessibility.

A manual analysis has been carried out of the accessibility conformity declarations published on the websites of the universities analysed. In this case, a percentage greater than 50% of absence of said declarations of conformity has been detected. Additionally, these declarations of conformity declare that web pages are not accessible, indicating web accessibility errors. Declarations of conformity required by law seem to become declarations of non-conformity that authorize universities to maintain errors over the years. It is essential that every university (especially in the case of private ones) correct its website accessibility errors, as they are known and published, rather than simply declaring their existence. The result is failure to meet regulatory objectives and dissatisfaction among users with disabilities.

6. FINANCING

This study did not receive funding for its completion.

7. CONTRIBUTION

Conceptualization, J.J-M; Data curation, J.J-M; Formal analysis, J.J-M, F.P.L, L.V.G, A.B.C; Investigation, J.J-M, F.P.L, L.V.G, A.B.C; Methodology, J.J-M; Project administration, L.V.G; Resources, F.P.L, L.V.G, A.B.C; Software, J.J-M; Supervision, F.P.L; Validation, J.J-M, F.P.L, L.V.G, A.B.C; Visualization, J.J-M, F.P.L, L.V.G, A.B.C; Writing – original draft, J.J-M; Writing – review & editing, J.J-M, F.P.L, L.V.G, A.B.C.

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