RESEARCH ARTICLE

Web accessibility of the libraries websites of Federal Universities of the State of Minas Gerais

Marcos de Souza[1] iD https://orcid.org/0000-0002-9829-7249

Fernanda Gomes Almeida [2] iD https://orcid.org/0000-0001-7913-827X

[1] Federal University of Minas Gerais, Belo Horizonte, MG, Brazil / e-mail: marcosdesouza82@gmail.com
[2] Federal University of Minas Gerais, Belo Horizonte, MG, Brazil / e-mail: usernanda@gmail.com

ABSTRACT

Introduction/Objective: Research of mixed nature that had as objective to verify if the sites of the libraries of the Federal Universities of the State of Minas Gerais are adequate for the resources of Web accessibility. **Methodology:** In step 1, a bibliographic research was performed in books and journals and also a documentary research by laws, decrees and government websites on accessibility. In stage 2, the 11 Federal Universities of the State of Minas Gerais were selected as a sample, where the number of students enrolled was requested, by e-mail and Fala.BR platform, as well as the number of students who declare themselves with some type of disability. In stage 3, an automatic web accessibility assessment was performed on the library websites of the 11 institutions of the sample using the Website Accessibility Simulator Assistant (ASES) e; heuristic assessment of Web accessibility by means of accessibility guidelines creating, at the end of the heuristic evaluation, a list of seven elements already implemented or that could be implemented on the libraries' websites, namely: 1) accessibility description; 2) jump menu; 3) contrast; 4) font size; 5) keyboard navigation; 6) Vlibras and; 7) text audio. **Results:** The survey indicated a low percentage of People with Disabilities enrolled in Minas Gerais universities, when compared to the 2010 Census. However, this is no reason for universities to stop improving web accessibility features on their respective websites. On the contrary, universities can develop accessible resources that meet different needs/levels of People with Disabilities. **Conclusion:** The combination of evaluation techniques, automatic and heuristic are fundamental for a more complete analysis of Web accessibility.

KEYWORDS

Library. Website. Web accessibility. Accessibility evaluation.

Acessibilidade Web dos *sites* das bibliotecas das Universidades Federais do Estado de Minas Gerais

RESUMO

Introdução/Objetivo: Pesquisa de natureza mista que teve como objetivo verificar se os *sites* das bibliotecas das Universidades Federais do Estado de Minas Gerais estão adequados quanto aos recursos de acessibilidade Web. **Metodologia:** Na etapa 1 foi realizada pesquisa bibliográfica em livros e periódicos e também uma pesquisa documental por leis, decretos e *sites* governamentais que versam sobre acessibilidade. Na etapa 2 foram selecionadas como amostra as 11 Universidades Federais do Estado de Minas Gerais, onde foi solicitado, por e-mail e plataforma Fala.BR, o quantitativo de discentes matriculados, bem como o número de discentes que se declaram com algum tipo de deficiência. Na etapa 3 foi realizada, nos *sites* das bibliotecas das 11 instituições da amostra, avaliação automática de acessibilidade Web utilizando o serviço Assistente de Simulador de Acessibilidade de Sítios (ASES) e; avaliação heurística de acessibilidade Web por meio de diretrizes de acessibilidade criando, ao final da

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avaliação por heurísticas, uma lista de sete elementos já implementados ou que poderiam ser implementados nos *sites* das bibliotecas, sendo eles: 1) descrição de acessibilidade; 2) menu de salto; 3) contraste; 4) tamanho da fonte; 5) navegação por teclas; 6) Vlibras e; 7) áudio do texto. Resultados: A pesquisa indicou baixo percentual de Pessoas com Deficiências inseridas nas universidades mineiras, se comparado ao Censo 2010. Entretanto, isso não é motivo para que as universidades deixem de aperfeiçoar os recursos de acessibilidade Web em seus respectivos *sites*. Muito pelo contrário, as universidades podem desenvolver recursos acessíveis que atendam diferentes necessidades/níveis de Pessoas com Deficiências. Conclusão: A combinação entre as técnicas de avaliação, automática e heurística são fundamentais para uma análise mais completa da acessibilidade Web.

PALAVRAS-CHAVE
Biblioteca. Website. Acessibilidade Web. Avaliação de acessibilidade.

JITA: DD. Academic libraries.

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1 INTRODUCTION

The first cases of respiratory infection caused by the new coronavirus (SARS-Cov-2) were reported in Wuhan - China on 29 December 2019. On 31 January 2020, the World Health Organization (WHO) officially declared a global emergency by infection with the new coronavirus, named COVID-19. Since March 11, 2020 the WHO has declared a COVID-19 pandemic, after the virus spread rapidly throughout the world (AL-JABIR et al, 2020; ROTHAN; BYRAREDDY, 2020). In Brazil, the first case was confirmed on February 25, 2020. On March 20 of the same year, following the recommendations of the Ministry of Health, the country took social isolation measures for the entire population, after recognizing the occurrence of community transmission of the new coronavirus (BRASIL, 2020c; SCHUCHMANN, 2020).

From this scenario, the Higher Education Institutions (HEI), public and private, announced the temporary suspension of classroom teaching activities and the adoption of Emergency Remote Education as an alternative to continue with the school year. In addition, action plans were prepared for the face-to-face return of activities not adaptable to the remote mode, such as the Federal University of Minas Gerais (UFMG), in its Plan for the face-to-face return of activities not adaptable to the remote mode that foresees the face-to-face return of activities in a gradual and safe way (UFMG, 2021).

Faced with this new scenario, the use of different Information and Communication Technologies (ICTs), Virtual Learning Environments (VLEs) and numerous online services offered by libraries gained prominence, for example, the libraries of universities that, in addition to providing information necessary for teaching, research and extension, they can be considered a door to access information for development in academic training, contributing to the teaching and learning process of students.

Accessibility to physical spaces has long been an important ethical and legal requirement. Although it is an existing right and guaranteed by Brazilian legislation, highlighting Law nº 10,098 of 19 December 2000, which establishes general rules and basic criteria for the promotion of accessibility for people with disabilities or reduced mobility, subsequently updated by Law nº 13.146, of July 6, 2015, establishing the Brazilian Law of Inclusion of Persons with Disabilities, called the Statute of Persons with Disabilities, highlighting the right of the person with disabilities not to face barriers in communications and information, in the use of communication systems and information technology. It is also considered that Law 12,527 of 18 November 2011, which regulates access to information and places accessibility to content in digital media and use of ICTs as an important requirement.

However, the intensification of the use of ICTs, promoted by the social distancing imposed during the pandemic period, especially in the educational context, raises discussions about the accessibility of information and services offered online.

Thus, the question is: how has the web accessibility of the library sites of the Federal Universities of the State of Minas Gerais been presented? The term accessible by considering that the services are able to serve "the whole" of an academic community is taken as North. When using the term "whole", it is considered its totality or the largest possible number of users, thus overcoming barriers such as accessibility, also present in the virtual world.

The research aims to verify whether the library sites of the Federal Universities of the State of Minas Gerais are adequate for Web accessibility resources, thus promoting the inclusion of the entire academic community.

Among the specific objectives, we highlight:

a) identify the number of students enrolled in the Federal Universities of the State of

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Minas Gerais and the number of students who declare themselves to be disabled;

b) analyze Web accessibility automatically on the library websites of the Federal Universities of the State of Minas Gerais based on the Electronic Government Accessibility Model (eMAG, in Portuguese);

c) analyze Web accessibility through heuristics and propose a set of resources in order to meet different types of deficiencies of library users of the Federal Universities of the State of Minas Gerais;

d) discuss the automatic modalities and heuristics of evaluation of Web accessibility.

It is noteworthy that, although terms such as digital inclusion, usability, navigability and objectivity are intrinsically associated with the term web accessibility, this research discusses only questions related to web accessibility, disregarding also its historical precedent already established in the literature.

The importance of research is justified once the use of ICTs has become an everyday in a society increasingly immersed and connected to the Web, especially in a pandemic moment such as commercial activities, education and government services. Brazil having a representative percentage of the population with some kind of disability, it is up to the providers of services, whether public or private, an attention - legislation and guidelines - regarding accessibility, also present in online services and seeking, thus, meet an increasing number of users.

It is important to emphasize that accessibility is already a right established in the Brazilian legislation and has been little contemplated, including, having different guidelines and heuristics that enable a better solution for different environments, whether physical or virtual, however, they need to be attended and/or inspected.

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2 THEORETICAL REFERENCE POINT

The theoretical reference of the research is divided into three sections. The first section addresses the concept of accessibility; the classification of types of disabilities; and the differentiation of the concepts of universal design and accessibility. The second section presents the concept of Web Accessibility through the advancement of Information and Communication Technologies (ICTs) and the needs to develop or adapt Web services so that they are widely used by their users. The third section presents guidelines for Web Accessibility, highlighting the Electronic Government Accessibility Model (eMAG), heuristics and web accessibility validators such as the Website Accessibility Assessor and Simulator (ASES).

2.1 Accessibility

The existence of the view of a standard man in society has been changing over the years in studies on the population. With the end of World War II, mainly from the 1960s, professionals began to conceptually modify the design of built spaces and produced objects, attending a significant portion of People with Disabilities (PwD), older adults and questions about social rights, resulting in an understanding of the differences and diversities of individuals and, consequently, more responsible and committed projects (MONTENEGRO; SANTIAGO; SOUZA, 2009; FEITOSA; RIGHI, 2016).

> [...] the way to develop architectural, urban and product projects as a universal design, had its origin in the United States, as a consequence of legal, economic, demographic

and social changes, involving people with disabilities and elderly (FEITOSA; RIGHI, 2016, p.20).

According to the Census conducted by the Brazilian Institute of Geography and Statistics (IBGE) in 2010, almost 46 million, about 24% of the Brazilian population declared themselves with some degree of disability, be it visual, auditory, motor or mental/intellectual. On the other hand, the PwDs that declared themselves with great or total difficulty to see, hear, walk or climb stairs, in addition to individuals with motor or mental disabilities, reach 6.7% of the Brazilian population (IBGE, c2021). In 2018, IBGE revised the PwD data in the light of the recommendations of the Washington Group on Disability Statistics and started to consider individuals with disabilities only those who cannot or have great difficulties to see, hear or get around (IBGE, 2018).

For Decree No 3.956 of October 8, 2001, the term disability means:

> [...] a physical, mental or sensory restriction, of a permanent or transitory nature, which limits the ability to exercise one or more essential activities of daily living, caused or aggravated by the economic and social environment (BRASIL, 2001, online).

It is important to be aware of the different types of disabilities so that they can create environments accessible to all people, that is, environments that allow the use of space and equipment. When talking about different types of disability, it is not only about physical disabilities, but also about social and informational deficiencies that make it impossible to include individuals in spaces, thus suggesting guidelines for adjustments (DISCHINGER; ELY; PIARDI, 2012).

According to Dischinger, Ely and Piardi (2012) the deficiencies can be classified as: a) physical-motor - change the individual's motor capacity, making it difficult or impossible to perform any type of movement; b) sensory - existence of significant losses in the individual's perception systems, resulting in difficulty in perceiving different types of environmental information; c) cognitive - difficulties in the development of interpersonal relationships in activities such as understanding, learning and decision-making, as well as difficulties involved in the treatment of existing information in the environment and; d) multiple - when the individual has association in more than one type of disability.

It is also necessary to differentiate concepts such as Universal Design and Accessibility, which, although close, present distinct characteristics.

The 2020 NBR 9050 Technical Standard defines Universal Design as "product design, environments, programs and services to be used by all people, without the need for adaptation or specific design, including assistive technology resources" (ABNT, 2020, p.4). For Monteiro, Santiago e Souza (2009, p.12) a key element of Universal Drawing lies in the observed experience of the world, where the "[...] concept of spaces and objects designed exclusively for people with disabilities (or adapted), in the sense of proposing environments and equipment that meet great array of people".

Therefore, the Universal Drawing seeks to incorporate dimensional parameters of use and manipulation of objects seeking to reach the largest number of people, without considering, for example, size, age, mobility and, respecting physical and sensory diversity in the design of spaces and objects, also considering the autonomy of the individual (MONTENEGRO; SANTIAGO; SOUZA, 2009).

In this way, it starts to develop environments seeking to meet the largest number of users possible aiming, thus, to create healthier spaces. However, the initial activity was to adapt

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spaces and objects to meet a portion of the population that has some kind of disability or reduced mobility (TIETJEN, 2020).

Dorneles, Afonso and Ely (2013, p. 57) state that "accessibility means providing an environment of minimum conditions to obtain information/orientation about the space, in order to allow the interaction between users, the displacement and use of equipment and furniture with safety and comfort".

According to Cohen, Duarte and Brasileiro (2012) there is a political dimension to accessibility. This dimension is related to the exercise of citizenship and must contemplate the plurality and diversity of the citizen, thus implying a broader vision of the concept of accessibility.

Table 1 presents accessibility concepts established by legislation and technical standards. Among the concepts, it is possible to identify a transposition of the limits of the physical space into the virtual and, above all, the need for a cultural change on the theme.

Table 1. Concepts of Accessibility

SOURCE	CONCEPT
Decree No 5.296/2004	the condition for the safe and independent use, whether total or assisted, of urban spaces, furniture and equipment, edifications, transport services and devices, systems and means of communication and information by a person with science or reduced mobility.
NBR 15.559/2008	possibility and scope condition for use of physical environment, media, products and services per person with disabilities.
NBR 9050/2020; Law nº 10,098 of 2000; Law nº 13,146 of 2015 - Statute of the Person with Disabilities	possibility and condition of reach, perception and understanding for the safe and independent use of spaces, furniture, urban equipment, buildings, transport, information and communication, including their systems and technologies, as well as other services and facilities open to the public, for public or private use, for collective use, both in urban and rural areas, per person with disabilities or reduced mobility.

Source: prepared by the authors (2021)

To Maria Célia Habib Moura Ferreira Gomes, who prepared the preface to the Accessibility Guide: Public Spaces and Buildings by Monteiro, Santiago and Souza (2009), from the 1990s, world projections and social demands for accessibility, have now justified the intervention of governments to transform and adapt physical structures for the universalization of the rights of people in their various conditions of mobility.

Also according to the preface of Maria C. H. M. F. Gomes (MONTEIRO; SANTIAGO; SOUZA, 2009), scholars and governments began to discuss and seek strategies to promote accessibility, eliminating different barriers, so that individuals can move freely through any public or private space. Corroborating this need and, according to the research "Dimensions and characteristics of the Brazilian Web: a study of gov.br" carried out by the Brazilian Internet Steering Committee (ISC.br) and the Information and Coordination Center of Ponto BR (NIC.br) only 2% of government web pages are accessible (ISC.br, NIC.br, 2010).

It should be noted that the studies conducted by ISC.br and NIC.br were published in 2010, before the enactment of Law 12,527, of November 18, 2011 (Access to Information Law) that impacted in different areas, including the accessibility of content for PwD. A study

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conducted in 2021 by Bigdatacorp[1] , in partnership with the Web Movement for All[2], showed an increase in the number of Brazilian websites and applications approved in all accessibility tests applied in the study, However, the percentage of sites approved in all accessibility tests does not reach 1% of the total of 16.89 million sites active in the country (WEB FOR ALL, 2021).

According to the survey conducted in 2021, 96.79% of the sites have some accessibility failure, based on the tests performed. The percentage showed an improvement when compared to the previous year, where 99.25% of the sites had some accessibility failure. In the sphere of government websites, accessibility barriers for PwD are being reduced. In 2021, the survey pointed out that 89.46% of government websites had some accessibility failure, against 96.71% in 2020 and 99.66% in 2019 (WEB FOR ALL, 2021).

According to Tietjen (2020) studies applied to accessibility enhance positive social outcomes for inclusive and sustainable development. However, change is no longer a matter of knowledge, but of culture and attitude. Thus, government decisions and public policies are fundamental to effectively guarantee the rights of citizenship.

The Monteiro, Santiago and Souza Accessibility Guide (2009) refers to a study focused on architectural spaces, however, with the evolution of Information and Communication Technologies (ICTs) in recent decades, there has been a need for adjustments to promote accessibility in a new space, on the World Wide Web, as a way to serve the entire population or as much as possible, especially on government websites and services. In this new space, accessibility is called Web Accessibility.

2.2 Digital Accessibility and Web Accessibility

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For Benyon (2011, p. 72), "access to physical spaces for people with disabilities has long been an important ethical and legal requirement. And this is increasingly true, also, for information spaces". Thus, according to João (2020) the concept of accessibility was expanded, since, with the advancement of ICTs, there was a need to think about accessibility beyond spaces, buildings and sidewalks. The sense of access was also considered for objects, as emphasized in the Convention on the Rights of Persons with Disabilities, signed by several countries. Brazil has ratified the Convention by promulgating Decree nº 6.949/2009 which provides that States Parties to the Convention shall recognize

> [...] the importance of accessibility to physical, social, economic and cultural media, health, education and information and communication, to enable people with disabilities to fully enjoy all human rights and fundamental freedoms (BRASIL, 2009, online).

In addition, Decree nº 6,949/2009 addresses in its article 9, item 1, accessibility in a broader sense, considering the media and information systems and technologies.

> 1. In order to enable persons with disabilities to live independently and to participate fully in all aspects of life, **States Parties shall take appropriate measures to ensure access for persons with disabilities, equal opportunities with other persons, the physical environment, transport, information and communication, including information and communication systems and technologies,** as well as other services and facilities open to the public or for public use, in both urban and rural

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[1] Big Data Corp. Available at: https://bigdatacorp.com.br. Accessed at: 30/10/2021.

[2] Web Movement for All. Available at: https://mwpt.com.br/. Accessed at: 30/10/2021.

> areas. Such measures, which shall include the identification and removal of barriers and barriers to accessibility, shall apply, inter alia, to:
>
> a. [...]
>
> b. **Information, communications and other services, including electronic services** and emergency services (BRASIL, 2009, online, emphasis added).

Decree nº 6.949/2009 also provides in its article 9, item 2, point g that the States Parties must take measures to "promote the access of people with disabilities to new information and communication systems and technologies, including the Internet) (BRASIL, 2009, online).

Previously, Decree no.296/2004 in its article 8, item I already brought the forecast for accessibility in systems and media and information. In this same sense, Law 13,146/2015, known as the Brazilian Law on Inclusion of Persons with Disabilities (Statute of Persons with Disabilities), in its article 3, item I also brings this forecast.

> I - accessibility: possibility and scope for safe and independent use of spaces, furniture, urban equipment, buildings, transport, information and communication, including their systems and technologies, as well as other services and facilities open to the public, public or private use for collective use, both in urban and rural areas, by people with disabilities or with reduced mobility (BRASIL, 2015, online, our emphasis).

Whereas much of the interaction of individuals with the outside world is carried out from ICTs and machine-based systems, it is necessary to adapt this reality to build accessible digital services as a result, "[...] what is the point of a bank being accessible if an ATM system is not accessible?" (JOÃO, 2020, p.68-69).

According to Dias (2003, p.103) digital accessibility refers to "[...] the ability of a product/artifact to be flexible enough to meet the needs and preferences of as many people as possible" considering also resources as assistive technologies used by individuals with special needs.

Digital accessibility has developed over the years, being an area aware of the challenges it needs to face and with the effective participation of designers. One of its main areas is Web accessibility, through the popularity of websites and services offered on the Internet.

According to the website of the Digital Government, the "Digital Accessibility is the **elimination of barriers on the Web**" so that websites and portals are designed to cater to all individuals, regardless of the type of disability or need, thus allowing, understand, navigate and interact effectively through pages and digital services (BRASIL, 2020a, online, author's emphasis).

Web accessibility allows anyone, using technologies suitable for browsing the global computer network, "[...] is able to visit any site, obtain the information offered and interact with the site" (MELO, 2006, p.33). It aims to ensure that an interface is accessible to all people with disabilities, regardless of type and degree, thus meeting any needs (JOÃO, 2020).

For Melo (2006) the sites offer a wide range of services and resources, such as webmails, discussion forums and chat, enabling communication between individuals. Another example is library services such as access to books, catalogues, magazines, dictionaries, encyclopedias, among other services that are intended for a heterogeneous audience, such as children, youth, adults and the elderly.

According to Benyon (2011, p. 73) Web accessibility is an area of great importance since "[...] many websites exclude people who are not perfectly healthy and capable". To make websites and Web services suitable for the use of individuals with different needs, it is necessary

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to first recognize these differences and, consequently, search for mechanisms to value them (MELO, 2006).

Whereas digital accessibility and web accessibility, Benyon (2011) presents five reasons for excluding individuals in computer systems: 1) physical exclusion, due to inadequate equipment location or because input and output devices demand too much of their abilities; 2) conceptual exclusion, when people are excluded because they cannot meet complicated instructions or obscure commands, or because they cannot form a clear mental model of the system; 3) economic exclusion, when they cannot afford to buy some technology that is essential; 4) cultural exclusion, when designers make inappropriate assumptions about how people work and organize life; 5) social exclusion, where the equipment is not available at the appropriate time and place, or where persons are not members of a particular social group and cannot understand certain social norms or messages.

For effective and efficient web accessibility, there are a number of standards and recommendations (JOÃO, 2020) that will be dealt with below.

2.3 Web accessibility guidelines and validators

The World Wide Web Consortium (W3C) is an international consortium composed of affiliated organizations, team of professionals with exclusive dedication and external public that contribute to the development of standards for the Web, available free of charge. The W3C's mission is to "lead the World Wide Web to reach its full potential, developing protocols and guidelines that ensure its long-term growth". According to W3C Brasil "it is essential that the Web is accessible, in order to promote equal access and opportunities for people with different capacities" (W3C BRASIL, 2013, online).

According to W3C Brasil, some factors should be considered in order to efficiently achieve Web accessibility (W3C BRASIL, 2013):

a) the importance, comprehensiveness and universality of the Web - making it easier for different types of users to access information so that there are no barriers. It is important that the Web is available at all times under the most diverse technical conditions;

b) reciprocity - the interaction between individuals and Web sites/systems cannot be considered a single route, but a two-way street, since different types of users can contribute to the Web, whether perceiving, understanding, navigating or interacting. In addition, they can contribute collaboratively to both sides;

c) the multiplicity and diversity of factors involved - to achieve Web accessibility it is necessary to develop a set of seven components: 1) content - natural information (text, image and audio), and code or marking; 2) user agents, like the browsers that are responsible for making multimedia content available; 3) assistive technology as readers and screen enlargers; 4) user - considering their experience and adaptive strategies; 5) developers and users - who contribute directly to the content; 6) authoring tools - software used to create websites; 7) evaluation tools - accessibility evaluators, Hypertext Markup Language (HTML) validatorsCascading Style Sheets (CSS) validators, among others.

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Thus, the Web assumes a role of paramount importance so that its accessibility is not restricted to the access of only one thing, but to a multitude of important aspects that becomes part of the daily life of individuals in society (W3C BRASIL, 2013).

Chart 2 presents some of the standards for website development/systems addressing Web accessibility practices developed by the World Wide Web Consortium (W3C):

Table 2. Web accessibility standards

STANDARD	DESCRIPTION
WCAG2.2 of 2021	Web Content Accessibility Guidelines - cover a wide range of recommendations that aim to make Web content more accessible. Compliance with these guidelines will make content accessible to a greater number of people with disabilities, including blindness and low vision, deafness and low hearing, learning difficulties, cognitive limitations, movement limitations, speech disability, photosensitivity as well as those that have a combination of these limitations. Following these guidelines will also make web content more usable to users in general. Available at: https://www.w3.org/TR/2021/WD-WCAG22-20210521/
WAI-ARIA 1.2 of 2021	Accessible Rich Internet Applications - defines a way to make web content and web applications more accessible to people with disabilities. It especially helps with dynamic content and advanced user interface controls developed with HTML, JavaScript and related technologies. Without WAI-ARIA, certain features used on websites are not available to some users with disabilities, especially people who rely on screen readers and people who cannot use a mouse. WAI-ARIA addresses these accessibility challenges, for example by defining ways of functionality to be provided for assistive technology. With WAI-ARIA, developers can make advanced web applications accessible and usable for people with disabilities. Available at: https://www.w3.org/TR/2021/CR-wai-aria-1.2-20210302/
WCAG-EM 1.0 of 2014	Website Accessibility Conformance Evaluation Methodology - provides guidance on how to assess whether websites comply with Web Content Accessibility Guidelines (WCAG) 2.0. It describes a procedure for evaluating websites and includes considerations to guide evaluators and promote good practices. It does not provide instructions for evaluating web resource content by resource, which is addressed by the WCAG 2.0 success criteria. This document is part of a series of W3C / WAI informational resources on how to evaluate accessibility sites that complement WCAG 2.0 documents. It does not define additional WCAG 2.0 requirements or replace or replace them in any way. The methodology described in this document is aimed at people with experience in assessing accessibility using WCAG 2.0 and its support features. Provides guidance on best practices to define the scope of the evaluation, explore the target site, select representative samples from sites where it is not feasible to evaluate all content, audit the selected samples and report the evaluation results. Available at: https://www.w3.org/TR/2014/NOTE-WCAG-EM-20140710/
ATAG 2.0 of 2015	Authoring Tool Accessibility Guidelines - The Authoring Tool Accessibility Guidelines (ATAG) 2.0 provide guidelines for designing web content creation tools that are more accessible to authors with disabilities (Part A) and designed to allow, support and promote the production of web content that is more accessible to all authors (Part B). Available at: https://www.w3.org/TR/2015/REC-ATAG20-20150924/
UAAG 2.0 de 2015	User Agent Accessibility Guidelines - guides developers in designing user agents that make the Web more accessible to people with disabilities. User agents include browsers, browser extensions, media players, readers, and other applications that process web content. A user agent who follows UAAG 2.0 will improve accessibility through its own user interface and its ability to communicate with other technologies, including assistive technologies. UAAG and support resources are also intended to meet the needs of different audiences, including developers, policy makers and managers. All users, not only disabled users, will benefit from user agents who follow UAAG 2.0. Available at: https://www.w3.org/TR/2015/NOTE-UAG20-20151215/

Source: prepared by the authors (2021), based on W3C (c2021)

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The standards developed by the W3C are technical specifications and guidelines developed to meet three pillars: 1) maximize the consensus on the content of a technical report; 2) ensure high technical and editorial quality; 3) obtain endorsement from W3C and the wider community. W3C develops high-quality web technology standards based on the community consensus (W3C, c2012).

In 1988, the United States Congress amended the Rehabilitation Act of 1973 so that all federal agencies would make their ICTs accessible to individuals with disabilities. The Law "[...] applies to all federal agencies when they develop, acquire, maintain or use electronic and information technology" (GSA, 2020, online, our translation).

The amendment to the Rehabilitation Act (Section 508 of the Rehabilitation Act of 1973) was enacted in three respects: 1) removing barriers to information; 2) providing new opportunities for people with disabilities; 3) encouraging the development of technologies (GSA, 2020).

In 2017 the final rule of updating accessibility requirements for ICTs established by Section 508 of the Rehabilitation Act 1973 and Section 255 of the Telecommunications Act 1996 was published. Thus, the Office of General Government Policy (OGP) of the General Services Administration of the United States (GSA) began to provide support to help federal agencies meet the requirements for ICTs to become accessible (GSA, 2018).

In Brazil, the Electronic Government Accessibility Model (eMAG) had its first version developed in 2004, based on 14 existing standards in other countries, such as US Section 508, accessibility guidelines for Ireland and other documents from countries such as Canada, Portugal and Spain (BRAZIL, 2014).

eMAG is committed to being a guiding document for the development and adaptations of the federal government's digital content, thus guaranteeing access to all. In 2007, eMAG was institutionalized in the domain of the Administration of Information and Computer Resources (SISP) system, making mandatory the recommendations for websites and portals of the Brazilian government (BRASIL, 2014).

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It should be noted that eMAG enables a standardization of the implementation of digital accessibility, being easy to apply, aligned with Brazilian needs and in compliance with international standards such as WCAG (Web Content Accessibility Guidelines) aimed at the Brazilian government (BRASIL, 2014).

Table 3 presents the documents that are part of the legislation and that guide the accessibility and implementation of eMAG.

Table 3. Documents guiding eMAG

DOCUMENT	DESCRIPTION
Brazilian Accessibility Committee (CB-40) of the Brazilian Association of Technical Standards (BATS)	dedicates to the normatization in the field of accessibility, attending to the precepts of universal design. The Committee has several committees, defining accessibility standards at all levels, from the physical to the virtual space.
Law Nº 10.098 of 19 December 2000	lays down general rules and basic criteria for promoting accessibility for persons with disabilities or reduced mobility, and other measures.
Decree number 5296 of 2 December 2004	regulates laws n° 10.048 of 8 November 2000 giving priority to the care of persons it specifies, and 10.098 of 19 December 2000 laying down general rules and basic criteria for promoting accessibility for persons with disabilities, and make other arrangements.

Ordinance No 3 of 7 May 2007	institutionalized eMAG within the Information and Information Resources Administration (SISP) system, making its observance mandatory on the websites and portals of the Brazilian government.
International Convention on the Rights of Persons with Disabilities of 30 March 2007	elaborated by the United Nations, defines, in its article 9°, the mandatory promotion of access of people with disabilities to new information and communication systems and technologies, including the Internet.
Decree No. 6949 of 25 August 2009	promulgates the International Convention on the Rights of Persons with Disabilities, making it a legal framework in Brazil.
Normative Instruction MP/SLTI n°04 of 12 November 2010	provides on the process of hiring Information Technology Solutions by the member bodies of the Information and Information Resources Administration System - SISP of the Federal Executive Branch.
Law 12,527 of 18 November 2011	in its Article 8, paragraph 3, paragraph VIII, it recommends that: "The sites of which the § 2 must, in the form of regulations, meet, among others, the following requirements: (...) adopt the necessary measures to ensure the accessibility of content for people with disabilities".
Decree No 7724 of 16 May 2012	regulated the law on access to information, states in its article 8 paragraph 3: "The websites of the bodies and entities shall, in compliance with the rules established by the Ministry of Planning, Budget and Management, (...)".

Source: prepared by the authors (2021), based in BRAZIL (2014)

In addition to the accessibility guidelines for the development of accessible websites and programs, there are numerous specific tools to perform the accessibility evaluation of these. These tools are software or online services that help determine whether Web content meets such guidelines. W3C has a list of various tools, provided by third parties, to perform the web accessibility assessment (W3C, c2020).

Such software or online services, following the standards of W3C, allow to validate, automatically, the code of the websites, thus verifying whether it complies with the accessibility guidelines. As a result, reports pointing out errors are generated (BRASIL, 2014). However, this is a quick and less laborious accessibility assessment, which does not determine whether a website is accessible or not, and it is necessary to perform a heuristic evaluation.

The Oxford Advanced Learner's Dictionary defines heuristics as "a method of problem solving, finding practical ways to deal with them, learning from previous experience" (HEURISTICS, 2005, p. 730, our translation). For Dictionary.com, a heuristic in the context of computation and mathematics refers to "[...] a method or set of rules for solving problems other than by algorithm" (HEURISTICS, c2021, online, our translation).

Tanaka (2009) developed a study on heuristic-based methods for assessing accessibility in information systems. In this occasion, the author presents five methods for obtaining heuristics in human-computer interface of high level, they are: 1) based on popular knowledge; 2) based on experiences of experts; 3) based on evaluations; 4) based on design statements and scenarios and; 5) based on research.

There are accessibility heuristics already established by specialists, such as Paddison and Englefield (2002)[3] which are focused on web accessibility guidelines[4]; Koivunen and Mccathienevile (2001)[5] which are aimed at the accessibility of graphics and multimedia elements; and Wattenberg's (2006)[6] which are specific to identify usability and accessibility problems in screen readers (TANAKA, 2009).

The fact is that, there is not a single method to obtain heuristics, but different methods to apply in an evaluation, and new heuristics can be elaborated to meet different needs as a solution to a given problem (TANAKA, 2009).

One of the tools that can be used is the Evaluator and Simulator of Accessibility in Sites (ASES[7]), developed through a partnership between the Department of Electronic Government (DEG) and the Federal Institute of Education, Science and Technology of Rio Grande do Sul (IFRS). ASES allows you to evaluate, simulate and correct the accessibility of pages, websites and portals and is intended to assist in the construction of websites and navigation devices that are accessible to any individual. In addition, it aims to provide instruments that enable the adoption of accessibility by government agencies (BRASIL, [201-]).

3 METHODOLOGY

The research is classified as: applied research from the point of view of its nature (GIL, 2010), of mixed nature, according to Creswell and Clark (2013), for considering the collection and analysis of qualitative and quantitative data in the same study. In addition, the research has an exploratory and descriptive character from the point of view of its objectives (GIL, 2010).

In step 1, a bibliographic search was performed on books and scientific articles found in databases such as Google Scholar, Scielo, CAPES Journal Portal and the e-book services My Library and Virtual Library Pearson. In addition, documentary research was carried out by laws, decrees and government websites available on the Internet.

Then, for stage 2, the 11 Federal Universities of the State of Minas Gerais were selected as a sample, where they were requested, by e-mail with the departments responsible or by the Integrated Platform of Ombudsman and Access to Information - Fala.BR[8], the quantitative number of students enrolled in the undergraduate and postgraduate levels lato and stricto sensu, as well as the quantitative number of students in both levels of education who declare themselves with some kind of disability.

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[3] PADDISON, C.; ENGLEFIELD, P. Applying heuristics to perform a rigorous accessibility inspection in a commercial context. **ACM SIGCAPH Computers and the Physically Handicapped**, New York, n. 73-74, p. 126-133, 2002.

[4] Sentence or principle to propose a set of standards or determine a course of action. Available at: https://www.dictionary.com/browse/guideline/. Accessed on: 30/10/2021.

[5] KOIVUNEN, M.; MCCATHIENEVILE, C. **Accessible graphics and multimedia on the Web**. Cambridge, MA: W3C, 2001.

[6] WATTENBERG, T. L. Accessibility heuristics utilizing learnability characteristics of synthesized speech applications. **ACM SIGACCESS Accessibility and Computing**, New York, n. 84, p. 45-47, 2006.

[7] ASES - Site Accessibility Evaluator and Simulator. Available at: https://asesweb.governoeletronico.gov.br/. Accessed at: 18/08/2021.

[8] Fala.BR - Integrated Ombudsman Platform and Access to Information. Available at: https://falabr.cgu.gov.br/publico/Manifestacao/SelectionTipoManifestacao.aspx?ReturnUrl=%2f/. Accessed on: 30/10/2021.

Requests for data were made between days 07 a 14 June 2021 for HEI: Federal University of Juiz de Fora (UFJF), Federal University of Lavras (UFLA), Federal University of Minas Gerais (UFMG), Federal University of Ouro Preto (UFOP), Federal University of São João del-Rei (UFSJ), Federal University of Triângulo Mineiro (UFTM), Federal University of Viçosa (UFV), Federal University of the Jequitinhonha and Mucuri (UFVJM), Federal University of Uberlândia (UFU), Federal University of Alfenas (UNIFAL-MG), Federal University of Itajubá (UNIFEI).

The last stage (stage 3) had the realization of web accessibility evaluations in the library sites of the 11 Federal Universities of the State of Minas Gerais used in the sample, being:

a) Automatic web accessibility assessment through the ASES service, which evaluates the accessibility of pages, websites and portals. For the automatic evaluation, the link to the initial page of the websites of the evaluated libraries was submitted to the ASES service. The automatic accessibility assessment was carried out on 18 June 2021;

b) heuristic assessment of Web accessibility through accessibility guidelines, creating, at the end, a list of elements already implemented or that could be implemented on library websites. The assessment of accessibility by heuristics was carried out between the days 19 a 25 July through the navigation in all hierarchical levels of the websites of libraries, being the initial pages and the internal pages.
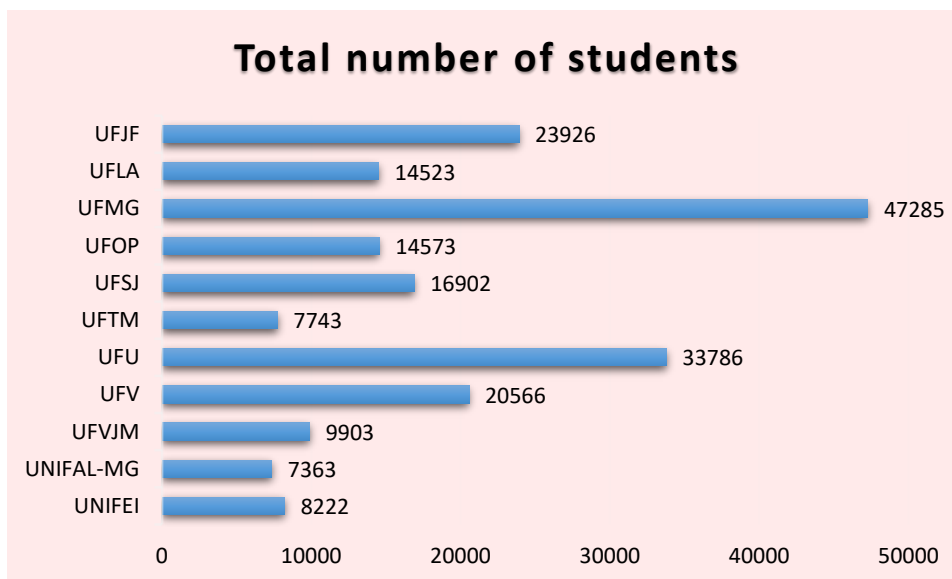
The study used as procedures for data collection bibliographic research, documentary research and web accessibility evaluation.

4 RESULTS AND DISCUSSIONS

Although the national scenario presents a representative number of 24% of the population that declares itself to have some degree of disability and that, 6.7% of the population has a high or total degree of disability, as pointed out in the 2010 Census (IBGE, c2021). It can be seen, by means of research conducted with the Federal Universities of the State of Minas Gerais that answered the research that, in the higher education universe, the percentages are lower.

Graphic 1 presents the total number of students of the Federal Universities of the State of Minas Gerais, regardless of the category of education, being undergraduate or postgraduate lato and stricto sensu.

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Graphic 1. Total students per university

Total number of students

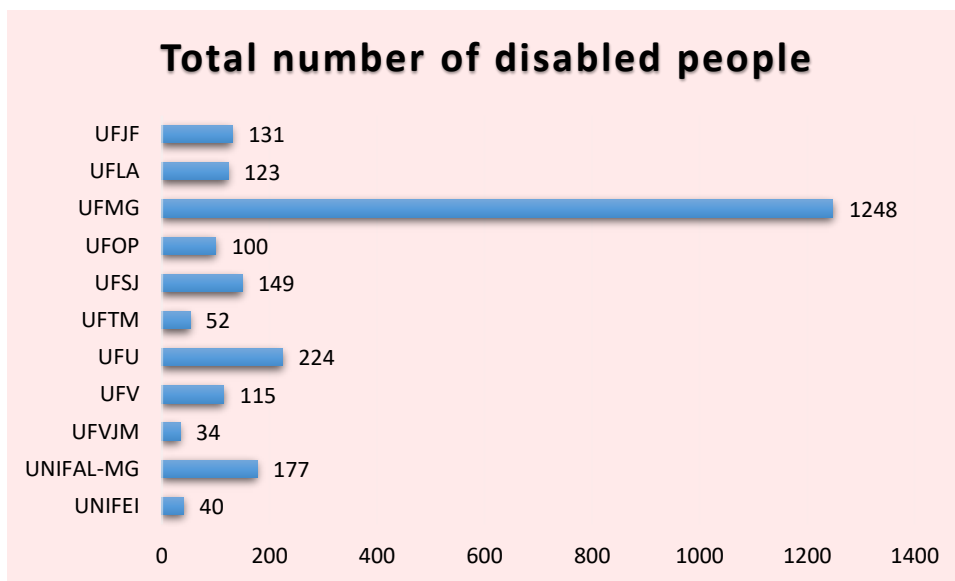| University	Total
UFJF	23926
UFLA	14523
UFMG	47285
UFOP	14573
UFSJ	16902
UFTM	7743
UFU	33786
UFV	20566
UFVJM	9903
UNIFAL-MG	7363
UNIFEI	8222

Source: research data (2021).

UFJF has 23,926 students, 18,827 of whom are enrolled in undergraduate level and 5,099 at graduate level; UFLA has 14,523 students, 10,969 of whom are enrolled in undergraduate level and 3,554 at graduate level; UFMG has 47,285 students, being 34,482 enrolled in the undergraduate level and 12,803 in the graduate level; the UFOP has 14,573 students, being 12,165 enrolled in the undergraduate level and 2,408 in the graduate level; the UFSJ has 16,902 students, being 14,130 enrolled in the undergraduate level and 2,772 in the graduate level; the UFTM has 7,743 students, 6,581 enrolled in the undergraduate level and 1,162 in the graduate level.

UFU has 33,786 students, of whom 25,962 are enrolled in the undergraduate level and 7,824 at the graduate level; UFV has 20,556 students, of whom 16,636 are enrolled in the undergraduate level and 3,930 at the graduate level; UFVJM has 9,903 students, 8,872 of them enrolled at the undergraduate level and 1,031 at the graduate level; UNIFAL-MG has 7,363 students, 6,511 of them enrolled at the undergraduate level and 852 at the graduate level; UNIFEI has 8,222 students, being 7,264 enrolled in the undergraduate level and 958 in the graduate level.

Graphic 2 presents the total number of students from the researched universities who declare themselves with some disability, regardless of the type and degree.

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Graphic 2 - Total of students with disabilities by university

Total number of disabled people

University	Total
UFJF	131
UFLA	123
UFMG	1248
UFOP	100
UFSJ	149
UFTM	52
UFU	224
UFV	115
UFVJM	34
UNIFAL-MG	177
UNIFEI	40

Source: research data (2021)

The UFJF has 121 undergraduate students and 10 graduate students who declare themselves handicapped, resulting in 0.55% of the total students of the university; the UFLA has 117 undergraduate students and 6 graduate students who declare themselves handicapped, equivalent to 0.85% of the total number of students at the university; UFMG has 593 undergraduate students and 655 graduate students who declare to be disabled, resulting in 2.64% of the total number of students at the university; UFOP has 98 undergraduate students and 2 post-graduate students who declare to be handicapped, which is equivalent to 0.69% of the total number of students at the university; UFSJ has 142 undergraduate students and 7 graduate students who declare themselves handicapped, resulting in 0.88% of the total number of students at the university; UFTM has 51 undergraduate students and 1 graduate student who declare themselves handicapped, resulting in 0.67% of the total students of the university.

UFU has 178 undergraduate students and 46 graduate students who declare themselves deficient, equivalent to 0.66% of all university students; UFV has 113 undergraduate students and 2 graduate students who declare themselves deficient, resulting in 0.56% of all university students; in UFVJM 34 undergraduate students declare themselves disabled, while no graduate student declared any type of disability, which is equivalent to 0.34% of all university students; UNIFAL-MG has 154 undergraduate students and 23 graduate students who declare themselves handicapped, resulting in 2.40% of all university students; UNIFEI has 36 undergraduate students and 4 graduate students who declare themselves handicapped, equivalent to 0.49% of total university students.

Chart 4 summarizes the percentages of students with disabilities in the 11 institutions surveyed.

Table 4. Percentage of students with disabilities per university

INSTITUTION	PERCENTAGE OF STUDENTS WITH DISABILITIES
UFJF	0,55%
UFLA	0,85%
UFMG	2,64%

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UFOP	0,69%
UFSJ	0,88%
UFTM	0,67%
UFU	0,66%
UFV	0,56%
UFVJM	0,34%
UNIFAL	2,40%
UNIFEI	0,49%

Source: research data (2021)

The low percentage of PwD enrolled in the Federal Universities of the State of Minas Gerais (Table 4) when compared to the results of the 2010 Census present margins for different discussions in the areas of social sciences, politics, and humanities that are not part of the objective of this research, such as, for example, inclusion and disease eradication policies, addressing issues such as: why is a low percentage of PwD able to reach higher education? Are the HEIs ready to receive individuals with disabilities? How are the government leaders acting in the inclusive policies? How has science contributed to the eradication of diseases that can cause some kind of disability?

Chart 5 presents the sites of the libraries of the Federal Universities in the State of Minas Gerais analyzed by the Assistant Site Accessibility Simulator (ASES). It is important to point out that the ASES uses evaluation criteria[9] where the recommendations were established by parameters, according to their nature. Furthermore, the evaluation is based on automatic tests on source code, thus not considering human evaluation.

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Table 5. List of sites analyzed by ASES

UNIVERSITY	DENOMINATION	SITE
UFJF	Library System	https://www2.ufjf.br/biblioteca/
UFLA	University Library	http://biblioteca.ufla.br/site/
UFMG	Library System	https://www.bu.ufmg.br/bu_atual/
UFOP	Library and Information System	http://www.sisbin.ufop.br/
UFSJ	Library Division	http://www.dibib.ufsj.edu.br/wordpress/
UFTM	Library	http://www.uftm.edu.br/biblioteca/
UFU	Library System	https://www.bibliotecas.ufu.br/
UFV	Central Library	http://www.bbt.ufv.br/
UFVJM	Library System	http://www.ufvjm.edu.br/biblioteca/
UNIFAL-MG	Library System	https://www.unifal-mg.edu.br/bibliotecas/
UNIFEI	Library System	https://unifei.edu.br/ensino/bibliotecas/

Source: elaborated by the authors (2021)

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[9]ASES Evaluation Criteria. Available at: https://asesweb.governoeletronico.gov.br/criteriosSucesso/. Accessed on: 18/08/2021.

As a result[10], ASES prints the accessibility percentage score with a legend (green for >=95%, yellow for >=85% and <95%, orange for >=70% and <85%, and red for <70%); summary of the evaluation; and; breakdown of errors and warnings by categories, being markup, behavior, content/information, presentation/design, multimedia and forms as per eMAG. The warnings are recommendations to respect Web standards, for example, an HTML source code or a CSS style sheet.

UFJF's site showed 82.38% accessibility, 69 errors and 1,668 warnings; UFLA showed 88.38%, 75 errors and 1,207 warnings; UFMG showed 78.16%, 115 errors and 326 warnings; UFOP showed 77.55%, 99 errors and 1,531 warnings; UFSJ showed 70.5%, 122 errors and 540 warnings; UFTM showed 78.36%, 86 errors and 1. 061 warnings; UFU presented 81.53%, 216 errors and 631 warnings; UFV presented 85.21%, 56 errors and 72 warnings; UFVJM presented 69.4%, 181 errors and 339 warnings; UNIFAL-MG presented 73.68%, 81 errors and 153 warnings; UNIFEI presented 70.96%, 98 errors and 452 warnings.

Reflections about the percentage of accessibility performed by any sites/software (automatic evaluation) such as ASES are necessary, since, these services use as parameters for evaluation the W3C and eMAG guidelines, among organizations that evaluate the source code of the site. In this case, the evaluation refers to markup, behavior, content/information, presentation/design, multimedia and forms.

You can build, for example, a site that reaches a percentage higher than 95% of accessibility, thus having a source code of excellence, but that has no visible Web accessibility resource. In this case, the site would be suitable for screen readers such as DOSVOX[11], NVDA[12], JAWS for Windows[13], Virtual Vision[14], Orca[15] or VoiceOver, thus serving only a portion of the disabled, the totally visually impaired.

Chart 6 presents a list of Web accessibility resources suggested so that the libraries of the Federal Universities of the State of Minas Gerais may adapt themselves and, consequently, reach the largest number of users. The set of elements was built based on the WCAG, W3C and eMAG guidelines and on the different needs such as: low vision, photosensitive, motor, illiterate and the deaf-mute. The features implemented in the sites are represented by ☑ and not implemented by ✖.

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Table 6. Elements and features that sites have and or can implement

UNIVERSITY	DESCRIPTION ACCESSIBILITY	JUMP MENU	CONTRAST	FONT SIZE	KEY NAVIGATION	VLIBRAS	AUDIO OF THE TEXT
UFJF	☑	☑	☑	✖	☑	☑	✖

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[10]Results of Web accessibility assessments of all universities evaluated. Available at: https://doi.org/10.6084/m9.figshare.14810400.v1. Access on: 18/08/2020.

[11] DOSVOX. Available at: http://intervox.nce.ufrj.br/dosvox/. Accessed on: 19/07/2021.

[12] NVDA. Available at: https://www.nvaccess.org/. Accessed on: 19/07/2021.

[13] JAWS for Windows. Available at: https://www.freedomscientific.com/products/software/jaws/. Accessed on: 19/07/2021.

[14]Virtual Vision. Available at: https://micropowerglobal.com/solucoes/virtual-vision/. Accessed on: 19/07/2021.

[15] ORCA. Available at: https://help.gnome.org/users/orca/stable/index.html.pt_BR. Accessed on: 19/07/2021.

UFLA	✓	✓	✓	✗	✓	✓	✗
UFMG	✗	✗	✓	✗	✗	✗	✗
UFOP	✗	✗	✗	✗	✗	✗	✗
UFSJ	✗	✗	✗	✗	✗	✗	✗
UFTM	✓	✓	✓	✗	✓	✓	✗
UFU	✓	✓	✓	✗	✓	✓	✗
UFV	✗	✗	✗	✗	✗	✗	✗
UFVJM	✗	✗	✗	✗	✗	✓	✗
UNIFAL-MG	✗	✗	✗	✗	✗	✓	✗
UNIFEI	✓	✗	✓	✓	✓	✓	✗

Source: elaborated by the authors (2021)

The description of Web accessibility resources is essential to present users with the means and alternatives for navigating the site, especially for some resources that differ because of the browser. Of the universities evaluated, only five have the informative page, being them: UFJF, UFLA, UFTM, UFU and UNIFEI.

The jump menu (for menu, content, footer and search) has the purpose of facilitating the user's navigation, so that he can go, for example, straight to the content, without the need to go through the whole menu. Another purpose of the jump menu is to forward the user directly to a search box on the site. This feature mostly caters to the totally visually impaired who use screen readers. Of the universities evaluated, only four make the drop-down menu available, as follows: UFJF, UFLA, UFTM and UFU.

The contrast option is used for individuals with photosensitivity, this way, there is an inversion in the background and font colors, usually using black and white. This possibility, although little used, can be extended to other colors. Among the universities evaluated, six have the contrast resource, as follows: UFJF, UFLA, UFMG, UFTM, UFU and UNIFEI.

The font size option allows to increase and decrease fonts. This functionality was removed from the standardized elements bar of digital accessibility in the Federal Government with the claim that users already know the native functionalities of web browsers (BRASIL, 2014). However, it is understood that, the need of individuals with multiple disabilities was not considered, for example, a user with motor disabilities who uses the computer with only one finger and who has low vision. In this situation, the user would not be able to use the key combination "Crtl" "+" or "Crtl" + "scroll" of the mouse.

With the increase and decrease font feature highlighted as an icon, the user can either bring the mouse cursor to the icon or navigate by tab (TAB key) until they reach the option to click on increase or decrease font. In addition, the eMAG site itself, which reports the removal of the increase and decrease font options, retains the features (increase font, normal size and decrease font). The only university with this feature implemented is UNIFEI.

Key navigation or key combination is another relevant Web accessibility feature, because it speeds up the navigation between blocks of content, such as going straight to the beginning of the content, menu, search or footer of a site. It requires a combination of keys that can be changed according to the browser. It is suggested, besides the eMAG [16] recommendations, the navigation by numeric keys that can be implemented for the main pages of the site, for example, key "1" loads the home page; key "2" opens the services page and key "3" opens the contact form. The library systems of UFJF, UFLA, UFTM, UFU and UNIFEI

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[16] eGAM. Available at: http://emag.governoeletronico.gov.br/. Accessed on: 19/07/2021.

have the guidelines for navigation by key combinations, however, the feature is inoperative at UNIFEI.

Vlibras[17] is an automatic translation resource through the Brazilian Sign Language. It is a free and open source tool that translates digital content, in Portuguese, into Libras. This resource caters to those who are literate in Libras. It is necessary to emphasize that there may be an individual who is illiterate in Portuguese, but fluent in Brazilian Sign Language. The libraries that have the Vlibras resource, developed in partnership between the Ministry of Economy (ME), through the Digital Government Secretariat (SGD) and the Federal University of Paraiba (UFPB) are: UFJF, UFLA, UFTM, UFU, UFVJM, UNIFAL-MG and UNIFEI.

Finally, the text audio resource is an alternative for the translation of the textual content into audio, and can help the low vision and illiterate people. This resource is used by means of players available on the websites that reproduce the audio of the site's text. There are softwares such as Ararajuba[18] and Text To Speech Reader[19] that perform the conversion of text to audio file and that can be used on websites. However, this is a watershed, because the totally visually impaired who use screen readers usually do not understand the functionality of this feature, players, since the screen reader itself already does this functionality. An alternative would be the description of the resource on the accessibility page. Of the sites, evaluated by heuristics, none has the feature implemented.

Of the seven functionalities evaluated by the Web accessibility heuristics in the 11 universities in Minas Gerais, five of them have at least five accessibility resources implemented: UFJF, UFLA, UFTM, UFU and UNIFEL. UFMG, UFVJM and UNIFAL-MG have only one feature implemented. UFOP, UFSJ and UFV do not even have one resource implemented.

The eMAG, which is committed to being a guideline in the development and adaptation of digital content from the federal government, provides a standard top containing elements of Web accessibility, such as jump menu, high contrast, page with the description of Web accessibility resources and Vlibras, as presented in Figure 1. In the evaluation by heuristics, it is noted that five sites of libraries of the Minas Gerais universities use the standard top, being them: UFJF, UFLA, UFU, UFTM UNIFEI. The UFVJM and UNIFAL-MG sites only have a top bar with the Vlibras resource. The UFMG, UFOP and UFV sites do not follow the model provided by eMAG.

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Figure 1. Top of UFU Libraries System website with the Web accessibility resources

Source: UFU (2021)

UFLA presented the highest percentage of Web accessibility in the automatic evaluation performed by ASES, expressing 88.38% of compliance. In the evaluation by heuristics, the institution is one of the five universities with the highest number of implemented resources. On the other hand, the UFV has the second highest percentage of adequacy in the

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[17] Vlibras. Available at: https://www.gov.br/governodigital/pt-br/vlibras. Accessed on: 19/07/2021.

[18] Ararajuba. Available at: https://cta-ifrs.bitbucket.io/ararajuba/. Accessed on: 30/10/2021.

[19] Text to Speech Reader. Available at: https://ttsreader.com/.Acesso on: 10/30/2021.

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automatic evaluation (85.21%) and none of the seven requirements verified in the evaluation by heuristics implemented.

In addition to the features pointed out in Table 6, it is suggested the implementation of tabular navigation for all sites, thus promoting a logical sequence of navigation performed by the TAB key; availability of the site map, enabling the totally visually impaired to have knowledge about all the site content in a single place, not needing to access all the pages and; implementation of responsive design allowing the interface to be adapted to any type or size of screen.

The opposition between a well evaluated site in an automatic way and a badly classified site in the evaluation by heuristics, as the case presented by UFV, shows that the combination between the evaluation methods, automatic and by heuristics, is fundamental for a more complete analysis of Web accessibility, aiming to identify the deficiencies regarding accessibility in the sites of the libraries of the institutions for later correction and, thus, to allow a greater inclusion of the students of these institutions. It is necessary to point out that the evaluation by heuristics must prevail, because the sites may meet the technical requirements, but may not work effectively.

The inclusion of students with different types of needs in the various services provided by universities is an "obligation" of the institution. Inclusion is extremely important, especially in a pandemic state where libraries are physically closed due to restrictions on the circulation of people as a measure to contain the virus. The accessibility to websites/portals and systems is of utmost importance, regardless of the percentage of enrolled students who have some kind of disability, although all the institutions assessed have students with some kind of disability, as presented in Chart 2 and Chart 4. Considering that libraries give support to the tripod teaching, research and extension, providing information and helping in the production and dissemination of knowledge, the non-adequacy of their websites may exclude or deprive an important part of the university community of the access to knowledge.

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It is worth mentioning that, in addition to the students, it is necessary to include the other members of the academic community, teaching and technical servers, since the Federal Constitution, Article 37, VIII ensures that it should be reserved percentage of public jobs and positions to people with disabilities (BRASIL, [2020] b). Law 8.112/90, which deals with the legal system for federal public servants, foresees in its Article 5, §2 the reserve of up to 20% of vacancies for people with disabilities (BRASIL, 1990). Decree No. 9,508/2018 ensures a minimum of 5% of vacancies offered to people with disabilities (BRASIL, 2018).

Besides all the legislation already established and guidelines for the development of websites/systems with Web accessibility resources, such as eMAG, there are a number of reflections and questions that should be made to understand the "whys" of a good part of the Federal Universities of the State of Minas Gerais, which effectively contribute to the formation of the citizen in society and also for science, has not yet paid attention to a reality increasingly present in the daily lives of students, the access to information effectively and comprehensively.

5 FINAL CONSIDERATIONS

Web accessibility has been fundamental for the process of inclusion of individuals with different types of disabilities in the most diverse services made available on the internet, a fact that gained evidence due to the pandemic, since universities and, consequently, libraries were deprived of physical access.

Regarding the research problem, in the academic scenario, there are few Federal Universities in the State of Minas Gerais that have Web accessibility resources implemented in their respective libraries, seeking to efficiently serve all students and or communities.

Regarding the automatic evaluation of Web accessibility, one (1) site, representing 9.09% of the sites evaluated, fits in the last range (red), with less than 70% accessibility; eight, or 72.72% of the sites fit in the third range (orange), with more than 70% and less than 85% accessibility; two sites, representing 18.19% of the sites evaluated fit into the second band (yellow), with more than 85% and less than 95% of accessibility, and one of them does not even have any of the resources considered in the heuristic evaluation of Web accessibility. None of the sites has Web accessibility in the first band (green), with more than 95% accessibility.

Regarding the heuristic evaluation of Web accessibility, five sites, or 45.46%, have five of the seven suggested features implemented. Three sites, representing 27.27% of the institutions, have only one feature implemented, and the other three, that is, 27.27% of the sites do not even have any features implemented, of those that were suggested in the heuristic evaluation.

The general research objective was achieved when identifying that the websites of the libraries of the Federal Universities of the State of Minas Gerais are partially adequate for a portion of the evaluated universities, while Web accessibility is practically nonexistent for others, requiring a critical and immediate look at the theme by the managers and technical staff.

The specific objectives of the research were also achieved, such as the identification of the number of enrolled students and students who have some kind of disability, thus presenting the need for adjustments in services made available online. Regardless of the percentage, it is worth pointing out that Web accessibility is provided for by law and must be met, in the best possible way and seeking to meet all types of users.

The combination between Web accessibility assessment techniques in an automatic way and by heuristics, which are also part of the specific goals, presents better results, since, besides broadly covering different needs of users with different types and levels of disabilities, it makes it possible to assess both background resources such as source code and front-end resources, visible or audible to users.

The resources proposed in the Web accessibility evaluation performed by heuristics seek to meet disabilities or needs such as: low vision, photosensitivity, motor, illiterate, and the deaf-mute. Although the theme was addressed based on the students of the Federal Universities of the State of Minas Gerais and their libraries, in the case of federal public servants, Law 8.112/90 provides for the reservation of up to 20% of vacancies for people with disabilities, while Decree No. 9.508/2018 ensures the minimum of 5% of vacancies offered in competitions to people with disabilities, so it is necessary that all space, physical or virtual, is accessible and promotes the inclusion of the individual, not only for students, but the entire university community.

As a limitation of the research, it is worth mentioning the use of only one automatic Web accessibility validator. Although the Website Accessibility Simulator Assistant (ASES) was used, which was developed by the Ministry of Planning, Development and Management and has the W3C and eMAG guidelines as parameters for evaluation, other validators could have been used, such as AccessMonitor, which is based on the WCAG international standard, to compare the results.

As suggestions for future work, we consider conducting research on Web accessibility with the students of the universities who declared they had some type of disability, being able to use, for example, different resources to test the Web accessibility of the systems/services with the users, as well as the use of screen readers and recorders, use of specialized operating

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systems and interviews to identify the perception of users, that is, to identify, in fact, the needs of PwD.

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