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Accessibility checklist in web informational environments

Checklist de acessibilidade em ambientes informacionais na web

Christiane Gomes dos Santo[1], Sueny Gomes Léda Araújo[1], Marckson Roberto Ferreira de Sousa[1], Wagner Junqueira de Araújo[2]
[1]Universidade Federal da Paraíba
[2]Universidade de São Paulo

RESUMO: Esta pesquisa aborda os processos de busca, navegação e recuperação da informação pela pessoa com cegueira em ambiente *web*, focalizando no conhecimento das áreas de recuperação e arquitetura da informação, para o entendimento das estratégias utilizadas por essas pessoas para o acesso à informação na *web*. Tem como objetivo propor a construção de um instrumento de verificação de acessibilidade, *checklist*, a ser utilizado para análise do comportamento da pessoa com cegueira em ações de busca, navegação e recuperação em *sites* e páginas. Trata-se de uma pesquisa de cunho exploratório e descritivo de natureza qualitativa, tendo como metodologia de investigação, o estudo de caso – pela pesquisa estabelecer um estudo específico de simulação de busca, navegação e recuperação da informação utilizando o sistema de síntese de voz, *NonVisual Desktop Access*, em laboratório de tecnologias assistivas, para fundamentação da construção do *checklist* para verificação de acessibilidade. Considera-se a confiabilidade da pesquisa efetuada e sua importância para a avaliação da acessibilidade em ambiente *web* para a melhoria do acesso à informação por pessoas com limitação à leitura, de modo a ser utilizado em análises de verificação de acessibilidade de *sites* e páginas.

PALAVRAS-CHAVE: Busca de informação. Acessibilidade na *web*. Deficiente visual. *Checklist*.

ABSTRACT: This research deals with the processes of search, navigation and retrieval of information by the blind in web environment, focusing on the knowledge of the areas of information recovery and information architecture, aiming at understanding the strategies used by these people to access information on the web. It aims to suggest the construction of an accessibility verification/checklist tool, with the goal of analyzing blind people's behavior in search actions, navigation and recovery in websites and webpages. It is an exploratory and descriptive research of qualitative nature, with the research methodology of a case study – due to the research establishing a specific search, navigation and information retrieval simulation study, using the speech synthesis system, NonVisual Desktop Access, in an assistive technologies laboratory, to substantiate the construction of the accessibility verification checklist. Considering the reliability of this research, and its importance for the evaluation of accessibility in web environment as a way to improve the information access for people with limited reading, to be used on accessibility analyzes verification of websites and pages.

KEYWORDS: Information retrieval. Information access. Blindness. Checklist.

Contact

[1] Christiane Gomes dos Santo
Universidade Federal da Paraíba.
João Pessoa, PB.
Email: christiane.gomes.cgs@gmail.com
ORCID: http://orcid.org/0000-0001-7271-0990

1 INTRODUCTION

For the visually impaired, the technological advances in the information and communication fields, referring to the emergence of the web, has made possible significant changes in informational search behavior, due to the development of information access assistive technology, based on resources and mechanisms derived from digital technology. In the use of computers, in the present day, digital text and sound are considered to be the key elements for information access by people with visual impairment. This condition is only possible with the softwares of magnification/contrast and character voice recognition, which allow access to texts, described images/graphics and other softwares.

With the technology of voice synthesis software, a new technological framework was observed. Its use is allowing new possibilities for information access, from reading and writing development, to the production of accessible digital products, which provide the development/adaptation of accessible digital texts and books from the conventional, or simple, digitization process. Also the troduction of accessible digital books using the standard Digital Accessible Information System (DAISY), or even access to electronic books (ebooks), and the worldwide network of computers using the web tool.

It is clear that the use of the web by the visually impaired comprises specificities that determine the search, browsing and information retrieval process in this environment. For instance, in order for a speech synthesis system to establish the recognition of textual characters that make up the contents, organization and structure of websites, it is necessary to establish an accessible construction, condition only possible with the follow-up of accessibility guidelines for the production of websites in a web environment. Hence the question: what are the tools that help in the process of searching, navigation and information retrieval by visually impaired users? Are these tools effectively used? And what are their use conditions?

With these questions, this research aimed at analyzing the organization systems of websites with search, navigation and information retrieval simulations, using voice synthesis software to verify accessibility. With the data obtained by the simulations, it was possible to carry out the construction of a simple checklist, which aims to use it in processes of evaluation of information search by visually impaired users. In it, can be evidenced the organizational structures of sites, the navigability and the information retrieval, implying the identification of the particularities of visually impaired users interactions - through voice synthesis software and informational organization systems on the web - allowing the verification of the main difficulties encountered by these users in the process of informational search in the web environment.

The inspection verification through checklist technique allows the identification of general and repetitive problems in web interfaces, containing a mechanism that permits remembering and/or seek attention to the questions and themes on what is intended to verify (SALES, 2002). The checklist can be built generally (with the description of process steps so that they are not forgotten), or specifically (with the detailed list of items that need to be

addressed). It is important to consider that the checklist is not a set of steps that need to be chosen, but that need to be brought into discussion and to results analysis (DOWNEY; BANERJEE, 2010).

For this study, the construction of a checklist corresponds to the provision of quick help procedures, which allows the verification of the information search on the web, from the visually impaired user interaction and the informational content organization systems. Both based on the accessibility recommendations as the use of voice synthesis software, enabling the production of uniform and general results for the identification of accessibility problems.

To accomplishment this research, an exploratory and descriptive methodology was established, focusing on the knowledge of the search, navigation and information retrieval processes. Moreover, qualitative nature, based on an investigative methodology determined by the single case study directed to the construction of the checklist for accessibility verification in the search process with the use of the voice synthesis software NonVisual Desktop Access (NVDA).

The NVDA is a free, that is, of open source, speech synthesis or screen reader software for Windows designed by Michael Curran in 2006. It is currently one of the most used softwares due to its free availability to anyone, without additional costs, and free license - which allows for contributions to its improvement - also due to the easy understanding of its design (ULIANA, 2008). The software is developed by NV Access with contributions from the global community, and it is currently in the version released in the second half of 2015.

The development of this study was justified by the lack of researches carried out to meet the informational needs of visually impaired people who use the Internet, and the web tool, as the main way for information access. The choice for the theme and its contribution to information science are mainly related to precisely meeting the information needs of this specific user group and the social responsibility that must be absorbed by information science, since it is part of its essence to provide information to those who need it.

2 DETERMINING ELEMENTS FOR THE SEARCH, NAVIGATION AND INFORMATION RETRIEVAL PROCESS IN WEB ENVIRONMENT

Information retrieval proposes the solution of the informational surplus problem, in which areas such as information science seek to propose solutions, to enable success in the process of information search and retrieval (SARACEVIC, 1996; RODRIGUES et al., 2011). According to Saracevic (1996), information retrieval is one of the supporters of scientific and technological bases development, influencing the evolution of the informational industry.

It is understood in this research that the information retrieval covers the information search process and the organization of the paths traveled by the user, in particular, occurred in a computer networks and using the web. The internet is a medium of easy access to information, as it allows for its storage and quick sharing. However, there is the problem of

informational excess in this medium that tends to make it difficult, in a way, to recover information.

In order for the user to be able to perform a search with effectiveness, the ideal is to be as specific as possible, able even to use boolean operators to assist in detailing their need, for the more specific the greater the probability of finding the desired information within the informational complexity the web has become. It is up to the user to specify their need. Technology can at most give suggestions, often based on artificial intelligence, but the search's success depends intrinsically on the way the search is conducted, that is, if the user does not know how to correctly describe the desired information, one will have a harder search.

Technology must auxiliate users so that, according to their physical and cognitive ability, they are able to find the desired information. To contribute to this process, information architecture can be a determining factor. Information architecture is based on the principle that "it is the result of the increasing distance between what we understand and what we think we should understand. It is the black hole that exists between data and knowledge, and occurs when information does not say what we want or need to know "(WURMAN, 1991, 38).

According to Morville and Rosenfeld (2006), the information architecture on the web refers to the structural design of shared information environments; The combination of organization, labeling, search and navigation schemes within websites and intranets; The art and science of shaping information products and experiences to support usability and retrieval; The emerging discipline and a practice community focused on bringing design and architecture principles into the digital space.

Information architecture aims to organize inherent data patterns and to create the information structure or map in order to allow others to find their own paths to knowledge making the complex clear (WURMAN, 1997). Currently, the information architecture emerges as a discipline concerned with websites design. In this context, for Nielsen (2000, p.15), the goal of information architecture should be to structure websites "to mirror the users' tasks and their visions of the information space".

To achieve this goal, Morville and Rosenfeld (2006) have described the information architecture of websites in four interdependent systems: organization system - which can be defined as the grouping and categorizing of all informational content; Navigation system – which specifies the ways to navigate, to move through informational and hypertextual space; System of labeling - establishes the forms of information representation and presentation, defining signs for each of its elements, and the search system, which determines the questions that the user can ask and the set of answers they will get. It is up to information architecture to design the organization, labeling, navigation and search in webpages, always focusing on the user.

Information architecture, in practice, seeks to balance the particularities and needs of users, content and context, where its components (organization, navigation, labeling and

search) determine the simplification and dimension of information architecture tasks that can reveal the quality of the organization of the elements that make possible the users' navigation process (MORVILLE; ROSENFELD, 2006). It is understood that the the user's knowledge in this process is essential for the effective availability of informational content in a web environment. In the case of the visually impaired, the procedure of accessing web information occurs according to the accessibility promoted by the information architecture components.

For Dias (2003, p.28), in reference to web accessibility in this perspective, "if a system is easy to use, easy to learn and even user-friendly, but cannot meet specific goals of specific users, it will not be used, even if it is offered for free." The author further clarifies that: "accessibility is the ability of a product to be flexible enough to meet the needs and preferences of the largest possible number of people, as well as being compatible with assistive technologies used by people with special needs" (DIAS, 2003, P 103). In this sense, accessibility is essential for the ease of use and structuring of inclusive sites for people who do or do not have some type of limitation, as in the case of this study, people with disabilities.

3 ACCESS TO INFORMATION AND THE VISUALLY IMPAIRED

Today, with the enhancement of information and communication technologies, new possibilities are emerging following digital technology, in terms of accessibility to information, allowing the visually impaired to acquire information no longer only by braille printed materials, but by other means of analog technology (GOLUB, 2002). However, according to Nascimento (2006) and Borges (2009), in the reality of less favored countries, the aspects of needs' relational activities, searches and information usage by the visually impaired, are still characterized by slow, and in certain cases, inaccessible processes due to the various factors to which they are conditioned. The problems that justify the accessibility difficulties are myriad, mainly regarding the lack of knowledge about these individuals' conditions, their informational needs, the process of how they carry out their information searches, and the strategies and supports that they use.

The diverse sources of information that at present supply the information needs - like books, reference materials, periodicals; to electronic media, such as databases, electronic publications and the worldwide computer network - are still mostly accessed through vision. The ability of vision is the sense that transmits most information to people by relating to the various activities of daily life, and therefore people with visual impairment need to look for alternative means to promote accessibility, so that their lack of vision does not present limitations to the strictly necessary (YATACO MARÍN, 2009; WEI; LIRONG; CHUNMING, 2012).

According to Borges (2009), for reasons that make it difficult to produce books in Braille, not only do people with visual impairment in the current context seek to acquire knowledge through this type of printed information, but also seek the use of other formats

such as digital and audio. According to Yataco Marín (2009), the daily activities of reading books, magazines and web pages would not be possible for these people if there were no alternative means (meant for people with visual impairment) for reading access. Currently, people with visual impairment can access information through different technologies, such as assistive technologies.

Bersch (2008) and Melo, Costa and Soares (2006) affirm that assistive technologies are resources and services that aim to facilitate the development of daily life activities by people with disabilities, assisting in locomotion, accessibility to information and communication access, environment control in various daily activities of study, work and leisure. Such as wheelchairs, walking sticks, orthoses and prostheses, loupes, hearing aids, remote controls, among others. Assistive technologies are adapted to the needs and characteristics of each person, allowing the use of its resources to provide and facilitate the development of skills, in order to increase functional capacities and promote autonomy. Concerning information access, assistive technology comprises the adaptation and accessibility of information and communication technologies for people with various limitations.

The resources for information access by the visually impaired can be presented in two aspects: resources that allow access to printed information and resources that allow access to information in digital media. According to the objectives of this research, only the resources for the access to information in digital environment will be evidenced, specifically in the web environment.

3.1 Resources for web accessibility used by people with visual impairment

According to Craven and Brophy (2003), for the information search in digital media, as in websites, people with visual impairment use as a main feature voice synthesis softwares (Table 1) that allows access to digital information content.

Table 1. Most used voice synthesis softwares

VOICE SYNTHESIS SOFTWARES	INSTITUTION/COMPANY	SPECIFICITIES
DOSVOX/LINVOX (Operational system)	Núcleo de Computação Eletrônica / Universidade Federal do Rio de Janeiro (NCE/UFRJ) (http://intervox.nce.ufrj.br/dosvox/)	Windows (DOSVOX), Linux (LINVOX) adaptative interfaces, text editor, resources for regular and braile printing, didatic and ludic games, calculator, web access, among others
NVDA (NON VISUAL DESKTOP	Michael Curran / NVDA team (http://www.nvaccess.org/)	Windows, softwares use, web navigation, automatic text enunciation from mouse

ACCESS)		positioning, can be played directly from USB porto r any any portable media, among others.
ORCA	Sun Microsystems / Internation company (projects.gnome.org/orca/)	Linux, Solaris, BSD, Unix based, combines speech synthesis, braille, magnification, openoffice, firefox, among others.
DELTA TALK	MicroPower / Brazilian company (http://www.micropower.com.br/)	Windows, voice type options, controls speech speed and voice tone, among others.
VIRTUAL VISION	MicroPower / Brazilian company (http://www.micropower.com.br/)	Windows, office apps, web navigation, communication softwares use, among others.
JAWS (JOB ACCESS WITH SPEECH)	Freedom Scientific / International company (http://www.freedomscientific.com/)	Windows, softwares use, web navigation, among others.

Source: Research data (2015).

It is generally understood that the computer itself can only be used by the visually impaired throught the use of these softwares that allow immediate reading, for they are devices capable of converting digital texts into spoken (synthesized) texts. Information materials, adapted by scanning processes for the purpose of being used by people with visual impairment, are basically interpreted by these softwares without major problems that compromise the reading of the material. However, some of the difficulties encountered by these people during the process of searching the information available in both software and archives, as well as navigability on websites, should be considered.

The difficulties presented by the visually impaired regarding information access on websites are the main discussions in the field of accessibility on the web. It is important to consider that voice synthesis softwares has made possibilited numerous benefits to web accessibility. However, these softwares are not capable of doing the entirety of the reading and, consequently, the effective search and retrieval of the information contained in the sites and pages if they are not structured in an accessible way. In this case, it is necessary to follow the specifications during the website development process so that the voice synthesis software can perform a practical, strategic and rapid reading of the information so that the search is effective.

According to Santos and Nascimento (2006), the main problems experienced by the visually impaired are the difficulties in obtaining information available in visual format, interaction with the use of devices different than the keyboard, provision of links in document format, navigation through spatial concepts and the distinction between sounds of a voice produced by synthesis. Santos and Nascimento (2006) and Melo, Baranauskas e Souza (2006) point out that, with the observation of these difficulties, the World Wide Web Consortium (W3C), responsible for the coordination, elaboration and standardization of accessibility rules to be followed in websites construction by the Web Accessibility Initiative (WAI), has

developed the Web Content Accessibility Guidelines (WCAG) document to promote web accessibility and technical specifications. This document is a reference worldwide, and is currently in 2.0 version, accompanying the evolutionary process of the web.

According to Santos and Nascimento (2006), the applications of the accessibility techniques proposed by the WCAG, not only help the disabled, but also other users, regarding types of connections and older browsers, because these techniques allow the development of more flexible and accessible websites and pages. Knowing specially that applying these recommendations does not imply not using features such as images and videos, but allow the developer to make all multimedia content accessible to a diverse audience.

The web content accessibility recommendations constitute general principles that propose the organization of web content in order to make it accessible to disabled users. However, it should be noted that:

Although the focus is on promoting accessibility for people with disabilities (perceptual, motor, cognitive), WAI recognizes that following its recommendations can also increase access to web content for people in diverse access situations, whether by using different navigation technologies (graphic desktop browsers, text browsers, voice synthesizers, screen magnifiers, cellphones), whether operating in restricted conditions (ie. obsolete technology, noise-free or noisy environment, varied lighting, different structure than conventional) (MELO, 2007, p.24).

The set of recommendations, or general principles, as evidenced by Melo (2007), within the WCAG document, assembles checkpoints, which designate how the recommendations must be understood according to the specificity of a given problem situation. It is understood that with the web development, the recommendations established by the W3C undergo reformulations so that the condition of accessibility is continuous according to the new technologies employed. Thus, in the recommendations established in 1999, the W3C prioritized in 14 recommendations topics that ensured pages harmony (ranging from alternatives to sound and visual content, indication of W3C technologies and recommendations usage) and comprehensible content (which provided evidence of context information, guidance, and clear navigation mechanisms, as well as assurance of document clarity and simplicity) (W3C 1999, MELO, 2007).

The W3C sought to develop new recommendations for web content in accordance with the current technologies used and the new communicational situations experienced, as well as according to the diversification of the public personified by the policy developers, managers, graphic designers and editors (MELO, 2007; W3C, 2008). According to Melo (2007, p.25), the new recommendations are grouped based on four "principles of accessibility considered fundamental to web access and use by any person"; And "for each recommendation, success criteria are associated with its application, in order to make the verifications more precise." The principles and recommendations established by W3C for web 2.0 are organized in Table 2.

Table 2. Accesscibility recomendations for web content (web 2.0)

PRINCIPLES	RECOMENDATIONS
Principle 1: Perceptible – information and user interface components should be perceptible to users.	Recomendation 1.1. Offer alternative text to every non-textual content in a way that can be modified for other formats that people may need such as magnified printing, Braille, voice, symbols or simpler language.
	Recomendation 1.2. Offer synchronized alternatives to the multimídia content.
	Recomendation 1.3. Create content that can be presented in different ways (ie. Read aloud, simpler layout) without losing information or structure.
	Recomendation 1.4. Make it easier for people with disabilities to see and hear the content, including separating what is on first plane and on background.
Principle 2: Operational – Interface components in content should be operational for users.	Recomendation 2.1. Make every feature available from the keyboard.
	Recomendation 2.2. Offfer to disabled users enough time to read and use contente.
	Recomendation 2.3. Do not create seazure prone content.
	Recomendatio 2.4. Offer ways to helpt disabled users navigate, find contente, and determine where they are.
Principle 3: Comprehensible – Information and operation of user interface should be understandable for the users.	Recomendation 3.1. Make the content text readable and understandable.
	Recomendation 3.2. Make webpages emerge and operate predictably.
	Recomendation 3.3. Help users avoid and correct mistakes.
Princípio 4: Robust – the contente should be sturdy enough to be interpreted in a trusted manner by a variety of users, inclusing assistive technologies.	Recomendation 4.1. Maximize the compactibility with user agents, current and future, including assistive technologies.

Source: MELO (2007, p. 25-26, adapted table); W3C (2008).

The accessibilities principles established for web 2.0 comprise four pillars for the effectiveness of the accessibility process in web environment, according to the basis of perceptibility, operability, comprehensibility and compatibility.

By perceptibility, in the sense of providing mechanisms and resources that users, in their different perceptual capacities (visual, auditory, etc.), are able to perceive its content. Operability is the second pillar, which guarantees not only access, but mainly interaction with web systems. The third concerns comprehensibility, which guarantees not only access and interaction, but the elements' intelligibility in such a way as to enable its use. Finally, content compatibility is required to enable access, interaction, and use with multiple user agents and artifacts. (MELO, 2007, p.26).

Using voice synthesis software as the tool responsible for web navigability, and consequently, for the process of information search and retrieval, consideration should be given to the aspects of accessibility recommendations. This knowing that the possibilities evidenced by the web contents, and the existing limitations in the search and retrieval processes due to lack of standardization in the construction of websites and pages, comprise determinations and lack of knowledge about these people's needs. This ends up limiting the accessibility to the informational content produced and shared, so there are still many existing barriers that prevent accessibility from becoming an effective universal access condition (CHRISTENSEN, STEVNS, 2012).

4 ASPECTS OF THE DEVELOPED RESEARCH AND ANALYSIS OF OBTAINED DATA

The developed research was based on the studies of information search, navigation and retrieval processes in a user-centered web environment, in order to establish the development of a simple checklist that can be used in evaluations of information search, navigation and retrieval processes for the visually impaired. The research for the construction of the checklist was established using the simulation method.

The research was configured as exploratory and descriptive, for having focused on the knowledge of the information search, navigation and retrieval process, focusing on the techniques and strategies used by people with visual impairment, as well as on the presentation of this process in order to specify its characteristics and intrinsic properties (HERNÁNDEZ SAMPIERI; HERNÁNDEZ COLLADO; BAPTISTA LUCIO, 2006). The nature of the research was determined as qualitative, due to the need to present the results of the data collection, adopted by this research, in qualitative data before the observation performed according to the established simulation for the construction of the checklist questions (ROGERS; SHARP).

As investigative methodology, it was characterized as a case study, due to the fact that this research focuses on the investigation of a specific case, delimited and contextualized, in order to allow a detailed search of information about the case, seeking to know this process in its aspects, as well as the fact that case studies are of great use in exploratory researches (VENTURA, 2007).

The data collection determined by this study has become essential to evidence the establishment of requirements and assessments. Regarding the requirements, data collection is aimed at obtaining sufficient, accurate and relevant data to produce a set of stable requirements. For the evaluation area, the data collection procedure allows the capture of user reactions and behavior in relation to their performance with systems and prototypes (ROGERS; SHARP; PREECE, 2013).

The data collection procedure was established using the application and direct verification method, in a simulation in a partially controlled environment - laboratory of assistive technologies for dyslexia and visually impaired users - with the use of voice

synthesis software in simulation procedures of information search, navigation and retrieval, based on techniques and procedures used by the visually impaired conducted by the authors of this research, without the participation of these people as system users in search process.

It is worth mentioning that for the development of the checklist proposed by this research, only the identification of the accessibility criteria points was considered, in order to make possible the construction of the basic structure of a simple checklist that can be used as a model for the construction of more general and specific accessibility checklists to be developed along with users with disabilities in the web browsing process. This condition centered this research on the application and technical behavior of the voice synthesis system in the web search process, not requiring the presence of the real user of the system (visually impaired person).

For the application method, the use of the direct verification instrument made it possible to supervise the simulation at the moment of its development, allowing observation during the application and procedures developed in the continuous verification process.

For the construction of the checklist, in addition to the development of the simulation, it was also necessary to have as a base the reformulations of guiding requirements regarding the accessibility evaluation in systems, web content, ergonomics, among others, for the accomplishment of a proposal that enables verifications in search, navigation and retrieval processes. The choice of the partially controlled environment for the practice of simulation, a laboratory specialized in assistive technologies, was due to the need to use the hardwares and softwares customarily used by people with visual impairment, so that the research was established in the most faithful possible plan. For example, the simulation of the information needs of these people, such as the knowledge of commands (shortcuts) used for speech synthesis software; it was a way of structuring the environment to simulate the context of the person with blindness.

Without the participation of the disabled user, the developed simulation did not obtained unreliable data, since the tests proposed focused on the aspects of search, navigation and retrieval processes in the web environment only considering the basic navigation from the speech synthesis system, in which many of the shortcuts are common amongst the most used speech synthesis software (Table 1). In this process it is essential to also consider the browser, search engine and operating system used in the research: Firefox browser version 33.0.1, Google search and Windows 7 operating system.

4.1 Simulation routing and checklist presentation

The simulation was structured to allow the development of a favorable environment, which enabled the application and verification from the use of NVDA, establishing information search, navigation and retrieval procedures, in order to analyze accessibility aspects in this process. For the construction of the checklist, the establishment of three stages was necessary: Step I corresponded to the identification of the criteria for accessibility; Step II analyzed, from the criteria, the relation of the W3C recommendation principles; And Step

III considered the development of the simulation with the NVDA, from the results obtained in the previous steps.

For the simulation, the selection of the research terms was established. The terms suggested by the research were: 1. Musicography Braille; 2. 2014 Elections. These terms were chosen due to two determinants: being composed, which allows more specific results, thus centralizing the search process, and because they correspond to different areas. The term "Musicography Braille" refers to a specific area of the musical information access universe for people with visual impairment, which resulted in more focused search results and, consequently, possibly more accessible websites. The term "2014 Elections", includes a more generalized term that provided the return of results from diversified, accessible and non-accessible websites. This procedure enabled the construction of the checklist based on a comparison of two dimensions, "accessible" and "inaccessible". As for the analysis of the results obtained, each term, with the search, focused on the first page of results retrieved by the Google search engine, highlighting the study of the first six websites.

In Step I, based on the study by Sales (2002), which focuses on improving web accessibility for elderly users in analyzes in the W3C recommendation document for web 2.0, and in the studies by Downey and Banerjee (2010), it was possible to develop, from four criteria selected for accessibility, 17 questions that aim to provide, for this study, access to information verification. The selected criteria are presented in Table 3.

Table 3. Accessibility criteria.

CRITERIA	REASON FOR SELECTION
Depth	Specific detailing of the search process from the possible interaction of user-voice synthesis software with the search system.
Amplitude	General verification of the search process focusing on the navigation and information retrieval process.
Time	Time used by the voice synthesis software andu ser during the search process and navigation until the retrieval of desired information.
Satisfaction	Possible user satisfaction regarding the search process in relation to the navigation and retrieval of desired information.

Source: Elaborated by the authors (2015).

With an analysis of the criteria from the levels 1 and 2 evaluation, in Step II, it was noted the importance of identifying the principles (Table 4) considered by the recommendations for web accessibility, concerning perception, operationalization, understanding and authentication.

Table 4. Principles that subsidized the accessibility criteria.

PRINCIPLES	RECOMENDATIONS
Perception	In the process of order of navigation, alternative text to non-textual content verifications, alternatives to content and its medias, simple layout (with no lost of information or structure), separation of the content of first and plan and background.
Operationalization	Keyboard feasibility, Reading time and content usage, confusing content, navigation assistance for finding content.

Understanding	Readable text, previsibility of the page operatings, understanding of errors.
Authentication	Compatibility among users and assistive technologies.

Source: Elaborated by the authors (2015).

The determination of these obtained items from the accessibility criteria was evidenced according to the establishment of the applications and verifications carried out during the simulation of search and navigation, when these were considered main conditions required for the accessibility of both the person with visual impairment and the speech synthesis software. With the results obtained through the simulation, the possible alternatives of depth, amplitude, time and satisfaction were specified in the checklist.

Table 5 shows the structuring of the checklist according to the simulation result that occurred in Step III, showing the possible inherent aspects to the process of information searching, navigating and retrieving using NVDA. These aspects considered the characteristics of the search in which the questions and the treatment that originated them were applied; Which in the case of this study, referred to the simulation.

Table 5. Checklist for the accessibility verification in th processo of information search, navigation and retrieval.

1. DEPTH	
Search system	
Operationalization	How is the navigation stablished in the search engine's home page in the identification of the editable combination box?
	Applies: Direct search function.
	Possible alternatives identified: Automatically; Navigation through search engine's home page navigation.
	Question source: Study stablished from the simulation.
Level 1 (Results page of the search engine)	
Perception and Operationalization	How is element navigation stablished in the results page? Inside the page (Level 1), to which result item did it reach?
	Applies: direct search function.
	Possible alternatives identified: Focus on elements; Detailed navigation; Does not apply
	Question source: Study stablished from the simulation.
Perception and Operationalization	The established search goes through results obtained or through the reading of more than one result? The search is made in horizontal order, that is by the order of obtained results; o ris the search made in vertical order, that is it rolls dows for the obtained result and only then enters the page that is considered as having the information?
	Applies: direct search function.
	Possible alternatives identified: Via result; Via more than one result.
	Question source: Study stablished from the simulation.
Level 2 (Navigation inside the websites)	

Perception	The search established in the website is developed via detailed reading of the page? Inside the pages, level 2, does the user detail it or stop at the beginning?
	Applies: direct search function.
	Possible alternatives identified: Complete reading; Incomplete reading.
	Question source: Study stablished from the simulation.
Perception	Existence of alternative texts to non-textual content (images, graphs, among others)? With the existence of numerous medias, is the access to it easy o ris there alternative content?
	Applies: Function of information architecture.
	There was no alternatives identified.
	Question source: Accessibilitiy recomendations for web content (WCAG 2.0/W3C) with study verification from the simulation.
Perception	Regarding structure (layout), is it of easy access o ris there loss of information?
	Applies: Function of information architecture.
	There was no alternatives identified.
	Question source: Accessibilitiy recomendations for web content (WCAG 2.0/W3C) with study verification from the simulation.
Perception	Is the identification of background and first plan content easy?
	Applies: Function of information architecture.
	There was no alternatives identified.
	Question source: Accessibilitiy recomendations for web content (WCAG 2.0/W3C) with study verification from the simulation.
Operationalization	Dificulties found with the use of shortcuts (availability from the keyboard)?
	Applies: Function of information architecture.
	There was no alternatives identified.
	Question source: Accessibilitiy recomendations for web content (WCAG 2.0/W3C) with study verification from the simulation.
Operationalization	How is the time of reading and use of the content?
	Applies: Function of information architecture.
	There was no alternatives identified.
	Question source: Accessibilitiy recomendations for web content (WCAG 2.0/W3C) with study verification from the simulation.
Operationalization	Is there confusion of content? Is there help in the navigation process for finding the desired content?
	Applies: Function of information architecture.
	There was no alternatives identified.
	Question source: Accessibilitiy recomendations for web content (WCAG 2.0/W3C) with study verification from the simulation.
Understanding	Regarding the texts, is it identifiable is they are legible, is it identifiable the page's operationalization and the understanding of possible errors?
	Applies: Function of information architecture.
	There was no alternatives identified.
	Question source: Accessibilitiy recomendations for web content (WCAG 2.0/W3C) with study verification from the simulation.

2. AMPLITUDE	
Level 2 (Navigation within the site)	
Perception	Was information retrieval effectively stablished in the site? Was it possible to find the desired information?
	Applies: Function of information architecture.
	Possible alternatives identified: Informação completa; Informação incompleta.
	Question source: Study stablished from the simulation.
Level 2 (Navigation within the site)	
Understandin	Is there withdrawl in the search processes in the chosen websites? (Is there withdrawl? If so, at what level was it: 1- in the results page with the search engine or 2- Within one of the websites? How long was the time until withdrawl?)
	Applies: direct search function.
	Possible alternatives identified: Withdrawl; No withdrawl.
	Question source: Study stablished from the simulation.
3. TIME (SEARCH [SYSTEM], RESEARCH [USER], VOICE SYNTHESIS SOFTWARE [SOUND RETURN])	
Operationalization	The return time of the search performed by the system (searchers) (how long did the searchers take to return the results?)
	Applies: Time of Search by the System (TSS).
	Possible alternatives identified: TSS> 0,70sec; TSS< 0,70sec; TSS = 0,70sec.
	Question source: Study stablished from the simulation.
Operationalization	Time established by the user in the research process (process begins with the search, it is verified with the navigation and ends with the information retrieval considered satisfactory) (How long from search to effective information retrieval?)
	Applies: Time of Search by the User (TSU).
	Possible alternatives identified: TSU> 50min; TSU<50min; TSU = 50.
	Question source: Study stablished from the simulation.
Operationalization	The time of sound returno os the voice synthesis software to the beginnning of the search by the user (how long does the searcher return the result with the voice synthesis software?)
	Applies: Time of Sound Return (TSR).
	Possible alternatives identified: TSR> 2sec; TSR< 2sec; TSR = 2sec.
	Question source: Study stablished from the simulation.
4. SATISFACTION (SATISFIED NEEDS)	

Perception	Check if the established search process allowed the user to satisfy the informational need (was information retrieval possible?)
	Applies: Information (achievement).
	Possible alternatives identified: Complete satisfaction; Incomplete satisfaction.
	Question source: Study stablished from the simulation.

Source: Elaborated by the authors (2015).

With the Depth criteria, it became possible to determine the navigation process with the search system for the navigability procedure, deepening within the results page, navigation according to the order (horizontal and vertical) of the results, and the detailing of the search and navigation according to Levels 1 and 2. In this part, we verified aspects that included the fields of Perception, Operationalization and Understanding, evidenced by the use of the search system, and in Levels 1 (regarding the results page of the search system) and 2 (corresponding to navigation in the six analyzed sites).

Verifying the search process with the system (Google search engine), it was possible to identify the path that the speech synthesis software went through for the beginning of the search: either directing to the editable combination box or to the navigation toolbar. The importance of this verification determines what exactly the visually impaired user can understand for the first stage of the search process, which is the recognition of the search engine's homepage. Regarding Level 1, two questions were raised in the field of Perception and Operationalization, which focused on navigation through the elements of the results page, which are: header, submenu and reading all elements following the tab order.

In this context it is possible to identify navigation detail, that is, if the visually impaired user can use the arrows command (above and below) to explore all the elements of the page, attempting to explore headings, submenu and links in the summaries presented by each result to be aware of the information available in the sites, or if they can choose to navigate using the TAB key in focusable elements. Since in this research we analyzed two compound terms "Musicography Braille" and "2014 Elections", the search engine returned an average of 10 results items for the first page. In this way, one can see to what extent the user can establish his search, knowing that they can analyse the summary of the information contained in the site before entering.

In the same process, it was verified the possibility of reading the results of the first page of the search engine horizontality and verticality. That is, if the user can establish a navigation through all the obtained results, or if it reads of each summary to then enter the chosen site. It is important to consider that, for this research, the analysis was performed in the first six items (sites) for each search performed.

Regarding Level 2, which includes website navigation, eight questions were elaborated according to the established simulation in the fields of Perception, Operationalization and Understanding. In this phase of the simulation process, the principles

established by the W3C recommendation were used as a basis, which was verified with the possibility of identifying the characters of the pages by the voice synthesis software, covering the organization and structure of the sites. In this phase, it was possible to verify the search detail identification that can be carried out by the visually impaired user in the whole page of the site, or if an incomplete search can occur, either for lack of interest in the information presented by the site, or due to accessibility problems in navigation. As a result, it was possible to analyze important aspects such as reading textual and non-textual content, assimilation of structure and contents, possible difficulties in using shortcuts (in combination with the keyboard), reading time for page content, ambiguity of content and its readability, and understanding the operationalization of the page.

Based on the Amplitude criteria, it was determined the findability of the information and possible withdrawls that may occur through the search and navigation process; In this phase the fields of Perception and Understanding were highlighted. According to the procedures established in Levels 1 and 2, it is possible to understand if the information retrieval can be total or if there is the possibility of withdrawl on a particular page, which may occur due to lack of interest or lack of access to the contents.

With the criteria of Time, the result return time of the search system was evidenced, the possible time that the user can use for the complete process (search, navigation and retrieval) and the time of sound return of the searchers with speech synthesis software. It is known that the visually impaired user can only manipulate the computer system with the use of a voice synthesis system that apprehends accessible (textual) information from the interaction with the operating system, transforming it into a sound response. In this sense, the user will always depend on the voice synthesis system to carry out the commands to use the computer system.

From this observation, it was deduced in relation to the time criteria, that in the process of web navigation, to proceed to the commands, the user will be dependent on the loading of the search system (search engine), and loading of pages, for the voice synthesis system to carry out the return of the loading. In this sense, for the construction of the checklist it was necessary to consider the loading time of the search engine and of each searched page (Time of Search by the System - TSS), with the time of sound return of the speech synthesis system (Time of Sound Return - TSR).

According to this research, the identified time estimates were established with the following values: approximately 0.70sec for loading webpages and search engines (TSS); And approximately 2sec for the voice synthesis system sound return after each loading (TSR). Based on these measurements, along with the search process carried out by this research, which considered: search, navigation and retrieval of the desired information, it was possible to reach an estimated time for the entire research time using the voice synthesis system, considering the terms used ("Musicography Braille" and "2014 Elections") and the accessibility found in each of the six websites (pages) studied. Thus, it was estimated the time of 50 minutes for the Time of Search by the User (TSU), considered acceptable for a search procedure on the first results page, referring to the first six results retrieved, with good

accessibility to information access. Disregarding the lack of accessibility found throughout the search process.

All the questions regarding the time criteria correspond to the field of Operationalization. It is essential to understand that the routing of the search, navigation and retrieval process depends on the performance of the voice synthesis software, therefore the importance of understanding the time this software takes to work along with the search system, and even in the website navigation, which will determine the possibility of an effective search process.

With the Satisfaction criterion, we verified the possible success that can be obtained with the effective retrieval of the desired information. For this criterion the field of Perception was contemplated. It is considered that the use of voice synthesis software is one of the main elements that will evidence the satisfaction of the information needs of a visually impaired user. The other elements refer to the organization and structuring of the search systems, sites and pages.

5 FINAL THOUGHTS

The current existing possibilities, with the availability of diverse information sources and the growing and complex informational flow characterized by in cloud storage and sharing, are configured as essential elements of study for the understanding of information access in a web environment, where it is seeked to highlight and understand the information needs of the visually impaired, as well as understanding if their informational needs are being effectively met.

The information retrieval, navigation and search processes, based on the use of devices such as voice synthesis software, highlight a reality, with its current proposal of accessibility to information access, with the current storage and sharing options, comprises one of the more effective solutions to obtain information. In this sense, trying to understand if this process is possible to being fully developed by all users with the same speed and effectiveness was precisely the goal of this research that sought to, in the context of the informational needs of the visually impaired, understand how to establish said processes based on the specific strategies used by these people in the web environment, with emphasis on its evaluation.

It is known that the information needs of visually impaired users are numerous due to the lack of diversity of physical and digital media, as well as the production of information materials in general that can supply their needs, considering that the advance of assistive technologies focused on speech synthesis software are transforming the behavioral aspect of searching, navigating and retrieving information.

The goal to build a simple checklist for assessing accessibility in search, navigation and information retrieval procedures made it possible to present some techniques applied in the navigation process by a person with blindness. Such as evidencing the main occurrences of difficulties in this process from the Application of the voice synthesis system, in a way that

has structured a basic instrument that can serve as a template for general and specific accessibility checklists based on web browsing performed by visually impaired users.

In this context, the achieved results with this research allowed the structuring of a checklist with basic verification points based on the behavior of the voice synthesis system. Its application allowed the technical observation of possible paths and difficulties that need to be considered in the use of this system in surveys that aim the construction of general and specific accessibility checklists, with the support of visually impaired users. Or even, the observation, analysis and evaluation of web browsing by these users. Considering that the effectiveness of these types of checklists (general and specific) in practice will only be embodied based on the user's participation and experience in its construction processes.

Thus, the checklist elaborated by this research is a prototype that visualizes the functionality of the software necessary to people visual impairment in general, in web browsing processes, which can provide future research, a predictament of the voice synthesis system’s behavior. Even, at certain checkpoints, the user's own behavior regarding the paths to be followed in search, navigation and information retrieval processes, supporting the observation and integration of new elements for verification of accessibility in a web environment, in order to present results and solutions that can guide future improvements to the access to the information made available to all.

LISTA DE VERIFICACIÓN DE ACCESIBILIDAD EN ENTORNOS WEB INFORMATIVO

RESUMEN: Esta investigación se ocupa del proceso de búsqueda, navegación y recuperación de la información por la persona con ceguera en un entorno web, centrándose en el conocimiento de las áreas de recuperación y la arquitectura de la información, para comprender las estrategias utilizadas por estas personas para acceder a la información en la web. Su objetivo es proponer la construcción de una herramienta de accesibilidad, lista de control, comprobando que se utilizará para el análisis del comportamiento de la persona con ceguera en las acciones de búsqueda, sitios de navegación y recuperación y las páginas. Es un estudio exploratorio y descriptivo de la naturaleza investigación de carácter cualitativo, teniendo como metodología de investigación, estudio de casos, - la investigación para establecer un estudio específico de simulación de búsqueda, navegación y recuperación de información mediante el sistema de síntesis de voz, Acceso de escritorio no visual, en las ayudas técnicas de laboratorio, por razones de construcción de la lista de verificación para la comprobación de la accesibilidad. Se considera la fiabilidad de la investigación realizada y su importancia para la evaluación de la accesibilidad en el entorno web para mejorar el acceso a la información para las personas con la lectura limitada con el fin de ser utilizado en el análisis de comprobación de accesibilidad sitios y páginas web.

PALABRAS CLAVE: Recuperación de información. Accesibilidad a la información. Ceguera. Lista de verificación.

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