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ARTICLE

People with visual disabilities and information accessibility for indoor mobility

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ABSTRACT

Introdution: Brazilian accessibility law 10,098 of 2000 establishes norms and criteria to promote accessibility for persons with disabilities. IBGE data from 2013 report that in Brazil out of a total of 146.3 million people over the age of 18, approximately 5.27 million are visually impaired people, equivalent to 3.6%. **Method:** Considering when information is correctly provided, it brings better mobility conditions to visually impaired, this article presents a development proposal of an electronic artifact that provides information on its mobility in any internal physical space, since it provides information on distance, depth and laterality of the environment, being categorized as an auditory map. **Results:** From Information Science perspective, addressing concepts of user study, accessibility and assistive technology, the proposal addresses the challenges of accessing information and also challenges to physical access. The artifact was developed using Dosvox system which is widely used by visually impaired. The University of Brasília Central Library was the physical space chosen as the location contemplated for designing the artifact, as it already has several accessibility resources for information to visually impaired. **Conclusion**: The objective of providing information accessibility through the developed artifact was achieved because it guides visually impaired people in their indoor mobility.

KEYWORDS

Access to Information. Information users. Disabilities. Information technology.

Pessoa com deficiência visual e a acessibilidade à informação para mobilidade indoor

RESUMO

Introdução: A lei de acessibilidade 10.098 de 2000 estabelece normas e critérios para promover acessibilidade às pessoas com deficiência. Dados do censo realizado pelo IBGE em 2013 informam que do total de 146,3 milhões de pessoas acima de 18 anos, aproximadamente 5,27 milhões são pessoas com deficiência visual (PDV), o equivalente a 3,6%. **Método**: Considerando que a informação quando é proporcionada de maneira correta leva melhores condições de mobilidade à PDV, este artigo apresenta a proposta de desenvolvimento de artefato eletrônico que lhe proporcione informação na sua mobilidade em qualquer espaço físico interno, posto que disponibiliza informações sobre distância, profundidade e lateralidade do ambiente, sendo categorizado como um mapa auditivo. **Resultados**: A partir da perspectiva da Ciência da Informação, abordando conceitos de estudo de usuários, acessibilidade e tecnologia assistiva a proposta trata dos desafios de acesso à informação e também de desafios ao acesso físico. O artefato foi desenvolvido utilizando o sistema Dosvox que é amplamente utilizado por

PDV. A Biblioteca Central (BCE) da Universidade de Brasília (UnB) foi o espaço físico escolhido como o local contemplado para o desenho do artefato, por já possuir diversos recursos de acessibilidade à informação para a PDV. **Conclusão**: O objetivo de proporcionar acessibilidade à informação por meio do artefato desenvolvido foi atingido porque orienta a PDV em sua mobilidade *indoor*.

PALAVRAS-CHAVE
Acesso à informação. Usuários da informação. Apoio à pessoa com deficiência. Tecnologia da informação.

JITA: CB. User studies

1 INTRODUCTION

According to General Coordination of Health of Persons with Disabilities of Department of Strategic Programmatic Actions of Secretariat of Health Care of Brazilian Ministry Health (CGSPCD/DAPES/SAS/MS) the International Convention on the Rights of Persons with Disabilities (ONU, 2016) brought new concepts of people with disabilities. In Brazil, Law No. 13,146 (BRASIL, 2015) instituted the Statute for people with disabilities, which expanded the concept of a person with a disability who has a physical, mental, intellectual or sensory impairment in the long term, which can hinder their coexistence before environmental barriers. It is possible to say that a person has a disability from the psychosocial assessment and thus allows the creation of instruments for a new type of assessment of the disabled person, with the aim of improving their inclusion in the national inclusion register (BRASIL, 2017).

According to the last demographic census conducted by Brazilian Institute of Geography and Statistics (IBGE) in 2010, of the total of 190,732,694 people in the Brazilian population, visual impairment reaches 6,585,308, which is equivalent of 3.5%. Of this percentage, 528,624 (8%) have total blindness and 6,056,654 have low vision or low vision, with great and permanent difficulty in seeing (BRASIL, 2010).

The Commission for Defense of Persons with Disabilities Rights of the Chamber of Deputies (BRASIL, 2019) has been discussing since April 2019 mapping of people with disabilities in Brazil, to be carried out in demographic census scheduled to be carried out in 2020. With the announcement by World Health Organization (WHO) of a pandemic caused by new coronavirus (VEJA SAÚDE, 2020), demographic census was postponed to 2021 (AGÊNCIA IBGE NOTÍCIAS, 2020). Commission intends to discuss which methodology will be adopted in the definition of people with disabilities, as this definition will directly impact governmental and non-governmental actors involved in person with disabilities cause.

On issues of human beings in their relations with technology and from the point of view of Information Science (IS), the study by Saracevic (1996) asks on what basis should problems be placed, on the human or technological basis? Following your guidance, should we analyze whether technology itself is a problem or a solution?

Malheiros (2019) presents a study of visually impaired users from Digital and Sound Library (BDS) of University of Brasília (UnB) and concludes that digital information is fundamental for these users and is the most used; visually impaired users access all types of information on the computer, but mainly seek didactic and professional information, where their information needs are mostly met.

Pimentel (2011) makes a study on digital inclusion of visually impaired users and identifies and analyzes policies that guide accessibility programs in environments that offer information services in Federal District. This research is identified with programs and public policies of technological digital inclusion, their interfaces with globalized world around the role of information and knowledge nowadays. Its conclusion is that there is a need to establish public policies to strengthen mechanisms of access to digital information for people with visual impairments and to promote social and digital inclusion as a way of reducing existing inequalities and barriers. Also Connors *et al.* (2013) argue that for this audience, the practice in virtual environments before physical travel can be beneficial to plan routes and avoid difficulties associated with trying to access information in an unknown environment.

Regarding the question of user studies that are involved with automation, Baptista and Cunha (2007) clarify that these studies emerged in the 1980s and since that time, completing almost four decades, it has been the object of study. Electronic artifacts need to be developed

so that people with visual impairment can use them as Assistive Technology (AT), in light of what was proposed with the audio-based environment simulator presented by Connors *et al.(*2013). This was designed to improve real-world navigation skills of people with visual impairments as it provides spatial information about the layout of an environment. In it user develops an accurate spatial cognitive map of a space to perform task of internal navigation, helping him to reduce insecurity with independent navigation before physically knowing an environment.

Santos *et al.* (2018) present evidence of difficulties presented to develop AT and state that in general, although investment in related research is increasing, national technological production is still limited. The scarce number of innovation production in Brazil indicates the need for incentives and initiatives to increase production and development of AT aimed at all types of people, as these resources make it possible to carry out daily activities such as walking in any physical space, practicing exercise, read a book and provide social inclusion and quality of life for users.

According to De Sá, Campos and Silva (2007), computer labs, tele-centers and digital inclusion programs should have computer resources accessible to blind and low-vision people, because using computers and other technological resources are as fundamental to them as the eyes are to those who see. Educators' expectations and investments should be the same in relation to all students. Blind and low vision students have the same potential as others, as visual impairment does not limit their ability to learn. The learning strategies, procedures and means of access to knowledge and information as well as assessment tools, must be adapted to their visual conditions.

Still according to De Sá, Campos and Silva (2007), computers expand possibilities of communication and personal autonomy and minimize or compensate for restrictions resulting from lack of vision. Without these tools, intellectual and professional performance of people with visual impairments would be seriously compromised and limited to a context of limitations and impossibilities. According to Maciel (2003), one of several definitions of locomotivity is the knowledge and control of the body's displacement in relation to the environment. This definition should be expanded to include a reminder of “where am I, what am I doing, where am I going” in relation to places, things and other people.

This paper aims to present the proposal for development of an electronic device for people with visual impairments user to provide information about paths and barriers faced in their mobility in an indoor environment. This guides the person to "walk" mentally in a previously studied physical space, without needding to know it in person. It was developed on a personal computer using Jogavox, an educational game editor that runs under the Dosvox computer system, developed for use by people with visual impairments computers. To serve as an indoor environment, the first floor of the Central Library (BCE) of University of Brasília (UnB) was chosen.

2 INFORMATION SCIENCE AND VISUAL IMPAIRMENT

Borko (1968) states that after the American Documentation Institute decided to change its name to the American Society for Information Science (IS), its members were forced to explain what Information Science is and what its scientist does. According to him, this term has been with us for some time and it is the discipline that investigates the properties and behavior of information and the forces that govern its flow and manual and mechanical processing meanings, to identify its characteristics and properties in order to improve the accessibility and

usability of information, regardless of the person who can use it.

Information Science must be viewed from a macroscopic view, from a global perspective as it is part of all disciplines and especially under a microscopic view, as it is the demand of each human being. It plays an important role in society, not only in human area, but in other areas.

According to Saracevic (1996, p. 54) economic and social roles of any and all information activities are becoming more and more pronounced; its strategic importance goes beyond the level of regional and global cooperation, towards national development and social progress, as well as towards organizational advances and competitive advantages.

According to Capurro and Hjorland (2007) we must stick to inclusion of interpretive processes as a *sine qua non* of information processes and this task is essentially multi and interdisciplinary. Saracevic (1995) argues that IS is a field dedicated to scientific research and professional practice, addressing problems of effective communication of knowledge and knowledge records among all humans in the context of social, institutional and / or individual use of information [...] taking as many advantages as possible from modern information technology.

2.1 Visual impairment in Brazil

Law 13.146 (Brasil, 2015) was built to ensure and promote on equal terms, the exercise of fundamental rights and freedoms by persons with disabilities, with a view to their social inclusion and citizenship. For Brazilian Council of Ophthalmology (CBO), attention to people with visual impairment as well as to every human being represents constant challenges and requires uninterrupted attention from public authorities, civil society, professionals involved in eye health and visual rehabilitation to reduce barriers to obtaining better quality of life (CBO, 2018).

People with visual impairments are a very large public and surveys such as Bastos (2017) present interviews with several of them, arguing that it is possible to observe access challenges that these users face, when interacting with digital information environments, so that professionals responsibility is reinforced information in giving them attention. Bernardo *et al.* (2013) argue that IS through users study allows to identify in which points the information services may be failing to meet people with visual impairments users and their particularities, demonstrating what needs to be modified, thus contributing to improve inclusion and access to information. Other authors also treat the issue as very important:

> Providing the information to people with visual impairment is essentially peculiar, different from other deficiencies, since most Assistive Technologies are developed with a visual characteristic, becoming "a challenge for the access of blind people [...] since such systems are not built on the principle of universal accessibility. Blind people now need other tools to enable this Access" (MADEIRA-COELHO *et al.*, 2016, p. 3).

2.2 Visually impaired user study

According to Cunha, Amaral and Dantas (2015) user's informational demand is identified by discovering process, analyzing, documenting and verifying restrictions that reflect the user's needs for an artifact that serves a purpose. These researchers make a parallel between

information user study and requirements management, stating that in Software Engineering the requirements management acquires its importance according to its perspective of action when it is concerned with incorporating the user, stimulating their active participation in modeling an information system. They further declare:

> [...]Software Engineering teaches us by highlighting the advantages of involving users in defining requirements of an information system. It is in this sense that learning when transferred to development of user studies, shows advantages of this concern with involvement of users [...]Thus, user studies are important as planning and management instruments, because they provide support for professionals to identify their users profile, in order to plan services and products to be developed to serve them (CUNHA, AMARAL E DANTAS, 2015, p. 59).

According to Carvalho (2019) one of the categories or divisions that define user studies is that studies how they search, use and build information in order to satisfy their needs. Together with nature of qualitative study, which is geared towards cognitive paradigm, it seeks to identify information needs and devise strategies for meeting those needs. Bastos (2017) states that the greater knowledge that people with visual impairments has about it and its interaction with the environment, the greater the references that it will be able to obtain and thus expand its understanding of the world, which allows observing contributions of socio studies cognitive in this field, as they allow to broaden the vision on the development of more inclusive and democratic digital interfaces and resources for them under the analysis of its informational needs.

As a new paradigm for users study the studies of informational practices arise from a critique of studies on informational behavior and information needs (BERNARDO, MUÑOZ e SILVA, 2020). Researchers De Lucca, Pinto and Vitorino (2019) relate studies of users and informational behavior to the processes of needs and information uses, stating that studies of behavior and needs relate information to the context.

Considering this picture, knowing the needs of visually impaired users in addition to characteristics presented above, presents greater care due to the fact that means of information provided are not the same, it is necessary to be concerned with the way in which information will reach this specific people. Lima (2018) states that in order to guarantee access to information it is extremely important that people with visual impairments have their right guaranteed. This guarantee of rights involves elimination of barriers using technological development and information as it is a product of society and allows elimination of these barriers. Knowledge causes personal growth and people with visual impairments can be active beings within society through information.

2.3 Accessibility for the visually impaired

Accessibility is treated as an essential environment attribute that guarantees improvement of people's life quality. In the recommendation of Brasil (2019) it should be present in spaces as physical environment, in transports, in information and communication, including in information and communication systems and technologies as well as in other services and facilities open to public or for public use, both in city and in countryside. According to Sassaki (2007) it is important to strengthen what was adopted in 1986 by non-governmental organization 'Disabled People South Africa (DPSA)', when defining the motto "*Nothing About Us, Without Us*". This was a manifesto to make humanity aware that no action on people with disabilities should be built without their participation.

Federal Government's Special Secretariat for the Rights of Persons with Disabilities states that it is a topic still not widespreading, despite its undeniable relevance. The document Accessibility Adaptations Manual is available on its website (BRASIL, 2016) that guides and subsidizes bodies and entities of the direct and indirect federal public administration managers in making the implementation of accessibility feasible in public buildings, especially in terms of the Brazilian Standard ABNT 9050 and other legislation. The manual foresees for these bodies elaboration of accessibility report, the contracting of projects if necessary and budget of the work and contracting the execution of common engineering services.

2.4 Barriers in indoor mobility of the visually impaired

Indoor mobility is the act of moving around in a closed environment involving previous actions such as visually environment mapping, deciding which path to take considering your starting point and your desired point of arrival, even if the distance is very short (BERNARDO, MUÑOZ and SILVA, 2020). An obstacle during the journey no matter how small becomes a challenge to be overcome and requires from the person many mental operations, including voluntary capture - or not - of environment information, its interpretation according to their knowledge and decision-making skills, what to do or not to do on that specific occasion (ABRAHÃO *et al.*, 2009).

A task such as a walk depends on the conditions of how much the workspace facilitates apprehensions of information or the search for new data plus availability of resources to perform this task. Intuitively and mechanically the person identifies whether or not he will be able to overcome the obstacle. For people with visual impairments the research was carried out that helps them in their mobility and recognition of specific points in closed environments, with the support of integrations of radio frequency identification technologies and mobile devices, described in the work of Roque *et al.* (2017).

Similarly, Filho and Oliveira (2015) present research that uses a mobile application for navigation and contains environment map, where obstacles and barriers are identified by several electronic tags scattered around the environment, indicating user's location. These tags consist of an integrated circuit where data is stored and can be installed on objects scattered around the environment. Despite the solutions developed, there are still several challenges to be overcome in order for indoor navigation applications to be inclusive for people with visual impairments in its simplest routines.

2.5 Assistive Technology for the visually impaired

Specific Assistive Technology development initiatives generally start with researchers, enthusiasts and organizations (SENS and PEREIRA, 2015). There are ways to ensure the inclusion of people with visual impairments in various environments that can be taken as an example to provide accessibility.

Bastos (2017) identifies that people with visual impairments information needs do not differ from other users. What distinguish them are information media and technologies used to gain access to information, which should not impose and have no exclusionary barriers. It argues that although there are several paths that promote information access, there are also numerous difficulties put in people with visual impairments way that prevent it from reaching the desired information and, therefore, important aspects related to information, such as

education, work and leisure.

According to De Sá, Campos and Silva (2007), working with students with low vision is based on the principle of encouraging full use of potential vision and other senses, as well as overcoming emotional difficulties and conflicts. The choices and levels of resources adaptation to be used in each case must be defined based on the reconciliation of several factors. These include specific needs, individual differences, age, preferences, interests and skills that will determine the most appropriate form of adjustment and activities. Thus, one realizes the importance of understanding the whole context and all its variables so that there is no damage to people with visual impairments, looking to observe all aspects from many different angles so that accessibility is complete.

With an increasing presence in the world, technology has been used in the areas of health, communication, education and others and the electronic games have been inserted in various media, showing uses in addition to fun. Jacko (2012) states that many researchers are still working on innovative designs of screens, input devices, multimedia output, programming toolkits and predictive user performance models that reinforced human-computer interaction.

Every day new technologies are developed to improve user experience. However, according to Sens and Pereira (2015) despite digital industry exponential growth, people with disabilities are part of consuming public that is not fully served. They have difficulty finding products that fit their physical, cognitive or motor conditions. Many affirm the importance of accessibility, including from market point of view. However, in practice, this inclusive is not verified.

Main *et al.* (2016) present research that demonstrates how students with disabilities could use technology developed for general market and how it can help them in principles of normalization, which defends that people with disabilities should have opportunities to share experiences of the same contemporaries. It concludes that these students were positively involved with technology and the observations allowed everyone to perceive incremental changes in students performance with disabilities.

3 ARTIFACT DEVELOPMENT IN DOSVOX

The development of the artifact described in this paper was performed based on results presented in research by Bernardo, Muñoz and Silva (2020), which presents validation of a data collection instrument made with forty-eight people with visual impairments. In it the perception of using Dosvox was obtained to allow access to information about paths and barriers to be faced in indoor mobility at the University of Brasília Central Library, establishing a relationship between people with visual impairment information needs in terms of mobility and the use of artifact, to be developed in Jogavox in order to meet these needs.

Based on this research authors developed the artifact using Jogavox within Dosvox computer system, following the guidelines presented in Borges (2019) and NCE/UFRJ (2019b).

3.1 Dosvox computer system

Dosvox is a system created in 1993 for microcomputers that uses a speech synthesizer in Brazilian Portuguese and the text synthesis can be configured for other languages. This speech synthesis allows people with visual impairments using computers and have independence to study, work and have fun. Most of the sound messages emitted by Dosvox are

made in recorded human voice, its code is open, allowing its editing to create new features.

The Electronic Computing Center of Federal University of Rio de Janeiro (NCE/UFRJ, 2019a) presents the estimate that there are about 100,000 people from all walks of life and throughout Brazil who make or have used Dosvox. It also states that

> With the computer reading the screen through synthetic speech, anyone who is blind or unable to interact with it uses a small set of shortcut keys which provides access to reading and writing, access to information and media disseminated over the Internet and use of adapted electronic games, in addition to controlling personal life through many utilities to support daily life NCE/UFRJ (2019a).

In the research by Da Silva (2017) a description of Dosvox creation is presented. In this text which presents a study of interaction between public school students in the Federal District and the adapted digital games present in Dosvox, the author presents difficulties of using these games and their relationship with working memory, such as attention and people with visual impairments decision making. According to him, to meet the demand for programs that allow people with visual impairments to access numerous technological resources, programs were created that allow access and interaction with social networks such as Googlevox which makes the searches carried out by people with visual impairments to Google, Twitox which is a version of the social network Twitter and Voxtube which is an accessible access to the YouTube video site.

At Instituto Tércio Pacitti, which belongs to NCE/UFRJ where is the birthplace of Dosvox there are projects aimed at providing people with disabilities with new opportunities based on computer technology. Among these projects those aimed at people with visual impairments. They are: Dosvox Project - computing for visually impaired; Project Dosvox en español; Easy Braille Project - Computerized Braille Printing by Benjamin Constant Institute; MecDaisy Project, which are digital sound books for the visually impaired; Jogavox, system for creating inclusive educational games; Musibraille Project - automating music production for visually impaired through Braille; TecnoAssist - Improvement in Specialized Educational Service for visually impaired student; I Assistive Technology Forum; II Accessibility and Assistive Technology Forum; Course for Dosvox Multipliers in the Perspective of Inclusive Education - Moodle platform; Braille for Teachers - a practical approach with Technology (NCE/UFRJ, 2019a). Da Silva (2017) presents a table with all the games of the Dosvox version 5.0 system.

3.2 Educative Games Editor Jogavox

Regarded as a project Jogavox is an application that works within Dosvox and developed by NCE/UFRJ team (2019b) so that teachers from public schools in Rio de Janeiro can produce multimedia educational games that are contextualized to be applied in projects of visually impaired students inclusion. To develop educational games it is necessary for the teacher to know their technology and methodology. Its central idea is allowing the teacher to develop educational games he will use, deciding what content to work on and which themes to use. Because is easy to use, it allows people with little computer knowledge to develop their own games.

Because it has guidelines on how to install, create games from scripts and how to create games from editing windows in addition to video lessons, Jogavox allows create many possibilities for a goal. The option to insert multimedia files increases interests in the developed artifact and becomes an interesting product for person with any level of visual impairment,

being also pleasant for people without visual impairment.

Da Silva (2017) presented a proposal for classifying digital games based on previous classifications, which takes into account dimensions of cognition, socialization, affectivity, motivation, creativity and psychomotricity. From there he created the categories: cognitive digital games, digital socializing games, affective digital games, motivational digital games, creative digital games and digital psychomotricity games. For him the functionality of creating and editing Jogavox explores users creativity to the extreme, as it allows games to be created and also for games already created to be improved.

Another research was carried out in a public school in Rio de Janeiro, when Robalinho and Costa (2019) presented the process of building a digital game created in a participatory way with visually impaired students using Jogavox. The research aimed to obtain students' perception regarding the validity of Jogavox considering its usability and playfulness, promoting inclusion as well as stimulating the use of playful resources for knowledge acquisition.

Regarding the use of Dosvox System and the Jogavox program, researchers understand that it serves the purpose of being inclusive, since its information seems clear and the way of interaction has proved to be very simple, which enables people with other disabilities and people who do not dominate information technology can make use of it. They affirm the belief in the transformative power of the system and reinforce the expectation that other people feel impelled to develop other inclusive, creative, innovative and meaningful proposals in the search for an increasingly emancipatory, autonomous, critical and for all education.

3.3 UnB Central Library as a background for artifact development

The space defined as an experiment for indoor mobility was the ground floor of University of Brasília Central Library (BCE/UnB), located in Brazilian Federal District. With the knowledge that people with visual impairment can gain functional independence through orientation and mobility training, it is possible to identify that creative use of interactive virtual navigation environments can provide flexibility and complement this type of training (CONNORS *et al.*,2013).

BCE mission is to carry out processes to manage the information required for teaching, research and extension activities and resulting from them, in an integrated perspective, for the formation of ethical and qualified citizens for professional practice and committed to the search for democratic solutions to issues national and international, through excellence (BCE, 2019).

A tactile map is a resource that allows people with visual impairments to have a more concrete perception of geographic space, which develops orientation and mobility in visual difficulty and through touch (SILVA JUNIOR, 2018). Figure 1 shows an example of a tactile map made available to public on the first floor of a Brazilian bank branch. In it are the names of all the locations on the first floor and below the location orientation there is a translation in Braille. Through tactile means the person identifies on that floor of the establishment which are his accessibility points, which allows him to “walk” mentally, guiding where he should go. The library does not have a tactile map as guided by Brazilian Standard ABNT 9050 (ABNT, 2015), it does not have a sound description of its physical spaces, but its physical accessibility item includes an access ramp at the entrance and a tactile floor throughout the ground floor.

A script was developed with the path to be followed by user. This script has the profile of a flowchart, with the difference that the orientation is not TOP-DOWN but DOWN-TOP. Initial phase begins at the bottom so that the impression of entering an environment is given

and the top represents the end of the "walk". When using the artifact the person who is operating is led to imagine that he is at a starting point. Every possible action that the user can get involved in wishing to walk the path has been thought out. It started from the premise that the person is at one point and wants to go to another point, so the artifact brings all the guidelines on how he should act to achieve the goal.

The synthesized text was created as an interactive conversation between the artifact and the operator. Although Dosvox allows you to create artifacts with the option of more than two exits, this artifact was created with binary responses, giving operator the option to choose one exit or another. Each bifurcation path leads to another bifurcation, until it reaches its end, with the possibility of starting all over again and choosing a path that has not yet been taken. Each path corresponds to another phase to be overcome. In this fork, there is another information about where the operator is and what he must do to follow that path.

Figure 1. Tactile map at a bank branch[1]

Source: the authors

At the end of each phase, the artifact presents a commemorative phrase, encouraging the person to continue his/her journey. In this way, the action takes on the image of competition, a target to be reached. The sewing flow followed the RESPONSE-HIT-ERROR trio. Figure 2 shows the original flow of the artifact created for mobility at the BCE, written in Portuguese.

The flow of designed artifact includes following options for walking through UnB Central Library: S - Yes to go to the fork; N - Not to end the game; E - Walk on the Left floor; D - Walk on the right floor; O - Other options; S - Access information about the reference room; A - Access information about the Collection room; V - Return to the library entrance staircase; S - Exit artifact. Certain human limits were obeyed in terms of communication, considering that the human mind has limited capacity for processing information from working memory (SANTANA, 2019). The intention was to avoid overloading the operator with a lot of data such as: direction to take, stairs to go up/down, doors to open, obstacles to overcome.

Blocks with up to five informative phrases were created and from each of these blocks there is the possibility of entering another new block, and within it five more information are provided so that they are not passed in just one moment, avoiding accumulation of information

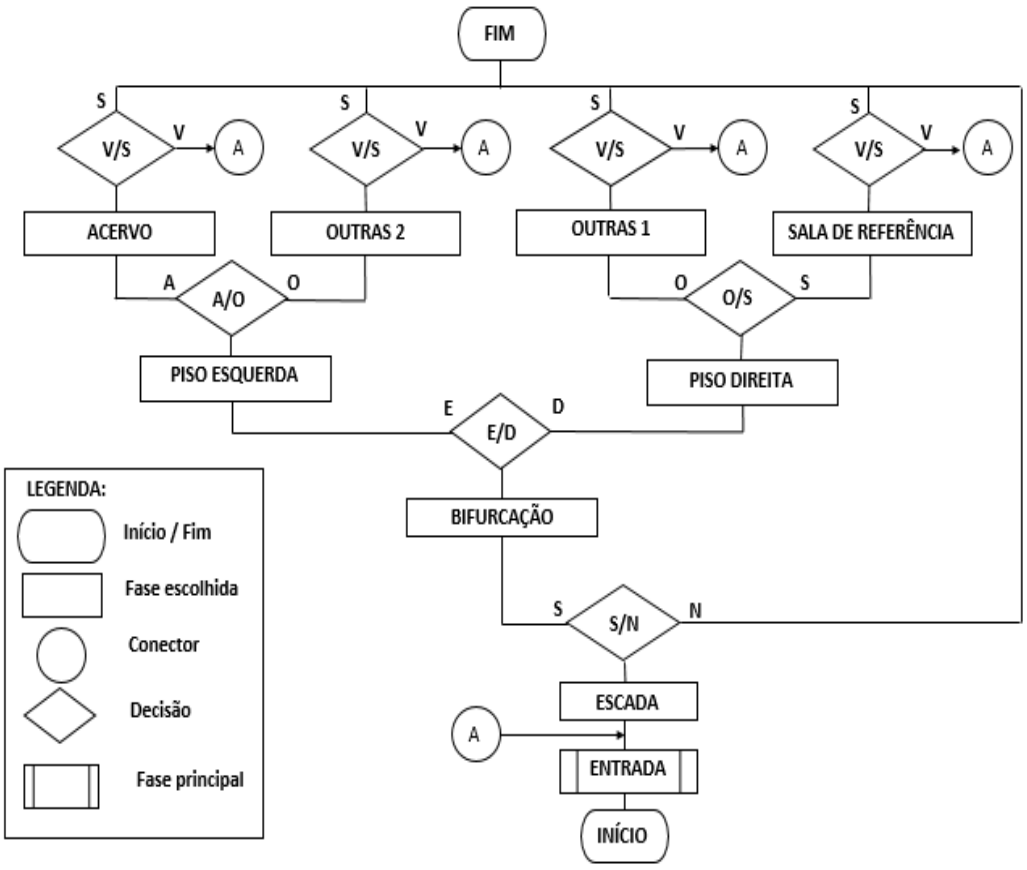
[1] In the image above, a tactile map of the agency's ground floor is shown, with a starting point at the entrance, then the revolving door and other accesses, such as elevator, ATM and staircase.

that leads to loss.

Information being provided hierarchically works better than if it is provided in a linear manner. This makes reference to metadata, which deals with data that brings information about other data, thus ensuring a more palatable context for users. To make the artifact more interesting, some multimedia items such as musical background and onomatopoeia were added to the script, making it more sensory, because people with visual impairment has a very strong auditory influence, since the sound for them is like the color for the seeer (KOHLER and FOERSTE, 2014).

The artifact was called "*Virtual visit to the library*" and was developed in June 2019. As it is an artifact that áudio describes a physical environment, describing the entire physical installation, it can be categorized as an auditory map. Photographs of accesses ground floor were taken with written authorization from the library administration, to be used in the developed artifact. It presents information to the person such as how to get to certain points in the library and what obstacles and barriers to overcome. The points are phases of the software and have been assigned the following names: 'Entrance, Stairs, Bifurcation, Right floor, Reference room, Others1, Left floor, Collection, Others2, Exit_general, Exit'.

Figure 2. Flow of developed artifact[2]



Source: the authors

Figure 3 presents an image of the first phase of the artifact that received the name "Entrance" and brings a photograph of BCE facade with a welcome message and the option to

[2] The image above shows the flow of the artifact, with a starting point at the entrance of the library, then access to the stairs, then the fork to the left and right. From these points there are accesses to other points.

start the “walk” through the artifact. Along with the presentation of figure 3, the text is narrated in Portuguese using Dosvox speech synthesizer: “*Welcome to the Central Library / University of Brasília / Press ENTER to begin*”. By pressing [Enter] the artifact starts the second phase.

Figure 4 shows a photo of the entrance to the BCE, which is part of the second phase called “Escada”. This figure shows the stairway to the library, which has 8 steps. On each step is painted the spine of several famous books, such as the classics 'The antagonist' or 'One hundred years of solitude'. At the end of the eighth step are three turnstiles to access the library. To the left of the stairs is a ramp with a rubberized floor.

Along with presentation of figure 4, the text is narrated using the synthesizer: “*You are on the main entrance stair / Go up 8 steps to reach the concierge / Wheelchair users can take the ramp on the left / The floor is rubberized! / At the end, there is an entrance ratchet. / Press Y if you went through the turnstile / Press N if you want to leave*”. The possible answers are "Y" and "N". If the option is the first, the artifact will send the operator to the “Bifurcation” phase, if it is the second, it will be sent to the “Exit_general” phase. In case of error, you will be taken to the “Ladder” phase.

Figure 3. Screen of the first phase 'Entrance' with the facade of the BCE[3]

Source: the authors

Visual part of the artifact is necessary as it can also be operated by people without visual impairment, people with low vision and people without visual impairment accompanying people with visual impairment, thus assuming an inclusive artifact role. Due to the limitations of this paper it is not possible to present the entire flow created as well as the other seven photographs equivalent to the other phases and respective texts, synthesized by Dosvox. After mentally “walking” through all the physical spaces on the library's ground floor accessing all the features, the person has a “vision” of what the physical map of this environment looks like, since a narrative of how to get to each of the points was created presented.

The idea was conceived by the fact that a person without visual impairment, when wishing to visit a place that is not an indoor environment and that is unknown to her/him, has ability to access internet and consult the map of this place. From that consultation, He/she have a sense of what this place looks like, what must do to access it, what barriers and difficulties

[3] In the image above, the façade of University of Brasilia Central Library is shown, with some students sitting on benches in front, with the totem in the background with the name of the library.

will face in reaching the place.

When wishing to walk in an indoor environment, people with visual impairment in addition to not being able to use the map over the internet or any other visual resource, has no resources to guide him/her where to enter or leave, what are the barriers, which and how many obstacles on him/her desired walk.

4 CONCLUSION

To continue the research, it is planned to carry out interviews with people with visual impairment that make use of developed artifact, to assess the degree of satisfaction with information provided. The creation of reference model for electronic artifact development, the refinement of artifact and model are also foreseen, considering people consulted opinion; the validation of artifact through a focus group composed of people with visual impairment that do not know the physical space defined in the artifact and final refinement of artifact and model. According to Sassaki (2007) physical accessibility and accessibility to information by people with visual impairment are themes that must be discussed with their participation, as they are targets of the product to be developed. Nothing about people with disabilities should be done without their participation.

Figure 4. Screen of second phase 'Escada'[4]

Source: the authors

Based on study protocol presented in this paper, it is expected that it will be possible to conduct more precise investigations to guide developers of other artifacts about people with visual impairment needs and specificities. From the availability of more constructed artifacts, it is understood that the inclusion process is expanded, allowing its use for learning, training, guidance or even entertainment purposes, guaranteeing their rights.

Thus, in addition to conducting the next empirical stages of the study, detailed sharing of theoretical and methodological framework that guided the construction of the instruments and the approach of this study is considered important, aiming at expanding scientific communication on the topic and supporting other related studies in their planning stage.

[4] The image above shows the staircase at the entrance to University of Brasilia Central Library, with eight steps, each with the name of famous books.

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