Multimodality by Electronic Games as Assistive Technology for Visual Disabilities

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Abstract — **With increasingly attention to the digital gaming industry in entertainment, games have become more graphical, solidifying the visual modality. In this reality, visually impaired people have little participation in the market and lose all the culture involved in this industry. Across the planet 246 million people have low vision and 39 million are blind. In Brazil there are 6 million people with low vision and 582,000 blind, almost all excluded from digital gaming. Analyzing gaming market for the blind and the adaptations of titles seeking their inclusion, this research aims to propose from the perspective of Information Science, the initial studies in order to help accessibility studies for the visually impaired using electronic games, treated as Assistive Technology with concepts of Multimodality. It intends to be a new approach for a theoretical work by analyzing accessibility guidelines for visually impaired people, which can serve as steps for interpreting these public demands in digital games development, aimed at the greater inclusion of them. This is still a theoretical work with a suggestion that there is a market for games developed for the visually impaired. Its conclusion is there is a lack of concern by developers to deploy best items in this area and there is a lack of opportunity by Brazilian government to promote such research and development. Researches made by organizations were observed and used as a basis for checking possibility of a better inclusion of the visually impaired.**

Keywords —Information Science, Multimodality, Electronic Games, Assistive Technology, Visual Impairment.

I. INTRODUCTION

As students of the graduate program in Information Science of University of Brasilia, Brazil, authors are participating in a research that aims to propose from the perspective of Information Science studies to present, with the multimodality approach guidance for accessibility studies for the visually impaired using electronic games, treated as Assistive Technology.

After analyzing accessibility guidelines that should act as a guide in interpreting the demands for the development of digital games, aims with this research guide Brazilian government and organizations that define the laws and focused guidance to the public with visual impairment.

With the growth in the game market many genres were created and established. With time and enhancement of technology, some types of game no longer offer a variety of possibilities that most modern games offer, thus becoming obsolete to market and abandoned by many players. The reason is that the games market is dynamic, like other markets (film, for example) and they require innovation to remain profitable. This profitability is driven by their public. In this case, the visually impaired public is just a small slice in the market. So these are not (or are less) considered during the production of the games.

Over time, electronic games get more elaborated both for graphics and usability while some become obsolete for not offering new challenges and for the rise of titles with more refined features (visual or other). Moreover, as in the film industry, the creation of fictional scenarios with real characters integration which the player identifies generates a greater appreciation. It is evident that one of video game industry's efforts is to make games more real.

Some tools that provide a sound transcription of what was being displayed on the screen during the game, made it possible for blind people to play, competing on equal terms with non-blind players. The problem is that even with sound answers, some functions still use quite graphical functionalities. Few games known in the market can provide a satisfying auditory response.

Audio games are presented as an alternative to market games and they are not intended for the visually impaired public, but have focused their function to the main public. They are simpler compared to the main games in the market and provide the player the same multiplayer experience, diversity and longevity of the main titles.

Even with the expansion of video games and adjustments made in popular games and games developed for the visually

impaired, people with any visual impairment is still not considered part of gaming world. According to [1] digital games appear as important spaces for human development, and also considering the online games, prosperous socio-digital environments. Thus, the lack of inclusion of the blind people in the digital game market is something that reduces the possibility of taking advantage of this social interaction tool.

II. ELEMENTS OF INFORMATION SCIENCE

In the field of Information Science (IS) [2] studied some of the difficulties in its history. One is the absence of agreement on what precisely it is, justified by its interdisciplinary nature, and this statement being a global consensus. In the context of interdisciplinarity, the study of shapes, forms of information to be handled by IS was named by [3] as Multimodality.

For Information Science, the essence of information is that it should be registered and treated to allow a future recovery [4]. According to [5] the organization of information occurs in an information system consisting of interrelated components to collect, to process and to disseminate information, under of a management of a commissionaire, appearing with a feedback mechanism to assist review, improvement and adaptation to the environment in which it operates.

Information Architecture is a design methodology that applies to any informational environment, as a space located in a context consisting of flow content that serves a community of users. Its purpose is to enable the effective flow of information through the design of information environments and as a concept, refers to both a process and its product [6]. It is one of the disciplines of Information Science, in charge of the investigation of a body of knowledge that adds the source, collection, organization, storage, retrieval, interpretation, transmission and use of information [7] [8].

Still about Information Science discussion, [3] states that a modality is a resource provided to bring meaning to something, socially and culturally formatted. Images, writing, layouts, music, gestures, speech, motion pictures, soundtracks and others are examples of methods used in information representation and communication, where each mode has its specific meaning. He also states that it is clear that the theory produced for each mode can handle the potential differences of all modes used in any culture. Electronic games are presented as another mode, a mode that brings information, and they may be molded to a general public, but also to a very specific one as the visually impaired.

III. ELECTRONIC GAMES

Electronic games is a generic term that refers to digital game designed to be played on a computer, console or other technological device [9] and can be defined as a game where Human-Computer Interaction (HCI) occurs [10], resorting to the use of technology [11]. There are several kinds of electronic games such as shooting games in first person, games in third person, two dimensional platform and three-dimensional platforms, multiplayer, open world games, and that provides the player many different types of interaction, creating experiences, developing skills and creating scenarios that stimulate various areas of the player. The action genre is one of the most popular in the world of digital games because allows the player to participate in full of challenging adventures. This requires that player has a good hand and eye coordination, emphasizing instant reaction. Reference [12] states that from brain games designed to enhance mental fitness, to games used to improve real-world problems, to games created purely to entertain, today's video games can have a variety of potential impacts on the brain.

There are other genres of games and they are simulation, elapsed simulation, flight simulation and many other types of simulation; also adventure games, these text-based, called text-based games and with the evolution of graphics cards, are represented graphically with large dimensions.

There are also some sub-genres of strategy games such as real-time strategy games, which are the dominant sub-genre of strategy games. Sports games are the games based on sports competitions, which depends heavily on player's skill, demanding to have a sense of what's happening on screen.

Another variation in the electronic game market is the phenomenon of electronic sports or e-sports, for example Wii console games, where world championships of several games with big cash prizes occur. They are well done and attract a huge amount of players and fans [19].

A. Other uses of Electronics Games

With more and more presence in the world, technology have been used in health, communication, education and other areas, the electronic games were inserted in various media, showing utilities beyond fun. Some technologies are used as a form of rehabilitation in patients with motor problems. According to [13] experiments have been developed to aid in physical therapy treatments and demonstrate that games help to regain balance, coordination, endurance and muscle strength, and stimulate brain activity and increase the ability to concentrate. Another area that electronic games can be used is in cognitive rehabilitation. Reference [14] conducted an experiment with 60 people with brain disorders and attention deficiencies, even when games for cognitive rehabilitation were not very researched, and realized a significant increase in the level of attention after conducting sessions with electronic games. Specifically for cognitive rehabilitation, there is the spread of products ranging from simple games that utilize multimedia power, with two dimensions images exploiting interfaces similar to the practice developed in the traditional therapeutic procedures, to more sophisticated proposals that rely on technology promising as Virtual Reality [14]. Reference [10] states as a fact that many researchers are still working on innovative display designs, input devices, multimedia output, programming toolkits, and predictive models of user performance that have reinforced Human-Computer Interaction (HCI).

Reference [35] presents researches that demonstrate how students with disability could use technology designed for the general market and how it can help them in the principle of normalization, which espouses that people with disability, should have the opportunity to share in experiences of their same-aged peers. Conclude that the students were positively engaged with the technology and observations enabled everyone to notice incremental changes in the performance of these students with disability.

Reference [15] describes Assistive Technology (AT) as "technological devices and software used to make course materials, instruction, and interactions with environments more

accessible to students with disabilities. The goal of AT is to remove barriers to the educational environment. For a student with a visual disability, this might include the use of screen-reader technology to ensure that the student can access written material. AT can also benefit students without disabilities, enhancing access to educational content. For example, a student with a strong auditory learning style may benefit from the ability to record lectures for playback at a later time".

Brazilian Ministry of Education (whose acronym in Portuguese is MEC) states that AT is an area of knowledge that encompasses resources and services in order to provide or expand functional abilities of a person with disabilities. Its goal is to promote quality of life and social inclusion of its members [16]. In education, games are used to provide a better learning experience due to its light and relaxed approach. These contain specific features to meet the needs related to learning.

According to [17], in Brazil AT is "even new term used to identify the entire arsenal of resources and services that contribute to provide or expand functional abilities of people with disabilities and consequently promote their Independent Living and Inclusion. Its objectives are to provide the person with disabilities greater independence, quality of life and social inclusion through the expansion of its communication, mobility, environment control, skills of learning, work and integration with family, friends and society".

Therefore educational games, according to [18] must have pedagogical objectives and their use should be inserted in a context and a methodology-based teaching situation to guide the process, through interaction, motivation and discovery, facilitating learning content. Reference [18] argues that other games and simulators benefits include improvement of strategic thinking and insight, improve psychomotor skills and the development of analytical skills and computer skills.

B. The electronic games market

With the various application areas of the games, you can see that this is not a market aimed only at children and adolescents, but also areas of human development, patient's rehabilitation, means of income and many other purposes. In electronic games for visually impaired, it is observed that the audio part of the games are much more important for this group. In some cases it is the only noticeable feature for the blind player. Although it's an important aspect of immersion, the development of audio in games does not receive the same attention as the visual design. According to [1], the audible feedback provided by the games is often not enough to display all the essential information in order to understand a scenario, guidance in an environment or navigation in a game menu. Although supported by Assistive Technology, blind players experience a widespread mismatch between screen readers and games, as this software require the possibility of interaction using only the keyboard and hidden textual descriptions in each interactive element. Even players with low vision need options that increase the size or increase the contrast of the elements of the game.

Some other options were created for players with visual impairments; others already existed and were adopted by the public. Some games like text-based ones, which include text adventures games, digital boards as Battleship and Multi-User Dungeons which are HTML-based games where several players connect and play via text. A project named Top Web Sites [20] proposes to provide useful information for the international community interested in accessible games. Among these there is a list called "Top 25 Web Sites for Top Web Accessible Gaming - 2015".

Audio Games consists of sound and have audio only, without graphics. Not specifically for the blind community, but since they do not need vision to be able to play, many of them are developed for and by this community. They are developed by small companies dedicated to this area, amateur game developers, and academic researchers and by the players themselves. Most audio games are very simple compared to the main game market and are not found with same variety [21].

About games that are accessible through original design, there are not many examples of this type, neither great variety as in main gaming industry. Most are developed by small companies dedicated to this industry and academic research projects. Accessible electronic games through modifications are changed by the players themselves to add different features.

Each new day new technologies are developed to improve the experience of players. However, according to [22], they do not observe this same concern, interest or effort to the public with disabilities. Many people claim the importance of accessibility, including in the market point of view. However, in practice, this inclusive concern is not fully verified.

Reference [23] publishes estimates per week relating to worldwide game hardware and software sales and hosts an ever-expanding game database. It provides consumers with a range of content from news and features to reviews to social networking and community features. To help in observing if main gaming market seeks to provide accessibility to players with visual impairments was elaborated Table 1 which presents the 10 best-selling games of all time to the present day. Game Duck Hunt occupies the 10th position of the top selling games to date. Developed in 2014 by Copenhagen Institute of Interaction Design, the game Blind Duck Hunt is a new take on game Duck Hunt and according [24] takes advantage of our abilities as humans to visualize, understand and react to space through audio. Its developers say that current video game experiences are commonly made through screen-based interactions, with more emphasis on the visual graphic representation of the gaming environment.

TABLE I. GLOBAL SALES (IN MILLIONS OF UNITS) PER GAME

Ranks	Games	Platform	Year	Sales
1º	Wii Sports	Wii	2006	82,7
2º	Super Mario Bros	NES	1985	40.2
3º	Mario Kart Wii	Wii	2008	35.7
4º	Wii Sports Resort	Wii	2009	32.9
5º	Pokemon Red/Pokemon Blue	Game Boy	1996	31.3
6º	Tetris	Game Boy	1989	30.2
7º	New Super Mario Bros	DS	2006	29.9
8º	Wii Play	Wii	2009	28.5
9º	New Super Mario Bros. Wii	Wii	2009	28.5
10º	Duck Hunt	NES	1984	28.3

IV. VISUAL IMPAIRMENT

To address accessibility for the visually impaired is necessary first to define visual impairment and their types. Understanding that people with these differences live and feel, for then observe as best as possible the current situation of accessibility in electronic games and define improvements that need to be made. World Health Organization (WHO) publishes the International Classification of Impairments, Disabilities and Handicaps [25]. Its reprinting made in 1993 has the following classifications: i. Impairment is any loss or abnormality of structure or psychological function, physiological or anatomical. It is the manifestation of a disease state and, in principle, reflects disturbances at the organ level; ii. Disability is any restriction or lack of ability (resulting from an impairment) to perform an activity within the normal way for a human being. It is the objectification of a disability and as such reflects disturbances in person.

According to International Classification of Diseases ICD-10, there are four levels of visual function, which are normal vision, moderate visual impairment, severe visual impairment and blindness. Moderate visual impairment combined with severe visual impairment are grouped under the heading of "low vision." low vision taken together with blindness represents all visual impairment [26]. In Brazil to make the correct citation two visual function components are used as a parameter to evaluate visual impairment: visual acuity (higher ability to discriminate two points at a distance) and visual field (range of the space perceived by sight). Both factors influence rather the ability to play the latest games, as they now have their focus on visual part, showing various screen elements simultaneously and challenges that need to screen the understanding as a whole to be solved, making it difficult to be played by visually impaired.

Blindness is not necessarily a full view disability, but the loss of that capacity at levels that incapacitate exercise routine tasks. It is defined as total blindness when it assumes complete loss of vision. In this case, the view is void, with no light perception [27]. In case of people with total blindness, games must be based entirely on audio, and it is another feature not very strong in current game market, since graphics becomes increasingly prevalent.

A. Inclusion of Rights in Brazilian Legislation

According to [28], by the Brazilian law all people including those with disabilities are entitled to access in education, health, leisure and work. Thus, they state that people should be perceived equally, thus implying recognition and meet their specific needs.

WHO states that in the entire world 285 million people suffer vision problems, 246 million have low vision and 39 million are blind. In Brazil, 6.5 million people have visual disabilities, 6 million have low vision and 582,000 are blind [26]. Despite the Decree of Brazilian Law 3,298 of December 20, 1999 ensures accessibility to people with visual disabilities to leisure, culture and sport, deprive this amount of people of great cultural and social diversity that the games provide are problems that needs to be discussed and solved.

B. Brazilian Accessibility Standards to the Visually Impaired

Products and techniques developed for visually impaired people are applied to various environments and situations to provide their inclusion on a daily basis and to ensure autonomy in various areas. Table 2 shows standards established by Brazilian Association of Technical Standards (whose acronym in Portuguese is ABNT) to ensure accessibility for people with disabilities, along with types of disabilities assisted by standards [34].

The main standard of accessibility is ABNT 9050 - Accessibility to buildings, furniture, spaces and urban equipment. This standard establishes criteria and technical parameters to be observed for the project, construction, installation and adjustment of urban and rural areas, and the conditions of accessibility. It has guidelines for various environments and situations, setting parameters that can be adapted and used to provide accessibility in many other environments. Other standards such as ABNT 13994, ABNT 14020 and ABNT 15250 using parameters set by the ABNT 9050 as a basis for accessibility guidelines in their different environments.

TABLE II. STANDARDS ESTABLISHED BY BRAZILIAN ASSOCIATION OF TECHNICAL STANDARDS (ABNT) TO ENSURE ACCESSIBILITY

Brazilian Standard	Inclusion Area	Types of Disabilities Assisted
9050	Accessibility to Buildings Furniture, Urban Spaces and Equipment	Visual, motor, mental and hearing
13994	Elevators for Transport of Persons with Disabilities	Visual, motor, mental and hearing
14020	Accessibility to Disabled People - Long Path Train	Visual, motor, mental and hearing
14021	Accessible in Urban and Metropolitan Train System	Visual, motor, mental and hearing
14273	Accessibility to Disabled People in commercial air transport	Visual, motor, mental and hearing
14970	Accessibility in Motor Vehicles	Visual, motor, mental and hearing
15250	Accessibility ATM Banking Box	Visual, motor, mental and hearing
15290	Accessibility in Communication by Television	Visual, motor, mental and hearing
15320:2005	Accessibility for People with Disabilities in Road Transport	Visual, motor, mental and hearing
14022:2006	Accessibility Features in Urban Vehicle for Public Transport of Passengers	Visual, motor, mental and hearing
15450:2006	Accessibility to Passenger of Water Transportation System	Visual, motor, mental and hearing
15570	Transport - Technical specifications to Manufacture of Vehicle for Collective Passenger Transport	Visual, motor, mental and hearing
16001	Social Responsibility - Management System - Requirements	Visual, motor, mental and hearing
15599	Accessibility - Communication in Service Delivery	Visual, motor, mental and hearing

C. Using Fundamentals of Information Science to Aid Assistive Techonology For Visually Impaired

This article presents the proposal to identify inside concepts of information science a correlation, basic in its first proposal, but with possibility of being expanded, detailed in more expertise from more research in the scientific field with the demands presented by the accessibility to electronic games for people with visual impairments. Whereas it is classified into four types, the demand for each type of deficiency is different. Thus this proposal identification should also be classified. Information Science studies all informational modalities and there is no research in Brazil, regulation or legislation in regard to meet informational demands submitted by public. In this

research visual impairment has been considered as one more form of multimodality [3].

The specific Assistive Technologies development initiatives often start by researchers, enthusiasts and organizations [22]. There are means to ensure the inclusion of visually impaired people in various environments that can be taken as an example to provide accessibility to electronic games. The form adopted by education, for example, shows that putting yourself in place of disabled people can provide tools and inclusion means to the visually impaired. Accessibility is defined as the possibility and conditions of reach for the utilization with security and autonomy, spaces, furniture and urban equipment, buildings, transport and communication systems and media for people with disabilities or reduced mobility [28] [29].

In education, accessibility for students with visual impairments is provided by changing perspectives, when a teacher puts in place of blind student and understand what his feelings are and how he perceives the world around. After that it is possible to adapt how classes and activities are given. Putting yourself in place, the teacher understands how the student with visual impairment absorbs information.

For gaming market it should not be different. Developers in order to create their games, could try to understand the way visually impaired people interact with electronic games, thus to make the experience closer to that of a person with normal vision. Enabling inclusion of blind player, since the blind player share the same experience as all of the other players, for inclusion, different tools and mechanics should be used based on what is known about the types of visual impairment.

According to [30], working with students with low vision is based on the principle of encouraging the full use of potential vision and the remaining senses, as well as in overcoming difficulties and emotional conflicts. The choices and adaptation levels of resources to be used in each case must be defined from conciliation of numerous factors. Among them are specific needs, individual differences, age, preferences, interests and skills that will determine modalities for adjustments and most appropriate activities.

Thus, we see the importance of understanding the problem so that there is no loss for the part of the visually impaired. Looking to observe every aspect from many different angles so that accessibility is complete. Thus, the differentiation of the two groups included as part of visual impairment by the BCO is of great importance and should be taken into account in this research.

For players who have blindness, graphical part of games is not as important, with the developer having to focus on the game audio design. For better audio design, which allows inclusion of people with blindness, it must be done in a way that each element has its characteristic sound, with differentiation of graphics for different sounds. A job that locates an object on screen through the sound emitted by it is also necessary, as they are made audio games. A hearing response to commands executed by the player is crucial so that he knows what he's doing. Developer has to think that for the blind, sound answers are equivalent to sprites of each element of the game. So for a ship's collision sprite, for example, you have to have an equivalent auditory response to it.

V. Providing Inclusion in Electronic Games

Among the institutions that foster research, defense and discussion of principles and accessibility solutions for digital games, some of them stand out, which are: International Game Developers Association (IGDA), Organization Able Gamers, Organization Special Effects, site Accessible Games and company Accessible [22].

International Game Developers Association has a group of volunteers with an interest in game development with accessibility, called Game Accessibility Special Interest Group (SIG-GA). This group published in 2004 a report on the results of their studies called "Accessibility in Games: Motivations and Approaches" which provides definitions and information about acting opportunities and technologies in fields of accessibility for games [22].

The site Game Accessibility Guidelines is prepared by designers, experts and researchers in the field of electronic games and can be considered as one of the best utilities for development of accessible games. In a document called "Includification" AbleGamers also reveals itself as a practical guide with heuristics and relevant information on the subject [22]. Is important to follow basic engineering principles explained in [36] and how developers can apply them in their games. The authors wrote in their book the principles and potential application areas for context-aware computing. They talk about how a kind of contextual information can be embedded into user-computer interactions and how these facilities and capabilities can be used to assist the visually impaired.

A. Basic guidelines for accessibility

According to guidelines proposed by [21] and [31], in electronic games the textual elements used are bad or impossible sources to be read by visually impaired people, also not providing options to change size. One solution would be using large font with the option to select the font size of text elements, so that disabled people can choose sizes that enables them to read. Using symbols that complement textual information also facilitates identification and must always be accompanied by a text identifier. Another problem encountered is the low contrast among text and background, making it difficult for letters and textual symbols to be easily identified.

It should also be considered the difficulty to distinguish characters on screen, where it is not known who the enemies are and who the allies are. Reference [31] proposes identification symbols that point what the character on the screen is, and also the identification colors of the same.

With basic proposed guidelines a developer can provide a minimum of accessibility for the visually impaired in their games. They lack the hearing supplement, which is most important to ensure inclusion of people with visual impairments, but with these proposed measures, people with moderate visual impairment and depending on the severity, people with severe visual impairment, may be able to play certain types games, but the experience will not be complete.

B. Intermediate guidelines for accessibility

For a visually impaired person, the audio is a great help and sometimes the only mean of understanding games for a blind with little or no vision. To provide a satisfying auditory

response and provides accessibility to players with a visual disability, the use of surround sound is recommended with immersive sound technology. Stereo audio which sets when the sound comes from the right or left, makes a difference in game play for visually impaired, but surround sound provides better immersion, identifying precisely where the sound comes from. Allowing the player to separately adjust the volume of each element also helps in their distinction [21].

In today's games many graphics are used on the screen, called User Interface (UI) and are important as they score points and other essential information of games. There are several ways to organize UI depending on the chosen style by developer; however it may not be ideal for players with visual impairment. Reference [31] proposes that to allow inclusion of people with visual impairments the game has a user interface where players can change position of items, color, size, and organize it in the best way, meeting their needs. It also proposes the possibility to adjust resolution of the game interface, and often the screen elements are too small and difficult to see by those who have some vision.

Many blind players can just use electronic media through screen readers. Ensure that players with visual disabilities could use these screen readers in the game would enable inclusion. Therefore, to make the game compatible with screen reading tools, developer must use an engine that supports this tool and also that all elements of the game have textual identification [21].

A common problem for players with visual impairment is the low contrast and simple solutions can be taken to solve it. The recommendation is to provide the option for players to adjust contrast and the possibility to be left in the background clear color to characters with dark colors or differentiating screen elements by colors of different shades color. Also ensure that every game element has specific sound and can be easily differentiated only by audio [21].

Players with poor eyesight may have trouble distinguishing when elements shown in the game are / are not interactive, disrupting game play, because it must differentiate the interactive elements of the non-interactive and can be for color, contrast, brightness or indicative icon.

It is noticed that intermediate guidelines more cover the scope of visually impaired benefit from the proposed improvements, providing means to ensure use of screen readers and improvements in auditory elements of games. With improvements in audio proposed in these guidelines, the inclusion of all kinds of visual function that characterize visual impairment is allowed. The possibility of using screen readers enable people who are in the group of visually impaired people with blindness to enjoy games that have many textual elements, as visually impaired people with blindness have little or no light perception.

Deployed together the basic and intermediate guidelines allow inclusion of visually impaired people of all levels but have more complex ways to be implemented, which can be adopted by any major developer.

C. Advanced guidelines for accessibility

People with visual impairments often need more time to understand what is happening on screen. Those with low vision need more time to distinguish graphics. Reference [31] suggests for better inclusion that the game can allow reduction of the speed of time, allowing him to play more slowly, at your own pace of playing. Enable three-dimensional navigation map sonar, where a player with little vision can identify where enemies and objects are found on the map, makes complex three-dimensional games can be played by this type of player.

Another option for people with little or no vision is the identification of objects around by audio, the same way it is done by GPS with a sound description of objects around and how far is the direction. Give the player's option to find without knowing where he is, jumping to a known point, helps him to getting lost. Also, the use of binaural sound recording results in a precise sound response, causing the player to listen exactly where the sound comes from and can be played with any stereo headphones. This benefits the players visually impaired, allowing a spatial concept needs to navigation in three-dimensional environments [21].

According to [32] binaural technique is an audio recording technique where two microphones are positioned in the exact positions of the human ear, thus capturing a sound in three dimensions, providing the listener the exact position of sound source in the environment when using headphones. With these advanced guidelines proposed by the two organizations, we can perceive that they are complex to implement, requiring more elaborate techniques and for that reason, more expensive.

These most advanced techniques together with the first two sets of guidelines enable visually impaired people to have an experience adapted to them, making they benefit almost entirely by it. Even if the implementation of all the proposed guidelines is expensive for the electronic games industry it does not prevent them from using them. In order to address informational demands of Brazilian target audience, Brazilian government could financially support these researches and developments.

Reference [33] presents a provocative list of proposals for accessibility, where it is important to consider that the given responsibility for setting can be modified, since it lacks other analyzes, such as legislation, technical and economic feasibility, commercial interest and political interest.

VI. CONCLUSION

This research has focus on proposing the use of Information Science concepts to assist in accessibility research for visually impaired people, with an approach of Multimodality, including proposals for creation and development of digital games as Assistive Technology, and also discuss guidelines that can serve as a guide development to improve the inclusion of these people in the market share. As a design methodology that applies to any information environment and space located in one context, can serve these communities of users with disabilities, focusing both on the process and the product. It is a modality that brings meaning to users of electronic games to have specific meaning, bringing information.

This is still a new approach for a theoretical work with a suggestion that there is a market for games developed for the visually impaired. Its conclusion is there is a lack of concern by developers to deploy best items in this area and there is a lack of opportunity by Brazilian government to promote such research and development. Researches made by organizations

were observed and used as a basis for checking possibility of a better inclusion of the visually impaired. The guidelines proposed by these organizations were separated by inclusion levels.

These guidelines suggest measures to be adopted in development of games such as better audio design and reproduction techniques, better identification of graphic items, contrast change possibility and resolution of graphic parts of the game.

It can be seen that the inclusion of the visually impaired is possible, since there are organizations working and continuously developing technologies to make it happen. Few games have some of the technologies and techniques proposed to provide inclusion of player with visual impairment.

Organizations of various sectors are interested in including visually impaired people in their markets, as there is a pent-up demand, with researchers and companies who care about this issue. Even if the results obtained and proposed by researches are something that makes the most expensive development of digital games, the digital games industry can indeed ensure inclusion of visually impaired people in the market.

Over the years and consequent expansion of research in this field if the proposed classification are changed, also this proposed use of information architecture and its branches should be changed to be compatible.

Although the text of this paper is just a theoretical work, it concludes that the design of a game is most of the times oriented by the graphical perception of the user (e.g. the Head-Up Display - HUD), which means that the job when of designing a game for visually impaired will be redesign a "new" game. Authors agree that just to design a game taking in consideration the guidelines presented in this paper will not result in a game for people with visually impaired. These people need games redesigned specially for them and for that reason the industry of games in general ignores this market.

As future work of this research authors hope that the discussion may be useful to awake the need for further research to assist the visually impaired and also arouse interest in other accessibility researches using electronic games, and they also hope that it can bring some other recommendations as calling attention of games developers to meet informational demands in any electronic game.

Authors compreends that for a better framework of this research is important to do a survey of electronic games for users with restricted vision. And based on these games make the crossing with the identified usability guidelines. To continue this research is fundamental that generate evidences or results to support the guidelines presented.

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