Chapter 36

Applications on mobile devices as a new possibility of assistive technology for reading and writing activities

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Wanessa Ferreira Borges
Professor at the School of Education and the Graduate Program in Education
Universidade Federal de Catalão - UFCAT
wanessafborges@ufcat.edu.br

Eniceia Gonçalves Mendes
Professor at the Psychology Department and the Graduate Program in Special Education
Federal University of São Carlos
eniceia.mendes@gmail.com

ABSTRACT
In the implementation of conventional Assistive Technology (AT) resources, a challenge is the acceptance and use of these devices by their users. However, technological development brings to the context of people with low vision new possibilities for AT resources, the applications in smartphones and tablets. Given this new reality, the present study aimed to identify and describe applications that take on the role of AT used in reading and writing tasks performed by people with low vision with the aid of mobile devices. The study included 28 people with low vision, who are members of an existing group on the WhatsApp application. Data collection took place in the virtual space of this application, individually, utilizing semi-structured interviews. The data were transcribed and organized into two categories of analysis: applications used and functionality. The participants mentioned 36 applications, which functionally assume the function of electronic magnifiers; digitizers and OCR programs, text readers; object and color identifiers; icon enlargers and keyboard contrast changes; digital bookshelves; and applications that assume an AT function because they are inaccessible devices. The survey revealed the potential of these applications in solving reading and writing difficulties faced by people with low vision, suggesting more research, investments, dissemination, and education programs to increase their use.

Keywords: Assistive Technology, Low Vision, Applications.

1 INTRODUCTION

There are a variety of situations that affect people with low vision, and that results in a variety of conditions: people with autonomy in locomotion and others needing to develop strategies to achieve it; people who carry out school activities without the need for any assistance, while others need optical (magnifying glasses and telescopes), electronic (electronic magnifying glasses and video magnifiers) and computer aids (software magnifiers and/or screen readers) to expand their visual functionality; people who can use manuscripts, even in enlarged formats, while others need tactile or sound materials (Braille or screen readers) (LAPLANE; BATISTA, 2008).

Therefore, people with low vision do not constitute a homogeneous group, as they are characterized by taking advantage of their visual residue in different ways. That is, each person with low vision has a way of using their visual residue, and this needs to be taken into account in habilitation, rehabilitation, and

in the elaboration of pedagogical proposals. In the school phase, accessibility barriers (pedagogical, informational, instrumental, etc.) to knowledge may be greater, since at this stage tasks that require reading and writing skills are more frequent (VINGERLING; KLAVER; HOFMAN, 1995; EVANS; FLETCHER; WORMALD, 2007). However, these difficulties prevail in other stages of the life of people with low vision, causing them to abandon or significantly decrease the performance of tasks involving reading and writing (MONTEIRO; CARVALHO, 2013).

To meet the accessibility difficulties related to people with low vision, Ferroni and Gasparetto (2012) indicate the use of Assistive Technology (AT) resources. AT is an interdisciplinary area of knowledge that comprises products, resources, methodologies, strategies, practices, and services that aim to promote functionality for people with disabilities, facilitating autonomy, independence, quality of life and social inclusion (ALVES et al.., 2009).

Most people with low vision will be able to have their visual abilities amplified with the aid of optical resources (CARVALHO et al., 2005); non-optical (GASPARETTO, 2010; MONTILHA et al., 2006); electronic and information technology (MORTIMER, 2010), as a means of guaranteeing access to the information necessary for the development of teaching and learning processes.

However, people with low vision need to become familiar with these AT resources to improve their performance in the intended activities, contributing to their social development (RABELLO et al., 2014). Despite the need to use these resources in the school (and out-of-school) context, there is evidence that one of the main barriers to the appropriation of AT by children and adolescents refers to the need for social acceptance and the desire to be part of a group, to young schoolchildren, and most of the time these devices are stigmatizing and mark the disability, so they are rejected (MONTEIRO et al., 2006; GASPARETTO et al., 2012). In this sense, in addition to access, accessibility and availability of resources, the individual must adapt to the most appropriate resource for him and learn to use it. Therefore, it is necessary to find AT solutions that have less stigmatizing characteristics.

Research in Brazil points out that AT devices are potentially beneficial for people with low vision, and generally contemplate school age. Regarding the perception of people with the low vision about the use of AT, Monteiro, Montilha and Gasparetto (2011) when investigating which AT resources were used by people with low vision, who attended a rehabilitation center, to help with reading practices and writing, observed that 80% of the participants made use of optical and non-optical resources, especially the use of glasses, manual magnifying glass, approaching texts and objects to the eyes and magnifying texts.

Ferroni and Gasparetto (2012) in a survey on the use of AT by students with low vision, identified that 52.6% use optical resources for distance, of which 90% (52.6%) use common glasses and only 10% telescopes; the same percentage (52.6%) use near optical resources, of these (52.6%) 70% use only near glasses, 20% make combined use of glasses and support loupes and 10% use only support magnifying glass; 68.4% use the enlargement of printed materials as the only cited non-optical resource; and most respondents

(76.7%) highlighted the use of information technology with specific programs as the main AT resource used.

Regarding the use of AT resources in reading activities, Rabelo et al (2014) observed the eye-object distance, font size and reading time before and after the prescription of optical and non-optical resources and guidelines regarding computer resources. Comparing the font size used on the computer, it was found that after the prescription of the telescope, spherical lenses, and magnifying glasses, three of the five students with low vision read smaller fonts on the computer and the majority (83.3%) improved. the reading time. Regarding the font size and time used to read the printed texts, all students with low vision were able to use smaller fonts and reduced the reading time in the second observation.

Montilha et al. (2006) when verifying the perceptions and conduct of students with visual impairment, concerning optical resources and equipment used in the schooling process, observed that even students who attend schools that have a resource room (73.1% of respondents) demonstrated not having specific knowledge regarding AT resources for students with low vision, often using resources for blind students or most of the time just using common glasses. This condition suggests the absence of teaching and implementation programs for the use of optical, non-optical, electronic and computer resources. On the other hand, an interesting fact is an assistance provided by colleagues when dictating the subject to the visually impaired student, since 81.8% of respondents reported receiving this assistance from their colleagues.

The aforementioned surveys were carried out in a national context, and generally refer to the use of AT by children and adolescents of school age, the interest in this locus is because, at this stage of life, reading and writing skills are required, which require greater visual effort. In summary, the research converges to describe an overview regarding the use of AT at school by visually impaired students, emphasizing that: schools are not prepared to implement AT (RABELLO et al, 2014); rehabilitation services are not always articulated with education (LOURENÇO, 2012); the resources are not present in the school and/or the school community is unaware of them (ALVES et al, 2009; JANIAL, MANZINI, 1999); students have not made use of AT to promote their functionality because they do not know it, due to economic barriers and even because they constitute stigmatizing resources, which would result in non-acceptance by colleagues (MONTEIRO; MONTILHA; GASPARETO, 2011; GASPARETTO et al, 2012).

Despite the conditions of access and implementation of AT resources occurring differently in other countries, a common challenge refers to the acceptance and use of AT devices by their users. Unfortunately, many AT resources are abandoned and/or unused after the acquisition, not fulfilling their role of providing functionality and improving occupational performance, no matter how much this is valued by service providers, suppliers and designers (STRONG et al, 2003; MANN; GOODALL, 2003; POLGAR, 2006; FOK; POLGAR; SHAW, 2011).

Many of the aforementioned factors that lead people with low vision not to use the resources can be minimized with alternative possibilities in AT. Mobile devices such as smartphones, tablets and laptops are

examples of potential possibilities to replace and/or complement optical, non-optical and electronic resources. They are widely available1, mainly smartphones, and through accessibility resources, they allow access and use by people with disabilities.

Families and teachers have noticed that children and youth with low vision use the magnifying features of these devices to magnify text or images and access information more independently. Furthermore, mobile electronic devices seem more socially acceptable, as opposed to bulky optical devices that mark disability (THOMAS et al., 2015).

Considering the profile of contemporary AT and its probable benefits and acceptance by visually impaired children and adolescents, Thomas et al. (2015) investigated, through a bibliographic review, experimental research and/or high-quality clinical trials, which evidenced the successful use of smartphones and tablets as AT at school and home, as well as the improvements resulting from their use in participation of children and adolescents with low vision in education. However, the author did not identify any publication that portrayed the effect of electronic mobile devices on reading, educational outcomes and quality of life of children and young people with low vision. The authors pointed out as possible reasons for the absence of publications the scarcity of intra-subject experimental research (inclusion criteria) in the area and the recent use of mobile electronic devices as AT resources.

The rapid evolution of electronic assistance resources for people with low vision is evident. In the 1970s, when the first commercial Closed Circuit Television (CCTV) model was launched, it was considered a revolution in terms of magnification (GERUSCHAT; DAGNELIE, 2017). At first, it was a large device and very difficult to move, in addition to being inaccessible economically. Over the years, there have been innovations in terms of electronic resources. These equipment were, then, taking smaller proportions (thanks to nanotechnology), more versatile, until the structure of portable video magnifiers. Although video magnifiers are recent devices, they are threatened by magnification applications, digitizers and text readers, available on smartphones and tablets. The acceptance of these applications and their great popularity among people with visual impairments are due to the almost imperceptible characteristics of an AT resource and to economic factors since many can be downloaded for free (MANDUCHI; KURNIAWAN, 2017; THOMAS et al. ., 2015).

In this sense, it is believed that the recent and rapid evolution of electronic and computer resources made it impossible to systematize them through training materials and specialized literature. For example, we have smartphone and tablet applications, whose search sources compiling what is available are scarce.

[1] Smartphones have been, since 2016*, the most popular means of accessing the Internet in Brazil, reaching 92.1% of households in the country. At the end of 2017, Brazil reached the mark of one cell phone per inhabitant**, with Android as the main operating system for this type of platform.

* Disponível em: http://agenciabrasil.ebc.com.br/geral/noticia/2016-12/ibge-celular-se-consolida-como-o-principal-meio-de-acesso-internet-no-brasil. Acesso em 23 de abril de 2018.

** Disponível em: http://link.estadao.com.br/noticias/gadget,ate-o-fim-de-2017-brasil-tera-um-smartphone-por-habitante-diz-pesquisa-da-fgv,70001744407. Acesso em 23 de abril de 2018.

Thus, the lack of systematization and dissemination of useful information about these AT possibilities demands further research in the area. Based on this premise, it is necessary to know and characterize the applications that assume the function of AT resources and have been used by people with low vision. This time, the present study started with the question: what have been the applications that assume the role of AT resources used by people with low vision in reading and writing activities?

To answer this question, the present study aimed to identify and describe applications that assume AT function used in reading and writing tasks performed by people with low vision with the aid of mobile devices (smartphones and tablets).

2 METHOD

This research is descriptive, as it intends to investigate a sample population with more than one variable without the purpose of establishing relationships or making predictions, as it sought to describe the existing conditions (SIGELMANN, 1984). The project was submitted and previously approved by the Ethics Committee for Research on Human Beings of the Federal University of São Carlos (UFSCar) - CAAE: 74755017.8.0000.5504.

2.1 RESEARCH CONTEXT AND PARTICIPANTS

The study included 28 people with low vision, who were selected from a Whatsapp group consisting of 104 members, formed by people with visual impairment, parents, guardians and spouses of people with this visual condition. This research included people with low vision, over eighteen (18) years old, users of AT applications on smartphones or tablets, and who consented to participate in the research.

Of the participants, 13 were women (46%) and 15 men (54%), with an average age of 35 years, with an interval between 18 and 63 years, distributed throughout the national and international territory, with representatives from approximately 10 states, namely: São Paulo (13), Minas Gerais (6), Paraná (2), Bahia (1), Rio de Janeiro (1), Rio Grande do Norte (1), Rio Grande do Sul (1) Santa Catarina (1), Tocantins (1) and New Jersey-USA (1). As for the level of education, 25% (7) had a postgraduate degree, 32% (9) completed higher education, 11% (3) had incomplete higher education, 7% (2) had technical education, 18% (5) completed secondary education, 3.5% (1) incomplete high school and 3.5% (1) incomplete elementary school.

Regarding the pathology that caused the low vision, 96% of the participants were affected by Stargardt's disease, and, of these, one participant had Stargardt in comorbidity with retinitis pigmentosa, and 3.5% (1) reported having only strabismus and stagmus. In this universe, based on visual acuity, 32% (9) had a moderate visual loss (<20/60 and ≥20/200), 46% (13) had a severe visual loss (<20/200 and ≥20/400), 18 % (5) profound visual loss (<20/400 and ≥ 20/1200), and 3.5% (1) was unable to inform.

Stargardt's disease is a progressive retinal dystrophy, hereditary autosomal recessive, usually bilateral, which often begins in the first two decades of life and mainly affects central vision (ARAGÃO;

BARREIRA; HORLANDA FILHA; 2005). Corroborating with the definition, the average age of diagnosis of the disease in the research participants was 13.5 years, and 82% claimed to have impairment only in central vision, while 18% said they had both central and peripheral vision affected.

2.2 INSTRUMENTS

The data collection instrument was a semi-structured interview script, organized according to the following categories of analysis: identification of participants, a survey of applications used and information related to functionality, and handling skills. The interview script was submitted to the judgment of judges who helped in the (re)formulation. The interviews were carried out individually. In this article, data referring to the first two categories will be presented, with a focus on applications for reading and writing tasks.

As for the materials and equipment, smartphones with the WhatsApp application and a notebook were used to transcribe the recordings of the interviews carried out in the virtual space of the application.

2.3 DATA COLLECTION PROCEDURES

Data collection was carried out through interviews in the virtual space of the WhatsApp application. The research objectives were presented to the members of the group composed of 104 participants, and individual invitations were also sent (private conversation). 28 people met the inclusion criteria in the research, and, according to their adherence, the participants were called individually for a private conversation between the researcher and the subject in the application to schedule the interview and accept the Free and Informed Consent Form (TCLE). At the scheduled times, the interviews were carried out using recorded voice messages. Thus, with each participant, in a private conversation (outside the group), the researcher started the interview by sending question-by-question in recorded voice messages, and the participants answered the questions in the same way. When submitting a question, the participant heard the question and then responded via audio recording.

2.4 DATA ANALYSIS PROCEDURE

The pre-analysis took place at the time of the transcriptions, since, according to Manzini (2004) and Bogdan and Biklein (1994), the transcription of the interview constitutes the researcher's first moment of analysis, because, while he is transcribing, he begins to make the first inferences about the speeches of the participants. The following signs used in transcriptions of oral information were adopted: for pauses (+); deletion of excerpts (...); when part of the speech was not understood and it was supposed to have been heard ( ); when syllables or words were pronounced with greater emphasis in UPPERCASE; and, to infer some statement by the researcher, (( )).

After the pre-analysis, the identification data of the research participants were analyzed to draw a profile of them. The texts of the transcripts were organized into the following categories: applications used and functionality, which was analyzed according to grounded theory.

3 RESULTS AND DISCUSSION

Research participants cited 36 applications, which assume the function of AT resources, directly related to reading and writing tasks, used on smartphones and/or tablets. Of these, 30 were intended for reading, three (3) for writing and another three (3) for both reading and writing. Among the reading applications, we highlight the following categories: a) seven (7) applications that simulated electronic and digital loupes; b) two (2) text reader applications, that is, they transformed visual textual information into audio; c) five (5) digitizers and OCR programs, these applications had the main function of transforming written contents into accessible formats; d) six (6) multifunctional (audio) reader applications, which, in addition to identifying textual information, also identified packages, objects, images and colors and; e) five (5) accessible digital and pdf bookshelf applications. The writing applications (3) were intended for enlarging and changing icons and keyboard contrast. The "notes", "agenda" and "calculator" applications were cited as applications that allowed writing and mathematical recording, as well as reading (audio or enlargement) of what they had recorded later. Chart 1 summarizes the following information about AT applications: category, function, application name and operating system in which the applications were used by respondents.

Chart 1- Applications used by people with low vision in reading and writing activities.

	Function	**Apps**	**Operational system****
Electronic/Digital Magnifiers	Applications that use the smartphone and tablet camera to simulate an electronic magnifying glass. By pointing to a certain object or printed content, it allows you to enlarge and reduce the image captured on the device.	Supervision+	Android e IOS
		Supervision for cardboard	Android
		Lupa lanterna	Android
		Lupa	Android
		Maglight	IOS
		Magnifier	Windows Phone
		Cellphone camera*	***
text readers	The sound reader of texts shared with applications. Lets you control the reading speed.	Voice Dream	IOS
		@Voice	Android
OCR and Scanners programs	Allows you to scan texts and/or convert characters into editable text accessible through OCR (Optical Character Recognition) programs. - Applications used by the group to digitize printed content (texts, cards, signs, etc.), and make them accessible to screen or text readers.	Office Lens*	Android, IOS e Windows Phone
		Google Tradutor*	IOS
		Perfect OCR*	IOS
		Text Fairy*	Android
		Scannable*	Android
Obje ct	Identifies objects, and/or colors and/or texts contained in printouts,	EYE-D	Android
		Be my Eyes	Android

	images and charts. Through the camera, the object and/or content to be identified is processed and, if found in the application's database, it will provide useful information about the captured image.	Aipoly vision	IOS
		Google Googles	Android
		Tap TapSee	IOS
		Collor ID	Androide e IOS
		Identifi	IOS
keyboard view	Allows you to enlarge and/or change the keyboard contrast, maximizing the use of the visual residue for typing.	Big Font	Android
		Huge Keyboard	Android
		Kii Keyboard	Android
Digital bookshelf and PDF.	Shelf, stores and textual supports for books and pdf. Generally used to acquire and/or store books and pdf for reading with the aid of screen magnifiers or screen and/or text readers.	Wattped*	Endoide
		Lev*	Android
		Documentos Google*	Android
		Adobe acrobat*	IOS
		Áudio Bíblia	Android
Strategies	Varied applications that allow the performance of activities that are impossible due to low vision, as they are on a device (smartphone and tablet) with various accessibility features. And apps that improve ambient brightness and image sharpness.	Gravador	Windows Phone
		Flashlight/lanterna	IOS***
		Cymera	Android
		Alarme	***
		Relógio	***
		Calculadora	***
		Agenda	***
		Notas	***

Source: Survey data.

Caption: * Applications that assume an AT function due to the way they are used by people with low vision; ** We used the operating system cited by respondents, but it may be that the application is also available on other operating systems that users have not mentioned; *** Applications that are already installed by the manufacturer and therefore do not need to be searched in virtual stores.

As for the specifics of the resources, the applications that simulate electronic and digital magnifying glasses had functions such as image freezing, lighting and contrast alteration. Image freezing allows users with low vision to capture an image that they want to be viewed (usually texts), avoiding loss of focus when access is performed directly by the camera. In addition, by freezing the image, it is possible to provide greater magnification, accumulating the application's magnification with the accessibility features of the device itself, such as zoom (screen magnification). Some of the applications are illuminated using the cell phone's flash, which illuminates the surface to be magnified by the camera, enabling better image quality. These features also allow you to change the contrast of the enlarged text, putting a black background and white letters, or a blue background and yellow letters, among other options, depending on the specifics of the applications.

Text readers generally work by transforming written content (accessible pdfs or digital books) into sound information. Among the main specificities of the aforementioned applications, the following possibilities were highlighted: changing voices and reading speed, reading in different languages, changing the text font, highlighting lines and words read, highlighting excerpts and inserting comments in text form

and audio, in addition to transferring text excerpts from the internet to be read, as well as copying content from applications.

However, for people with low vision to use text readers, the texts must be in accessible digital formats. For this reason, in the case of printed and digital texts saved in image format, scanning applications and OCR programs are used, which recognize the text contained in the image (if printed, the text must be scanned) and transform it into editable text. After this transformation, it is possible to share the file with text reader applications, or use the device's screen reader and have access to printed information and textual content of images.

In addition to applications that assist in reading texts (magnified or in audio), the research subjects cited applications that identify objects, colors, barcodes, QR codes and texts contained in images, signs, pictures, business cards and scanned prints . Generally, these applications are used to recognize food packaging, and accessing label information, such as product name, nutritional value, expiration date, mode of use, etc. Applications that identify colors and objects can work by accessing a volunteer through video calls (Be My Eyes); or through a database of products and objects previously cataloged in the application, in which, through the camera, the application tries to recognize the object through similarity; or even through the recognition of QR codes and bar codes, which emit the registered information through audio.

Another category cited by almost all participants is virtual bookshelves. According to them, these applications are increasingly accessible, being compatible with screen readers of mobile devices, allowing sharing, and changing the font and contrast, in addition to some already providing audio books. Internet access, the existence of applications that allow the acquisition of digital books and their compatibility with the accessibility features of mobile devices, have transformed the reading habits of this population, as shown in the excerpt below:

> Excerpt 1: (...) greatly increases accessibility to content, books, articles, news, something that a person who has low vision and does not have access to this type of technology, does not have accessibility to this type of content. And it would probably be very limited to find books in Braille, or even magnifying glasses and conventional book readers (P15).

Corroborating the above excerpt, the literature points out difficulties in reading tasks as the most common for people with low vision (SMITH, 2008; ALVES et al., 2009; RABELLO et al., 2014). Stating that this population may have reading difficulties even aided by optical and non-optical resources (RABELLO, 2014; ALVES, 2009), difficulties in reading what they wrote, and in understanding texts when reading is performed by another person, a sense each person reads differently, both in terms of time and the inferences made, which are individual and shape the meaning of what is read (MONTEIRO; CARVALHO, 2013). To overcome these difficulties, Alves et al. (2009) and Rabello et al. (2014) point to the benefits of the combined use of Information and Communication Technology (ICT) resources, such as screen magnifiers and screen and text readers on computers. Although the authors do not mention the use of smartphone and tablet applications as ICT resources, this research corroborates the notes made, broadening

the look of rehabilitation, health, and education professionals to the advantages of using these devices in access to reading and to writing.

Regarding writing, only 3 applications were cited, which are generally related to expanding the keyboard icons and changing the contrast. We noticed that users with greater visual acuity make use of these applications that facilitate the visualization of the keyboard, and that the others use the accessibility features of mobile devices to carry out writing activities, such as: typing by voice command and the assistants of voice.

When relating the cited applications to the age group of the population, it is noticed that subjects aged over 50 years cited a greater number of applications. This fact is directly related to the perception of resources that help to perform tasks that were previously impossible due to visual impairment, because, as a result of not belonging to the information technology generation, these participants listed resources such as clock, agenda, alarm, notes and calculator. And the use of these applications as AT resources was advocated, as they replaced resources previously used by this population, such as: sound clocks, sound calculators, adapted agendas and notepads, among others. Although these aforementioned applications are not essentially AT applications, it was possible to perceive in the users' justifications (excerpt 2) how they assumed characteristics of AT resources because they are available on accessible devices.

> Excerpt 2: Now with this cell phone, through Voice Over, I can read messages and send messages. Thing I couldn't on the other cell phone. I can program the alarm clock for example. I can use WhatsApp, send messages (+) So, my God, the cell phone is very useful for me, it gives me a lot of independence. I had to ask people to read the messages for me when I received them or I had to ask them to set the alarm clock, and today I manage to do everything myself. (P 22)

These data demonstrate the importance of the resources elaborated in the perspective of universal design, in which means and strategies that meet the diversity of human needs are already foreseen in the elaboration of the equipment itself. The ideology of universal design foresees the creation of resources, equipment and structures in the physical environment intended to be used simultaneously by all people, without requiring reforms, adaptations or additional resources to serve a specific group. Thus, its purpose is to simplify everyone's life, whatever their age, stature or ability, making products, structures, communication/information and the built environment usable by as many people as possible at low cost or without extra costs (BRASIL, 2004; CARTA DO RIO, 2004; LIMA, 2007). Based on this conception, it can be inferred that smartphones and tablets, through their accessibility features, have enabled access and use by people with visual impairments, regardless of their condition and visual performance, thus meeting the principles of design universal.

4 CONCLUSION

By proposing to identify and describe the new profile of AT resources used in reading and writing tasks on smartphones and tablets by people with low vision, this research identified 36 applications, of which 30 were intended for reading, three (3) for writing and another three (3) performing both reading and writing. These applications present functions similar to conventional resources, with the advantage of allowing the sharing and combined use of several applications, as well as finding many functions in a single device. We realized that these applications have given people with low vision access to information, and prevented them from abandoning tasks that require reading and writing.

From this survey it was possible to identify the potential of these applications in solving reading and writing difficulties faced by people with low vision. The survey was carried out with a heterogeneous group in terms of age, visual performance, work and academic activities, however, it would be interesting if there was greater diversity in relation to the pathology, which could provide a different profile of applications and tasks. This time, it is suggested for future studies samples with greater diversity regarding the causes of low vision, in addition to investments, dissemination and teaching programs to increase the use of these applications.

In addition, the adoption and financing of tablets in government programs can constitute a solution to the problems of access to reading for students with visual impairments, since didactic and literary books can be made available on these interfaces, which become immediately accessible with the use text and screen readers, screen magnifiers, color inversion, font enlargement, among others. Dispensing, in some cases, the voluminous enlarged books. It is also added that the use of these devices in the school context should be universalized, due to the benefits they would bring both to students with and without disabilities.

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