DIGITAL TECHNOLOGIES OF INFORMATION AND COMMUNICATION AS TEACHING AND LEARNING TOOLS FOR THE VISUALLY IMPAIRED: A BIBLIOGRAPHIC REVIEW

TECNOLOGIAS DIGITAIS DA INFORMAÇÃO E COMUNICAÇÃO COMO FERRAMENTAS DE ENSINO E APRENDIZAGEM DE DEFICIENTES VISUAIS: UMA REVISÃO BIBLIOGRÁFICA

LAS TECNOLOGÍAS DIGITALES DE INFORMACIÓN Y COMUNICACIÓN COMO HERRAMIENTAS DE ENSEÑANZA Y APRENDIZAJE PARA PERSONAS CON DEFICIENCIAS VISUALES: UNA REVISIÓN BIBLIOGRÁFICA

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ABSTRACT: It is estimated that there are 314 million people with visual impairment in the world; therefore, this manifestation is classified as having the highest prevalence in Brazil, contemplating a total of 18.8%. As a development of Information and Communication Digital Technologies (ICT), it has been applied in new environments. This bibliographic review of the quantitative approach aims to compile studies developed in the last decades about the application of DTIC in the teaching and learning process of visually impaired people. The PICo Strategy was applied to guide the selection of articles. The collection of articles was carried out through research in Google Scholar, Scielo, CAPES Periodicals, Science Direct, and NCBI databases. Screen readers and tactile prototypes are some examples of technologies developed in the studies found. With this, it is understood that these DTICs are applied in several places and that it is already a reality that has been studied and put into practice with visually impaired people.

KEYWORDS: Education for the Visually Impaired. DICTs. Education.

RESUMO*: Estima-se que existam 314 milhões de pessoas com deficiência visual no mundo. Logo, essa manifestação é classificada como de maior prevalência no Brasil, contemplando um total de 18,8%. Com o desenvolvimento das Tecnologias Digitais da Informação e Comunicação (TDIC), a tecnologia assistiva vem sendo aplicada em novos ambientes. Esta revisão bibliográfica, de abordagem quantitativa, tem como objetivo compilar estudos desenvolvidos nas últimas décadas sobre a aplicação de TDIC no processo de ensino e aprendizagem de deficientes visuais. Foi aplicada a Estratégia PICo como norteadora da seleção dos artigos. A coleta dos artigos foi realizada por meio da pesquisa nos bancos de dados Google Scholar, Scielo, Periódicos CAPES, Science direct e NCBI. Leitores de telas e protótipos táteis são alguns exemplos de tecnologias desenvolvidas nos estudos encontrados. Com isso, é compreendido que estas TDICs são aplicadas em diversos locais, e que já é uma realidade que vem sendo estudada e colocada em prática com deficientes visuais.*

PALAVRAS-CHAVE*: Ensino de Deficientes Visuais. TDIC. Educação.*

RESUMEN*: Se estima que hay 314 millones de personas con discapacidad visual en el mundo, por lo tanto, esta manifestación se clasifica como la de mayor prevalencia en Brasil, contemplando un total de 18,8%. Como desarrollo de las Tecnologías de la Información y la Comunicación Digital (TDIC), se há aplicado en nuevos entornos. Esta revisión bibliográfica, de enfoque cuantitativo tiene como objetivo recopilar estudios desarrollados en las últimas décadas sobre la aplicación de TDIC en el proceso de enseñanza y aprendizaje de los discapacitados visuales. Se aplicó la Estrategia PICo para guiar la selección de artículos. La recopilación de artículos se llevó a cabo a través de la investigación en las bases de datos Google Scholar, Scielo, Periódicos CAPES, Science direct y NCBI. Lectores de pantalla y prototipos táctiles son algunos ejemplos de tecnologías desarrolladas en los estudios encontrados. Con eso, se entiende que estas TDICs son aplicadas en varios lugares, y que ya es una realidad estudiada y puesta en práctica con personas con deficiencia visual.*

PALABRAS CLAVE*: Educación para Deficientes Visuales. TICDs. Educación.*

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Introduction

When it comes to visual impairment, few people would know how to define what it means for a person to have this type of disability. According to the World Health Organization (WHO, 2021), a person is classified as visually impaired when "They present functional visual impairment even after treatment or correction through the use of glasses" (WHO, 2021, p. 01, our translation).

It is estimated that there are 314 million people with disabilities in the world, with 46 million of these individuals residing in Brazil. Therefore, this manifestation is classified as the most prevalent in this country, covering a total of 18.8% of Brazilians (BRASIL, 2010). In Brazil, visual impairment is subdivided into 3 (three) categories: low vision, close to blindness and total blindness (PARANÁ, 2012). Of these categories, the one with the greatest representation is total blindness, comprising 45 million individuals worldwide (BRAZIL, 2010).

Taking into account the previously mentioned situation, what can be done to help these individuals in their learning process?

The solution that has been widely studied is the use of Digital Information and Communication Technologies (DIT), such as computers, *smartphones*, *tablets*, among other digital media. Studies have shown that its use can have a positive impact on the learning of these individuals (MCCREATH; CUTHBERTSON, 2005; SINGHAL *et al.*, 2019).

TDIC has been evolving exponentially over the years, becoming increasingly applicable as a facilitator in different aspects of human life. They can be used for research, diagnosis, protection, dissemination, among other applications (BALLETTI *et al.,* 2017). The use of the *touchscreen* interface on *tablets* and *smartphones* has already presented several benefits for the majority of people who use them (TRAVIS; MURANO, 2014).

The advances in TDIC in helping the visually impaired have had a positive impact on their independence (FERRI; GIANNOUMIS; O'SULLIVAN, 2015), taking into account that the difficulties experienced by the visually impaired are directly linked to the fact that society is not adequate for the inclusion of these individuals.

There is still resistance to using TDIC as a way of helping people with disabilities. In part, this may be associated with the idea that TDICs are linked to an attempt to "cure" the disability, being interpreted as yet another barrier that must be overcome by the visually impaired (JAEGER, 2014; SCHNEIDER, 2012). Probably because of these barriers, studies

have shown that the amount of material available in an accessible way for the visually impaired is still very small (VASHISTHA *et al.*, 2014).

On the other hand, we can see a change in this scenario, with a slow increase in the number of works that seek to use TDICs with the aim of eliminating barriers for the visually impaired (FERRI; GIANNOUMIS; O'SULLIVAN, 2015). One of the areas that has been seen as highly encouraged in the application of these TDICs is Education (RETORTA; CRISTOVÃO, 2017). Federal Universities present platforms for depositing study materials, where tests can be taken and information can be transmitted from teachers to students.

In this sense, the role of innovations, methodologies, equipment, etc., comes from the teacher, so that they enable inclusive digital education and that the disabled student becomes aware of their active role within the classroom (LEMOS; FERNANDES, 2020). It is also important to highlight that implementing and monitoring the use of technologies in the classroom is of great importance for developing digital skills and abilities for students (LEÓN VALDEZ; GARCÍA LÓPEZ; CUEVAS SALAZAR, 2021).

Knowing this, expanding its applications to improve digital inclusion and the teaching-learning process for visually impaired people can be a key step in reducing the gap between visually impaired people and modern society. Therefore, the demonstration and association of studies already developed with the theme of applying TDICs as a facilitator for the visually impaired are of vital importance for the integration of their results and understanding of the current limitations observed by these studies.

This bibliographic review aims to compile studies developed in recent decades on the application of TDIC in the teaching-learning process for visually impaired people. It is hoped that, through the presentation of these studies in the same location, it will be possible to understand the gap in this topic and encourage more studies to be carried out in this area.

Thus, the text is arranged in four parts. It begins by introducing the theme, study methodology, results and discussion, and presents the conclusive summaries.

Methodology

In the development of this article, the theme of "digital technologies applied in the learning of visually impaired people" was selected. Therefore, the PICo Strategy was applied as a guide for the selection of articles in this review, thus avoiding the search for information that is not relevant to the study. This strategy aims to define a population (corresponding to the letter P), a study interest with this population (corresponding to the letter I), understand the context that one wishes to study (corresponding to the letter C) and the result expected from the study, also called *outcome* (corresponding to the letter O) (SANTOS; PIMENTA; NOBRE, 2007).

Using this strategy, two questions were developed that guided the entire development of this article. These questions are called "guiding questions", which define the interest of the research and direct towards a better final result. The questions were: What digital technologies are being applied to learning for the visually impaired? How are they used within this context?

The integrative review, with a quantitative approach, is a broad review method that allows the inclusion of different studies, compiling the knowledge obtained by them, synthesizing them for a better understanding of the phenomenon covered in the previously selected topic (SOUZA; SILVA; CARVALHO, 2010).

The articles were collected through a search in the following article databases: *Google Scholar, Scielo*, Periódicos CAPES, *Science direct* and NCBI (*National Center for Biotechnology information*). The keywords used for the research were "Digital technologies", "visually impaired" and/or "teaching". These words were searched in Portuguese, English and Spanish on all previously mentioned platforms.

Figure 1 – Study selection flow diagram for the integrative review
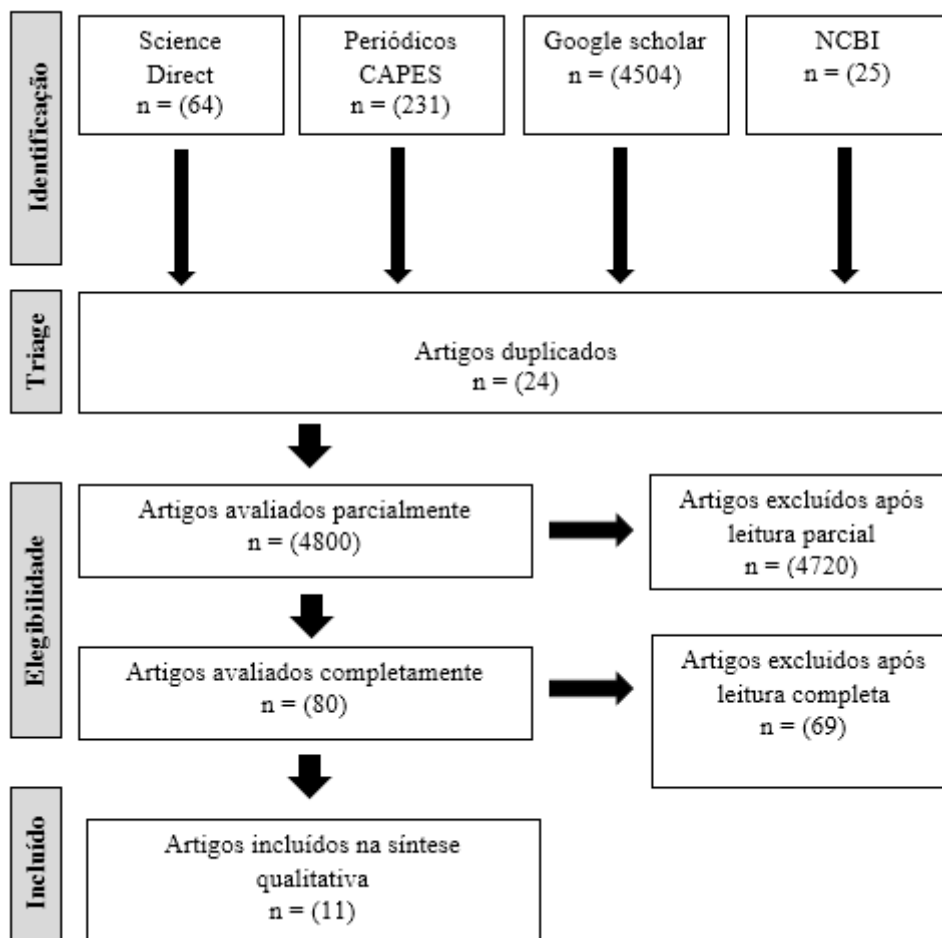
Source: Prepared by the authors (2022)

The inclusion criteria applied in this review were: articles published in the determined languages, articles related to the topic of the article and articles published in the time interval between 2000 and 2021. As exclusion criteria, the following were used: duplicate articles, articles outside the determined topic, theses, dissertations, monographs, abstracts, articles published in conferences, review articles and articles in languages not listed. In figure 1, mentioned previously, there is a *Prisma Flow*, which is the detailed graphic representation of the article selection process (ANDRADE *et al.*, 2019).

Results and discussion

Table 1 presents the results found through the systematic literature review, in which we can see that there are few studies focused on the topic of applying TDICs in the teaching and training of visually impaired people, a total of ten studies. Furthermore, we can see that the number is even lower in research carried out in Brazil. With this, we can point out the precariousness of research directed towards this very relevant line.

Using digital technology as a method of reducing segregation between disabled people and the population has been a focus in studies published in the 21st century (SINGHAL *et al.*, 2019). Therefore, it can be understood that these TDICs are applied in different locations; in particular, in education systems (SANTOS *et al.*, 2012). The use of these technologies within education aims to expand meaningful learning, as well as guarantee educational training for the disabled population (MENEZES; RIBEIRO, 2018; SANTOS *et al.*, 2012).

TDIC, in addition to ensuring better learning, guarantees an environment without distinction of race, gender, disability, ensuring that each individual can use technology in the most appropriate way for them (MENEZES; RIBEIRO, 2018). With its use, we can see positive results in the consolidation of knowledge (MCCREATH; CUTHBERTSON, 2005; RETORTA; CRISTOVÃO, 2017). Furthermore, the *feedback* presented by research participants demonstrates that its impact goes beyond what was expected, making people with disabilities feel like they are a functional part of society (MCCREATH; CUTHBERTSON, 2005; O'SULLIVAN *et al.*, 2015).

There is no correct digital technology that is capable of meeting all the needs of a visually impaired person. However, it can be understood that efforts have been made to develop tools that use TDICs as learning methodologies that facilitate this process, such as the development of applications (COSTA *et al.*, 2015; MOELLER; SGANZERLA; GELLER, 2018), development of educational courses (CARVALHO *et al.*, 2018), making materials available in *online repositories* (SINGHAL *et al.*, 2019), up to the development of tactile surfaces that interface with computerized systems (O'SULLIVAN *et al.*, 2015).

Many barriers, however, need to be overcome. Even with all the encouragement received by educational institutions, it is widely understood that they are still not prepared to accommodate visually impaired individuals (VOJTECH, 2016). A study carried out by Rogec Vojtech, in 2016, demonstrated that the electronic accessibility of universities in the Czech Republic and the Slovak Republic were below satisfactory (VOJTECH, 2016). These values can probably be extrapolated to universities in several other countries, including Brazil.

Table 1 – Main references of articles included in the integrative review

Author and year	Goals	Main outcomes	Conclusions	Journal
McCREATH, G.; CUTHEBERTSON, J. 2005	Development of digital audio material DAISY (*Digital Accessible Information System*), including, which helps in teaching the visually impaired.	Individuals who used DAISY had a positive impression, demonstrating that it guaranteed greater accessibility to content, since, in libraries, content was not presented in an accessible way for the visually impaired.	The use of a virtual system that presents information in electronic audio format is a major step towards improving teaching for the visually impaired.	Elsevier
SANTOS, CP *et. al*. 2012	Use InfoAcesso as an initiative to collaborate with the teaching-learning process of individuals with disabilities.	The application of this initiative positively impacted the participants in the social, regional, economic, personal and scientific context.	The project enabled significant learning, both for members of the teaching team and for people with visual impairments.	Experience
COSTA, LCP *et al*. 2015	Features an Affordable Digital Book for Education developed for *tablets* using touch, audio and vibration interface to complement affordable digital book solutions for educational purposes.	A digital book was developed that featured *quizzes*, geometric shapes, maps, figures and graphs, games and a book reader. It was seen that the vibratory *feedback* was not sufficient for its usability, so auditory *feedback* was added.	The technology demonstrated a positive impact on research participants. The work hopes to contribute to improving teaching for disabled and non-disabled people.	IEEE *Transactions on Consumer Electronics*
O'SULIIVAN, L. *et. Al.* 2015	Present an *Audio prototype Tactile Map* (ATM) that provides specialized audio *feedback* based on the user's interaction with the haptic element.	The usability test with five visually impaired subjects had positive results. Clear tactile *design* to learn about the place before entering was one of the highlights.	The prototype was highlighted by blind participants as useful, informative and easy to use.	*International Journal of Mobile Human Computer Interaction*

RETORTA, MS; CRISTOVÃO, VLL 2017	Investigate the role of smartphones in teaching English to visually impaired students.	Initially, the students did not have skills in using smartphones; however, after training, they acquired necessary skills, writing texts in both Portuguese and English.	The use of smartphones helped students improve their learning and social development.	*Languages*
CARVALHO, LV *et. al.* 2018	Develop an accessible education course for the blind on hypertension prevention.	Through the Digital Educational Materials Development Model, an accessible course was built through analysis and planning stages; modeling; Implementation; evaluation and maintenance; distribution.	An Assistive Technology was built, a distance learning course on hypertension prevention made available in the AVA Solar Virtual Learning Environments.	Brazilian Nursing Journal
DAMSMA, P.; NORGAARD, J. 2018	Addressing issues that blind children experience when they have no programming experience and are novice users of *VoiceOver*, a built-in screen reader for iOS devices.	Development of an innovative educational iPad app that allows blind children to learn the fundamentals and concepts of coding.	The team claims that the project developed proves to be a valuable support for young children who are blind to take their first steps into the world of coding.	*Journal of the South Pacific Educators in Vision Impairment*
MENEZES, NC; RIBEIRO, SF 2018	Present the audiobook, a valuable informational resource for educational training and the development of reading and research habits for people with special needs.	Visually impaired people participating in the project know and use the resource actively and say that it encourages reading.	The article highlighted that the use of audiobooks contributes to the educational training of participants in the BPEB Braille Sector.	Access point
MOELLER, JD; SGANZERLA, MAR; GELLER, M. 2018	*Math Touch* Assistive Technology based on Contact and Golden Material, to assist in teaching basic Mathematics concepts to blind and/or low vision	Math *Touch* was well accepted by the students participating in the project, who performed satisfactorily in the activities developed, creating several possibilities for new activities and challenges	The *Math Touch project* helped children with visual impairment and/or low vision acquire basic mathematical knowledge.	Qualitative research

	students.	for these students.		
SINGHAL, R. *et. al*. 2019	Development of an audio repository platform for visually impaired students.	The platform was successfully developed, giving students the ability to access classes and lectures organized by semester and topic.	The article demonstrated how technology can help in teaching visually impaired students.	Springer

Source: Prepared by the authors (2022)

On the other hand, we can see a rise in studies aimed at better developing these TDICs with the aim of improving teaching for the visually impaired (MENEZES; RIBEIRO, 2018; O'SULLIVAN *et al.*, 2015; SINGHAL *et al.*, 2019). These studies encourage and direct new researchers to enter this field that is so lacking in development, and these same studies have already been using their learning to improve and modernize their technologies (MCCREATH; CUTHBERTSON, 2005; MOELLER; SGANZERLA; GELLER, 2018).

Final remarks

The development of Digital Information and Communication Technologies (DICT), as a way of triggering the teaching and learning process for visually impaired people, is already a reality that has been studied and put into practice. Screen readers, digital books, accessible courses and tactile prototypes are some examples of technologies developed in the studies found, which aim to include children, young people and adults with visual impairments in the educational context.

The lack of teacher training for the creation and use of technologies that help blind students is still a problem, along with the precariousness of universities and schools that facilitate or promote this creation. But it is possible to highlight and affirm the evolution in the process of including visually impaired people within schools and universities, mainly through the use of TDICs for the construction and adaptation of technologies. Finally, little by little, we can make teaching and learning for visually impaired people a more practical, enriching and meaningful process, so that we can train qualified people who can exercise their rights with more autonomy and criticality.

The results presented here will serve as a basis for future research and, mainly, for teachers who tirelessly seek the inclusion of students with visual impairments in their classes, as well as, it is expected that they will contribute to encouraging further studies on this theme.

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