

Digital Accessibility And Inclusive Education: A Systematic Review On The Use Of Assistive Technologies For The Literacy Of Students With Special Educational Needs

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Abstract:

This research aimed to analyze the opportunities of using assistive technologies for the literacy of students with special educational needs. To this end, a systematic review was carried out under the guidance of the PRISMA guidelines. The search included complete Brazilian articles from 2020 to 2023, excluding theses, dissertations, abstracts, monographs and duplicate articles. The search was carried out on academic platforms such as Google Scholar, Scielo and Web of Science, with inclusion and exclusion criteria for the selection of studies. The articles were analyzed in two separate stages. In the first stage, initial screening was carried out, which focused on assessing the titles and abstracts of the articles. Then, in the second stage, the full texts of the articles that passed the initial screening were analyzed. As a result, a sample of 11 articles was obtained, where it was possible to see the importance of the use of Assistive Technologies (ATs) in the literacy and inclusive education of students with disabilities. ATs have emerged as essential tools for eliminating barriers and guaranteeing equal educational opportunities, personalizing teaching according to students' individual needs. In addition, AT promotes student autonomy and contributes to breaking down the stigmas associated with disabilities, which fosters an inclusive learning environment where diversity is respected and valued. The interactivity provided by these technologies also promotes the engagement of students with disabilities, making the literacy process more interactive. However, challenges such as a lack of resources and the need for teacher training emphasize the importance of investment to ensure the effectiveness of AT and make inclusion a reality. Thus, adequate investment in AT has the potential to transform education and society, providing equal opportunities and promoting the full development of all students, regardless of their disabilities.

Key Word: Assistive technologies; school inclusion; students with disabilities.

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I. Introduction

Digital accessibility and inclusive education are two interconnected areas that play a crucial role in promoting equal opportunities and access to education for all people, regardless of their abilities, limitations or needs. The combination of these two concepts has the power to transform the way teaching is transmitted in classrooms, adapting to the interactions of a world that is increasingly digital (TEIXEIRA, 2014).

Digital accessibility refers to the creation of digital products, services and environments that can be used effectively by all people, including those with visual, hearing, motor and cognitive disabilities, among others. This

means making websites, applications, electronic documents and information and communication technologies accessible to everyone (SANTOS et al., 2021).

On the other hand, inclusive education is a pedagogical approach that seeks to ensure that all students, including those with disabilities, learning difficulties or special needs, have the opportunity to participate in mainstream educational environments. Inclusive education involves adapting the curriculum, teaching methodologies and the school environment to meet the individual needs of each student, creating a learning environment where diversity is valued (FRANCO; GOMES, 2020).

In this scenario, assistive technologies play a crucial role in realizing digital accessibility in inclusive education. These technologies are tools, devices and software designed to support people with disabilities in carrying out tasks that might otherwise be challenging or inaccessible. The proper integration of assistive technologies into the educational environment can offer a number of benefits for both students with disabilities and educators (PEREIRA et al., 2023).

According to Oliveira (2022), a significant part of the research in this area has focused on evaluating the effectiveness of assistive technologies in promoting literacy among students with disabilities, including visual, hearing, motor and cognitive impairments. Thus, the combination of digital accessibility and inclusive education, along with the use of assistive technologies, is key to ensuring that education is truly accessible to all people, regardless of their individual abilities and needs. This approach not only promotes equal opportunities, but also recognises and values the diversity of students in educational environments.

In this context, this research sought to analyze the opportunities for using assistive technologies for the literacy of students with disabilities. In this context, this research sought to analyze the opportunities for using assistive technologies for the literacy of students with disabilities. It is hoped that the results of this research will provide theoretical and practical support that will contribute to the advancement of knowledge around inclusive education and the literacy process of students with disabilities through the use of assistive technologies.

II. Material And Methods

This study is a systematic review, which is a type of research that seeks to systematically synthesize and analyze the evidence available in the literature on a specific topic (GALVÃO; RICARTE, 2019). The systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which, according to Page et al. (2022), is a set of recommendations for the conduct and transparent reporting of systematic reviews.

The search for articles took place on scientific platforms, including Google Scholar, Scielo and Web of Science, which are recognised for hosting a wide range of academic publications. The search for articles was carried out taking into account the use of keywords and Boolean operators, following the following search sequence: ("assistive technology") and ("literacy") and ("contributions") and ("students with special needs").

As an inclusion criterion, only articles that addressed the relationship between assistive technology and the literacy process of students with disabilities were considered. In this case, only full-length articles published between 2020 and 2023 were included.

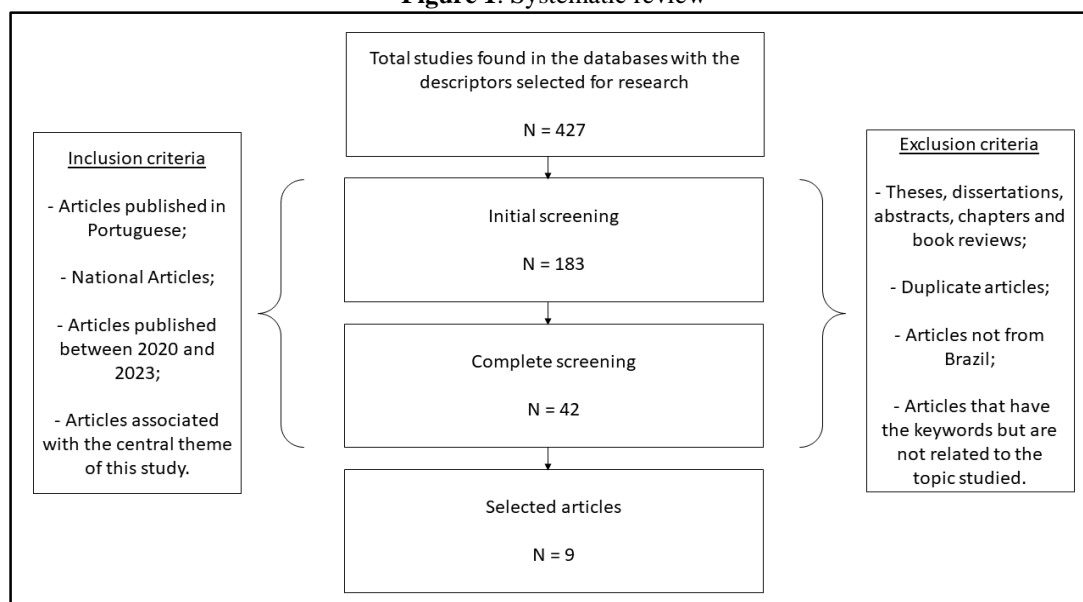
As for the exclusion criteria, articles that did not deal directly with the relationship between assistive technology and the literacy of students with disabilities were excluded, ensuring that only studies directly relevant to the topic were considered. In addition, theses, dissertations, expanded abstracts, monographs and duplicate articles were excluded. Articles from other countries were also excluded.

As recommended by Brizola and Fantin (2017), the articles were analyzed in two stages: initial screening and full screening. In the first screening stage, the titles and abstracts of the articles were analyzed to see if they met the previously defined inclusion and exclusion criteria. Articles that did not fit the scope of the study were discarded at this stage.

In the second screening stage, the articles selected in the previous stage were analyzed in more detail. The full texts of the articles were reviewed to assess whether they really addressed the relationship between assistive technology and the literacy process for students with disabilities. Exclusion criteria were applied again at this stage to ensure that only relevant articles were included in the review. In addition, an assessment of the methodological quality of the included articles was carried out in order to identify any potential bias and ensure the reliability of the evidence reviewed.

After screening and analyzing the articles, the relevant data was extracted and synthesized appropriately. This involved compiling information on the methods, results and conclusions of each study, as well as identifying trends and patterns that emerged from the articles reviewed. As a result, a sample of 9 articles was obtained, as shown in figure 1 below.

Figure 1. Systematic review



Source: Research data (2023).

Once the nine articles had been selected, the data from the studies was summarized and organized in a spreadsheet containing the names of the authors, the research objectives and the main findings.

III. Result

As a result of the systematic review, 9 articles were found that addressed the use of assistive technologies for the literacy of students with special educational needs. Table 1 shows these articles.

Table 1. Articles from the systematic review

Authors	Research objective	Conclusion of the research
Paulino and Filho (2023)	To analyze the impact of literacy practices and inclusive education on the learning process of students with special needs, with a focus on the role of assistive technologies in this process.	Literacy, literacy and inclusive education practices play a significant role in the learning process of students with special needs. The research highlighted the importance of personalized strategies adapted to students' individual needs, emphasizing the value of multi-sensory practices, the use of assistive technologies and the promotion of collaborative work between educators, family members and specialized professionals. However, challenges were observed, such as the lack of adequate resources and the need for ongoing training to enable teachers to cope with new technologies.
Frazão et al. (2020)	To bring to light the latest developments in Assistive Technology used by people with visual impairments that can be used in the classroom, as well as to present the contributions of Assistive Technology (AT) as resources that facilitate the learning process of students with visual impairments through innovative applications.	The text emphasizes the importance of assistive technologies for people with visual impairments, and that encouragement and appropriate education are fundamental to the development of these individuals, promoting their autonomy and overall growth. The use of assistive technologies at school is seen as an essential resource for making the learning process more inclusive, allowing interaction with other students and facilitating the assimilation of information. In addition, the text emphasizes the need for teachers to adapt to new educational technologies, training themselves to better meet the needs of visually impaired students.
Souza et al. (2023)	Addressing the use of assistive technologies as a methodology to facilitate the learning process of students with disabilities.	The text highlights the importance of assistive technologies in education, emphasizing that technologies can be a crucial tool for improving the learning of students with special needs. It points out that assistive technologies are essential for optimizing the learning process and exploiting the potential of each student. The use of computers and software, such as the Paint programme, is mentioned as an effective way of improving students' motor coordination and facilitating the creation of drawings and shapes. However, the text notes that access to software developed for special education is limited and calls for awareness and an increase in the production of electronic material aimed at the inclusion and promotion of people with disabilities. It

		concludes by emphasizing that computers and technologies can help overcome barriers faced by students with disabilities, contributing to their cognitive and intellectual development and self-esteem.
Gonçalves and Bittencourt (2022)	To analyze the possibilities presented by the scientific productions developed in Brazilian Public Universities, from 2016 to 2020, regarding the use of Assistive Technology (AT) as a form of inclusion for students with Special Educational Needs (SEN).	Analyzing academic productions on the use of Assistive Technology in the inclusive education of students with Special Educational Needs reveals significant advances in this field. Technology has played a fundamental role in promoting inclusion and developing strategies to meet the specific needs of these students. Studies point to efforts in various social fields to promote inclusion and have proposed new approaches to teaching and learning through Assistive Technology. The use of AT has enabled a more inclusive life for students with SEN, whether permanent or temporary, allowing them to participate in social life.
Silva, Cruz and Fortes (2020)	Evidence of the use of assistive technology, integrating the role of monitoring.	The article highlights the importance of assistive technology in teaching physics to students with special educational needs (SEN). It highlights how this personalized approach helps students to better understand concepts, overcoming learning barriers, including for deaf and blind students. Assistive technology is used to adapt materials, provide practical activities and readiness to deal with different SEN, improving the academic success of these students.
Fonseca and Schirmer (2020)	Present and discuss how applications for multifunctional mobile devices with the Android operating system can contribute to the learning of people with Autism Spectrum Disorder.	The text addresses the need to implement new pedagogical practices to support the inclusion and learning of autistic children in mainstream schools. It emphasizes that traditional methods can be uninteresting due to the difficulty children with Autism Spectrum Disorder (ASD) have in concentrating and interacting. The use of multifunctional mobile devices and their applications should not replace the work of the teacher, but act as a tool to bring the teacher and student closer together. Inclusion is not just about having children with ASD in mainstream classes, but requires specific methods and resources to meet their needs. Technology can play a crucial role in inclusive education, provided it is carefully evaluated, taking into account factors such as the child's interest, personalisation, scientific basis and accessibility. The shift to a collaborative model of teaching requires rethinking school culture and embracing technologies as support tools for people with ASD.
Frasson, Bortoluzzi and Ghisleni (2022)	Present a reflection on the use of Assistive Technologies (AT) as a tool to support the work of English language teachers who have special education students in their classrooms.	The article concludes by emphasizing the importance of including students with disabilities in the municipal school system and how Assistive Technologies can facilitate their participation in school. These technologies range from playful educational applications to simple adaptations such as text supports. Assistive Technology is not limited to screens or software, but encompasses any resource that helps students with disabilities to learn and participate actively. The use of Assistive Technology requires creativity on the part of teachers, who must find alternatives suited to the students' needs. The text also emphasizes the importance of actively involving students with disabilities and encouraging them to interact with their peers. Assistive Technology is seen as a way of enriching teaching and promoting student autonomy. Finally, it suggests that researchers expand their knowledge of Assistive Technology aimed at specific cases in Special Needs Education in order to promote autonomy and maintain students' interest in learning.
Cruz, Alves and Nunes (2020)	Analyzing the advances of technology in the teaching-learning process of deaf students.	The article focuses on the importance of assistive technologies in the education of deaf students, emphasizing that technological advances are fundamental to guaranteeing access to quality education for this public. Technologies play a crucial role in the learning of deaf students, providing opportunities for effective interaction in society and making sign language a learning tool. It is concluded that new educational technologies have made a significant contribution to deaf students, allowing them to become builders of their own stories by advancing the teaching-learning process.
Oliveira (2022)	Analyzing the contributions of the use of assistive technologies as resources that enhance inclusive education for students with disabilities	The research concludes that Assistive Technologies developed for students with disabilities are essential tools that contribute to the construction of learning and the creation of inclusive environments. Assistive technologies facilitate pedagogical practice, promote student participation and autonomy, and are fundamental to improving the

		quality of inclusive education. Therefore, the use of these technologies has enabled significant advances in education, providing opportunities for classroom activities and driving positive changes in the educational process.
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Source: Research data (2023).

Through the systematic review, it can be seen that the studies consistently highlight the importance of Assistive Technologies in the teaching-learning process of students with special needs. The study by Paulino and Filho (2023) provides fundamental insight into the relevance of assistive technologies and literacy and inclusive education practices in the context of learning for students with special needs. The importance of these practices is crucial, as they play a significant role in promoting the cognitive development and autonomy of these students. The personalized approach adapted to individual needs is particularly highlighted, underlining the need to recognise and value differences in the classroom.

However, the study also highlights the challenges that persist in this scenario. One of the main challenges identified is the lack of adequate resources, which can include everything from adapted teaching materials to assistive technology devices. The limited availability of these resources can hinder the full potential of inclusive education. In addition, the study draws attention to the need for ongoing teacher training. The rapid evolution of assistive technologies and pedagogical approaches requires educators to be constantly updated and prepared to integrate these tools into their practices.

In this sense, the importance of the intersection between literacy practices, inclusive education and assistive technologies for students with special needs is noted. While recognising the benefits of these approaches, the study also calls for challenges to be overcome, emphasizing the need for investment in resources and teacher training to guarantee truly inclusive, quality education for all students.

The study by Frazão et al. (2020) analyzes the importance of assistive technologies in the context of people with visual impairments. The study emphasizes the contribution of these technologies to promoting more inclusive education. By emphasizing this issue, the authors highlight the ability of assistive technologies to provide equitable learning opportunities for visually impaired students, helping to break down barriers and prejudices that have historically been obstacles to their full participation in society.

Frazão et al. (2020) draw attention to a crucial point: teacher training. The researchers argue that for assistive technologies to be used effectively, it is essential that educators are properly trained. This involves not only technical knowledge about how the technologies work, but also a sensitive understanding of the needs and challenges faced by visually impaired students. Teacher training thus becomes a key element in promoting educational inclusion.

The authors' concern with teacher training is extremely relevant, as the successful implementation of assistive technologies depends to a large extent on the competence and commitment of educators. Well-trained teachers not only know how to use technologies effectively, but are also able to create a welcoming and inclusive learning environment where visually impaired students feel valued and supported in their educational journey.

In this sense, assistive technologies are seen as key tools for the inclusion of visually impaired people in education. For these technologies to be used effectively, there is a pressing need to invest in teacher training in order to ensure that these technologies are applied effectively and that inclusion becomes a tangible reality in the educational environment. The research thus makes a significant contribution to the advancement of inclusive education and the promotion of a more equal society.

According to Souza et al. (2023), assistive technologies are essential tools for improving the learning process of students with special needs. This is because these technologies play a fundamental role in promoting inclusion and overcoming the specific challenges that these students face in the educational environment.

The use of computers and software such as Paint helps to improve students' motor coordination. This approach is particularly important as it recognises the importance of adapting technologies to the individual needs of students. Paint, for example, can be a valuable tool for developing and improving motor coordination, allowing students with special needs to have a more effective and satisfying learning experience.

In addition, the study emphasizes the urgent need to raise awareness and produce electronic materials aimed at inclusion. This implies not only the creation of accessible educational content, but also the dissemination of knowledge about the use of assistive technologies and the importance of their implementation in educational practices. Awareness-raising plays a critical role in ensuring that education is truly inclusive and that technological resources are available to everyone who needs them.

To complement this, Gonçalves and Bittencourt (2022) offer an analysis of academic productions that focus on the use of Assistive Technology in the context of inclusive education for students with Special Educational Needs. This research plays a fundamental role in consolidating existing knowledge in this area and highlighting the significant advances that have been made.

One of the main contributions of the study by Gonçalves and Bittencourt (2022) is to highlight how Assistive Technologies play a central role in promoting the inclusion of students with Special Educational Needs. These technologies have the potential to eliminate significant barriers in the educational process, allowing these students to access the curriculum more effectively and participate fully in school life.

The authors point to the positive transformation that Assistive Technologies have generated, making more equitable and inclusive education possible. This includes the ability to personalize learning to meet students' individual needs, adapting resources and approaches according to specific demands. This aspect is crucial, as it recognises the diversity of learning styles and needs of students with Special Educational Needs, thus promoting teaching efficiency.

Authors such as Silva, Cruz and Fortes (2020) offer an important analysis of the role of assistive technology in the context of teaching physics to students with Special Educational Needs (SEN). One of the main highlights of the article is the emphasis on personalizing teaching, which is key to helping students with SEN understand complex physics concepts. Personalisation involves adapting content, teaching strategies and technological tools according to the individual needs of each student, taking into account their abilities, difficulties and learning styles. This personalized approach is crucial to maximizing the effectiveness of teaching and ensuring that students with SEN have the opportunity to reach their full academic potential.

Nevertheless, the authors highlight assistive technology as a powerful tool for overcoming the learning barriers that students with SEN may face when studying physics. Assistive technology encompasses a variety of devices, software and resources that are designed to help people with disabilities or special needs, facilitating access to information and participation in educational activities.

In the context of physics teaching, assistive technology can be used to translate complex concepts into more accessible formats, provide communication support, adapt teaching materials and offer personalized learning strategies. This contributes significantly to inclusion and equal educational opportunities for students with SEN.

Assistive technology not only improves access to content, but also promotes the independence of students with SEN, enabling them to actively participate in lessons and become more autonomously involved in the learning process. This is crucial for raising students' self-esteem and promoting a more inclusive and welcoming learning environment. In addition, assistive technology can help reduce the stigma associated with disabilities, as classmates and teachers realize the positive impact it has on the ability of students with SEN to engage in learning.

According to Fonseca and Schirmer (2020), the use of applications for multifunctional mobile devices are essential tools to help the development and learning of children with Autism Spectrum Disorder (ASD). This is because it is important to adopt specific methods and resources to meet the needs of these children, recognising that ASD is a spectrum of conditions with unique characteristics for each individual. In this context, personalisation emerges as a key element in the teaching and learning process to ensure that children with ASD benefit fully from educational technologies.

Frasson, Bortoluzzi and Ghisleni (2022), on the other hand, focus on the use of Assistive Technologies in the context of English language classes for students with disabilities, highlighting the importance of including students with disabilities in English language classes. This emphasizes the need to provide equal educational opportunities to all students, regardless of their abilities or disabilities. Inclusion is not only an ethical approach, but also one that promotes an enriching and diverse learning environment.

Assistive technologies can help students with disabilities learn English. These technologies can include translation software, screen readers, accessible language learning applications, among others. In this scenario, teachers play a key role in finding appropriate alternatives to the needs of students with disabilities, which involves the ability to adapt the curriculum and teaching methodologies, as well as using Assistive Technologies effectively to support student learning. Teachers need to be creative and flexible in the way they approach English language teaching, taking into account the different needs and learning styles of their students.

According to Cruz, Alves and Nunes (2020), assistive technologies can also be used for the literacy of deaf students. Assistive technologies play a key role in promoting inclusion and developing sign language as a learning tool. The inclusion of deaf students in mainstream education has been a challenge that requires innovative and adaptive approaches. Assistive technologies play a vital role in this context, enabling deaf students to access information and learning resources more effectively.

The use of assistive technologies for deaf students can include the use of applications, communication devices and other technological tools that aid comprehension and communication. In addition, the study highlights the importance of sign language as an essential tool in the educational process of deaf students. Sign language is the natural language of the deaf community and plays a fundamental role in their communication and cultural expression. Technology plays a crucial role in the development and promotion of sign language, making it accessible to a wider audience and facilitating its use in the educational context.

In this sense, assistive technologies not only promote inclusion, but also help to overcome communication barriers that deaf students may face. They can be used to translate texts and speech into sign

language, as well as to provide access to learning resources that are adapted to the specific needs of deaf students. This significantly improves accessibility and the quality of the education these students receive.

According to Oliveira (2022), assistive technologies play a fundamental role in creating inclusive learning environments and improving the quality of inclusive education as a whole. One of the key points highlighted by the study is AT's ability to facilitate pedagogical practice. This means that these technological tools help educators to develop more effective teaching strategies, adapted to the specific needs of students with different types of disabilities. This includes the possibility of adapting materials, providing individualized support and creating more flexible teaching methods.

The author emphasizes that assistive technologies play a crucial role in promoting student participation and autonomy. By providing tools that help with communication, accessing information and carrying out tasks, assistive technologies enable students with disabilities to actively participate in educational activities and, at the same time, develop skills that make them more independent in their daily lives.

The conclusion of Oliveira's study (2022) highlights the importance of recognising that ATs are not just devices or applications, but essential tools that make high-quality inclusive education possible. Such technologies have the potential to break down barriers, provide equal educational opportunities and contribute to the full development of all students, regardless of their special needs.

IV. Conclusion

Analyzing the studies presented, the importance of Assistive Technologies (ATs) in the process of literacy and inclusive education for students with special needs becomes clear. These technologies are emerging as tools capable of promoting equal educational opportunities, eliminating barriers and allowing all students to have access to quality education, regardless of their disabilities or specific conditions.

The research, as demonstrated by several authors in the systematic review, reveals that assistive technologies contribute to the personalisation of teaching, adapting to students' individual needs. This approach is essential to cater for the diverse forms of learning and challenges that students with special needs may face. In addition, assistive technologies play a crucial role in promoting students' autonomy, enabling them to actively participate in educational activities and develop more independently.

The studies also emphasize the pressing need for awareness-raising and ongoing training for teachers, who play a central role in the effective implementation of AT. Thus, well-trained teachers not only know how to use technologies effectively, but also create welcoming and inclusive learning environments where students feel valued and supported.

Furthermore, assistive technologies not only promote inclusion, but also contribute to breaking down the stigmas and prejudices associated with disabilities. Such technologies help to reduce communication barriers, making education more accessible for deaf students and those with other special needs, promoting a more equal and diverse society.

Therefore, the studies presented corroborate that Assistive Technologies are crucial for promoting inclusive, high-quality education. However, they also emphasize the challenges that remain, including the lack of adequate resources and the need for ongoing training. It is therefore imperative to invest in resources, teacher training and awareness-raising to ensure that assistive technologies are applied effectively and that inclusion becomes a tangible reality in the educational environment. Through this investment, assistive technologies have the potential to transform education and society as a whole, providing equal opportunities and promoting the full development of all students, regardless of their special needs.

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