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EDUCATIONAL TECHNOLOGY AND ASSISTIVE TECHNOLOGY: SPECIFICITIES AND APPLICATIONS FOR THE INCLUSION OF STUDENTS WITH VISUAL IMPAIRMENT

TECNOLOGIA EDUCACIONAL E TECNOLOGIA ASSISTIVA: ESPECIFICIDADES E APLICAÇÕES PARA A INCLUSÃO DE ESTUDANTES COM DEFICIÊNCIA VISUAL

TECNOLOGÍA EDUCATIVA Y TECNOLOGÍA DE ASISTENCIA: ESPECIFICIDADES Y APLICACIONES PARA LA INCLUSIÓN DE ALUMNOS CON DISCAPACIDAD VISUAL

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ABSTRACT

With the inclusion of Educational Technology (ET) and Assistive Technology (AT) in the educational context, this article conceptually distinguishes the terms focused on the inclusion of people with visual impairments, arguing that technology can assist, but not replace, pedagogical mediation. Based on a theoretical and conceptual analysis of the literature and national frameworks, criteria are presented for recognizing when a resource qualifies as AT, presenting examples of applications and resources such as screen readers, audio description, tactile materials/diagrams, tactile cartography, mobility and navigation devices and apps, and discussing their articulation with teaching practices. Through this study, it is possible to conclude that differentiating ET from AT is an ethical and technical decision with impacts on pedagogical planning and teacher training, and that effective inclusion depends on the consistent implementation of new resources, in addition to public policies and research in the field.

Keywords: Educational Technology. Assistive Technology. Visual Impairment. Accessibility. Inclusion.

RESUMO

Com a inclusão da Tecnologia Educacional (TE) e Tecnologia Assistiva(TA) no âmbito educacional este artigo distingue conceitualmente os termos com foco na inclusão de pessoas com deficiência visual sustentando que a tecnologia pode auxiliar, mas não substituir a mediação pedagógica. Com base em análise teórico-conceitual da literatura e de marcos nacionais, apresentam-se critérios para reconhecer quando um recurso configura-se como TA, apresentando exemplos de aplicações e recursos, como: leitores de tela, audiodescrição, materiais/diagramas táteis, cartografia tátil, dispositivos e apps de mobilidade e navegação e discute-se sua articulação com práticas docentes. Por meio deste estudo é possível concluir que diferenciar TE de TA é decisão ética e técnica com impactos no planejamento pedagógico e na formação docente e que a inclusão efetiva depende de

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implementação consistente de novos recursos, além de políticas públicas e produção de pesquisas da área.

Palavras-chave: Tecnologia Educacional. Tecnologia Assistiva. Deficiência Visual. Acessibilidade. Inclusão.

RESUMEN

Con la inclusión de la Tecnología Educativa (TE) y la Tecnología de Asistencia (TA) en el contexto educativo, este artículo distingue conceptualmente los términos enfocados en la inclusión de personas con discapacidad visual, argumentando que la tecnología puede asistir, pero no reemplazar, la mediación pedagógica. Con base en un análisis teórico y conceptual de la literatura y los marcos nacionales, se presentan criterios para reconocer cuándo un recurso se califica como TA, presentando ejemplos de aplicaciones y recursos como lectores de pantalla, audiodescripción, materiales/diagramas táctiles, cartografía táctil, dispositivos y aplicaciones de movilidad y navegación, y analizando su articulación con las prácticas docentes. A través de este estudio, es posible concluir que diferenciar la TE de la TA es una decisión ética y técnica con impacto en la planificación pedagógica y la formación docente, y que la inclusión efectiva depende de la implementación consistente de nuevos recursos, además de las políticas públicas y la investigación en el campo.

Palabras clave: Tecnología Educativa. Tecnología de Asistencia. Discapacidad Visual. Accesibilidad. Inclusión.

1 INTRODUCTION

The technological advances of the last decades are bringing numerous tools to pedagogical practices, such as: expanding access to information, diversifying methodologies and enabling the personalization of learning. Even so, innovation does not replace the essence of the pedagogical relationship. The teacher's mediation, the human bond and the student's sociocultural context continue to be at the center of the teaching-learning process. And when we talk about the inclusion of visually impaired students, this point is even more sensitive with the need for clear verbal descriptions, materials and concepts with tactile accessibility and other strategies that make all the difference to ensure everyone's participation.

In this scenario, in literature and in school practice, they end up mixing terms and functions of Educational Technology (ET) and Assistive Technology (AT). On the one hand, TE brings together resources and methodologies designed to qualify everyone's education. While AT focuses on products, services and strategies aimed at removing functional barriers and expanding the autonomy of people with disabilities with a strong backing in public policy frameworks and interdisciplinary guidelines. Distinguishing these terms is a necessary step to guide pedagogical decisions in teacher education.

This article has three central goals to delimit the specificities between ET and AT, with emphasis on the Brazilian context: to present frameworks, criteria and terminology that guide what ET is in the school environment; systematize AT resources and applications aimed at visual impairment, contemplating both digital solutions and tactile and mobility materials. For this, we propose a theoretical-conceptual analysis in the literature of the area, which allows us to identify that technology, in isolation, does not replace pedagogical mediation and effective inclusion, arising from pedagogical practices and technological resources appropriate for each situation.

2 EDUCATIONAL TECHNOLOGY AND TEACHER MEDIATION FOR VISUALLY IMPAIRED STUDENTS

There is a consensus among theorists such as Borges (2009), Motta (2015), Filho and Kassar (2019), Roma (2020), Mianes (2020) and Amorim (2021) that technology and its advances move towards a simplification of daily activities, making them comfortable and easy to perform, as well as playing an increasing role in education, allowing new ways of teaching and learning. However, the authors warn, even though technology can offer many advantages

in education, it does not mean that it can make an exclusive substitution for teaching and interaction between teachers and students, because the relationship of trust built from the reality that both experience constitutes the fundamental element in the teaching-learning process.

This interactive guidance between teacher and student is especially important for the teacher who has blind or low-vision students in the classroom. In addition to the relationship of trust, some strategies need to be adopted by the teacher to overcome the obstacles that may appear. In this case, Barbosa and Guedes (2020, p.7) indicate, it becomes necessary for the teacher to "associate the knowledge perceived by sight with verbalization through clear and explanatory descriptions". In addition, the authors add, "transpose abstract concepts to tactile perception, adapting the use of models and 3D materials, which can help the blind student to interact with all the other students in the room".

Some of the main advantages of incorporating technology into education include access to knowledge, where Information and Communication Technologies (ICT) allow students a wide variety of educational information and resources, regardless of their skill level, including everything from teaching materials and digital libraries to online courses and interactive simulations. Digital tools, such as email, chat, and social networks, allow students to communicate, including from geographically distant locations, even facilitating the occurrence of online courses and learning to learn throughout life.

Other aspects mentioned by theorists in the field about the advantages of using technology in education in general are that it allows teachers to personalize learning to meet the individual needs of students. This allows students to work at their own pace and get instant feedback on their performance. It allows the diversification of methodologies, such as gamification, augmented virtual reality, among others, which add new features for student engagement, personalization, motivation, and even more playful and interactive learning.

3 ASSISTIVE TECHNOLOGY IN BRAZIL: CONCEPTS, MILESTONES AND DISTINCTION IN RELATION TO EDUCATIONAL TECHNOLOGY

It is important to note that this expansion and evolution of technology in the educational context has a special meaning when used by people with disabilities. It not only facilitates routine activities but also represents alternatives that serve as learning resources and services, which aim to improve the quality of life of people with disabilities, providing more independence and insertion in school and society in general. This technology, with these

characteristics, is called Assistive Technology, according to the Technical Aid Committee (CAT), established on November 16, 2006, by the Special Secretariat for Human Rights of the Presidency of the Republic (SEDH/PR) through Ordinance No. 142. This committee, made up of Brazilian experts and representatives of government agencies, aimed to present proposals for government policies and partnerships between civil society and public agencies regarding Assistive Technology, as well as:

> structure the guidelines of the area of knowledge; carry out a survey of the human resources that currently work with the theme; to detect the regional reference centers, aiming at the formation of an integrated national network; to stimulate the creation of reference centers at the federal, state, and municipal levels; to propose the creation of courses in the area of assistive technology..., with the objective of training qualified human resources and to propose the elaboration of studies and research, related to the theme of assistive technology (Bersch, 2017, p.3).

Thus, in 2007, the CAT approved the Brazilian concept of Assistive Technology as an area of knowledge with an interdisciplinary characteristic, which encompasses "products, resources, methodologies, strategies, practices and services that aim to promote functionality, related to the activity and participation, of people with disabilities, disabilities or reduced mobility, aiming at their autonomy, independence, quality of life and social inclusion" (BRASIL-SDHPR-Comité de Ajudas Técnicas - ATA In: Bersch, 2017, p. 4).

It can be said that Assistive Technology is still a new term, but widely used to "identify the entire arsenal of resources and services that contribute to providing or expanding functional abilities of people with disabilities and consequently promoting independent living and inclusion". It aims to provide people with disabilities with "greater independence, quality of life and social inclusion, through the expansion of their communication, mobility, control of their environment, ability to learn and work" (Bersch, 2017, p. 4).

Bersch (2017) begins the discussion around the distinction between the terminology Educational Technology and Assistive Technology by stating that, when it comes to the use of technology in the classroom for students with disabilities, there is a national trend already formed to use the term Assistive Technology. This interpretation is accepted in academia, in organizations of people with disabilities and in government sectors such as the Ministry of Education (MEC), Ministry of Science and Technology (MCT) and National Council for Scientific and Technological Development (CNPq).

In an attempt to differentiate Educational Technology from Assistive Technology, Bersch (2017, p. 12) suggests asking three questions. If the answers are affirmative to the three questions, the tool used by the student can be called AT, even when it also refers to common education:

> Is the resource being used by a student who faces a barrier due to his or her disability (sensory, motor or intellectual) and does this resource/strategy help him or her to overcome this barrier?
>
> Is the resource supporting the student in carrying out a task and providing him with autonomous participation in the educational challenge, always aiming to reach the proposed educational objective?
>
> Without this resource, would the student be at a disadvantage or excluded from participation?

As mentioned above, if the answers are affirmative, we will be making use of Assistive Technology. However, Bersch (2017, p. 12) observes that Educational Technology will not always be Assistive, but "may perform the Assistive function when it significantly favors the participation of the student with disabilities in the performance of a school task proposed to him". It is characterized as Assistive Technology when "withdrawing the support given by the resource, the student finds it difficult to perform the task and is excluded from participation". As suggested by the Technical Aids Committee, the expression Assistive Technology can always be used in the singular because it refers to an area of knowledge and not to a collection of products. In this way, one set of equipment is equivalent to TA Resources. To specify services and procedures, the terms AT Services and AT Procedures are used (BRASIL – SDHPR- Technical Aid Committee, CAT, 2009).

Bersch (2017, p. 4) clarifies with the Technical Aids Committee the meaning of Categories, Equipment and Accessibility Resources of Assistive Technology. The author tells us: the Categories of Assistive Technology are intended for "aid for daily life and practical life, materials and products that favor autonomous and independent performance in routine tasks ... in activities such as ... Cooking, dressing up... to execute personal needs". Examples are: modified cutlery, clothes designed to make it easier to put on and take off, grab bars, among others. Equipment for the independence of people with visual impairment in performing tasks refers to: "consulting a watch, using a calculator, checking body temperature, identifying

whether the lights are on or off, cooking, identifying colors ... check blood pressure, identify phone calls, write", among others.

When it comes to Accessibility Resources related to the computer, we are referring, according to Bersch (2017, p. 4), to the "set of hardware and software specially designed to make the computer accessible to people with sensory (visual and auditory), intellectual and motor deprivations". The author includes mice, keyboards, and differentiated triggers as input devices, and sounds, images, tactile information as output devices. Examples of input devices include "modified keyboards, virtual keyboards with scanning, special mice and various triggers, voice recognition software, pointing devices that value head movement, eye movement, brain waves, ... orthoses and tips for typing", among others. As output devices, Bersch (2017, p. 6) cites "screen reader software, software for adjusting colors and sizes of information (magnifying glass effect), printed text reader software (*Optical character recognition*), Braille printers and Braille line, embossed printing, among others".

Bersch (2017, p. 10) is concerned with clarifying that "optical aids, lenses, manual magnifying glasses, electronic magnifying glasses; screen magnifying software", as well as "graphic material with textures and reliefs, maps and tactile graphs; Optical *character recognition software* on mobile phones for identification of informative text", among others, represent aids for expanding visual function and resources that translate visual content into tactile information.

Thus, Assistive Technology should be understood as resources that the user can use whenever he wants or when "he needs to perform daily functions independently. For example, the cane belongs to the blind person... the reader software speaks the content of scanned texts to the visually impaired person". All these resources, says Bersch (2017, p. 10), promote greater efficiency and autonomy in the various activities of interest to its users. Thus, we can say that differentiated mice, virtual keyboards with scans and triggers, alternative communication software, text readers, enlarged texts, Braille texts, texts with symbols, accessible furniture and personal mobility resources are examples of Assistive Technology in the educational context.

The concern with the distinction between AT and ET dates back to the early 2000s. It is observed that in Gil (2000) we find the need to explain the possible confusion: Educational Technology can be confused with Assistive Technology when, for example, a teacher proposes the use of new technological tools with the objective of diversifying students' access to information and suggesting other ways of presenting constructed knowledge. Thus, any

student, whether or not they have a disability, when using educational software, is benefiting from technology for learning. Borges (2009) makes the function of AT very clear, emphasizing that when the visually impaired person makes use of Assistive Technology, it is as if they rescue, due to visual limitation, their ability to develop numerous tasks that until then were impossible to be performed.

Thus, we close the discussion by stating that Technology can be considered AT in the educational context when we realize that, without this technological resource, "the student's active participation in the learning challenge would be restricted or non-existent", applied in the following context: when it is used by a student with disabilities that aims to "break sensory, motor or cognitive barriers that limit/prevent their access to information, records and expression about the knowledge acquired by him", or even when they favor visually impaired students "access to active and autonomous participation in pedagogical projects, when they enable the manipulation of objects of study" (Bersch, 2017, p. 12).

4 ASSISTIVE TECHNOLOGY RESOURCES AND APPLICATIONS FOR PEOPLE WITH VISUAL IMPAIRMENTS

On the other hand, the advance in the area of informatics, centered on Information and Communication Technologies (ICT), has offered other resources for the teaching-learning process of visually impaired students, such as, for example, the letter enlargement system for people with reduced vision, special software such as the Lentepro program, developed by the Electronic Computing Center of the University of Rio de Janeiro, and systems that allow the direct amplification of the text, such as closed circuit television.

Within this context, for people with blindness, there is software that, with a voice synthesizer, reads what appears written on the microcomputer screen, emerging as one of the main resources of Assistive Technology today. In Brazil, we have some programs with this technology, such as, for example, Dosvox, developed at the Electronic Computing Center of the Federal University of Rio de Janeiro, by Professor Dr. José Antônio Borges, from the same university, when in 1993 there was a student with blindness taking the discipline he taught in the higher education course of Data Processing. Another program with this same technology is Virtual Vision, developed by Micro Power, a company in the municipality of São Caetano do Sul, SP. According to Borges (2009), through information technology, the visually impaired person assimilates information without the mediation of other people.

Currently, other accessibility software enhances the operationalization of computers and mobile devices, with applications that complement and personalize the learning process according to the pace and level of technical knowledge of the students. Thus, accessibility software, Barbosa and Guedes (2020, p. 9) tell us, can contribute significantly so that "blind students can overcome barriers traditionally present in the educational process, allowing them to perform the same tasks that other students perform in everyday school life, with autonomy and appreciation of their personal learning characteristics".

It is also worth remembering that, at the end of the 1990s, in Brazil, another resource of Assistive Technology became popular and, to this day, has been gaining "recognition in academic research, legislation and in the production of accessible material in different media": Audio Description (AD), which, in the words of Barbosa and Guedes (2020, p. 10), is "the narration of visual elements that cannot be understood by blind people due to the visibility present in the various contexts, such as in dynamic scenes or still images." In other words, "audio description can be considered a technique to transform images into words, requiring knowledge of the translation guidelines of audio description".

As Motta (2015) reminds us, in the school and academic environment, images can contribute to favor learning, since it uses the visual sense, also contributing to make classes more interesting, illustrative and motivational, and can facilitate the understanding of a text. In this scenario, the role of audio description is "to read and translate these images, gestures, graphs, maps, posters, schemes, exhibitions considering the diversity present in the classroom and the possible communication barriers that the absence of accessibility can cause for blind students" (Barbosa; Guedes, 2020, p. 10).

Another interesting aspect of audio description is that, by increasing the sense of observation and expanding the perception of everything visual, audio description also meets the requests of non-blind people, who aim to unveil details of an image that would go unnoticed if looked at naturally.

There are also devices capable of printing texts in Braille, suitable for both personal use and for the large-scale production of books and magazines. According to Amorim (2021), microcomputers and printers are the most common computer equipment in Brazil. However, other devices are already available, such as the desktop slate, the Braille display and the spoken Braille (minicomputer).

Another AT resource can be found in Cartography, an area that deals with the making of maps and other cartographic products. Within this context, there is a specific branch, tactile

cartography, intended for reading by people with blindness or low vision. Nogueira *et al*. (2010) state that the tactile graphic map is characterized as an instrument whose function is to help the visually impaired person to mentalize the geographical space, and can work as an educational resource by expanding the intellectual capacity of blind and low-vision people, allowing them to expand their knowledge of the universe.

In addition, Nogueira *et al*. (2010) identify tactile cartography as a facilitator of mobility for people with visual impairment, as it allows guidance on the course of an accessible route, combining Braille texts, embossing and information such as the contrast of colors and the typology used, which provide guidance on the environment to be traveled, as long as it presents a very high level of quality, the authors note. In this way, they assist and promote mobility independence in public buildings of large circulation, such as bus terminals, subway and air terminals, shopping malls, university campuses and urban centers.

Regarding the importance of the tactile map, some relevant points are highlighted by Nogueira *et al*. (2010) in the context of accessibility signage (according to criteria contained in the Brazilian Accessibility Standard 9050 (NBR), published in 2004): Safety: the visually impaired person can move more safely when he knows the route he needs to take; Independence: the map allows the visually impaired person to move around with greater independence without needing the help of others and Location: even with visual impairment, through the tactile map, the person can know the location of a store inside a shopping mall, or a classroom at a university.

Thus, Safety, Independence and Location are part of the criteria that must be adopted to make accessibility an imperative right of people with visual impairment or reduced mobility, according to the Brazilian Association of Technical Standards (ABNT) NBR 9050: Accessibility to buildings, furniture, spaces and urban equipment (2015). In other words, Accessibility refers to the ability and condition for people with disabilities or reduced mobility to reach, perceive, and understand safely and autonomously the use of spaces, furniture, urban equipment, buildings, transportation, information, communication, systems and technologies, as well as other services and facilities open to the public, whether for public or private collective use. both in urban and rural areas.

Barbosa and Guedes (2020, p. 10) draw attention to the fact that ensuring accessibility "goes beyond the understanding of physical, urban, and architectural structures alone and gains a much greater dimension if added to Assistive Technology resources aimed at access to quality information that will be accessed by everyone, regardless of the act of seeing". In

this way, the "quality of the information received by blind students is directly linked to the accessibility promoted by those who make this content available".

The following is a summary of some Educational Technologies and tools available, already mentioned above, aimed at people with visual impairment, which aim to contribute to teaching and learning, professional development and social inclusion:

Screen readers: "convert written information into sound information, into audio, allowing greater speed in the production, consumption and sharing of information" (Barbosa; Guedes, 2020, p. 9). These tools can read aloud the content of documents, websites, and software, allowing people with visual impairments to access and understand these materials. In this way, knowledge occurs by listening to the texts. However, the authors warn, some peculiar difficulties may occur, such as "the lack of accessibility to written graphs or tables in image formats, in addition to websites that do not respond to the commands of screen reader software".

Voice recognition software: These tools allow visually impaired people to control their computer using voice commands, which can help access and create documents, do calculations, and draw electronic schematics.

Voice-based navigation systems: These systems can guide visually impaired people through physical environments, providing audible directions on how to get to certain places.

Tactile diagrams and drawings: These materials can be created especially to be read by people with visual impairments, and may include tactile drawings and schematics to help understand electronic concepts.

Within the general social context, we can also mention a synthesis of some technologies intended for common daily activities, but which can be allies for the inclusion of the visually impaired person, such as the electronic cane itself, which allows the identification of obstacles ahead, emitting a sound signal; The closer the object is, the smaller the gaps between the signals.

Other resources that aim to help the visually impaired person in everyday tasks: screen reader software, such as Jaws, Virtualvision, Orca (on Linux), Voiceover (Mac and iOS), Talkback (Android), NonVisual Desktop Access (NVDA); screen magnifiers and high-contrast features, such as tactile floors, audible traffic lights, high-contrast signage, which seek to enable locomotion; magnifying glass, guide dog, sunglasses, visor, among others.

The Be My Eyes app, available for iOS and Android, works as a camera system that connects visually impaired people with volunteers. The platform allows, through speech and

image, difficulties such as identifying places, photos, what a sign says, to be identified, as well as proposing to read, for example, the expiration date of products and check the color of a piece of clothing (BE MY EYES, 2023).

Another free application to be highlighted, an example of social technology, is Veever, which uses microlocation technology and artificial intelligence to facilitate the locomotion and interaction of visually impaired people indoors and outdoors. Through a voice assistant, the user receives information and guidance in real time. The operation is offline, as the database is stored on the device itself, ignoring the need for an internet connection. The app has an accessible interface. The in-app experience is designed to the digital accessibility guidelines. Thus, with micromapping, when pointing the smartphone in the desired direction, the application warns the user which points of interest are mapped there (Legacy, 2020).

Although there is an evolution, Bersch's observation made in 2017 (p. 15) is pertinent in the sense that research should continue because:

> We are at the beginning of a work for the recognition and structuring of this area of knowledge in our country. Initial is also the stage of incentives for research and national production of Assistive Technology resources, which will meet the great existing pent-up demand, however, important steps are taking place in recent years.

Therefore, from this reading, it is important to understand and respect the needs of people with visual impairment, as well as to offer adaptive tools that favor their autonomy and learning. Research and the production of Assistive Technology resources should be stimulated and disseminated, aiming at the effective inclusion and quality of life of people with visual impairment.

5 FINAL CONSIDERATIONS

The use of Educational Technology and Assistive Technology allows us to bring great possibilities and benefits to the educational environment, clarifying during the development of this article the distinction between ET and AT, making them an ethical and technical decision, with a direct impact on the participation, autonomy and learning of students with disabilities. In practical terms, we emphasize the need to adopt the three criteria observed to classify something as AT: remove barriers; enable the autonomous performance of the task and; avoiding exclusion by offering an operational guide for schools, networks and teachers.

The Brazilian scenario already has sufficiently consolidated normative frameworks, categories and examples to guide policies, teacher training and public procurement. The important thing is to move away from the conceptual-theoretical consensus and move towards practical implementation, reducing ambiguities between ET and AT, planning continuity and improvements.

For this, we perceive the need for continuous training of teachers with the adoption of disciplines including ET and AT; public policies aimed at accessibility; research involving studies of the impact of tools in the classroom; incentive to the national production of AT, in order to seek the inclusion of all inside and outside the educational environment.

It is important to emphasize that this is a theoretical-conceptual study that does not replace a large-scale study. We suggest that, in future research, the effects of learning and autonomy in different didactic arrangements be qualitatively quantified. We consider, in summary, that the effectiveness of the inclusion of visually impaired students depends essentially on the articulation between pedagogical practices and adequate technological resources. When technology is mobilized to remove barriers and ensure everyone's participation, it fulfills its assistance and educational role, promoting equity and autonomy of individuals, bringing quality of life and social justice to all.

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