Literature Review: Enhancing Education Accessibility: The Role of Assistive Technology in Promoting Equality for the Visually Impaired

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Abstract. Visually impaired individuals, who belong to the special needs group, experience a loss of visual abilities and play a significant role as 85% of information is visual. Visually impaired individuals require education that addresses their needs and maximizes the use of tactile and auditory functions. However, many schools and educational institutions still lack the resources and facilities to support their education. Therefore, it is important to conduct an in-depth review of various types of assistive technology that can enhance the accessibility of education for visually impaired individuals. This research employs a systematic literature review methodology by analyzing 20 national and international articles. The results demonstrate that assistive technology is crucial in the education of visually impaired individuals as it enables accessibility, participation, and equality in learning. By utilizing assistive technology, visually impaired individuals can overcome difficulties in communication, access to information, and independent participation in educational environments.

Keywords: assistive technology, education, visually impaired

1   Introduction

Visually impaired individuals are considered a special needs group who experience partial or total loss of vision. According to legal definitions, visual impairment can be classified into two categories: low vision and blindness. Low vision refers to individuals with visual acuity ranging from 20/70 to 20/200, aided by assistive devices, while those with a visual field no greater than 20 degrees are considered blind. In terms of education, individuals with blindness require braille or aural techniques, while those with low vision can utilize their remaining visual abilities by reading enlarged print [1]. According to statistical data from the World Health Organization (WHO), approximately 253 million individuals have visual impairments, with 36 million being totally blind and 217 million experiencing moderate to severe visual

The loss of vision significantly impacts various aspects of individuals' lives, as the eyes play a crucial role in receiving 85% of information through visual. Similar to other alert individuals, visually impaired individuals also require education, considering that education is a fundamental right for all individuals, as stated in Article 31 Paragraph 1 of the 1945 Constitution of Indonesia, which emphasizes that "every citizen has the right

to education". Education plays a vital role as a gateway to open opportunities for visu-
ally impaired individuals to acquire academic knowledge, life skills, and necessary ex-
pertise, enabling them to actively participate in social, economic, and cultural activities.
Therefore, visually impaired individuals require education that addresses their needs in
overcoming visual limitations by maximizing the functions of touch and hearing to ob-
tain information [2]. Additionally, there is a need for learning related to independent
living skills such as orientation and mobility, as well as the use of assistive technology.
Through inclusive education, they can develop their potential, learn independently, and
solve everyday life problems.

Ideally, education for the visually impaired should provide equal access to knowledge
and skills while considering their specific needs, such as accessibility to information
through resources like braille texts, screen readers, and other non-visual approaches [3].
Additionally, the school environment should be inclusive, where visually impaired in-
dividuals feel accepted and respected. They should receive support from classmates
without experiencing discrimination or stigma. However, the current reality in the field
reveals that many schools and educational institutions still lack adequate resources and
facilities to support their education. Consequently, visually impaired individuals face
difficulties in accessing learning materials and have limited abilities for independence.
Furthermore, negative stereotypes still exist, hindering their social interaction and in-
fluencing their motivation and participation in learning.

With the advancement of digital technology in this era, assistive technology plays a
significant role in enhancing the quality of life for visually impaired individuals and
reducing information gaps among the community [4]. By utilizing assistive technolo-
gies such as screen readers, digital braille, or audio-based electronic devices, visually
impaired individuals can access information more easily, thereby promoting independ-
ent learning and providing key educational opportunities for them [5]. They can read
texts, access the internet, read and write emails, access electronic books, and obtain
access to various online information sources. Therefore, with broad information acces-
sibility and proficient assistive technology, they can enhance their knowledge, stay up-
dated with global developments, and make wiser decisions. This allows them to over-
come educational constraints, increase their participation, and improve their learning
outcomes.

In the aspect of education, the role of assistive technology is crucial in accessing rele-
vant and high-quality information, enabling visually impaired individuals to receive
equitable education, and providing convenience for teachers in delivering materials and
information [6]. The appropriate use of assistive technology to access information can
enhance the quality of activities carried out by students with special needs, both during
and outside the learning process [7]. Information accessibility is essential for visually
impaired individuals to access textbooks, learning materials, academic journals, and
other educational resources, enabling them to learn independently, keep up with ad-
vancements in their field of study, and actively participate in discussions and academic
activities [8].

The utilization of assistive technology can provide visually impaired children with
equal access to education, improve their academic and social skills, and maximize their

potential. Assistive technology helps reduce the gaps and barriers that visually impaired children may encounter in the teaching and learning process. Thus, they have equal opportunities to achieve academic success, develop interests and talents, and prepare for their future. Based on these conditions, this literature review aims to describe various types of assistive technology that can be used in the education of visually impaired individuals and their role in enhancing educational accessibility for visually impaired individuals.

2   Methods

This research employs a literature review method to address the research problem. Literature review or literature survey is a critical examination and evaluation of existing knowledge, ideas, or findings in academic-oriented literature, aiming to formulate theoretical contributions and methodological approaches regarding a specific topic [9]. Literature review involves summarizing articles in journals and/or proceedings, books, and other relevant documents related to the chosen topic [10]. The review process consists of three steps: planning the review, conducting the review, and reporting the review.

The first step is planning the review, which involves determining the reasons for selecting the topic and its urgency. Additionally, research questions are formulated, including (1) types of assistive technology that can be used in the education of visually impaired individuals, and (2) the role of assistive technology in enhancing educational accessibility for visually impaired individuals. After identifying the urgency of these research questions, review criteria are developed. Review criteria refer to a set of indicators that describe the content of the research conducted in a predetermined format.

The second step is conducting the review. This research utilizes relevant research findings, and the researcher evaluates the quality of the research according to the review criteria. Data collection is carried out by selecting and gathering data related to the utilization of assistive technology in supporting the education of visually impaired individuals. The selected data must address the research questions. Twenty research articles related to the utilization of assistive technology for promoting educational equality among visually impaired individuals were selected through various literature sources such as articles and journals from ERIC, ResearchGate, SpringerLink, Sage, ScienceDirect, Google, and Google Scholar. Keywords used include visually impaired, education, assistive technology, in both Indonesian and English. The articles used were published within the past eight years, from 2015 to 2023. The research process involves summarizing information about the authors, results, and conclusions. The data is then analyzed by synthesizing the research findings. Thus, out of the 28 discovered articles, 20 articles were used as references for this research, while the remaining eight articles were not utilized.

The third step is organizing the data by entering it into a database for synthesis and conclusion. In this step, the author thoroughly examines the literature review to obtain new core findings, which are then condensed and presented as clear and concise dis-

cussion topics. Subsequently, the research findings are reported in the form of a scientific article. In this phase, the researcher documents the research results in a report and draws conclusions based on the data analysis.

3   Findings and Discussion

Table 3.1. Types of Assistive Technology: Screen Readers to Enhance Educational Accessibility for the Visually Impaired

Assistive Technology	Authors	Research Type	Subjects	Benefits
NVDA Software	Wijaya, H., Efendi, J., & Sopandi, A., A. (2018)	Experimental research	5 elementary school visually impaired students	Effective in improving the use of Microsoft Word skills in visually impaired children.
	Ariyanto, D., et al. (2022)	Non-experimental quantitative (interviews)	10 totally blind and low vision university students	Enhances cognitive learning outcomes and independence in completing academic tasks, particularly in operating and creating documents in Microsoft Office.
	Sulistyowati, H. & Rafi, M., F. (2020)	Qualitative (observation and interviews)	1 visually impaired university student	Facilitates reading materials, completing assignments, and answering semester exams for visually impaired students.
JAWS Software	Panggabean, T. Y. S., & Ati, S. (2017)	Descriptive qualitative (case study)	n	Provides ease of access to information for visually impaired individuals as it is a technology used to access electronic sources of information.
	Apriani, F., Dantes, N., & Jampel, N. (2015)	Experimental research	11 visually impaired high school students	Using JAWS can improve students' motivation and academic achievements.

	Utama, A. P. & Ariyanto, D. (2023)	Descriptive qualitative (case study)	3 visually impaired university students	Facilitates total visually impaired students in understanding the material through technology tailored to their abilities.
Talkback Software	Fathurahmat, R., M. (2021)	Qualitative descriptive (interviews and case study)	3 adult visually impaired	The presence of screen reader features assists visually impaired individuals in literary pursuits.

Assistive technology is an alternative for modern education that is beneficial for the visually impaired, as it can be used to develop foundational professional skills and social skills [11]. Screen reader software is one of the widely used assistive technologies, including NVDA (Non Visual Desktop Access). NVDA is a type of screen reader used by the visually impaired to operate computers. It is a free screen reader that provides assistance amid the abundance of paid screen reader applications [12]. NVDA also enhances support for various programs, braille display output, and multiple language. Additionally, it automatically updates its features and provides support for Microsoft Office programs and social media applications, enabling visually impaired individuals to engage in both academic and non-academic activities. Therefore, the NVDA screen reader is effective in improving the utilization of Microsoft Word skills among the visually impaired [12]. Moreover, by utilizing the NVDA application, visually impaired individuals can access laptops or computers more independently [5]. resulting in improved cognitive learning outcomes and independence in completing academic tasks, especially in operating and creating documents in Microsoft Office [13]. It also enhances independence in reading materials, completing assignments, and answering semester exams [14].

Another commonly used screen reader application among the visually impaired is JAWS (Job Access With Speech). JAWS can be used to access MS Office, email applications, and browse the Internet using Internet Explorer, minimizing the information gap between the visually impaired and sighted individuals by facilitating information retrieval from electronic sources. Furthermore, JAWS facilitates visually impaired children in operating computers, thereby enhancing their motivation to learn and academic achievements, especially in the field of computer technology and information [15].

NVDA and JAWS are two popular screen reader applications designed to assist the visually impaired in accessing electronic devices. NVDA is more open-source, while JAWS is a paid application. However, both have the same function of converting text and visual elements into accessible information through synthetic speech. They are continuously updated and developed to enhance functionality according to user needs.

NVDA and JAWS are screen reader tools to support computers and laptops. As for Android mobile phones, they are equipped with a feature called Talkback. Talkback is an additional feature in Android version 4.0 that enhances accessibility for visually impaired users [16]. Talkback was developed to enable visually impaired individuals to use touchscreen Android phones, which are more challenging for them compared to phones with physical keyboards [17]. The functioning of Talkback involves vocalizing everything the user does on the Android phone, such as typing a name, accessing menus, settings, opening applications, and more. This feature allows visually impaired individuals to access more information, knowledge, and other resources through technology, reducing their reliance on braille books, particularly in book reader applications, and enabling them to enhance their creativity in literacy [18].

Therefore, screen reader devices offer numerous benefits to visually impaired users, allowing them to access various types of information in text format on websites, documents, text messages, and more. They serve as essential tools for visually impaired individuals to obtain information from various sources, such as textbooks, academic journals, and instructional materials, thereby aiding in their comprehension of the subject matter.

Table 3.2. Types of Assistive Technology-Based Media to Enhance Accessibility in   Education for the Visually Impaired.

Media Products	Authors	Research Type	Subjects	Benefits
Laptop Application (Game)	Gutierreza, J., A., T. (2021)	Experimental Research	18 visually impaired students	Highly useful in classifying numerics with different stimulations.
Laptop Application (Game)	Yanfi et al. (2017)	Developmental Research	5 visually impaired individuals	Assists visually impaired individuals in learning typing skills and reviewing lessons aligned with the Indonesian curriculum.
Computer/Laptop Application	Perianto et al. (2020)	Developmental Research	n	Serves as a database for learning

				materials, instructional resources, and final project compilation.
Android Application (Game)	Mahardika, G., P. & Anwar, H. (2018)	Developmental Research	6 teachers and visually impaired students from grades 4, 5, and 6	Easy to learn application with a simple interface that enhances interaction in learning arithmetic.
Android Application (Game)	Rizky & Destya (2022)	Qualitative Descriptive	7 visually impaired students	Numerical data input method in the game proves to be more efficient.
Android Application (Game)	Octanto, A. (2021)	Developmental Research	7 visually impaired students	Beneficial in creating a new learning system at school and home, incorporating exciting and enjoyable learning concepts.
Android Application (Podcast)	Kusumawati, G. & Prabawati, W. (2022)	Developmental Research	7 visually impaired university students	Meets the learning needs of visually impaired students through audio-based material output that considers the auditory

				learning style.
Android Application (Reading)	Hermawanto et al. (2019)	Developmental Research	n	Assists visually impaired individuals in accessing information through text-to-speech conversion.
Android Application	Ardha et al. (2022)	Developmental Research	3 visually impaired students	Easily understandable application features that facilitate the teaching and learning process.
Android Application	Fatimah et al. (2021)	Developmental Research	n	Enables visually impaired individuals to learn independently and operate applications using voice commands and alternative touch assistance. Also allows repetition of material until users understand.
Application (Text-to-Speech)	Manu & Masan (2020)	Quantitative Research	15 students	Enhances the understanding of students with disabilities.

Software (Web)	Iyer et al. (2020)	Developmental Research	n	Facilitates access to any website for the visually impaired using a voice command system.
Software (Artificial Intelligence/AI)	Mina et al. (2023)	Descriptive Qualitative	5 visually impaired students	Assists visually impaired individuals in exploring their potential, completing academic tasks such as instructional materials, and communicating with teachers.

Applications have opened new doors for visually impaired individuals in their learning process. The software applications are developed with careful consideration of the needs and challenges of the visually impaired, providing better accessibility and a more inclusive learning experience. Many laptop applications are designed to be accessible for visually impaired individuals with audio-based features, which facilitate their interest and utilization of technology in teaching [19]. One of the benefits is their significant usefulness in classifying numerics with different stimulations [20]. Furthermore, with more complex benefits, laptop applications can be used to assist visually impaired individuals in learning typing skills and reviewing lessons aligned with the curriculum in Indonesia [21]. Therefore, these applications enable learning on various topics such as mathematics, science, history, languages, and more, tailored to the initial goals of application development. Not only supporting computer and laptop devices, but these applications can also be accessed through Android phones.

Android applications related to mathematics, such as arithmetic and numerical learning, enhance interaction in mathematics learning [22], and their usage is more efficient [23]. Additionally, the simplicity of the application features makes them easier to understand and facilitates the teaching and learning process [24]. With the availability of games on Android phones, which are more accessible and portable, a fun and enjoyable learning system can be created, not limited to school but also available at home [25].

The development of Android applications as assistive technology for visually impaired individuals covers all education levels, from elementary to higher education. These applications meet the learning needs of visually impaired students through audio-based material output that considers the auditory learning style [17] and serve as databases related to learning materials, instructional resources, and the compilation of final projects [26]. Therefore, these materials contribute to enhancing user. In addition to application development, AI (Artificial Intelligence) technology, which assists visually impaired individuals in exploring their potential, completing academic tasks such as instructional materials, and communicating with teachers [27], plays a significant role. Furthermore, the simple features of the applications facilitate accessing any website for visually impaired individuals through a voice command system [28].

Hence, assistive technology has become an essential element inseparable from students with special needs as a support in the learning process [29].

4   Conclusion

Based on the review and data analysis of the seven articles investigating the utility of screen reader software for visually impaired individuals, it can be concluded that screen reader software such as NVDA, JAWS, and TalkBack are highly beneficial for accessing a wider range of information. These devices greatly support visually impaired individuals in learning materials and acquiring new skills relevant to their study programs, such as completing assignments, reading materials, literacy skills, and independent operation of Microsoft Word.

Furthermore, based on the review and analysis conducted on 13 research articles, it can be concluded that the development of applications, websites, and AI can serve as learning media for visually impaired individuals. Their role is highly significant, providing platforms for learning mathematics (numerics and arithmetic) with various stimuli and enhancing interaction, aligning with the learning characteristics of visually impaired individuals, which rely on touch and hearing. The simplicity of features facilitates the process by converting text to audio, improving learner understanding.

Therefore, assistive technology is crucial in the education of visually impaired individuals as it enables accessibility, participation, and equality in learning. Through the use of assistive technology, visually impaired individuals can overcome difficulties in communication, accessing information, and independently participating in educational environments. Assistive technology continues to evolve, enhancing the education of visually impaired individuals. Tools and solutions such as screen reader applications, Braille devices, and navigation systems enable visually impaired individuals to read, write, access learning materials, communicate, and collaborate with classmates and teachers.

were 29 (80,6%) data of accurate translation, 7 (19,4%) data of less accurate and there was no inaccurate translation.

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