Effect of Assistive Technology on Visually Impaired Students: A Review Study

Mridul Krishna Ghosh[1], Research scholar, Dept. Of Education & Special Education, Arunachal University of Studies, Arunachal Pradesh, India.

Dr. Navajyoti Konwar, Associate Professor, Arunachal University of Studies, Arunachal Pradesh, India.

Abstract

Inclusive education has been a stronger vocal in the educational policy. For visually challenging learners, assistive technology is a tool to enhance the effectiveness of learning. The present study was a review study about assistive technology for visually impaired students. The study collected documents published in the past 15 years dating back from 2009 to 2024. The study included 31 research articles, seminars, and conference papers as well as research theses focused on assistive technology for visually impaired students. The objective of the study was to analyze the effects of assistive technology on visually impaired students. The contents analysis from the previously published documents showed assistive technology has a positive learning effect on visually impaired students. It also cast challenges of resource constraint, high cost, and low accessibility of technology among the developing and socio-economically weaker countries. The study concluded by suggesting improving funding, adequate staff training, and the need for better policies and infrastructure to improve the facilities of assistive technology use at schools and institutions.

Keywords: Assistive technology, visually impaired, inclusive education, blind

A visually impaired student is an individual who experiences difficulties with vision to the extent that it impacts their ability to learn or perform tasks that rely on visual information. This term encompasses a wide range of visual impairments, from partial sight to total blindness. Visually impaired students may face challenges in accessing educational materials, navigating physical environments, or participating in visual-centric activities. However, with the aid of specialized tools, technologies, and support systems, visually impaired students can effectively engage in educational pursuits and achieve academic success. With a sense of greater responsibility of government and leaders, inclusive education became a focal point of education in the new education policy of India known as the National Education Policy (NEP) 2020. Inclusive education itself could face challenges in

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[1] Mridul Krishna Ghosh was a Ph.D research scholar at the time writing this article.

implementation. Assistive technology could enhance the learning quality and better integration of visually challenging students in an inclusive classroom. Assistive technology for students with impairments encompasses a wide range of tools, devices, and software designed to support and enhance the learning experience of students with various disabilities. These technologies help to bridge gaps caused by physical, sensory, cognitive, or learning disabilities, enabling students to participate more fully in educational activities and achieve their academic goals. Here are some key types of assistive technology used for Visual Impairments.

Screen Readers: Software like JAWS (Job Access With Speech) reads aloud the text on a computer screen.

Braille Displays: Electronic devices that convert text on a screen to Braille, allowing blind students to read through touch.

Magnification Software: Programs like ZoomText enlarge text and images on a computer screen.

Audio Books and E-Books: Digital books that can be listened to, often provided through services like Learning Ally and Bookshare.

Assistive technology has revolutionized the way individuals with visual impairments interact with the world around them. From enhancing accessibility to facilitating independence, a plethora of tools and devices cater to varying needs and preferences. Among these, Braille, screen readers, magnifiers, keyboards, voice recognition software, audio description, audiobooks, CCTV systems, computers, font size adjustments, smart glasses, and tactile tools stand out as essential aids. Each of these technologies addresses specific challenges faced by the visually impaired, promoting inclusivity and empowerment in various spheres of life.

Braille, a fundamental tool for the visually impaired, allows them to read and write through a system of raised dots representing letters, numbers, and punctuation. Screen readers further bridge the accessibility gap by converting digital text into synthesized speech or braille output, enabling users to navigate websites, documents, and applications effortlessly. Magnifiers, both physical and digital, enlarge text and images for individuals with low vision, while keyboards equipped with tactile markings facilitate typing accuracy and speed. Moreover, voice recognition technology empowers users to control devices and dictate text using their voice, enhancing productivity and independence. These technologies, coupled with audio description features in multimedia content and the availability of audiobooks, contribute to a more inclusive environment where information and entertainment are accessible to all.

The present study was a content analysis of the primary findings of studies on the effects of assistive technology in education for visually impaired students.

Objective

To find the effects of assistive technology on visually impaired students.

Materials

The study collected 31 research articles, and papers presented in seminars, conferences, and theses from different countries. The original papers were published from 2009 to 2024. The study analyzed the research works conducted in the past 15 years. The source papers were categorized into three ranges of publication years. Forty-two percent of primary studies were conducted in the past five years, 39% of sources were published 6-10 years ago and 19% of documents were published between 11-15 years period from now, 2024, as shown in Figure 1.

Figure 1

Primary Research Documents Publishing Years
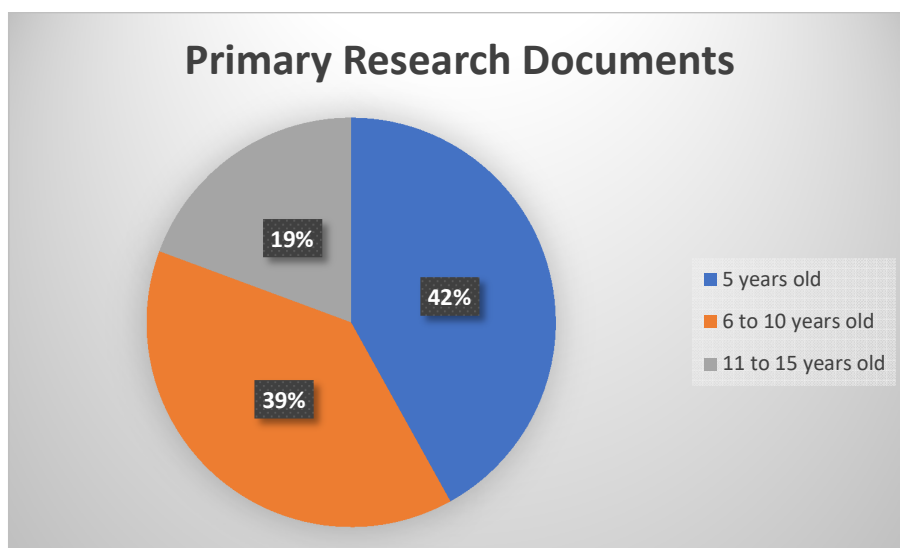
Note: 42% of data collection published within the past five years from now (2024).

Review of Literature

The United Nations set a goal for equal opportunity for education irrespective of gender, caste, religion, and physically challenging individuals under the Sustainable Development Goals (SDGs) in 2015. This goal is aiming to be achieved by 2030. This will eliminate disparities and achieve equality and equal access for everyone (United Nations Foundation 25 years, n.d.). The government and schools are trying to promote inclusive education.

Effecting teaching of visually impaired students needs suitable assistive tools based on the conditions of the affected individuals. A study by Sze (2009) found that pre-service teachers were not at the comfort level of using assistive technology in an inclusive classroom. Data collected from the previous studies showed there are positive and negative aspects of assistive technology used for teaching visually impaired learners.

Positive Aspects

The integration of assistive technology in educational settings has been increasingly advocated as a means to enhance academic performance among students with visual impairments. The data of the previous studies were compiled in a chronological sequence and it gives a trend of growth in assistive technology usage. Mutua (2013) emphasized the necessity for tertiary institutions to invest in assistive technologies to support the academic success of these students. Assistive technology gives benefits to visually impaired learners. Nees and Berry (2013) conducted a comprehensive review of audio-assistive technology, highlighting its potential benefits and the barriers impeding its implementation. Despite the advantages, such as enhanced educational accessibility for individuals with disabilities, challenges including validity concerns in audio testing, technical difficulties, and the stigma associated with assistive technology need to be addressed to fully realize its potential. Mulloy et al. (2014) examined the impact of assistive technology on students with visual impairments and blindness, suggesting that these technologies can significantly improve academic outcomes by enhancing existing sight abilities and engaging other senses. They emphasized the importance of thorough assessments for the successful long-term implementation of assistive technologies, recommending practices for assessment, selection, and encouragement of technology use. Rabello et al. (2014) found that assistive technology devices significantly improved reading skills and reduced reading time for students with low vision, allowing them to perform tasks at par with their peers. This improvement was particularly evident when participants used assistive technology devices (ATDs) in place of traditional printed text.

Bhatt and Kumari (2015) demonstrated that assistive technologies positively influenced the educational outcomes of visually impaired children at the National Institute for Visually Handicapped in Dehradun. Their study noted an increase in the rate of visually impaired students pursuing higher education, attributed to the higher availability and accessibility of assistive technologies. However, socio-psychological barriers still hinder the widespread adoption of these technologies.

Researchers also applied their studies on specific subjects regarding the using assistive technology. Wachiuri (2015) highlighted the significant impact of compatibility of assistive technology

on teaching and learning integrated English among visually impaired students in Kenya. Similarly, Foley and Masingila (2015) observed that mobile devices provided visually impaired students with access to education, participation in daily life, and the opportunity to create supportive communities of practice.

There has been research in wide geographical extent this area of study. Many studies' findings are reported in the context of Asia and Africa. In a Kenyan study, Oira (2016) identified major equipment used by visually impaired students, including braille machines and embossers. However, modern technologies such as computers and smart devices were underutilized due to resource constraints and a lack of skilled teachers. The study emphasized the need for policies to support the integration of advanced technologies in education. Erdem (2017) reviewed various types of assistive technology used in special education and generally found positive effects on students.

Bin Tuwaym and Berry (2018) emphasized the essential role of assistive technology in the educational programs of students with visual impairments, facilitating skill development and independent functioning. Opie (2018) stressed the necessity for specialized training for both students and teachers to maximize the benefits of assistive technology. This highlighted that teacher students were not able to utilize the assistive tools effectively.

The importance of assistive technology was felt among the scholars that assistive technology must be supported by the higher level of governing authorities. A study by Amurani (2019) recommended that the Rwandan Ministry of Education recognize the potential of assistive technology to support the education of visually impaired students, highlighting the need for adequate funding and training.

Komolafe (2020) found a positive correlation between the use of audio and non-optical devices and the learning outcomes in social studies for visually impaired students in Nigeria, suggesting that these devices be encouraged in secondary schools.

Kirboyun (2020) reviewed the impact of assistive technology on reading, writing, and social interaction among students with visual impairments. Advanced assistive technology devices improved academic skills, while mainstream devices enhanced social interaction. However, barriers such as equipment cost and lack of training were noted. Gitari (2020) found that computers and iPads were highly recommended assistive tools but noted challenges like inadequate resources and computer literacy skills among students and teachers in a study at Thika School for the Blind in Kenya.

The technology growth trend has been even faster in the last two and three years. Siddiqua et al. (2022) conducted an experimental study showing significant improvement in the academic performance of visually impaired students when assistive technology was used, advocating for its

inclusion in classrooms. Kisanga and Kisanga (2022) also highlighted the benefits of assistive technology in higher education in Tanzania, recommending sustainable funding and encouragement for students to use modern devices to reduce exclusion. Another study by Hamid and Setiawan (2022) explored the use of assistive technology in learning English among visually impaired students in Indonesia, finding positive impacts on learning outcomes and student engagement. Abualrejal et al. (2022) underscored the critical role of assistive technology in providing access to information and learning for visually impaired students. Among the latest studies, Saeedakhtar et al. (2024) found that assistive technology significantly enhanced English vocabulary learning for visually impaired students, recommending its incorporation into instructional materials.

This literature collectively underscores the critical role of assistive technology in enhancing educational outcomes for visually impaired students while also highlighting persistent challenges such as resource constraints, training deficiencies, and socio-psychological barriers. Future research and policy efforts must address these issues to fully harness the potential of assistive technologies in education. The literature review indicates that assistive technology significantly enhances the academic performance and educational experiences of visually impaired students. Despite the evident benefits, such as improved reading skills and greater engagement, challenges like resource limitations, technical difficulties, and social stigma persist. Effective implementation requires sustained investment, robust policy support, and comprehensive training for both students and educators. Addressing these barriers is crucial to fully harnessing the potential of assistive technologies and ensuring equitable educational opportunities for visually impaired students.

There are research findings about the weaknesses of assistive technology mainly for visually impaired students.

Negative aspects

The literature review highlights several barriers affecting the adoption and effective use of assistive technologies for visually impaired students. Bhatt and Kumari (2015) identify high costs, user reluctance, and low accessibility as significant impediments. Al-Zboon (2020) highlighted the challenges perceived by teachers, including issues related to computer use, lack of technology in schools and homes, and insufficient training. These barriers encompass financial constraints, inadequate training, societal attitudes, and lack of family support. Moreover, there are ethical concerns regarding the potential negative effects of assistive technology, such as exposure to negative community attitudes, addiction, bullying, abuse, and extremism.

A study in Kenya by Oira (2016) emphasized the scarcity of resources, the absence of legal frameworks, and the lack of skilled teachers as major obstacles to the effective use of assistive technology. Similarly, Morash and Siu (2016) found that the mere availability of assistive technology is not enough. Successful implementation in K-12 education depends significantly on the proficiency of teachers of visually impaired students in using these technologies. This comprehensive analysis underscores the need for targeted investments, robust policy support, and comprehensive training to overcome these barriers and maximize the benefits of assistive technology for visually impaired students. In one of the latest meta-analyses, the findings of Thapliyal and Ahuja (2023) revealed that high-tech assistive tools and educational software specifically designed for learners with learning disabilities are often unavailable. Their study emphasized the critical gap in resources necessary to support these students effectively. With this finding the situation in India regarding assistive technology is explained in the following paragraph.

Studies in India

A study by Pradhan and Samanta (2018) in West Bengal found that only one institution in the Medinipur division, Vivekananda Mission Asram (VMA), utilizes adequate Braille resources and assistive technology. Similarly, in the Burdwan division, Asansol Braille Academy also employs sufficient Braille resources and assistive technology. The study revealed that these institutes face funding shortages due to inadequate information about government assistance at both the central and state levels. Additionally, a lack of teaching faculty hampers the overall development of visually challenged students. School authorities must introduce assistive technologies and provide proper training for visually challenged students. There is a significant need for the development and implementation of laws, regulations, policies, practices, and organizational structures that promote access to assistive technology devices and services, as people with disabilities continue to be underrepresented in libraries.

Dey et al. (2019) emphasized that, in addition to Braille books, there is an urgent need for an accessible and affordable online platform for science and math content specifically designed for visually impaired school students.

Bhardwaj and Kumar (2017) conducted a study at Delhi University, which found that 35.8 percent of respondents accessed online electronic resources daily, insufficient assistive technology, unfamiliarity with devices such as Vachak (a Hindi reading device), SARA CE, and Lex (a scanner for Hindi script), primarily due to a lack of training and availability of trained staff. School-level education in Delhi showed comparatively higher levels of using assistive technology. Senjam et al. (2020) found

that in blind schools in Delhi, 96.4% of students used assistive Braille technology for reading (books), and 96.8% used it for writing (using a Braille slate and stylus), regardless of their visual status. However, Senjam et al. (2022) noted a shortage of modern assistive technology in Delhi's schools for the blind, emphasizing the need for more resources and trainers to improve educational access. Similar issues were reported from the studies in different regions of India. Shanker and Kant (2021) identified several significant issues in Patna, Bihar, including the high cost of assistive technologies, lack of availability, insufficient training, negative attitudes, inadequate funding, and poor infrastructure. Senjam et al. (2023) observed that a substantial number of students would benefit from visual-based assistive technology.

Conclusion

The integration of assistive technology in educational settings significantly enhances academic performance among students with visual impairments. Studies highlight a positive trend in the usage of such technologies, emphasizing their benefits, including improved reading skills and engagement. However, challenges such as resource constraints, inadequate training, and socio-psychological barriers persist. Effective implementation of assistive technologies requires sustained investment, robust policy support, and comprehensive training for both students and educators. Addressing these barriers is crucial for fully harnessing the potential of assistive technologies and ensuring equitable educational opportunities for visually impaired students. In India, despite some institutions effectively utilizing assistive technologies, many face funding shortages and lack adequate staff training, highlighting the need for better policies and infrastructure.

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