

Assistive Technology in Communication Development Learning for Deaf Students: A Literature Review

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Abstract

Students with hearing impairments face significant barriers in accessing auditory-based information, particularly in the learning of sound and rhythm perception within communication training. With the advancement of technology, various assistive devices have been developed to support deaf and hard-of-hearing students in recognizing, understanding, and responding to auditory stimuli through visual, tactile, and multisensory approaches. This article aims to review the literature on the use of assistive technology in the teaching of sound and rhythm perception for students with hearing disabilities. The method used is a systematic literature review of articles and research findings published in the last ten years. The findings indicate that assistive technologies such as digital hearing aids, FM systems, auditory training applications, and visual-based software have contributed positively to enhancing the engagement and auditory perception skills of students with hearing impairments. However, the implementation of these technologies still faces challenges, including limited access, teacher training gaps, and curriculum adaptation. Therefore, collaboration among teachers, schools, parents, and policymakers is essential to ensure the effective integration of assistive technology in communication learning. This review is expected to serve as a reference for practitioners and researchers in developing inclusive education responsive to the needs of students with hearing impairments.

Keywords: assistive technology, deaf and hard-of-hearing students, sound perception, rhythm, communication learning, literature review

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INTRODUCTION

Hearing loss has a wide-ranging impact on various aspects of individual development, such as delays in language acquisition, barriers to effective communication, and reduced ability to achieve optimal learning outcomes. It can also hinder the development of social skills, identity formation, emotional stability and self-confidence. Not only that, other cognitive and emotional aspects are also at risk of experiencing obstacles in the development process (Rahmawati et al., 2018). Students with hearing disabilities are students who have hearing impairments, both mild and severe impairments, these disorders have an impact on their ability to communicate with others (Suhartini et al., 2021). Students with hearing disabilities face significant challenges in developing communication skills, especially in understanding and responding to sound and rhythm stimuli. One important aspect of education for deaf students is the learning of Bina Komunikasi Persepsi Bunyi dan Irama (BKPBI). BKPBI is a training or coaching process designed to train understanding of sound, both through spontaneous approaches and through structured programmes. In their research, (Suhartini et al., 2021) mentioned several stages of BKPBI learning, namely:

- a. Sound Recognition or Detection Stage

This is the initial ability of students to realise the presence or absence of sound, either with or

without the aid of a hearing aid. For example, students are trained to respond to sound stimuli that are heard directly.

b. Sound Discrimination Stage

At this stage, students are directed to identify the direction from which the sound comes and distinguish various characteristics of sound, including height, type, intensity, and sound source.

c. Sound Identification Stage

d. This stage emphasises students' ability to recognise the characteristics of various sound sources and understand their properties in more depth.

e. Sound Comprehension Stage or Stage of Understanding or Comprehension of Sound

This is an advanced stage that integrates all abilities from the previous three stages. In this stage students are expected to be able to interpret, understand, and respond to various types of language and sounds they receive.

The purpose of BKPBI is to optimise the potential of residual hearing and sensitivity to vibrations possessed by deaf children, so that they can more easily communicate and socialise with people in the surrounding environment (Maulana & Suntoda, 2019). The benefits of BKPBI according to (Masunah et al., 2022) are BKPBI learning materials that combine musical elements such as rhythm and beat, as well as dance movements, have a positive impact on increasing the confidence of deaf students. Students demonstrate non-verbal communication skills through body movements, as well as verbal communication supported by sign language.

However, the limited hearing function causes the BKPBI learning process to be less than optimal when done with conventional approaches. Therefore, assistive technology comes as an alternative solution that allows deaf students to gain access to auditory information through visual, tactile, and other sensory-based technologies. Assistive technology is a tool or system designed to support individuals with disabilities to perform certain activities more independently. This technology plays a role in supporting the development of new skills, improving mobility, and increasing the capacity to learn and communicate (Dyzel et al., 2020). (Pradhan, 2020) in his research revealed that assistive technology plays an important role in supporting deaf students, both in learning activities and in their personal lives. This tool is designed to help them go through the daily learning process more easily. Technologies such as hearing aids, visual-audio based applications, and auditory training software have developed rapidly and started to be integrated in learning. Various studies reveal that assistive technology contributes positively to helping students develop the skills needed to communicate effectively (Erdem, 2017).

There are two main types of assistive technology used to support the learning of students with hearing disabilities, namely hearing aids (ABDs) and cochlear implants (CIs). ABDs are small electronic devices that are fitted into the ear canal to amplify sound so that it is more easily heard by the user. Meanwhile, IK is a surgical device fitted to the inside of the ear, which works by bypassing damaged hair cells and converting sound waves into electrical impulses that directly stimulate the auditory nerve. In their research (Hata et al., 2023) mentioned that in school-aged children, it appears that individuals with IK have significantly higher performance in auditory perception. Research and development of assistive technology has shown its important role in improving the participation and learning outcomes of students with hearing disabilities, especially in the context of sound and rhythm perception. (Subagya et al., 2023) in their research explained that to increase the effectiveness of learning Communication, Sound Perception, and Rhythm for students with hearing impairments, learning media are needed that are not only attractive and inclusive, but also continuously adapted to technological advances and student needs. In addition to supporting the improvement of teacher skills, the development of Augmented Reality-based Communication, Sound Perception and Rhythm learning media is an urgent matter to answer the needs of multimedia learning, as well as having a major impact on improving the ability to communicate, understand sounds and recognise rhythms in deaf students. However, the implementation of assistive technology for deaf students still faces various challenges, including limited access, teacher competence, and lack of in-depth understanding of integrative strategies in learning.

The difference between this study and previous studies is that it examines the implementation of assistive technology in the learning process of Bina Komunikasi Perception Bunyi dan Irama (BKPBI) for students with hearing disabilities. This study will review the latest literature on the use of assistive technology in learning Bina Komunikasi Perception Bunyi Irama for students with hearing disabilities. The focus of the review includes the type of technology used, its effectiveness in learning, relevant pedagogical approaches, as well as barriers and recommendations for developing practice in the field. Through this study, a

comprehensive picture of the role of assistive technology in creating inclusive learning that is responsive to the needs of students with hearing disabilities is expected.

METHOD

This review method uses a literature review study with a descriptive qualitative approach. Literature review study is an activity of summarising articles in journals or proceedings, books, and other documents relevant to the chosen topic (Prawitasari et al., 2023). The purpose of this study is to collect, analyse and synthesise various results of previous studies related to the use of assistive technology in supporting the learning process of Bina Komunikasi Perception Sound and Rhythm (BKPBI) for students with hearing disabilities.

Data sources were obtained from published national and international scientific journals. These sources were obtained through systematic searches on various online databases such as: Google Scholar, Scopus, and ResearchGate. The criteria for the selected articles included: published between 2015-2025; focused on studies involving students with hearing disabilities; research that examined the use of assistive technology; focused on Bina Komunikasi Perception Sound and Rhythm (BKPBI) learning of students with hearing disabilities; and articles in Indonesian or English, then 12 selected manuscripts were determined.

The researcher used search keywords such as “assistive technology for student with hearing impairment”, “assistive technology for Communication and Perception of Sound and Rhythm Training children with hearing impairment”, “implementation Communication and Perception of Sound and Rhythm Training children with hearing impairment”, and similar. The selection process was conducted in three stages: 1. Identification: Initial search using keywords. 2. Filtering: Eliminating irrelevant articles based on title and abstract. 3. Eligibility: Full reading of articles that met the criteria to determine their eligibility for analysis. Data analysis was conducted using a thematic synthesis approach, grouping the findings from the various studies into key themes such as: types of technology used, implementation strategies, learning outcomes and challenges.

RESULTS AND DISCUSSION

The studies obtained in this literature review were 12 articles. The data focused on objectives, variables, and outcomes. Table 1 lists the characteristics of the studies obtained. Table 2 shows a summary of the implementation of assistive technology in the learning process of Bina Komunikasi Perception Sound and Rhythm for students with hearing disabilities. All studies were published in the last ten years (2015 to 2025).

Table 1. Characteristics of the studies obtained

No	Judul	Penulis	Tahun
1.	Optimalisasi Pelayanan Bina Komunikasi Melalui Program Persepsi Bunyi Dan Irama (Bkpbi), Untuk Anak Yang Berkebutuhan Kusus Tunarunggu di SDLB Negeri Jenangan Ponorogo	Suhartini, E., Murdianto, etyowati, Nanik.	2021
2.	Pembelajaran Bina Komunikasi Persepsi Bunyi Irama pada Masa Pandemi Covid-19 Bagi Peserta Didik Tunarunggu	Poetra, A. M., Bachtiar, I. G., Lianty, L.	2022
3.	The Role of Phonetic Rhythmic Activities in Enhancing Speech Development and Socialization of Deaf and Hardof-Hearing Children	Sirodjobna, I. O., Abdumalikovna, A. Z.	2024
4.	Opportunity to Provide Augmented Reality Media for the Intervention of Communication, Perception, Sound, and Rhythm for Deaf Students based on Cultural Context	Subagya, Anggrellanggi, A., Sari, E. K., Priyono	2023
5.	The Effort To Improve The Movement of Rhythms of Student with Hearing	Maulana, M. J., Suntoda A., Slamet S.	2019

	Impairment Through BKPBI Learning (Sound and Rhythm Perception Communication)		
6.	Program for Development of Communication, Perception, Sound, and Rhythm to Build Self Esteem of Students with Special Needs	Masunah J., Milyartini, R., Aprilia, I. D.	2022
7.	Assistive Technology to Promote Communication and Social Interaction for People With Deafblindness: A Systematic Review.	Dyzel V., Calo, R. O., Worm, M., Sterkenburg, P. S.	2020
8.	Effective Use Of Assistive Technology For Better Quality Of Education Of Students With Hearing Impairment	Pradhan, P.	2020
9.	Implementation of Perception Communication Construct of Sound and Rhythm in Children with Hearing Impairment: Case Study in Pre-School and Kindergarten	Rahmawati, S. D., Somad, P., Aprilia, I. D.	2018
10.	Utilization of Internet Media by Deaf Persons for Language Learning (Case study on 11-year-old child at SLB B Tunas Kasih 2, Bogor City, West Java)	Putri, S. S., Supena, A., Yatimah, D.	2019
11.	Music Training for Children With Sensorineural Hearing Loss Improves Speech-in-Noise Perception	Lo, C. Y., Looi, V., Thompson, W. F., McMahon, C. M.	2020
12.	Students with Special Educational Needs and Assistive Technologies: A Literature Review	Erdem, R.	2017

Assistive Technology in BKPBI Learning

Assistive technology provides significant support for students with hearing disabilities in their educational activities and personal lives (Pradhan, 2020). These devices are designed to facilitate students' engagement in daily learning routines more independently and efficiently. Students with hearing disabilities can establish more effective communication and access important information needed to overcome challenges, both in the classroom environment and in social interactions outside of school. The use of this technology not only expands access to learning, but also helps reduce the functional barriers they often face in everyday educational contexts.

In BKPBI learning practices, teachers can utilise various types of assistive technology ranging from low-tech to high-tech. Low-tech assistive technology refers to assistive devices that do not involve electronic components in their use (Zen et al., 2025). This type of technology has a number of advantages, such as easy access for various groups, the ability to replace components simply in the event of damage, and does not require special maintenance or technical training for its use (Suwahyo et al., 2022).

Meanwhile, mid-tech assistive technologies generally consist of devices that are fairly simple, do not require specialised training, and are relatively affordable. These devices usually require a small amount of electrical power, such as batteries, but are still easy to use (Suwahyo et al., 2022). High-tech assistive technology involves the use of electronic or computer-based systems specifically designed to support individuals with disabilities. This type of technology generally requires specialised training and ongoing support to enable users to operate it effectively (Zen et al., 2025). Therefore, teachers are required to have competence in selecting and implementing technology that suits the abilities and needs of individual students

with disabilities effectively in the learning process.

Table 2. Assistive Technology in the Learning Process of BKPBI for Students with Deaf blindness

No.	BKPBI Stages	Assistive Technology	Level of Technology	Implementation
1.	Sound Detection	Glass bottle, glass, spoon, bell, musical instrument (tambourine, drum, gong, tambourine)	Low	When the assistive technology is sounded, if the learner hears a sound, the learner responds by raising their hand; drawing a sound symbol; looking towards the sound source; or stomping their foot.
		Sound recorder, speaker	Middle	
		Augmented reality, music player, learning video/animation	High	
2.	Sound discrimination	Musical instruments (pianica, tambourine, drum), glass/bottle (high pitch), gallon/plastic bucket (low pitch)	Low	Low Long-short sound When the sound is long, the hand is stretched forward and when the sound is short, the hand is pulled to the side of the back.
		Microphone	Middle	High-low sound When the sound is high, both hands hold the head or cover the ears and when the sound is low, both hands hold the stomach.
		Augmented reality, music player, learning video/animation	High	Fast-slow sounds When hearing fast sounds, run in place and when hearing slow sounds, walk in place or symbolize fast sounds with the symbol [===] and slow sounds with [- - -] in the students' notebooks.
3.	Identify sounds	Guitar, gallon, glass, can, plastic bottle	Low	Count sounds Write down the number of sounds played, sounding assistive technology a number of sounds played Source of sound Mention the type of sound played/listened to, for example the sound of a cock crowing or a meow Direction of sound
		Sound recorder, speaker, microphone	Middle	
		Augmented reality, music player, learning video/animation	High	

				Raise your right hand if the sound you hear comes from the right and raise your left hand if you hear the sound from the left. You can also draw an arrow to the right if you hear the sound from the right and an arrow to the left if you hear the sound from the left.
4.	Sound comprehension	Musical instruments (Pianika, guitar, tambourine, flute)	Low	Playing a musical instrument; performing rhythmic movements according to a video; naming sounds that are played, saying sentences, and role-playing.
		Sound recorder, speaker, microphone	Middle	
		Augmented reality, music player, learning video/animation	High	

Effectiveness and Challenges of Assistive Technology Implementation in BKPBI Learning

There are a number of important considerations that must be considered by educators in selecting appropriate assistive technology for students (Zakiah et al., 2024), including: suitability to the individual needs of students, ease of use, availability of support for the use of technology, and affordability in terms of budget so that the technology can be accessed optimally. Therefore, special education teachers are required to have competence in selecting and applying assistive technology appropriately based on the learning needs of students with disabilities. Teachers also need to identify the needs and characteristics of students and involve them in the process of selecting the assistive technology to be used, to suit their learning preferences and interests. In addition, support from families plays a crucial role in the successful implementation of assistive technology. Thus, close collaboration between schools and families is needed to ensure the integration of assistive technology is effective during the learning process of students with disabilities.

In addition to various considerations in the selection of assistive technology, there are a number of significant challenges that hinder its optimal implementation in the educational environment for students with disabilities (Zen et al., 2025), including:

a. High Procurement Costs

Although technological advances have produced a variety of assistive devices that can improve the quality of life of people with disabilities, financial limitations are often the main obstacle for families in obtaining these devices. Not only individuals, educational institutions also often experience similar obstacles due to limited budget allocations, which have an impact on the lack of access to educational technology and training needed by students with disabilities.

b. Stigma and Discriminatory Treatment

One of the sociocultural challenges faced in the use of assistive technology is the existence of stigma, which is a negative view or stereotype attached to individuals with disabilities. This condition can lead to discomfort or reluctance to use assistive devices for fear of being considered "different" by their social environment. In addition, forms of discrimination such as inequality in obtaining educational services, employment, or access to assistive technology are still common, which further exacerbates the social exclusion experienced by people with disabilities.

c. Lack of Training and User Competence

The lack of educators or trainers who have competence in assistive technology is a major obstacle to its implementation. Without adequate training, the available devices may not be used effectively. Therefore, synergy between educational institutions, professionals, and the government is needed to organize continuous training on the utilisation of assistive technology in the context of learning.

d. Limited Resources and Infrastructure

The implementation of assistive technology is also often constrained by limited resources and infrastructure, especially in remote areas. The absence of stable electricity or adequate internet connection makes the use of technology-based devices difficult to access evenly. In this case, the active role of the government is needed, especially in building basic infrastructure such as providing electricity and internet networks to support equitable access to assistive technology.

CONCLUSION

Based on the results of the literature review, it can be concluded that assistive technology has a role in supporting the learning process of *Bina Komunikasi Persepsi Bunyi dan Irama* (BKPBI) for students with hearing disabilities. The variety of assistive technology available includes low, medium, and high-tech categories, each of which has specific functions and characteristics. Therefore, the selection of these technologies needs to be tailored to the specific needs and individual abilities of each learner.

In practice, the implementation of assistive technology is affected by a number of factors and challenges, including limited teacher knowledge of the types of assistive technology and their functions, skills in implementation, limited funds that make it difficult for families and educational institutions to access the technology, as well as social stigma and discrimination against people with disabilities. In addition, the uneven distribution of resources is also an obstacle.

By considering these conditions, teachers are expected to develop creativity in exploring the potential of the environment and maximising available resources to create more inclusive learning. Cross-sector support, including from schools, families, communities, social institutions and the government, is needed to ensure the implementation of quality and equitable education for students with disabilities.

AUTHOR CONTRIBUTIONS

Putri, Maringgar Hangesti: Conceptualization, Methodology, Writing, and Finalization .; Hidayat, Erfin Candra: Methodology, Formal Analysis, Resources, and Validation; Pratiwi, Tri Sedyo Silo: Resources and Writing - Original Draft; and Khasanah, Uswatun: Data Curation and Project Administration.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that Generative Artificial Intelligence and other assistive technologies were not excessively utilized in the research and writing processes of this manuscript.

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