

CONTRIBUTION OF TECHNOLOGY TO ACADEMIC PERFORMANCE OF LEARNERS WITH HEARING IMPAIRMENT IN SELECTED SCHOOLS IN LUSAKA AND NDOLA DISTRICTS IN ZAMBIA: TEACHERS' VIEW

Muvombo Moono¹, Biggie Shanzuwa², Clement J. Kabungo³, Juliet Chibwe⁴, Annie Penda⁵, Shadrack Chansa⁶

¹Department of Special Education, Kwame Nkrumah University, Zambia, muvombomoono22@gmail.com

²Department of Special Education, Kwame Nkrumah University, Zambia, shanzuwab@gmail.com

³Department of Educational Psychology and Sociology, Kwame Nkrumah University, Zambia, jnkabungo@gmail.com

⁴Department of Special Education, Kwame Nkrumah University, Zambia, jchibwe26@gmail.com

⁵Department of Special Education, Kwame Nkrumah University, Zambia, anniependa@gmail.com

⁶Department of Special Education, Kwame Nkrumah University, Zambia, chansashadrack2@gmail.com

Correspondence: Clement J. Kabungo jnkabungo@gmail.com

Abstract

Learners with hearing impairment have a fundamental right to equitable to education, and this extends to the integration of assistive and digital technologies in classroom settings. This study explored the contribution of technology to the academic performance of learners with hearing impairments in selected secondary schools in Zambia. Employing an interpretivism paradigm and a case study research design, the study targeted secondary school teachers across five schools in Lusaka and Ndola Districts, with a purposively selected sample of 35 participants. Data were collected through unstructured interview schedules and analysed using qualitative thematic analysis. The practical significance of the study lies in its provision of contextually grounded, empirical evidence to inform policy reform, institutional planning, and teacher professional development in Zambia's inclusive secondary education system. Findings revealed that, while technology devices including hearing aids, FM systems, captioning services, and sign language interpretation tools were available in varying degrees, their effective deployment was constrained by insufficient resources, device incompatibility, inadequate teacher training, and the absence of structured sign language support in ICT instruction. Despite these challenges, teachers consistently affirmed that appropriately utilised assistive technologies improved classroom engagement, communication, and academic performance among hearing-impaired learners. The study underscores the need for institutionalised procurement of assistive technologies, targeted professional development for teachers, and policy alignment to ensure equitable and sustainable technology integration in inclusive secondary education in Zambia.

Keywords: Assistive technology, academic performance, hearing impairment, inclusive education, secondary schools, Zambia.

Published online: 27 September 2026

1.0 INTRODUCTION

The integration of technology into education has emerged as a transformative force in shaping learning experiences, particularly for learners with disabilities. Globally, the deployment of assistive technologies has been recognised as a critical mechanism for bridging communication gaps and ensuring that learners with hearing impairments can access educational content on an equal footing with their peers. In Zambia, where inclusive education remains a key policy priority, the role of technology in enhancing academic outcomes for learners with hearing impairments carries particular significance. Technological advancements such as hearing aids, cochlear implants, FM systems, captioning services, speech-to-text software, and online learning platforms have made it increasingly possible for learners with hearing impairments to communicate more effectively, engage with instructional content, and participate meaningfully in classroom activities (Foster and Alghazo, 2016). These technologies serve as conduits for bridging the communication divide, thereby ensuring that learners with hearing impairments are afforded equitable opportunities to succeed academically. Beyond individual device functionality, the broader evidence base emphasises that the availability and appropriate use of assistive technologies tailored to the unique needs of hearing-impaired learners contribute significantly to improvements in comprehension, retention, and overall academic performance (Foster and Alghazo, 2016). In resource-constrained contexts such as Zambian secondary schools, however, the translation of this potential into consistent classroom practice remains uneven. Although some schools have made deliberate steps toward integrating technology into teaching and learning, systemic gaps in procurement, training, and infrastructure continue to limit the impact of these tools.

This study is grounded in the recognition that teachers occupy a central role in mediating the relationship between technology and learner outcomes. It is through their perceptions, competencies, and instructional decisions that technology either becomes a functional learning tool or remains an underutilised resource. Technology in educational settings for learners with hearing impairments can offer access to specialised tools, including sign language interpretation software and assistive listening devices, that facilitate more effective communication and interaction in the classroom (Luckner and Muir, 2001; Lang et al., 2020). Understanding how teachers perceive and utilise these tools is therefore essential to improving educational practice for this population.

The rationale for this study further derives from a specific empirical gap in the Zambian literature on technology use in special education. Whilst prior studies conducted within Zambia have addressed inclusive education in broader terms examining issues such as teacher attitudes toward learners with disabilities, general school enrolment trends, and the policy framework for special education provision these investigations have not sufficiently examined the particular role of assistive technologies in mediating the academic performance of learners with hearing impairments at the secondary school level. Specifically, the intersection of assistive technology use, teacher perceptions, and academic outcomes in secondary schools in Lusaka and Ndola Districts remains underexplored. The existing literature does not account for how technology devices such as FM systems, captioning services, and sign language interpretation tools are experienced by teachers in Zambian secondary school settings, nor does it document the institutional and professional barriers that constrain their effective deployment. This study was therefore conducted to address this specific gap. Unlike broader inquiries

into special education provision in Zambia, this study foregrounds the lived professional experiences of teachers in secondary schools and directly investigates the link between technology use and academic performance outcomes for learners with hearing impairment.

1.1 Purpose of the Study

The purpose of this study was to assess the contribution of technology to the academic performance of learners with hearing impairment in selected secondary schools in Zambia.

1.2 Scope of the Problem

Assistive Listening Devices (ALDs), including FM systems, loop systems, and amplification technologies, represent a foundational category of support for learners with hearing impairments in classroom settings (Crandell and Smaldino, 2000). However, despite these demonstrable advances in assistive technology, little is known about how such tools are effectively deployed to enhance the academic performance of learners with hearing impairments in Zambian secondary schools, particularly regarding their impact on children with hearing impairment in this context. Therefore, this study sought to address this gap by generating contextually grounded insights to inform the development and implementation of tailored technological solutions that support the academic success of learners with hearing impairments, and to assess how benefits are realised or constrained within the local educational context. Key factors requiring investigation include the accessibility, usability, and instructional effectiveness of technological tools such as captioning software and sign language.

1.3 General Objective

The main objective of the study was to assess the contribution of technology to the academic performance of learners with hearing impairments in selected secondary schools in Zambia.

1.4 Specific Objectives

The study was guided by the following specific objectives:

1. To establish the availability of technology devices in schools that enhance the academic performance of learners with hearing impairments.
2. To explore the impact of technology devices on the academic performance of learners with hearing impairments in selected secondary schools in Zambia.
3. To identify the challenges learners face in using technology devices to enhance their academic performance.

2.0 REVIEW OF RELATED LITERATURE

The literature on technology integration in special education consistently highlights its potential to transform learning experiences for learners with hearing impairments. When appropriately applied, assistive technologies provide learners with the tools necessary to bridge communication gaps, access instructional content, and achieve academic success. Several categories of technological intervention have been documented in the empirical literature, each demonstrating measurable contributions to the learning outcomes of students with hearing impairment.

Assistive Listening Devices (ALDs), including FM systems, loop systems, and amplification technologies, represent a foundational category of support for learners with hearing impairments in classroom settings. These devices enhance the listening environment by amplifying the teacher's voice and minimising background noise,

enabling learners to focus on spoken content with greater clarity. Tharpe and Bess (1999) and Crandell and Smaldino (2000) document that FM systems significantly improve the academic experience of students with hearing impairments by transmitting the teacher's voice directly to the learner's hearing aid or cochlear implant, thereby enhancing instructional comprehension. By reducing the interference of ambient noise, ALDs contribute to increased engagement, sustained attention, and improved academic performance, particularly in larger or acoustically challenging classroom environments.

Captioning and subtitling technologies have similarly been established as effective tools for supporting literacy development and content comprehension. By providing real-time written text corresponding to spoken dialogue, these technologies make instructional content accessible to learners who cannot fully rely on auditory cues. Wyatt (2010) found that learners with access to captioned videos demonstrated improved reading comprehension, as the visual text facilitated connections between spoken language and its written representation. Marschark and Hauser (2012) further observed that captioning played a crucial role in enhancing both literacy and content comprehension, enabling learners to follow lessons in real time. The multi-sensory approach fostered by captioning, combining auditory and visual information, supports retention and deepens understanding across subject areas.

Speech-to-text and transcription tools are increasingly being utilised to support learners with hearing impairments in accessing classroom interactions. These technologies convert spoken language into written text in real time, enabling students to follow class discussions and lectures without relying solely on lip-reading. The availability of real-time transcription also facilitates note-taking and ensures learners do not miss critical instructional content. Borg et al. (2017) confirm that speech-to-text technologies significantly improve learners' access to information and enhance participation in class discussions, contributing to improved academic outcomes.

Cochlear implants and hearing aids remain foundational technologies for enhancing the auditory experience of learners with hearing impairments. Archbold et al. (2002) demonstrate that cochlear implants, which directly stimulate the auditory nerve, positively impact language development, communication skills, and academic performance. Hearing aids amplify environmental sound, enabling learners to access classroom cues that would otherwise be missed. Both technologies contribute to improved social integration and academic participation by enhancing auditory discrimination and communication capacity.

Online learning platforms and e-learning tools have gained growing relevance in supporting flexible and accessible educational experiences for hearing-impaired learners. These platforms deliver content in multiple formats, including captioned video, interactive exercises, and digital texts, accommodating diverse learning preferences. Baker et al. (2015) indicate that online learning platforms improve academic outcomes for learners with disabilities by offering personalised and accessible learning environments. The capacity to review recorded lessons with captions, access resources at individual pace, and participate in online discussions fosters independence and broader academic engagement.

Visual learning tools, including interactive whiteboards, graphic organisers, and educational software, further enrich the instructional environment for learners with

hearing impairments. Foster and Alghazo (2016) note that interactive whiteboards allow dynamic, real-time content presentation that supports visual comprehension even where auditory access is limited. Okolo and Englert (2019) affirm that educational software designed for learners with disabilities provides adaptive and engaging platforms that accommodate diverse cognitive needs, enhancing processing and promoting inclusive learning experiences.

2.1 Communication Apps and Devices

Advancements in communication technology have yielded a range of applications and devices specifically designed to facilitate communication for individuals with hearing impairments. Text-to-speech applications and speech recognition software convert text to spoken output and spoken input to text respectively, enabling learners to both receive and express information without exclusive reliance on auditory processing. Video conferencing platforms equipped with real-time captioning have become increasingly significant, particularly in remote and hybrid learning contexts, where they ensure that hearing-impaired learners can follow spoken content and participate in virtual interactions (Marschark and Wauters, 2008). Vanderheiden (2016) underscores the importance of these communication tools in dismantling barriers that would otherwise impede learners' access to and participation in classroom discourse.

The expansion of online learning has further extended opportunities for hearing-impaired learners by enabling flexible, self-directed educational experiences. Virtual classrooms and e-learning platforms allow learners to access instructional content remotely, review materials at their own pace, and engage with multimedia resources including captioned videos and interactive exercises. Lang et al. (2020) confirm that the adaptability of online learning systems supports engagement across diverse learning styles and preferences. Virtual learning environments also provide structured opportunities for peer interaction and collaborative learning, promoting inclusion beyond the physical classroom.

The evidence base on technology for learners with hearing impairment, while demonstrating considerable promise, also consistently highlights the significance of individual differences, infrastructure constraints, and ongoing institutional support in determining equitable outcomes. Further research contextualised within specific educational settings, including under-resourced secondary schools in Zambia, remains essential for translating global evidence into locally applicable implementation strategies.

Within the African context, scholars have begun documenting both the potential and the persistent barriers associated with assistive technology in inclusive education. Eleweke and Rodda (2002) highlight systemic obstacles to inclusive education in developing countries, including insufficient funding, limited teacher training, and inadequate assistive technology provision — all of which resonate with challenges observed in Zambian secondary schools. Donohue and Bornman (2014), examining special education in South Africa, document the gap between policy commitments to inclusive education and the practical realities of resource-constrained school environments, noting that technology provision in isolation, without accompanying teacher development, yields limited outcomes. Chimhenga (2016), in a study of special needs education in Zimbabwe, found that teachers' limited competency with assistive technologies was a primary barrier to effective inclusion — a finding directly relevant to the present study's focus on teacher perceptions and practice in Zambia.

2.2 Lessons Learnt from the Literature Reviewed

The reviewed literature yields several instructive insights relevant to the Zambian context. First, technology plays a crucial role in providing accessible learning materials and communication platforms for learners with hearing impairment, enabling fuller participation in educational activities. Second, tailored technological solutions, including captioning, sign language interpretation tools, and speech-to-text applications, can significantly enhance individual learning experiences and accommodate the diverse needs within this population. Third, technology facilitates communication among learners, teachers, and peers, fostering collaboration and social integration that are essential to both academic success and holistic well-being. Fourth, equitable access to assistive technologies empowers learners to exercise greater control over their learning, promoting independence and self-advocacy. Fifth, the literature underscores that ongoing research, policy commitment, and institutional investment are indispensable for addressing emerging challenges and ensuring sustainable access to quality, technology-supported education for learners with hearing impairment.

2.3 Theoretical Framework

This study is informed by the Technology Acceptance Model (TAM), originally proposed by Davis (1989) and subsequently extended by Venkatesh and Davis (2000). The TAM posits that the adoption and effective use of technology is primarily shaped by two constructs: perceived usefulness, defined as the degree to which a person believes a given technology will enhance their task performance, and perceived ease of use, defined as the extent to which a person expects using the technology to require minimal effort. In the educational context, these constructs offer a productive explanatory lens for understanding why teachers may actively deploy assistive technologies in their instructional practice or, alternatively, leave available tools underutilised.

The TAM is particularly appropriate for this study because it provides a theoretically grounded framework for interpreting the variability in technology adoption documented across the five participating schools. Teachers who perceived assistive technologies — including FM systems, captioning services, and sign language interpretation tools — as useful for bridging communication gaps were more likely to integrate them meaningfully into their lessons. Conversely, where teachers reported limited familiarity, inadequate training, or perceived technical complexity, the TAM framework anticipates reduced uptake, which is consistent with the patterns revealed by the data. The model further explains why hardware availability alone does not translate into effective technology use: unless teachers perceive both the utility and the accessibility of a tool, adoption remains limited.

By applying the TAM, this study moves beyond descriptive documentation of technology availability to offer a theoretically informed account of the conditions under which assistive technologies contribute to meaningful improvements in the academic performance of learners with hearing impairment. This theoretical positioning is supported by research in special education and assistive technology adoption (Borg et al., 2017; Foster and Alghazo, 2016), which confirms that teacher perceptions of usefulness and competency are critical mediators of technology impact in inclusive classroom settings.

3.0 RESEARCH METHODOLOGY

3.1 Overview

This section presents the methodological framework that guided the study. It covers the research paradigm, approach, design, target population, sample size, sampling techniques, instruments for data collection, data collection procedure, data analysis, and ethical considerations governing the conduct of the research.

3.2 Research Paradigm

This study was guided by an interpretivism paradigm, which is premised on the understanding that knowledge is socially constructed through the interactions and lived experiences of people (Chilisa and Preece, 2005; Creswell, 2009). Within the interpretivist worldview, ontology positions reality as subjective and context-dependent, while epistemology foregrounds the researcher's engagement with participants as co-constructors of meaning. This paradigm was appropriate for the present study given its focus on teachers' perceptions and experiences of technology use in the education of learners with hearing impairment. It enabled the collection of rich, contextualised accounts that illuminate the meanings teachers attribute to technology's contribution to academic performance.

3.3 Research Approach

Consistent with the interpretivist paradigm, a qualitative approach was adopted as the overarching methodology for the study. The qualitative approach was suitable for exploring the subjective experiences, perceptions, and contextual realities of teacher participants, and for generating in-depth, descriptive data on the role of technology in supporting learners with hearing impairment (Patton, 2015; Yin, 2010). This approach guided all phases of the study, including sampling, data collection, and the analysis and interpretation of findings.

3.4 Research Design

An intrinsic case study design was employed to investigate the phenomenon of interest within its real-life educational context (Creswell, 2009; Chilisa and Preece, 2005). The case study design was particularly appropriate because it enabled a contextualised, in-depth exploration of how technology is deployed, experienced, and perceived within specific secondary school settings in Zambia. The selection of five schools was methodologically deliberate. In qualitative case study research, the number of cases is determined not by statistical representativeness but by the diversity and richness of insight each site is expected to yield (Yin, 2010). The five schools were selected because they collectively represented a range of institutional contexts: urban and peri-urban settings, two geographically distinct districts, and institutions with varying levels of assistive technology availability and teacher specialisation. This diversity enabled comparative analysis across different contextual conditions, thereby generating richer and more transferable insights than a single-site study would have allowed. The five-school scope was also considered manageable within the resources available for the study whilst remaining sufficient to achieve data saturation. By focusing on these five schools in Lusaka and Ndola Districts, the study generated rich, school-specific insights while contributing to a broader understanding of technology integration in inclusive secondary education.

3.5 Target Population

The target population comprised all teachers across five selected secondary schools in Lusaka and Ndola Districts, namely Munali Girls Secondary School, Kafue Secondary

School, Lukanda Secondary School, Kalulushi Secondary School, and Valley View Secondary School. This population was identified as the most appropriate source of information given the study's focus on teachers' perceptions and practices in relation to technology and hearing-impaired learners. The target population therefore included all classroom teachers and specialist educators within these institutions (Kombo and Tromp, 2013).

3.6 Sample Size

The study involved a sample of 35 participants drawn from the five selected secondary schools, comprising five class teachers and thirty subject teachers. This sample size was considered adequate for a qualitative case study investigation, where the goal is not statistical representativeness but rather the attainment of data saturation, at which point no new themes or substantive insights emerge from further data collection (Kombo and Tromp, 2013).

In terms of demographic profile, the 35 participants comprised 18 female and 17 male teachers. Their teaching experience ranged from 2 to 21 years, reflecting a combination of relatively new and more experienced educators. Of the total sample, 5 participants were class teachers, the remaining 30 were subject teachers with experience in inclusive classroom settings. A total of 12 participants had received structured in-service training in the use of assistive technologies, while the remaining 23 reported having acquired such knowledge informally or through ad hoc exposure. This range of professional backgrounds, qualifications, training experiences, and years of service contributed to the diversity and richness of perspectives captured in the study.

3.7 Sampling Techniques

Participants were selected using expert purposive sampling, a deliberate strategy for identifying and recruiting key informants who possess the specific knowledge and experience pertinent to the research questions (Chilisa and Preece, 2005; Kombo and Tromp, 2013). Teachers were selected on the basis of their direct involvement in teaching learners with hearing impairment and their familiarity with the technology resources available in their schools. This approach ensured that the data collected were grounded in authentic, first-hand professional experience.

3.8 Instruments for Data Collection

Data were collected using unstructured interview schedules, consistent with the qualitative and interpretivism orientation of the study. Unstructured interviews allowed participants to respond freely and expansively, generating rich descriptive accounts of their experiences with technology in the education of hearing-impaired learners. This instrument enabled the researcher to probe emerging themes in depth and to follow the natural flow of participants' narratives, capturing the nuanced perspectives that are central to interpretivist inquiry (Yin, 2010). The interview guide comprised open-ended prompts structured around the study's three specific objectives, covering: (i) the types and availability of technology devices in participants' schools and their accessibility to learners with hearing impairment; (ii) teachers' perceptions of the impact of specific technology devices on learner engagement, comprehension, and academic performance; and (iii) the challenges experienced by teachers and learners in using technology devices effectively in classroom settings. Probing questions were embedded throughout to elicit elaboration on initial responses. The guide was reviewed by two experts in special education research prior to data collection to ensure alignment with the study's research

questions and the broader interpretivism orientation, and minor revisions were made based on their feedback.

3.9 Data Collection Procedure

The data collection process involved three distinct phases: entry into the research sites, data collection, and exit from the field. Introductory letters were obtained from Kwame Nkrumah University to facilitate access and establish institutional credibility. Permission was sought from all relevant gatekeepers, including school administrators and district education authorities. Data collection was preceded by appropriate arrangements with each school, and interviews were conducted in a manner respectful of participants' time and professional responsibilities. Following data collection, multiple strategies were employed to establish and demonstrate the trustworthiness of the study, drawing on the credibility criteria proposed by Lincoln and Guba (1985). Member checking was conducted with selected participants to verify the accuracy of recorded information and to ensure that interpretations reflected participants' intended meanings. Credibility was further strengthened through triangulation: data were gathered across five schools in two districts, and patterns were cross-verified across institutional contexts to reduce the risk of site-specific bias. An audit trail was maintained throughout the research process, documenting methodological decisions, field observations, and analytical choices in sufficient detail to allow for external review of how conclusions were reached. Peer debriefing was conducted with a colleague experienced in qualitative research methodology, who reviewed emerging themes and offered critical interrogation of interpretations to mitigate researcher influence. Prolonged engagement with the research sites, through multiple visits to each school, further deepened contextual understanding and strengthened the credibility of the findings generated. The researcher expressed formal appreciation to all participants upon concluding fieldwork at each site (Kombo and Tromp, 2013; Yin, 2010).

3.10 Data Analysis and Ethics

Data were analysed using thematic analysis, following the systematic six-phase framework proposed by Braun and Clarke (2006). The process began with familiarisation with the data through thorough reading and transcription, followed by the generation of initial codes representing recurring ideas and patterns. In the third phase, codes were grouped and analysed to identify overarching themes. Subsequent phases involved reviewing, refining, defining, and naming themes, culminating in the production of a coherent thematic account of the findings. Themes were aligned with specific research questions to ensure systematic and focused analysis.

Ethical rigour was maintained throughout the research process. Participants' identities were protected through the use of codes, with all 35 teachers assigned participant codes from TR1 to TR35 and schools anonymised as School A through School E. Informed consent was obtained from all participants prior to data collection, and voluntary participation was emphasised. Confidentiality of all data was strictly observed, with findings reported in aggregate thematic form to prevent individual identification.

3.11 Significance of the Study

The findings of this study carry significance for multiple stakeholders, including researchers, educational policy makers, school administrators, special education practitioners, and learners with hearing impairment. For policy makers, the study provides empirical grounding for decisions related to the procurement and integration of assistive technologies in secondary schools. For school administrators and teachers,

the findings offer practical, evidence-based insights into how technology can be deployed to improve learning outcomes for hearing-impaired learners. For researchers and academics, the study contributes to the body of knowledge on inclusive education and assistive technology in the Zambian context, identifying directions for future inquiry. Ultimately, the study advocates for an educational environment in which learners with hearing impairment have reliable access to effective technological support that enables them to participate fully and achieve their academic potential.

4.0 RESULTS

Thirty-five teacher participants drawn from five secondary schools in Lusaka and Ndola Districts participated in the study. Participants were assigned codes TR1 through TR35 and schools were anonymised as School A through School E, corresponding to Munali Girls Secondary School, Kafue Secondary School, Lukanda Secondary School, Kalulushi Secondary School, and Valley View Secondary School respectively. Data saturation was reached for all research questions, with findings remaining consistent across participant responses collected from the field.

4.1 Availability of Technology Devices for Learners with Hearing Impairment

A central focus of this study was the availability and accessibility of technology devices for learners with hearing impairment in the participating secondary schools. Teachers were asked to describe the technological resources in their schools and assess their relevance to the teaching and learning process for hearing-impaired learners. Analysis of interview data revealed a pattern of limited but variable availability, characterised by present but inadequate resources, uneven distribution across schools, and a notable absence of specialised assistive software.

Several participants confirmed the presence of computer laboratories and general ICT infrastructure, but noted significant gaps in both functionality and specialisation. TR1 from School A observed:

Yes, the computer devices are of great help to the learners, making it easier to teach and also equipping them with ICT skills that can help them find work after school. Additionally, it serves as a recreation room where learners engage in video lessons.

TR4 from School B added:

Yes, the arrangement of the room allows learners with hearing impairment to engage in hands-on activities on the computers, making it easier for them to understand the lessons.

These responses indicate recognition of the educational value of available devices, though their scope remains largely confined to general ICT use rather than targeted assistive functionality. Challenges related to device quantity, functionality, and specialisation were consistently reported.

TR9 from School E remarked:

The computers are available, but not all are functioning. Some are outdated and need maintenance to be more effective for learners with hearing impairments.

TR10 from School A noted:

Yes, but there are challenges. Some learners need specialised assistive software like speech-to-text applications, which are not yet available in our school's lab.

TR11 from School B stated: 'Yes, but the number of computers is not enough for all learners, so they have to share, which sometimes limits individualised learning experiences.'

These accounts point to systemic limitations in the availability and condition of technology resources across the five schools.

Beyond computers, participants described a range of other devices available in their schools, though again with notable caveats.

TR7 from School D contributed:

The school is privileged to have tablets that are used in teaching learners. However, learners with hearing impairment do not fully benefit because sign language is not included in the programmed lessons.

TR19 from School D emphasised: 'Hearing aids and FM systems are available, but not all learners have access to them due to financial constraints'.

TR32 from School E shared:

While the computers are helpful, most teachers lack training on how to integrate ICT into lessons for hearing-impaired learners. More workshops are needed to maximise the benefits of these resources.

These findings collectively indicate that, while foundational technology infrastructure exists across the participating schools, its effective utilisation for learners with hearing impairment is constrained by functional limitations, insufficient specialisation, inequitable access, and inadequate teacher preparation.

Table 1: Availability and Accessibility of Technology Devices for Learners with Hearing Impairment

Technology Device	Availability in Schools	Teacher Observations
Hearing Aids	Present in most schools; provided individually to eligible learners	TR4: "Hearing aids allow learners to hear and respond effectively during lessons"
FM Systems	Available in select schools; not universally deployed	TR3: "FM systems amplify sound, helping learners follow lessons and engage in discussions"
Computer Laboratories	Present in all five schools; varying levels of functionality	TR9: "Computers are available but not all are functioning; some are outdated"

Captioning Software	Limited; not yet standard in most computer labs	TR10: "Specialised assistive software like speech-to-text are not yet available"
Sign Language Apps	Largely absent; dependent on individual teacher initiative	TR35: "There is a need for sign language-integrated learning software"

Table 2: Teacher Perceptions and Acceptance of Technology Devices Across Schools

School	Teacher Perception of Technology	Interpretation
School A	Computers and hearing aids described as highly beneficial for bridging communication gaps	Strong acceptance; technology seen as essential pedagogical support
School B	Technology recognised but sign language integration essential	Acceptance conditional on adequate interpreter support
School C	Mixed views; some teachers unaware of available devices	Inconsistent institutional communication about resources
School D	Computer lab enables knowledge acquisition and independent learning	Positive acceptance tied to learner autonomy outcomes
School E	Technology helpful but training gaps limit effective use	Acceptance hindered by inadequate professional development

4.2 Impact of Technology Devices on Academic Performance

The study explored teachers' perceptions of the impact of assistive technologies on the academic performance of learners with hearing impairment. Findings revealed that teachers across all five schools affirmed the positive contribution of technology to learner engagement, comprehension, and academic outcomes, although the extent of impact was seen to depend significantly on the quality, availability, and appropriate use of specific devices and services.

Participants highlighted the role of hearing aids and FM systems in improving classroom interaction and communication.

TR1 from School A observed:

The devices visibly improved learner participation by bridging communication gaps between teachers and hearing-impaired students, making interaction and learning more accessible given the nature of the learners' condition.

TR4 also from School A similarly affirmed that hearing aids had a direct and significant impact on academic performance by enabling learners to hear, process, and respond to lesson content more effectively.

TR3 from School A noted:

FM systems and assistive listening devices are particularly beneficial for learners who are hard of hearing. These devices amplify sound, making it easier for them to follow lessons and engage in classroom discussions.

Captioning services and sign language interpretation were identified as particularly effective in supporting academic performance for learners with hearing loss.

TR1 from School A emphasised that:

Captions served as essential visual representations of spoken content, and that their combination with sign language created a complementary communication mode that meaningfully connected teachers and learners. (see Table 4).

TR18 from School B noted:

To address language barriers, our school has employed a sign language interpreter alongside specialist teachers. As a result, there has been a noticeable improvement in academic performance, as learners now experience more effective communication with teachers.

Participants consistently identified the quality and accuracy of interpretation and captioning as key determinants of their impact on learning.

TR1 from School A explained:

The knowledge and skills of the interpreter matter. Some complex words require clear explanation, and it takes time for some learners to fully understand. Sign language is crucial in ensuring clarity.

TR26 from School D emphasised: *Captioning must be synchronised properly with the teacher's speech. If captions appear too late, learners struggle to follow along.*

Teachers further affirmed the value of digital tools including interactive whiteboards, tablets, and educational applications in enhancing academic engagement.

TR18 from School C noted: *'When learners use captioned videos and visual learning tools, they retain more information and perform better in written assessments'.*

TR22 from School C said:

Interactive whiteboards and visual learning applications help break down complex concepts, making it easier for learners with hearing impairment to understand subjects such as science and mathematics.

TR29 from School E added: *'Assistive technologies foster independence in learning, as students can use digital resources to supplement what they learn in class.'*

Teachers further linked the consistent use of visual and digital learning tools to improved academic engagement among hearing-impaired learners.

Table 3: Participants' Perspectives on the Impact of Assistive Technologies on Academic Performance

Participant	Verbatim Response on Technology Impact
TR1 (School A)	<i>The results of this initiative are seen when learners actively participate, as the devices help bridge communication gaps between the teacher and the students.</i>
TR4 (School A)	<i>Hearing aids have a significant impact on academic performance because they allow learners to hear, listen, understand, and respond effectively during lessons.</i>
TR18 (School C)	<i>When learners use captioned videos and visual learning tools, they retain more information and perform better in written assessments.</i>
TR27 (School D)	<i>Hearing aids help students with hearing impairment hear properly, enabling them to grasp concepts more easily and participate actively in lessons.</i>

Table 4: Participant Perspectives on Captioning Services and Sign Language Interpretation

Participant	Verbatim Response on Captioning and Sign Language
TR1 (School A)	<i>Captions are essential tools as they bring a visual representation of spoken content. When combined with sign language, they create a communication mode connecting teachers and learners.</i>
TR14 (School B)	<i>It remains challenging for some teachers to lead lessons effectively when they are not fluent in sign language.</i>
TR18 (School B)	<i>Our school has employed a sign language interpreter alongside specialist teachers. There has been a noticeable improvement in academic performance.</i>
TR26 (School D)	<i>Captioning and sign language interpretation help learners catch up with lessons and engage more effectively in the learning process.</i>

4.3 Challenges in Using Technology Devices

Despite the perceived benefits of technology, teachers identified a range of challenges that impede its effective deployment in supporting learners with hearing impairment. These challenges span technical, financial, and professional dimensions and together constitute a significant barrier to the full realisation of technology's potential in inclusive secondary education.

Device compatibility and technical limitations emerged as a primary challenge.

TR1 from School A noted:

The compatibility of devices and software with assistive technologies, such as cochlear implants, poses a challenge. Some students struggle with lip-reading or following captioned videos due to audio disruptions and limitations in sign language interpretation.

Teachers across schools identified three interconnected categories of challenge. TR1 raised concerns about device and software compatibility, particularly regarding cochlear implants and captioning tools. TR4 highlighted financial constraints and electricity dependency as factors that made consistent device provision difficult, alongside a shortage of trained ICT teachers. TR10 and TR27 both pointed to the absence of sign language proficiency among ICT teachers as a particularly consequential barrier, rendering digital tools inaccessible to learners who depend on sign language even where devices are physically present. TR16 and TR32 noted limitations in laboratory resources and teacher training respectively. A summary of these perspectives is presented in Table 5.

TR16 from School C emphasised: *‘Limited resources in computer laboratories make it difficult to deliver effective lessons to learners with hearing impairment.’*

These findings collectively indicate that challenges including device compatibility, financial constraints, inadequate teacher training, and the absence of sign language support constrain the full implementation of technology for hearing-impaired learners. Taken together, these accounts reflect a combination of technical, financial, and training-related constraints reported across the five schools.

Table 5: Participant Perspectives on Challenges in Using Technology Devices

Participant	Challenge Identified
TR1 (School A)	<i>Cochlear implants and other assistive technologies often face compatibility issues with software, making it difficult for students to lip-read or follow captioned videos.</i>
TR4 (School B)	<i>The high cost of devices makes it difficult for schools to acquire enough for all learners. Reliance on electricity further limits usability.</i>
TR10 (School B)	<i>ICT teachers often lack knowledge of sign language. Without an interpreter, digital tools do not always provide sign language support.</i>
TR16 (School C)	<i>Limited resources in computer laboratories make it difficult to deliver effective lessons to learners with hearing impairment.</i>
TR27 (School D)	<i>Some teachers lack computer literacy and limited knowledge of how to integrate technology into lessons.</i>
TR32 (School E)	<i>Most teachers lack training on how to integrate ICT into lessons for hearing-impaired learners. More workshops are needed.</i>

4.4 Strategies for Improving Learning of Learners with Hearing Impairment

In response to the challenges identified, teachers proposed a range of practical strategies to improve the integration of technology in the education of learners with hearing impairment. These recommendations reflect a multi-faceted approach addressing resource investment, professional development, instructional practice, and institutional policy.

TR1 from School A recommended:

Schools should invest in more computers and other assistive devices. Additionally, workshops should be organised to train in-service teachers on emerging technological advancements to improve teaching and learning.

TR2 from School A emphasised the need for technical support: *‘Ensuring access to specialists or audiologists would help in quickly resolving technical issues that may arise when using assistive technology.’*

TR7 from School D stated:

Apart from ICT teachers, an interpreter should be present in computer lessons. Sign language should be integrated into ICT lessons to ensure learners with hearing impairment fully benefit from the subject.

TR8 from School D recommended: *‘Teachers handling learners with hearing impairment should undergo ICT training to better support the use of technology in the classroom.’*

Additional strategies recommended by participants across schools included government and stakeholder involvement in providing financial support for the procurement of assistive devices; regular professional development programmes equipping teachers with skills in both ICT and sign language interpretation; and collaboration between schools and technology developers to produce customised learning software addressing the specific needs of hearing-impaired learners.

These strategies, taken together, point to the necessity of a systemic, institutionally supported approach to technology integration that addresses both the supply of resources and the professional capacity to deploy them effectively.

Table 6: Strategies Recommended by Teachers for Improving Technology Integration

Strategy Area	Recommended Action	Attributed To
Resource Investment	Increase functional computers and assistive devices in school laboratories	TR1 (School A)
Teacher Training	Organise in-service workshops on ICT integration and sign language	TR32 (School E)
Sign Language Integration	Incorporate sign language into all ICT lessons to ensure full participation	TR7 (School D)

Technical Support	Employ audiologists and ICT specialists for ongoing maintenance	TR2 (School A)
Policy Alignment	Develop school-level policies mandating assistive technology procurement	TR35 (School E)
Specialised Software	Procure captioned video tutorials and sign language-integrated software	TR14 (School E)

5.0 DISCUSSION OF THE FINDINGS

5.1 Availability of Technology Devices

The findings of this study reveal a picture of limited but variable availability of technology devices for learners with hearing impairment across the participating secondary schools. While foundational ICT infrastructure in the form of computer laboratories and general devices was present in most schools, specialised assistive technologies, such as dedicated speech-to-text software, sign language-integrated applications, and FM systems accessible to all eligible learners, remained largely absent or insufficient. This finding is consistent with documented patterns of technological disparity in schools serving learners with disabilities in Sub-Saharan Africa, where general ICT investment does not consistently translate into targeted assistive technology provision (Foster and Alghazo, 2016; Chilisa and Preece, 2005).

The emphasis placed by participants on ICT skills acquisition alongside academic learning is significant. TR1's observation that computer laboratories serve not only as teaching tools but as preparation for post-school employment resonates with Brunner's (2001) argument that technology integration equips learners with competencies essential for participation in contemporary economies. However, the concurrent challenges of outdated equipment, insufficient device numbers, and the absence of specialised software indicate that the potential articulated by participants is not yet consistently realised in practice. TR11's account of learners sharing computers, TR9's description of non-functional devices, and TR10's identification of missing assistive software collectively illustrate the gap between infrastructure presence and functional adequacy (Foster and Alghazo, 2016).

The absence of sign language-integrated content, as noted by TR7 from School D and TR30 from School E, represents a particularly critical gap. The literature affirms that multimedia resources combining captioning, sign language, and interactive elements are essential for effective learning among hearing-impaired students (Luckner and Muir, 2001; Lang et al., 2020). Addressing this gap requires not only investment in specialised software but also a reorientation of content development priorities to ensure that hearing-impaired learners are served by resources designed for their specific communicative and learning needs.

5.2 Impact of Technology Devices on Academic Performance

The study's findings affirm the positive impact of assistive technologies on the academic performance of learners with hearing impairment, whilst also identifying conditions that mediate this impact. Teachers' testimonies indicate that hearing aids, FM systems, captioning services, and sign language interpretation tools each contribute to improved

communication, engagement, and comprehension in classroom settings. These findings are consistent with the broader empirical literature. The role of FM systems in facilitating clearer communication between teachers and learners corroborates Tharpe and Bess (1999) and Crandell and Smaldino (2000), who document significant improvements in listening conditions and learner engagement following the deployment of these devices.

The central role of captioning and sign language interpretation in academic success, as affirmed by multiple participants, reflects the findings of Marschark and Hauser (2012) and aligns with Crandell and Smaldino's (2000) argument that these tools are essential for equalising access to educational content. The evidence from participants at School B, where the introduction of a sign language interpreter resulted in measurable improvements in academic performance, illustrates the concrete academic impact of appropriately deployed language support technologies.

The divergence of views regarding interpretation quality, with some participants noting no discernible difference based on style while others identified significant variation in comprehension outcomes, reflects a genuine complexity in understanding technology-mediated learning for hearing-impaired students. This divergence may reflect differences in learner profiles, interpreter competency, and institutional context across schools. It underscores the finding of Tharpe and Bess (1999) that the effectiveness of captioning and interpretation is contingent on technical accuracy and linguistic appropriateness, and points to the need for quality assurance mechanisms in the deployment of these services.

5.3 Challenges in Using Technology Devices

The challenges identified in this study are multidimensional and systemic in nature. Device compatibility issues, financial constraints, limited teacher competency, and the absence of sign language support collectively constitute a set of interrelated barriers that inhibit the effective utilisation of technology for hearing-impaired learners. These findings are consistent with prior research documenting the structural challenges of technology integration in inclusive education contexts (Foster and Alghazo, 2016; Luckner and Muir, 2001).

The knowledge gap among ICT teachers regarding sign language is particularly consequential. As TR10 from School B highlighted, the absence of sign language proficiency renders digital tools effectively inaccessible for learners who depend on this mode of communication, even where devices are physically present. This finding reinforces the argument that technology alone is insufficient without the human capacity to deploy it appropriately. The challenge of device compatibility, as noted by TR1 regarding cochlear implants and captioning software, further illustrates the need for integrated, system-level approaches to assistive technology procurement and deployment that account for the full range of learner needs.

5.4 Strategies for Improving Learning

The strategies recommended by participants reflect a coherent, multi-pronged approach to improving technology integration for hearing-impaired learners. Increased investment in assistive devices and computer infrastructure, structured professional development in ICT and sign language, the embedding of sign language interpreters in ICT lessons, and technical support from audiologists and ICT specialists collectively address both the supply and capacity dimensions of the challenge. These recommendations are

broadly consistent with the comprehensive approach advocated by Vanderheiden and Marschark (2021), who argue that effective technology integration requires simultaneous attention to technological provision, teacher competence, and pedagogical adaptation.

The call for government and stakeholder involvement in funding assistive technology procurement reflects the structural reality that school-level resources alone are insufficient to close the identified gaps. Collaboration between schools, technology developers, and policy makers to produce contextually appropriate learning software, as suggested by participants, further indicates awareness among practitioners of the systemic nature of the challenge and the need for coordinated institutional responses.

6.0 CONCLUSION

This study examined the contribution of technology to the academic performance of learners with hearing impairment in selected secondary schools in Zambia. The findings reveal that technology devices, including hearing aids, FM systems, captioning services, sign language interpretation tools, computer laboratories, and digital learning applications, are present in the participating schools to varying degrees, but their effective deployment for hearing-impaired learners remains constrained by systemic challenges. These challenges include insufficient and non-functional devices, the absence of specialised assistive software, inadequate teacher training in both ICT and sign language, and the absence of sign language-integrated instructional content.

Despite these constraints, teachers consistently affirmed the positive impact of appropriately utilised assistive technologies on classroom engagement, communication, and academic performance. The study underscores the critical importance of equitable access to functional, specialised technology resources, supported by structured teacher professional development and sustained institutional commitment. Targeted investment in assistive technology procurement, the integration of sign language into ICT instruction, technical support from specialists, and policy alignment at institutional and governmental levels are identified as essential conditions for realising the full educational potential of technology for learners with hearing impairment in Zambia.

Beyond institutional concerns, the findings carry important implications for educational policy, teacher education, and curriculum reform. At the policy level, the study provides empirical grounds for the Zambian Ministry of Education to develop enforceable assistive technology standards within the national Special Education Policy framework, ensuring that secondary schools are equipped with, and held accountable for, the provision of appropriate technology resources. In terms of teacher education, the documented gaps in teachers' sign language competency and ICT skills point to the urgent need for pre-service and in-service teacher training programmes to incorporate dedicated modules on assistive technology use and inclusive pedagogy. Regarding curriculum, the findings highlight the need for the Zambia Curriculum Development Centre to review ICT syllabi so that sign language integration and digital accessibility features are embedded as standard components rather than optional additions. Looking ahead, future research should extend this inquiry to primary school contexts, incorporate the perspectives of learners with hearing impairment themselves, and investigate the long-term academic impact of sustained and well-supported technology integration.

6.1 Contribution to the Body of Knowledge

This study contributes to the growing body of knowledge on assistive technology and inclusive education in the African secondary school context. By documenting the lived experiences and professional perceptions of teachers working with hearing-impaired learners in Zambian schools, the study provides empirically grounded insights that extend the international literature into a context that has received limited research attention. The findings offer practical guidance for educational policy makers, school administrators, and special education practitioners on the conditions required for effective technology integration. They further highlight specific areas, including sign language-integrated software development, teacher training frameworks, and procurement policy, where targeted intervention is most urgently needed to advance equitable and effective inclusive education for learners with hearing impairment in Zambia and comparable contexts across Sub-Saharan Africa.

7.0 REFERENCES

- Adom, D., Hussein, E. K., & Agyem, J. A. (2018). Theoretical and Conceptual Frameworks: Mandatory Ingredients of a Quality Research. *International Journal of Scientific Research*, 7(1), 438-441.
- Archbold, S., Lutman, M. E., & Marshall, D. H. (2002). Categories of auditory performance. *Annals of Otology, Rhinology and Laryngology*, 111(5 Suppl), 312-314.
- Baker, P., Sherwood, K., & Jones, C. (2015). E-learning and students with disabilities: Access and engagement. *British Journal of Educational Technology*, 46(3), 550-561.
- Borg, J., Lindstrom, A., & Larsson, S. (2017). Assistive technology in developing countries. *Disability and Rehabilitation: Assistive Technology*, 12(3), 219-226.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101.
- Brunner, J. J. (2001). Globalization, education and the technological revolution. Prospects: *Quarterly Review of Comparative Education*, XXXI(2).
- Chilisa, B., & Preece, J. (2005). *Research Methods for Adult Teachers in Africa*. UNESCO Education Publishers.
- Chimhenga, S. (2016). Challenges of implementing inclusive education in Zimbabwean primary schools. *International Journal of Innovative Research and Development*, 5(5), 231-237.
- Crandell, C., & Smaldino, J. (2000). Classroom acoustics for children with normal hearing and with hearing impairment. *Language, Speech, and Hearing Services in Schools*, 31(4), 362-370.

- Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches (3rd ed.)*. Sage Publications.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340.
- Donohue, D., & Bornman, J. (2014). The challenges of realising inclusive education in South Africa. *South African Journal of Education*, 34(2), 1–14.
- Eleweke, C. J., & Rodda, M. (2002). The challenge of enhancing inclusive education in developing countries. *International Journal of Inclusive Education*, 6(2), 113–126.
- Foster, P., & Alghazo, M. (2016). Accessible educational media: Toward a common goal for blind and deaf students. *Information Technology and Disabilities*, 8(2), 95–103.
- Imenda, S. (2014). Is there a conceptual difference between conceptual and theoretical frameworks? *Journal of Social Science*, 38(2), 185–195.
- Kombo, D. K., & Tromp, D. L. A. (2013). *Proposal and Thesis Writing: An Introduction*. Paulines Publication Africa.
- Lang, H. G., McKee, B. G., & Conner, K. (2020). Characteristics of effective teachers: A descriptive study of the perceptions of faculty and deaf college students. *American Annals of the Deaf*, 138(3), 252–259.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.
- Luckner, J. L., & Muir, S. (2001). Successful students who are deaf in general education settings. *American Annals of the Deaf*, 146(5), 435–446.
- Marschark, M., & Hauser, P. C. (2012). *How Deaf Children Learn: What Parents and Teachers Need to Know*. Oxford University Press.
- Marschark, M., & Wauters, L. (2008). Language comprehension and learning by deaf students. In M. Marschark & P. Hauser (Eds.), *Deaf Cognition: Foundations and Outcomes* (pp. 309–350). Oxford University Press.
- Okolo, C. M., & Englert, C. S. (2019). Technology and inclusive education: A systematic review. *Journal of Special Education Technology*, 34(1), 1–15.
- Patton, M. Q. (2015). *Qualitative Research and Evaluation Methods (4th ed.)*. Sage Publications.
- Tharpe, A. M., & Bess, F. H. (1999). Minimal, progressive and fluctuating hearing losses in children. *Pediatric Clinics of North America*, 46(1), 65–78.
- Vanderheiden, G. C. (2016). The role of technology in integrating people with disabilities in society. *Information Society*, 16(1), 1–12.

- Vanderheiden, G. C., & Marschark, M. (2021). Technological advances in education for deaf students: A critical overview. *Deafness and Education International*, 10(4), 197-214.
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, 46(2), 186-204.
- Wyatt, T. (2010). Captioning and reading: A review of research. *Journal of Deaf Studies and Deaf Education*, 15(3), 220-235.
- Yin, R. K. (2010). *Qualitative Research from Start to Finish*. The Guilford Press.