

Unlocking the relationship between assistive technology and academic transformation of learners with hearing impairment in Tanzania: Insights from selected schools Dar-es-salaam and Tabora Region

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ABSTRACT

Assistive technology is increasingly recognised as an important means of improving access, participation and learning among learners with hearing impairment. This study examined the relationship between assistive technology and academic transformation among learners with hearing impairment in selected schools in Dar-es-Salaam and Tabora Regions, Tanzania. Specifically, the study assessed the availability and utilisation of assistive technologies and determined their statistical relationship with academic transformation. The study was informed by technological acceptance model (TAM). A quantitative research approach guided by a cross-sectional research design was employed. The study involved 234 respondents, comprising 90 learners with hearing impairment and 144 teachers. Purposive sampling was used to select relevant schools, while total population sampling was applied where eligible respondents were small and manageable. Data were collected using a structured questionnaire. Data were analysed using frequencies, percentages, chi-square tests and binary logistic regression, with statistical significance determined at $p < .05$. The findings indicate a critical gap between the presence of assistive technology and its effective educational utilisation. Many respondents reported inadequacies in hearing aids, Frequency Modulation (FM) systems, Digital Modulation (DM) systems, captioning, visual alert systems and tablets with educational applications. Chi-square results showed statistically significant associations between academic transformation and hearing aids ($\chi^2 = 14.833$, $p = .001$) and FM systems ($\chi^2 = 17.297$, $p = .001$), whereas tablets ($\chi^2 = .758$, $p = .384$), DM systems ($\chi^2 = .361$, $p = .548$), and visual alert systems ($\chi^2 = 3.689$, $p = .055$) did not demonstrate statistically significant associations. Logistic regression further showed that adequate hearing aids significantly increased the likelihood of academic transformation (AOR = 2.37, $p = .015$), while satisfaction with FM systems was also positively associated with academic transformation (AOR = 2.75, $p = .003$). These findings suggest that assistive technology contributes to academic transformation when it directly addresses learners' communication and classroom-access needs and is adequately available and effectively integrated. The study concludes that technology provision alone is insufficient; effective management, maintenance, teacher support and meaningful classroom utilisation are essential for converting assistive technology into educational benefit. The study therefore recommends strengthened investment in appropriate assistive technologies, teacher capacity-building, technical support and systematic monitoring of their classroom use.

Keywords; Assistive Technology; Academic Transformation; Educational Technology, Inclusive Education; Learners with Hearing Impairment; Tanzania

I. INTRODUCTION

Assistive technology (AT) has increasingly become an important component of inclusive education because it enables learners with disabilities to overcome functional barriers that may otherwise restrict their access to teaching, learning and participation (Ahmed, 2018). AT broadly refers to devices, equipment, software, products and related services designed to increase, maintain or improve the functional capabilities of persons with disabilities (UNESCO, 2020). Its development has progressed from relatively simple technologies such as canes and Braille to sophisticated electronic and digital technologies that support communication, information access, mobility and learning (Bryant et al., 2011). In educational settings, AT can facilitate academic skills, communication, independence and participation by enabling learners to access activities that might otherwise be difficult or inaccessible (Stanislaus, 2026). Evidence from children with developmental and motor disabilities, for example, indicates that AT can support writing, communication, mobility and participation in school activities, while interactive computer-based interventions have demonstrated potential to stimulate reading, phonological awareness and communication among children with developmental disabilities (Alimi et al., 2021). However, these findings also demonstrate that technological provision alone does not guarantee educational improvement, since successful outcomes depend on individualised planning, teacher involvement, monitoring and appropriate matching between the technology and learners' needs.

The importance of AT is particularly evident among learners with hearing impairment because restricted access to auditory information can affect communication, classroom interaction, curriculum access and academic engagement (Schafer & Wolfe, 2010). Technologies such as hearing aids, frequency-modulation (FM) systems, assistive listening devices, speech-to-text applications, captioning, visual alert systems, multimedia resources and other digital tools can potentially reduce communication barriers and improve learners' access to classroom instruction (Alharbi, 2016)). Research on hearing assistance technology indicates that its selection should consider the learner's characteristics, listening environment, available device options and evidence concerning effectiveness rather than assuming that one technology is appropriate for all learners. Similarly, Borg et al (2012) found among people with hearing impairment in Bangladesh that assistive technology users reported enhanced capabilities and that hearing-aid use interacted positively with education, suggesting that technology and educational opportunities can reinforce one another. Nevertheless, AT should not be interpreted as an automatic solution to poor academic outcomes. Its educational contribution is influenced by teachers' familiarity and training, the availability of technical support, appropriate pedagogical integration, maintenance, affordability and the characteristics of the learning environment (Senjam & Manna, 2024). Thus, the critical issue is not simply whether learners possess AT, but whether the available technology is appropriately selected, accessible, functional and meaningfully incorporated into teaching and learning process.

At the global level, the increasing emphasis on inclusive education has consequently shifted attention from the mere provision of assistive devices towards their actual utilisation and educational effects (UNESCO, 2020). AT has been associated with improved functional capabilities and participation among persons with disabilities, although outcomes vary according to the type of disability, technology and context (Borg et al., 2012). Research involving learners with physical and developmental disabilities similarly demonstrates that AT can support academic skills and participation, but effective implementation requires collaboration among teachers, parents, therapists and other professionals (Senjam & Manna, 2024). This evidence challenges a technology-centred assumption that the availability of devices automatically produces academic transformation. Instead, AT appears to operate through a combination of technological, pedagogical and environmental conditions (UNESCO, 2020). This distinction is important for learners with hearing impairment because technologies intended to improve access to sound or visual information may have limited educational value where teachers lack the competence to use them, classrooms remain acoustically unsuitable, devices are unavailable or poorly maintained, or instructional practices do not accommodate learners' communication needs (UNESCO, 2020). Therefore, understanding academic transformation requires attention not only to examination performance but also to changes in curriculum access, classroom participation, communication, engagement, independent learning and the ability to benefit from instruction.

The challenge becomes more pronounced in developing-country contexts, where inequalities in resources, infrastructure, teacher preparation and access to specialised services may constrain the effective utilisation of AT. Evidence from Bangladesh demonstrates that AT can contribute to enhanced capabilities, but also indicates that the benefits of technology are connected to other enabling conditions, including education (Borg et al., 2012). Within Tanzania, emerging evidence indicates that access to and effective use of AT remains an important concern. For example, a recent Tanzanian study found a statistically significant relationship between AT use and academic performance among pupils with disabilities, while emphasising that provision alone is insufficient without appropriate teacher training, infrastructure and effective implementation (Ndibalema, 2025). Similarly, research on learners with hearing impairment in Tanzanian secondary schools has identified shortages of assistive technologies such as hearing aids and FM systems, alongside unsuitable classroom environments, as challenges affecting educational participation and attainment (Jullu & Wandela, 2025). Studies have also identified limited access to assistive technologies, inadequate teacher preparation and insufficient financial resources as barriers to learning among deaf children in Tanzania (Ndibalema, 2025). These findings suggest that Tanzania has an emerging evidence base on AT, but they also revealed an important concern that, the existence of AT does not necessarily indicate effective utilisation or educational transformation.

Against this background, a significant knowledge gap exists regarding the relationship between assistive technology and the academic transformation of learners with hearing impairment in Tanzanian schools. Although previous studies have established the general importance of AT and have documented associations between AT availability or use and educational outcomes, limited attention has been given to how different forms of AT are actually experienced and utilised by learners with hearing impairment (Ndibalema, 2025; UNESCO, 2020). Existing evidence also provides limited comparative insight into differences between locations with potentially different levels of infrastructure, resources and institutional support. The study is consequently positioned to generate contextual evidence on whether, how and under what conditions AT facilitates learners' access to instruction, communication, classroom participation, independent learning and academic progress. Such evidence is important because recent Tanzanian researchers like Ndibalema (2025), and Jullu and Wandela (2025), pointed mostly to the relationship between AT and academic performance, but the specific experiences and mechanisms underlying this relationship

among learners with hearing impairment, particularly across the Dar-es-Salaam and Tabora contexts, remain insufficiently understood, which is the gist of this study.

1.1 Research Objective and Research Question

The objective that govern this study is to determine the relationship between the use of assistive technology and academic transformation among learners with hearing impairment in selected secondary schools in Dar-es-Salaam and Tabora Regions, Tanzania, which responds to the research question, thus What is the relationship between the use of assistive technology and academic transformation among learners with hearing impairment in selected secondary schools in Dar-es-Salaam and Tabora Regions, Tanzania?

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Technological Acceptance Model

The Technology Acceptance Model (TAM) was formulated by Fred Davis in 1989 to explain how users come to accept and use new technologies. The model is grounded in the assumption that an individual's intention to use a technology is primarily influenced by two central perceptions, namely perceived usefulness and perceived ease of use. Perceived usefulness refers to the extent to which a person believes that using a particular technology will improve task performance, while perceived ease of use concerns the extent to which the technology is perceived as requiring little effort to use (Davis, 1989). TAM further assumes that these perceptions influence users' attitudes and behavioural intentions, which subsequently affect actual technology use. In the context of this study, the model is applicable because the academic contribution of assistive technology (AT) to learners with hearing impairment may depend not merely on whether technologies are provided, but also on whether learners and teachers perceive them as useful, accessible, manageable and relevant to learning needs. Thus, TAM provides a useful theoretical lens for understanding why available AT may be utilised effectively in some educational settings but underutilised in others.

TAM fits perfectly to this study in examining how learners' perceived usefulness and perceived ease of use of assistive technologies relate to their academic transformation. For learners with hearing impairment, technologies such as hearing aids, FM systems, captioning applications, speech-to-text tools and other digital communication technologies are more likely to contribute to learning when they are perceived as useful for accessing instruction, communicating with teachers and peers, participating in classroom activities and completing academic tasks (Borg et al., 2012). Similarly, technologies that are difficult to operate, uncomfortable, unreliable or poorly supported may be less likely to be used consistently, even when they are available. TAM therefore helps the study move beyond measuring the mere availability of AT to examining its acceptance and actual utilisation, which may help explain differences in academic participation, curriculum access, independent learning and academic progress (Ndibalema, 2025). Consequently, this theoretical model is particularly relevant to the study because it provides a quantitative framework for examining whether perceptions of usefulness and ease of use are associated with the academic transformation of learners with hearing impairment in selected schools in Dar-es-Salaam and Tabora Regions.

2.2 Empirical Review

Empirical studies have increasingly demonstrated a positive association between assistive technology (AT) and educational outcomes among learners with disabilities, but the evidence remains uneven when considered specifically in relation to learners with hearing impairment. Borg et al. (2012), for example, found that the use of hearing aids among people with hearing impairment in Bangladesh was associated with enhanced capabilities and interacted positively with educational opportunities. Similarly, Ndibalema (2025) reported a statistically significant relationship between AT use and academic performance among learners with disabilities in Tanzania. These findings suggest that AT can contribute to improved educational outcomes by reducing functional barriers and increasing access to learning. However, both studies provide limited explanation of how AT produces educational change for learners with hearing impairment, particularly in classroom communication, participation, curriculum access and independent learning. The broad disability focus in Ndibalema's study may also conceal disability-specific experiences because technologies and support mechanisms required by learners with hearing impairment differ from those required by learners with physical, visual or other disabilities (Ndibalema, 2025). Furthermore, an association between AT use and academic performance does not necessarily demonstrate that the technology itself produces academic transformation, since teacher competence, availability of technical support, classroom conditions, device functionality and pedagogical practices may influence the observed outcomes. Therefore, existing empirical evidence establishes the relevance of AT but leaves unanswered questions concerning its actual utilisation and contribution to the broader dimensions of academic transformation among learners with hearing impairment.

Evidence from Tanzania further indicates that the availability and use of AT remain constrained by contextual and institutional factors. Jullu and Wandela (2025) identified shortages of technologies such as hearing aids and FM systems, together with unsuitable classroom environments, as barriers to educational participation and attainment among learners with hearing impairment in Tanzanian secondary schools. Likewise, Ndibalema (2025) reported limited access to AT, inadequate teacher preparation and insufficient financial resources as barriers to learning among deaf children in Tanzania. Although these studies provided important evidence about barriers to AT access, they give comparatively less attention to whether and how available technologies are actually integrated into everyday teaching and learning and whether such integration translates into measurable academic transformation (UNESCO, 2020). Importantly, the existing literature also provided limited comparative evidence across different Tanzanian contexts. This created a specific empirical gap for the present study in Dar-es-Salaam and, Tabora Regions, where differences in infrastructure, availability of specialised support, teacher preparedness and access to technological resources may shape learners' experiences differently. Consequently, the present study extends previous research by empirically examining the relationship between AT and academic transformation among learners with hearing impairment.

III METHODOLOGY

3.1 Research Approach

The study adopted a quantitative research approach to examine the relationship between the use of assistive technology and academic transformation among learners with hearing impairment. The quantitative approach was appropriate because the study sought to collect numerical data on the availability, accessibility, utilisation and perceived usefulness of assistive technologies and determine their association with measurable dimensions of academic transformation. The approach further facilitated the use of statistical techniques to establish whether the use of assistive technology was significantly associated with academic transformation among learners with hearing impairment.

3.2 Research Design

The study employed a cross-sectional research design, in which data were collected from respondents at a single point in time. The design was appropriate because the study intended to assess the existing status of assistive technology use and its relationship with academic transformation among learners with hearing impairment without manipulating the study variables (Apentiik, & Parpart, 2012). The cross-sectional design enabled the researcher to obtain information on learners' access to and utilisation of assistive technologies, their perceived usefulness and ease of use, and selected indicators of academic transformation within the selected schools. It also enabled comparison of responses across the study settings in Dar-es-Salaam and Tabora Regions. Although the design can establish statistical associations between variables, the findings are interpreted as relationships rather than definitive causal effects.

3.3 Study Area

The study was conducted in selected schools in Dar-es-Salaam and Tabora Regions, Tanzania. The regions were selected because they provide relevant educational settings in which learners with hearing impairment access education and where assistive technologies may be used to support communication and learning process. The selection also enabled the study to capture experiences from two different geographical contexts with potentially different levels of educational infrastructure, availability of assistive technologies, teacher preparedness and institutional support. Including schools from both regions therefore provided an opportunity to examine whether patterns of assistive technology utilisation and its relationship with academic transformation were consistent across the selected settings..

3.4 Target Population

The target population comprised learners with hearing impairment and teachers involved in teaching learners with hearing impairment in the selected schools in Dar-es-Salaam and Tabora Regions. Learners with hearing impairment constituted the primary population because they are the direct users or beneficiaries of assistive technologies and experience their contribution to communication, classroom participation, curriculum access and academic learning. Teachers were included because they interact with learners during the teaching and learning process and play an important role in facilitating, supporting and integrating assistive technologies into classroom instruction. The inclusion of these respondents enabled the study to obtain quantitative information concerning the availability, utilisation, perceived usefulness and educational contribution of assistive technology.

3.5 Sampling Procedure and Sample Size

The study employed purposive and total population sampling procedures, depending on the size and characteristics of the selected schools. Schools were purposively selected based on their established provision of

education to learners with hearing impairment and their relevance to the study of assistive technology. Where the number of eligible learners or teachers in a selected school was small and manageable, total population sampling was used to include all eligible respondents. This approach was considered appropriate because learners with hearing impairment and teachers with direct experience of assistive technology constitute relatively specialised populations. The final sample size of 234 (90 students and 144 teachers) was determined based on the accessible population in the selected schools and the requirements for quantitative statistical analysis. The sampling procedures ensured that respondents had direct experience with the educational use of assistive technology and could provide relevant quantitative information for examining its relationship with academic transformation.

3.6 Data Collection Tool

Data were collected using a structured questionnaire developed in accordance with the study objectives and variables. The questionnaire consisted mainly of closed-ended items measured using Likert scale type scales and categorical responses. Items relating to assistive technology assessed aspects such as availability, accessibility, frequency of use, functionality, perceived usefulness and ease of use, while items on academic transformation assessed indicators such as classroom participation, communication, curriculum access, engagement, independent learning and academic progress. The questionnaire was administered to eligible respondents in the selected schools. The structured nature of the instrument enabled the researcher to obtain standardised numerical data that could be statistically analysed and compared across respondents and study locations.

3.7 Data Analysis

Quantitative data were coded, entered and analysed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequencies, percentages, were used to summarise the characteristics of respondents and the distribution of responses regarding assistive technology and academic transformation. The chi-square test of association was used to determine whether a statistically significant association existed between categorical measures of assistive technology use and academic transformation. In addition, binary logistic regression was employed to determine the extent to which assistive technology-related factors predicted the likelihood of academic transformation of learners with hearing impairment. The results were interpreted using appropriate statistical significance levels, with $p < .05$ used as the criterion for statistical significance. The use of these statistical techniques enabled the study to move beyond descriptive evidence and establish the statistical relationship between assistive technology and academic transformation among learners with hearing impairment.

3.8 Ethical Considerations

Ethical principles were observed throughout the study to protect the rights, privacy and welfare of participants. Relevant research permission was obtained from the responsible authorities before data collection, while informed consent was obtained from participants after explaining the purpose, procedures, potential benefits and voluntary nature of participation. For participants who required communication support, information and consent procedures were presented in an accessible form, including appropriate sign-language support where necessary. Participants were informed of their right to decline participation without penalty. Confidentiality and anonymity were maintained by avoiding the collection of unnecessary identifying information and by using codes instead of participants' names. Completed questionnaires data were securely stored and accessed only for academic research purposes. These measures helped protect participants and strengthen the credibility and ethical integrity of the study.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1 The Influence of Assistive Technology on Academic Transformation of Learners with Hearing Impairment

Assistive technology is important on academic transformation of learners with hearing impairment because it shows how technological tools can improve access to learning materials, classroom communication, participation, and academic achievement. It also helps to identify appropriate technologies and support for their effective use in inclusive education practices.

Table 1

Descriptive Analysis of Variables (assistive technology) influencing academic transformation of learners with hearing impairment

Variable	Freq.	Percent
Hearing Aids		
Not sufficient	140	59.83
Sufficient	94	40.17
Frequency Modulation (FM) systems		
Not satisfied	167	71.37
Satisfied	67	28.63
Digital Modulation (DM) systems		
Poorly utilised	127	54.27
Well utilised	107	45.73
Captioning		
Un adequately utilised	165	70.51
Adequate utilised	69	29.49
Visual alert systems		
Active managed and available	66	28.21
Not managed and not available	168	71.79
Tablets with educational applications		
Inadequate	160	68.38
Adequate	74	31.62

The descriptive findings indicate that the academic transformation of learners with hearing impairment was generally constrained, as reflected in the learners' reported experiences with access to and use of assistive technologies. The findings show that most assistive technologies were perceived as inadequately supporting learners' academic transformation. Specifically, 59.83% of respondents reported that hearing aids were not sufficiently influencing academic transformation, while only 40.17% considered them sufficiently influential. Similarly, 71.37% of respondents were not satisfied with the use of FM systems, whereas 54.27% reported poor utilisation of DM systems. In addition, 70.51% indicated that captioning was inadequately utilised, while 71.79% reported that visual alert systems were poorly managed or unavailable. Furthermore, 68.38% considered tablets with educational applications inadequate for supporting their learning. These findings, together with the descriptive results for the dependent variable, suggest that the academic transformation of learners with hearing impairment was affected by limitations in the availability, accessibility, utilisation, and management of assistive technologies. Thus, inadequate access to appropriate assistive technologies may constrain learners' participation in classroom activities, access to instructional content, communication with teachers and peers, and ultimately their academic transformation. The findings therefore indicate that the extent to which assistive technologies are available and effectively utilised is an important consideration in understanding academic transformation among learners with hearing impairment.

4.1.2 Association between Assistive Technology and Academic Transformation of Learners with Hearing Impairment

Understanding the association between assistive technology and academic transformation for learners with hearing impairment helps educators and policymakers identify which tools genuinely improve access to information, communication, and learning outcomes. When assistive technology effectively matched to students' needs, it can boost comprehension, participation, and confidence, leading to better academic performance and more meaningful inclusion.

Table 2*Association between assistive technology and academic transformation of learners with hearing impairment*

Variable	Response	Level of Association		Chi -square value	P-value
		High	Low		
Tablets with educational applications	In adequate	43(30.71%)	97(69.29%)	0.7583	0.384
	Adequate	34(36.17%)	60(63.83%)		
Digital Modulation (DM) systems	Poorly utilised	53(31.74%)	114(68.26%)	0.3613	0.548
	Well utilised	24(35.82%)	43(64.18%)		
Hearing Aids	Not sufficient	94(40.17%)	140(59.83%)	14.8332	0.001
	Sufficient	49(45.79%)	58(54.21%)		
Visual alert systems	Not managed	48(29.09%)	117(70.91%)	3.6889	0.055
	Well managed	29(42.03%)	40(57.97%)		
Frequency Modulation (FM) systems	Not satisfied	167(71.37%)	67(28.63%)	17.2969	0.001
	Satisfied	57(44.53%)	71(55.47%)		

The findings suggest that the association between assistive technology and the academic transformation of learners with hearing impairment is generally weak for most factors. Specifically, the adequacy of tablets with educational applications ($\chi^2 = 0.7583$, $p = 0.384$) and the level of utilization of Digital Modulation (DM) systems ($\chi^2 = 0.3613$, $p = 0.548$) were not significantly linked to higher or lower academic transformation. Visual alert systems also showed only a borderline/marginal relationship ($\chi^2 = 3.6889$, $p = 0.055$), indicating that they may have limited influence unless better implemented. However, hearing aids ($\chi^2 = 14.8332$, $p = 0.001$) and Frequency Modulation (FM) systems ($\chi^2 = 17.2969$, $p = 0.001$) had statistically significant associations, implying that adequate access to hearing aids and higher satisfaction with FM systems are likely to support stronger academic transformation among learners with hearing impairment.

4.1.3 Relationship between assistive technology and academic transformation of learners with hearing impairment

Understanding the relationship between assistive technology and the academic transformation of learners with hearing impairment is crucial because it shows how the right tools directly improve access to instruction, comprehension, and participation. When schools integrate Assistive Technology effectively, learners can engage more independently, build stronger literacy and communication skills, and achieve more equitable learning outcomes. Supporting not just improved grades, but also greater confidence, retention, and long-term academic success.

Table 3*The relationship between technology and academic transformation of learners with hearing impairment*

Variable	Response	Level of relationship		COR(95%CI)	P-Value	AOR(95%CI)	P-Value
		High	Low				
Hearing Aids	Not sufficient	28(22.05%)	99(77.95%)	Ref	Ref	Ref	Ref
	Sufficient	49(45.79%)	58(54.21%)	2.98(1.69,5.262)	0.001	2.37(1.18,4.75)	0.015
Visual alert system	Not practiced	48(29.09%)	117(70.91%)	Ref	Ref	Ref	Ref
	Active practiced	29(42.03%)	40(57.97%)	1.76(0.985,3.16)	0.056	0.69(0.33,1.44)	0.334
FM systems	Not satisfied	20(18.87%)	86(81.13%)	Ref	Ref	Ref	Ref
	Satisfied	57(44.53%)	71(55.47%)	3.45(1.89,6.28)	0.001	2.752(1.39,5.41)	0.003

The findings show that hearing aids and FM systems had statistically significant positive relationships with the academic transformation of learners with hearing impairment, while visual alert systems did not show a statistically significant relationship. Learners with sufficient hearing aids were more likely to demonstrate high academic transformation (45.79%) compared with those with insufficient hearing aids (22.05%), with a significant crude association (COR = 2.98, 95% CI: 1.69–5.26, $p = 0.001$) and adjusted association (AOR = 2.37, 95% CI: 1.18–4.75, $p = 0.015$). Similarly, learners using FM systems satisfactorily had a higher proportion of high academic transformation (44.53%) than those who were not satisfied (18.87%), with both the crude relationship (COR = 3.45, 95% CI: 1.89–6.28, $p = 0.001$) and adjusted relationship (AOR = 2.75, 95% CI: 1.39–5.41, $p = 0.003$) being statistically significant. In contrast, visual alert systems showed no statistically significant association after adjustment (AOR = 0.69, 95% CI: 0.33–1.44, $p = 0.334$). Overall, the results suggest that adequate access to and satisfactory use

of hearing aids and FM systems are associated with higher academic transformation, whereas visual alert systems did not independently predict academic transformation in this study.

4.2 Discussion

The findings show that assistive technology is not yet being used effectively enough to fully support the academic transformation of learners with hearing impairment. Many of the technologies were reported to be unavailable, insufficient, poorly managed, or not adequately used in teaching and learning. This finding is supported by Borg et al. (2015), who explained that assistive technology can create opportunities for education, inclusion, and participation when learners have access to appropriate tools. Similarly, Mishra et al. (2024) identified limited access, availability, and proper use of assistive technology as important barriers to benefiting from such technologies. Alkahtani (2013) also emphasised the importance of teachers' knowledge and ability to use assistive technology effectively. Therefore, the findings suggest that providing technology alone is not enough; schools also need to ensure that the devices are available, functional, appropriate to learners' needs, and properly used by teachers and learners.

The findings further indicate that hearing aids can play an important role in supporting academic transformation among learners with hearing impairment. Learners who have adequate access to hearing aids are more likely to benefit from classroom communication and instructional information. This finding agrees with Schafer and Wolfe (2010), who noted that hearing assistance technology can improve children's access to speech and other auditory information in learning environments. It is also consistent with Borg et al. (2012), who associated access to assistive technology with improved capabilities and greater opportunities for participation. In the classroom, hearing aids can help learners follow teachers' explanations, discussions, and instructions more effectively. However, their effectiveness depends on proper fitting, maintenance, regular use, and support from teachers. Thus, the finding suggests that hearing aids should be considered as part of a wider educational support system rather than as a standalone solution to the learning challenges faced by learners with hearing impairment.

The findings also demonstrate the importance of FM systems in supporting learning among learners with hearing impairment. These systems can make it easier for learners to hear the teacher's voice, particularly where classrooms are affected by distance or background noise. The positive relationship found in the study is consistent with Schafer and Wolfe (2010), who emphasised the value of hearing assistance technologies in improving access to spoken communication. The finding is also in line with Borg et al. (2015), who argued that appropriate assistive technologies can promote participation and inclusion in education. However, the absence of a significant relationship for some other technologies, such as DM systems and tablets, suggests that technology does not automatically improve academic outcomes simply because it is available. This observation is consistent with Davis (1989), whose Technology Acceptance Model emphasises that perceived usefulness and ease of use influence whether technology is meaningfully adopted. Therefore, teachers need adequate training and learners need appropriate support to ensure that available technologies are actually integrated into classroom learning.

The finding concerning visual alert systems provides an important additional perspective. Although such systems can help learners notice important signals and events that might otherwise depend on hearing, their contribution to academic transformation may be limited when they are not directly connected to teaching and learning activities. This does not contradict UNESCO (2020), Borg et al. (2015), or Senjam and Manna (2024), which recognise assistive technology as important for improving accessibility and participation. Rather, it suggests that the usefulness of a particular technology depends on the learner's needs and how the technology is integrated into educational activities. The findings are also consistent with Jullu and Wandela (2025) and Ndibalema (2025), which draw attention to challenges surrounding educational support and learning opportunities for learners with hearing impairment in Tanzania. Overall, the study suggests that schools should move beyond simply providing assistive devices and focus on appropriate selection, availability, maintenance, teacher competence, learner support, and effective classroom integration so that technology can contribute meaningfully to academic transformation.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study concludes that assistive technology has an important role in supporting the academic transformation of learners with hearing impairment, but its potential is not being fully realised. The findings indicate that many assistive technologies are insufficiently available, poorly managed, or inadequately utilised in teaching and learning. This means that the presence of assistive technology in schools does not automatically lead to improved academic participation and outcomes. Effective use requires appropriate technologies, reliable availability, proper maintenance, and teachers who can use the devices effectively to meet learners' communication and learning needs.

The study further concludes that hearing aids and FM systems are particularly important in supporting academic transformation because they have a significant relationship with learners' academic outcomes. In contrast,

DM systems, tablets with educational applications, and visual alert systems did not show significant independent relationships with academic transformation in this study. Therefore, schools and education stakeholders should focus not only on providing assistive technologies but also on ensuring that technologies are appropriate to learners' needs and effectively integrated into classroom instruction. Overall, the findings demonstrate that accessibility, effective utilisation, and appropriate management of assistive technology are essential for creating meaningful learning opportunities for learners with hearing impairment.

5.2 Recommendations

The study recommends that the Ministry of Education, local government authorities, and school management should strengthen the provision, management, and effective use of assistive technology for learners with hearing impairment by ensuring adequate and appropriate hearing aids, FM systems, captioning facilities, visual alert systems, and tablets with relevant educational applications. Particular attention should be given to hearing aids and FM systems because the findings showed a significant relationship between their effective use and academic transformation. Schools should also provide regular training and practical support to teachers on how to operate, maintain, and integrate assistive technologies into classroom instruction, while establishing mechanisms for timely repair and replacement of faulty devices. In addition, schools should involve learners with hearing impairment when selecting technologies to ensure that the devices respond to their actual communication and learning needs. Education authorities should provide sufficient funding and technical support to reduce inequalities in access to assistive technology across schools, while school management should regularly monitor whether available technologies are actually being used during teaching and learning. These measures would help move assistive technology from simply being available in schools to becoming a practical tool for improving classroom participation, access to information, and academic transformation among learners with hearing impairment.

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Ethics Statement

We declare that we observed research ethics and citation criteria throughout the study; there was no conflict of interest, and the study was not funded.

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