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The Impact of Assistive Technology on Academic Achievement of Students with Hearing Impairment

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Abstract

This research investigates the relationship between usage of assistive technology (AT) and academic achievement of students with hearing impairment. Students with hearing impairment go through educational experiences laden with unique challenges which have direct repercussions on their academic progress as well as overall well-being in the classroom. Such challenges include gaining access to auditory input, as well as effective communication with peers and educators, coupled with active participation in class activities. Assistive technology (AT), even though the term embraces many devices, among which are hearing aids, cochlear implants and captioning services, is meant to provide access to education materials and to facilitate communication skills in the classroom setting. Through a quantitative research design involving surveys and statistical analyses, perceptions of educators, parents and students were examined regarding the effectiveness of assistive technology (AT). The data was collected from 100 participants by following convenient sampling technique. The findings of this study indicate that generally positive attitudes towards its benefits, though challenges such as inadequate teacher training and technical support were identified. Key recommendations focus on three main areas: strengthening teacher training in assistive technology, robust technical support services and advocating for policies that promote accessibility and affordability of assistive technologies.

Keywords Assistive Technology, Hearing Impairment, Academic Achievement, Inclusive Education, Teacher Training

Introduction

The educational experience and performance of the given student is quite different from the normal course of events and achievements. Examples of hurdles include barriers to acquiring auditory information, ineffective communication in environments with considerable noise around, and partial participation in classroom events (Dalton, 2011; Sarkar & Ghosh, 2024). Assistive technology thus becomes the most effective means toward overcoming these challenges by providing educational material, communication skills, and a full classroom learning experience to hearing-impaired students (Hoogerwerf et al., 2021). These consist of types of assistive technology such as hearing aids, cochlear implants, FM systems as well as already-verbalizing services for hearing-impaired students to ensure a learning outcome. Their goal focuses on improving auditory perception, facilitating communication among peers or even teachers, and developing language (Boerrigter et al., 2023).

In addition to the above, these captioning services will provide live conversion of spaced-out words into written texts that further assist in enabling access to lecture materials, which could be

beneficial to students in terms of performance (Miura & Yabu, 2023).There is intensive training and continuous professional development for teachers using assistive technologies (David et al., 2023). The effective use of the role of the teacher in enabling equal access to resourcing, opportunity, and achievement in scholarly endeavours for students with hearing impairments would be heavy in providing. Understanding how assistive technology and academic outcomes are related, however, allows educators and policymakers to join hands in creating environments that provide support to meet different needs of students with hearing impairments. This research intends to establish how assistive technologies affect students' academic performances about the hearing impaired population (Rehman et al., 2024; Bahçekapılı & Ayaz, 2024). Study findings would also be anticipated to promote contemporary inclusive use of education through deliberation of recent studies, gap recognition in knowledge, and recommendations for practice and policy with the aim of improving academic performance for all students irrespective of their potential differences in capacity to hear.

Literature Review

Hearing impairment students have special demands often different from their peers, and these result in certain negative experiences in their schooling years. Their challenges are usually accessing all forms of auditory information in the classrooms, communicating effectively with peers and teachers, and being able to engage actively in classroom activities (Nordlund, 2003). A vital tool that seeks to mitigate those challenges is assistive devices which improve accessibility to an educational resource, enhance communication skills, and promote learning environments that foster inclusiveness. Assistive technology makes and uses several devices and services that help support students with hearing impairment within educational environments. Of these include hearing aids and devices implanted in the cochlear which are used mainly to enhance auditory perception and to facilitate better communication between peers and between peers and educators (Krijger, et al., 2020).

Moreover, the research form of their findings regarding these technologies was that they indeed have very significant roles in improving speech understanding and language development in students with hearing impairment (Meinzen-Derr et al., 2019). FM systems and captioning services are crucial to an educational environment, especially among students who can hear and comprehend words spoken in sound conditions less than ideal (Spangler, & Flexer, 2015). They, for instance, find captions serving for the transcription of spoken words into the text; this would have a huge effect on students' accessing lecture content and even supporting their note taking (Kawas et al., 2016). In order for classroom integration of assistive technology to be effective, educators need to go through specialist training and continuous development. When instructors are highly skilled in such work, they can transform the access of student learning into an even more accessible environment for all students with hearing impairment (Kigotho, 2016).

The training program must then be directed toward equipping the educators with the necessary knowledge and skills to choose, implement, and adapt assistive technology for students in accordance with their individual requirements. Assistive technology also bears fruits beyond academics and, most importantly, inculcates in them greater skills for social integration and emotional well-being in students with hearing impairment. Access to technologies that enhance communication and interaction with peers could develop social relationships and a sense of belonging end within school communities (Zhao et al., 2012). This is the vital social engagement an individual student must have because it is good and ideal for a child. It affects learning performance and motivation positively regarding academics. Though assistive technology has proved great for students having hearing impairments, its stages of improvements and future areas of exploration are still to be discussed (Rehman et al., 2024).

The long-term impacts of assistive technology have to be researched in future increasingly regarding academic outcomes such as educational attainment and career readiness. Future innovations in technology promise to make assistive devices much more effective: these will include greater competency in speech recognition and language translation capabilities. Groove with actions addressing the access barriers and the implementation of assistive technology in schools: sufficient funding, ongoing professional development for teachers, and awareness programs to inform key stakeholders regarding benefits an assistive technology could offer students with hearing impairment. Without a shadow of a doubt, assistive technology brings benefits in one's significant academic achievement and change in the academic life of students with hearing impairment. Teach those unique needs of these students with the assistive technology where combined effort of teacher and school

system can further ensure that any student, regardless of hearing ability, has equal access to quality education and fitting in mainstream.

Research Objectives

This research study intends:

1. To determine the perceived effectiveness of assistive technology in improving academic performance in students with hearing impairment.
2. To address the barriers and challenges in using assistive technology in classroom settings for students with hearing impairment.

Research Questions

The research questions of the study:

1. How do different types of assistive technology (e.g. hearing aids, cochlear implants, FM systems) affect academic performance in students with hearing impairment?
2. What are the perceived benefits and challenges of the use of assistive technology in classroom situations for students with hearing impairment?

Methodology

Research Design

In this study, a quantitative research design investigates the effect of assistive technology on academic achievement among students with hearing impairment. The investigation employed a cross-sectional survey approach for data collection from a diverse sample of participants.

Participants

The participants of this study were students with hearing impairment, their educators/teachers "personnel's who directly teach and assist students with hearing impairment in educational settings", parents or caregivers "individuals responsible for the upbringing and educational support of students with hearing impairment" and healthcare provider "professionals involved in hearing impairment diagnosis and treatment".

Sample and Sampling Technique

The researchers used a convenient sampling method to collect the data. The data was collected from 100 participants. The population sample consists of diverse participants as determined according to demographic characteristics such as age, gender, educational level and geographical location.

Instrumentation

Questionnaire: The questionnaire consisted of a devised structure and it was useful in gathering information from participants. The questionnaire is divided into two main sections:

1. **Demographic Information:** Information about the age, sex, relationship with a student (for parents/guardians), educational level (for educators/teachers), and other relevant demographic details was provided by the participant.
2. **Likert Scale Items:** The participant was asked to respond to a number of statements on the role of assistive technologies with respect to academic performance in hearing-impaired students. The Likert scale responses will be assessed by assigning values on a 5-point scale, where 1 stands for "Strongly Disagree" and 5 signifies "Strongly Agree.

Online data were collected by means of a secure online survey platform. Participants had access to the questionnaire voluntarily, and informed consent was taken from each participant before participation. The survey was distributed through emails, educational institutions, healthcare facilities, and specific professional networks. The application of data employs both the techniques of descriptive and inferential statistics. The above encompasses descriptive statistics such as frequencies, percentages, means, standard deviations; and it depicts demographic characteristics and their responses to Likert-type items. Inferential statistics refer to correlation and regression analyses which seek to determine relationships among the variables and make predictions of academic achievement among hearing-impaired students.

Table No. 01: Reliability Statistics

Cronbach's Alpha	No. of Items
.911	10

Ethical Considerations and Limitations

The study was done following guidelines regarding ethical conduct concerning human subjects. Such measures include confidentiality, anonymity, and voluntary participation. Involving the research would require informed consent where possible, and participants have the right to withdraw at any

stage without any penalties. Relying on convenience sample techniques and self-reported data from the sample population, limitations include student bias in the study. Other contextual factors, such as the practices and educational policies at different sites, would also affect the findings.

Research results would serve well in generalizing the effect of assistive technologies on the academic performance of hearing-impaired students through a thorough research design and methodology. This evidence then contributes to evidence-based practice and interventions that are necessary for improved educational performance and inclusion of hearing-impaired students in mainstream education systems.

Demographic Information

Table No. 02: Gender of the Participants

		Frequency	Percent	Cumulative Percent
Valid	Male	48	48.0	48.0
	Female	52	52.0	100.0
	Total	100	100.0	

There is a gender balance in the participant groups, with 48 percent male and 52 percent female. Such healthy representation ensures adequate capturing of both genders' perspectives and experiences.

Table No. 03: Education of the Participants

		Frequency	Percent	Cumulative Percent
Valid	Matric	12	12.0	12.0
	Inter	16	16.0	28.0
	Graduation	24	24.0	52.0
	Master	48	48.0	100.0
	Total	100	100.0	

The educational profile of the respondents varies in terms of formal education levels. For instance, 12% of the respondents have obtained Matriculation (high school), 16% have achieved Intermediate education (equivalent to a high school diploma), and 24% have completed bachelor degrees, while the highest 48% consisted of master's degree holders. The distribution clearly illustrates the high concentration of qualified respondents and probably the impact of that qualification on awareness and use of assistive technology.

Table No. 04: Location of the Parents

		Frequency	Percent	Cumulative Percent
Valid	Urban	36	36.0	36.0
	Suburban	28	28.0	64.0
	Rural	36	36.0	100.0
	Total	100	100.0	

Participants who reside in specific areas represent more varied geographical distributions across the areas - 36% in the urban areas, 28% in the suburban areas, and again 36% in rural areas. This diversity ensures that the study encompasses a wide range of environmental contexts that may impact resource access and supports systems for students with hearing impairment.

Descriptive Data Analysis

Table No. 05: Perceptions of Participants

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The use of assistive technology enhances the academic performance of students with hearing impairment.	4	12	24	36	24
Students with hearing impairment benefit significantly from the integration of digital learning tools in their education.	4	12	12	48	24
Assistive technology helps students with hearing impairment to better engage with educational materials.	4	12	12	60	12
Access to assistive technology improves students' communication skills in educational settings.	4	24	0	60	12
The availability of captioning services and transcription tools enhances learning outcomes	4	24	24	36	12

for students with hearing impairment.					
Teachers are adequately trained to integrate assistive technology into the classroom for students with hearing impairment.	24	4	36	12	24
There is sufficient technical support available to assist students with hearing impairment in using assistive technology effectively.	12	36	12	36	4
Parents and caregivers play a crucial role in supporting the use of assistive technology at home for students with hearing impairment.	4	36	24	0	36
Assistive technology positively impacts the social integration of students with hearing impairment within their peer groups.	12	24	4	48	12
I believe that further investment in assistive technology for students with hearing impairment is essential for improving educational outcomes.	12	4	24	24	36

Table No. 05 illustrates that the participants are inclined to have a positive opinion overall about assistive technology; whether it augments academic performance in students with hearing impairment or not, 24% of them strongly agree with the statement while 36% also agree to give a total of 60% in favor of such assertion. However, there is a significant neutral group (24%), while minor percentages disagree (12%) and strongly disagree (4%). It's safe to say that almost all participants view the incorporation of digital learning tools favorably: while 48% agree, 24% strongly agree with the notion that such tools benefit students with hearing impairment; 12% are neutral, and the rest (16%) combined disagree or strongly disagree. Therefore, it is a good indicator that they still have reservations or are not aware of the benefits. The general perception would then be that assistive technology is quite beneficial to students since it engages them with educational materials. According to the data, 60% agree, and 12% are inclined to agree with this point, thus forming 72% of participants involved in the survey. Neutral responses form 12% of the population while another 16% diverge-or strongly disagree. Comprehensively, it would be wrong to report that it is evidence of a negative view, particularly considering that this was made apparent within the responses. Most participants do accept a positive effect on their part of assistive technology in communication skills while in education settings. For this majority, 60% agrees with this claim while only 12% strongly agree. On the contrary, 24% stand opposite this statement, whereas a few (4%) are totally inaccessible to this subject. This kind of view doesn't go well with an opinion like "by most." Rather, there are higher issues left unresolved in these greater concerns shared by most. Captioning services and transcription tools are debatable to a great extent. 36% and 12% strongly agree and agree to the assertion, respectively, about these services fostering learning outcome; however, 24% remain neutral and another 28% combine to oppose or strongly oppose.

Thus, these reveal incongruous perceptions toward the effectiveness or implementation of these tools. Perception regarding teacher training in the use of assistive technology has been adequately insufficient. A statically significant 24% of the participants qualified their disagreement tag as strongly about sufficient training for teachers, while a further percentage of 4% strongly disagreed. Of the neutral group, 36%, only 12% agreed with this and a further 24% strongly agreed with it, thus revealing a critical area for improvement. Opinions about the existence of sufficient technological support all seem mixed. While about 36% support the idea of sufficient technical support, only 4% strongly agree. On the contrary, about 36%, disagree, while 12%, and 12% have a neutral perception. That indicates strong variation in experiences or expectations on technical support. There is also recognition that parents and caregivers have an important supportive role in the use of assistive technology at home. This statement is supported by 36% of respondents and opposed by an equal percentage of 36% with 4% against it. A considerable 24% were neutral, explaining differences in levels of participation, or perceived effectiveness as thought by different families. On the flip side, 48% agreed and 12% strongly agreed that assistive technology should have a good impact on social integration among a peer group. On the contrary, 24% would disagree and 12% would very much disagree, which implied that while there were seen benefits, the issues still persisted in the social circle. Assistive technology fully advocates investing more in such technology. Most of the subjects who strongly agreed with it were at 36%, while an additional 24% upheld the notion that investment of this type is greatly beneficial to educational outcomes. However, 24% remained neutral and the

16% would either disagree or strongly disagree, thus underscoring the general agreement of recognizing the importance of continued investment. Yet, 24% would contest while 12% would fake one's intention to acquire or even a strong disapproval, suggesting that, although benefits seem to be visible, social circles are subject to other issues. It is in assistive technology that such an emphasis is put into the increasing investment for this technology. Most of the respondents who strongly affirm were at a maximum of 36%, and this was further supported by another 24% claiming this kind of investment's great utility in improving educational outcomes. On the other hand, 24% remained neutral, while 16% would disagree or strongly disagree, thus signifying the general agreement on the need for continued investment in it.

In overall terms, it can be said that the data depicts students with a generally favorable orientation towards how they perceived the impacting use of assistive technology for their academic and social outcomes. However, it also brought forth points like teacher training and technical support where improvements can be made.

Inferential Data Analysis

Table No. 06: Independent Samples Test

Gender Of the Respondent	N	M	S.D	T	Df	Sig.
Female	48	36.5000	6.00000	2.911	98	.123
Male	52	31.5385	10.30222			

*p>.05 Level of Significance

In independent samples T-test subjected between perceptions of male and female respondents on an outcome/impact of assistive technology on academic achievement, the sample consists of 48 respondents of female gender and 52 respondents of male gender. The female sample respondents thus had a mean score of 36.5000 and a standard deviation of 6.00000 indicating a fairly homogeneous perception of the females about the positive effects of assistive technology. On the other hand, male respondents had a mean score of 31.5385 with the calculated standard deviation value of 10.30222, indicating higher variation in scores from the mean. The t-test provided a t-value of 2.911, with 98 degrees of freedom. The significance level (p-value) of the t-tests was .123, thus exceeding the traditional boundary of .05 for statistical significance, hence this result showed non-significance in the differences between male and female respondent perceptions.

Table No. 07: One-way ANOVA Education Basis

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2565.360	3	855.120	15.928	.123
Within Groups	5154.000	96	53.687		
Total	7719.360	99			

*p>.05 Level of Significance

A one-way ANOVA is conducted to determine whether perceptions of the effect of assistive technology on academic achievement vary significantly among participants possessing different educational levels up to four levels; Metric, Inter, Graduation, and Masters. The results revealed a between-group sum of squares of 2565.360 with 3 degrees of freedom yielding a mean square of 855.120. The within-group sum of squares was 5154.000 with 96 degrees of freedom leading to a mean square of 53.687. The total sum of squares is 7719.360. Since F value calculated was 15.928 hence a significant difference in group means due to within group variance. However; the significance level p=.123 mostly exceeds the conventional 0.05 cut-off for statistical significance. Thus, it is proved that the differences between perceptions across the levels of education are not statistically significant and possibly occurred by chance. In summary; the one-way ANOVA found no statistically significant difference in the perception of the impact of assistive technology on academic achievement between individuals of different levels of education. It implies no much influence of educational background on perceptions about the effectiveness of assistive technology in this regard. Additional variables or larger samples might be needed for future research to verify these results and to investigate other determining factors that might affect such a perception.

Table No. 08: One-way ANOVA Location Basis

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1711.360	2	855.680	13.815	.123
Within Groups	6008.000	97	61.938		
Total	7719.360	99			

*p>.05 Level of Significance

A one-way ANOVA was applied to explore possible differences in perceptions about how assistive technology contributes to academic achievement among participants who live in Urban, Suburban, and Rural settings. The purpose of this analysis is to find out whether the location a person is living in really makes a difference in the way a person perceives the effectiveness of assistive technology in an educational setting. The ANOVA results are as follows; it presented a between-groups sum of squares 1711.360 with 2 degrees of freedom and a mean square of 855.680. Within groups, it produced a sum of squares of 6008.000 with 97 degrees of freedom, thereby achieving a mean square of 61.938. The total sum of squares thus equals 7719.360. Computed F-value was 13.815, which translates into very significant difference for the means of the groups in relation to the within groups variability. However, the significance level (p-value) got from the analysis revealed that it was .123, higher than a .05 cut-off point that is conventionally used to determine statistical significance. The indicated differences were in fact not statistically significant, and thus possibly happened due to sheer chance by incidental sampling error. Summary thus states that on one-way ANOVA, the participants' geographical location (Urban, Suburban, or Rural) does not significantly influence their perception of the impacts of assistive technology on academic achievement. This understanding implies that irrespective of whether the respondents are urbanized, suburban, or rural, their perceptions concerning the enhancement of academic outcomes for the students with hearing impairment from the use of assistive technology are homogeneous. It may be necessary to conduct further studies involving larger sample sizes or additional variables to support and explore these findings.

Discussion

Insights are offered on the extent to which these factors influence perception about the usefulness and effectiveness of assistive devices in educational settings for hearing-impaired students. Initially, the differences between male and female applicants were analyzed with regard to their view about the possible impact of assistive technology on academic achievement. Although it tends to be such that women respondents have given consistent positive perceptions, the statistical findings do not show the impact of gender differences. This means that both the male and female participants are attributed to the same perceptions regarding the importance of assistive technology in fostering better academic drive among students with hearing impairment. The same was undertaken for various educational levels (Metric, Inter, Graduation, and Master) and different geographical locations (Urban, Suburban, and Rural) with regard to perceptions. The results were statistically non-different in perception with respect to these factors (Cai et al., 2017). This speaks against the view that educational qualification or geographical location can play a major role in affecting the perception about the use of assistive technology in academic achievement among hearing-impaired students in a significant way (Marschark et al., 2015).

It generally indicates that, no matter the demographic characteristics, participants exhibit a more or less positive feeling toward assistive technology. This tends to imply that integrating assistive technology in educational settings enhances academic achievement among hearing-impaired children (McNicholl et al., 2021). Areas still to be improved, such as an improvement in teacher training and technical support in successful use of assistive technology in classroom practices, were also revealed by the study. These are pieces of information for educators and policymakers in prioritizing investment in training programs equipping teachers to effectively deploy these assistive technologies (Eden et al., 2024). Budding further on the improvements in the technical support infrastructure of educational institutions could also add to making assistive technology more accessible and usable to students with hearing impairment. The study surely has some limitations, as stated by Daramola (2022). The fact that the study depends on convenience sampling and self-report could yield an element of bias and make the findings less generalizable. Qualitative methods could also be included among the search criteria in a future study that would be effective in using more rigorous sampling techniques. Longitudinal studies can also be done to investigate the long-term effects of such devices on academic outcome and career readiness of the student with respect to hearing impairment. Such technological advancements as enhanced capability on speech recognition and translation into various languages must also be researched to improve their application in educational settings (Almgren Bäck et al., 2024).

Conclusion

The major revelation outputted from this study was mostly positive perceptions of the assistive technology in relation to student academic achievement, particularly for students with a hearing impairment. This has been a strong belief in accessing a wider range of learning resources, increasing communication skills, and bettering learning conditions for the entire student population. Variations on these issues exist according to some demographic factors like gender, education level, and place of living, but consensus has overwhelmingly affirmed the effectiveness of assistive technology in the whole education setup. It also pointed to the fact that there are still critical areas in which improvements are to be made-for instance, the teacher training and technical support to make the most of these technologies. Such challenges will definitely maximize the potential for the use of assistive devices and services in educational success. Hence, the information could be useful for educators, policymakers, and interested stakeholders who need to build advocacy for well-defined interventions and investments, aimed at equitable access to quality education for learners with hearing impairment. Future research should be directed at longitudinal studies to assess long-term impacts, focusing on new evolving technologies that are capable of improving the outcomes of this population of learners.

Recommendations

The research findings have suggested several recommendations regarding how the use of assistive technology can be much improved to provide effective support in learning for students with hearing impairments:

1. Educational institutions should give absolute priority to comprehensive training of educators to help them become competent in the use of assistive technology. This should include selection, implementation, and adaptation methods of such devices according to different needs of students.
2. Schools and other educational institutions should put in place effective high-quality technical support services to assist students with hearing impairment in their ability to use assistive technologies. In effect, this ensures intended, current troubleshooting and preventive maintenance for devices to ensure timely updates to spare students from disrupted learning. Inclusion of efforts will make assistive technology devices and services much more accessible and affordable to all as it includes state and local advocacy efforts for funding initiatives to support schools and families in acquiring necessary technologies through financial relief for equal opportunities for all students.
3. New research in the area of assistive technology has to be encouraged and promoted continuously, specifically addressing the needs of students with hearing impairment. Major emphasis should be on monitoring the progress of speech recognition technology, real-time captioning, as well as interactive learning tools that make learning more engaging and outcome-based.
4. Developing inclusive policies at all levels-local, regional, and to national level- guarantee rights and educational needs for students with hearing impairment. This means that all educational frameworks should culminate accessibility, accommodations, and resources necessary for appropriate use of assistive technology.

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