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THE ROLE OF ASSISTIVE TECHNOLOGY IN SUPPORTING COMMUNICATION AND ACADEMIC ACCESS FOR DEAF STUDENTS: A QUALITATIVE STUDY AT GALLAUDET UNIVERSITY

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ABSTRACT

The biggest challenge faced by deaf students in education is the limited access to verbal communication, which affects their participation in learning. Communication technology and translation solutions are viewed as potential remedies, but their application in educational settings remains suboptimal. This study highlights the importance of exploring and identifying the most effective assistive technologies to support the communication and academic access of deaf students, with the goal of creating an inclusive and empowering learning environment that enhances their academic outcomes. The research methodology employed a qualitative approach, with in-depth interviews conducted with 10 teachers at Gallaudet University to gain deep insights into the most relevant and effective assistive technologies. The findings indicate that communication technology and translation solutions, such as mobile applications, iCloud services, and sign language, have great potential to support learning, help deaf students efficiently translate educational content, and facilitate knowledge sharing in the classroom. In conclusion, assistive technologies play a significant role in improving the communication and translation abilities of deaf students, thereby contributing to their academic achievement.

Keywords: *Assistive Technologies, Communication Accessibility, Deaf Education, Inclusive Learning, Translation Solutions*

INTRODUCTION

Education for deaf students continues to face significant challenges, particularly due to limited access to verbal communication, which greatly impacts their participation in learning. The inability to receive information through verbal means directly limits the interaction of deaf students with teachers and classmates, ultimately negatively affecting their comprehension of materials and academic achievement (Aljedaani et al., 2023). Research shows that deaf students often struggle to follow learning processes that rely on verbal communication, making them feel academically and socially isolated in the school environment. This issue becomes critical, as effective communication skills are one of the key factors for success in education (Mohd Hashim & Tasir, 2020).

In recent years, communication technologies and translation solutions such as mobile apps and cloud-based services have emerged as potential solutions to bridge this gap. For instance, research by Millett (2021) has shown that cloud-based translation services can provide real-time access to learning materials, enabling deaf students to more easily follow classroom instruction. Additionally, sign language-based applications have been proven to enhance students' understanding of lesson content and increase their participation in class discussions (Carpenter et al., 2020). However, despite the significant potential of these technologies, their use in classrooms remains suboptimal, especially in terms of effective and sustained integration across diverse educational settings (Cawthon & Garberoglio, 2021; Leigh & Crowe, 2020).

This challenge forms the basis of this study, which aims to further explore how appropriate assistive technologies can overcome communication barriers and provide better academic access for deaf students. By investigating the subjective experiences of teachers in using these assistive technologies, this study hopes to identify more comprehensive and practical solutions to enhance the quality of learning and the academic outcomes of deaf students in the future (Kelly et al., 2022). Recent studies highlight the relevance of technology in supporting deaf students' education. For example, research by Cabanillas-Carbonell et al. (2022) shows that mobile apps using sign language can enhance students' understanding of educational material. Similarly, Al Raisi & Al Harthy (2023) found that integrating cloud-based technology enables real-time access to translation materials, giving deaf students more equal access to information. Additionally, research conducted by Paatsch et al. (2022) underscores how the use of digital hearing aids in education can facilitate student interaction with teachers and peers, ultimately improving their academic performance.

Furthermore, Dyzel et al. (2020) study also supports the importance of using assistive technology to aid non-verbal communication, with findings showing that a combination of translation technology and hearing aids yields better outcomes compared to using a single technology alone. Another study by Mohammed (2021) identifies that using digital sign language applications has significantly increased deaf students' engagement in the classroom. All these studies highlight the potential of assistive technologies to enhance the learning experience for deaf students, yet there is still no consensus on which technologies are the most effective, especially in the classroom setting.

Although much research has discussed the importance of assistive technologies in the education of deaf students, there remains a gap in understanding which technologies are the most effective and targeted in addressing the various challenges they face. Most studies also tend to focus on specific aspects of technology, such as the use of certain apps or hardware, without offering a more holistic view of how these technologies can be effectively integrated into an inclusive classroom environment. Thus, this study seeks to bridge this gap by exploring the most relevant and effective assistive technologies for deaf students, and how these technologies can be practically applied to improve their academic outcomes.

This study offers a comprehensive and in-depth approach to exploring assistive technologies for deaf students, with an emphasis on their practical application in the classroom. In addition to identifying the most effective technologies, it also delves into teachers' subjective experiences in using these technologies, providing a more holistic perspective. This approach is expected to contribute to the development of more inclusive and empowering educational strategies, ultimately having a positive impact on the quality of learning for deaf students.

RESEARCH METHOD

This study employs a qualitative approach with the aim of exploring and gaining an in-depth understanding of the use of assistive technologies in supporting the education of deaf students. A qualitative approach was chosen because this research focuses on the subjective experiences of teachers and the practical impact of assistive technologies in the classroom (Walliman, 2021). This method allows the researcher to delve deeper into respondents' perceptions and experiences, which cannot be fully captured through a quantitative approach. In this study, the main variables used are assistive technologies (such as mobile applications, cloud services, and sign language) and teachers' experiences in using these technologies to support deaf students in the classroom (Ditlhale & Johnson, 2022; Emereole, 2022).

The data required for this research includes information on various types of assistive technologies used in educational settings, the effectiveness of these technologies in supporting communication and comprehension for deaf students, and the challenges faced by teachers in their implementation. Additionally, data related to changes in student participation, comprehension of material, and academic achievement were collected to assess the direct impact of assistive technology use (O'Neal, 2021). The data sources for this research are teachers who have experience teaching deaf students in classroom settings, with a focus on those working in institutions that provide specialized services for hearing-impaired students.

The data sources were selected using purposive sampling, where 10 teachers from Gallaudet University, a leading institution in deaf education, were chosen as respondents. The teachers were randomly selected but met the criterion of having at least three years of experience using assistive technologies in the classroom. The selection of respondents with such experience is crucial to ensure they have in-depth knowledge of the application of assistive technologies and can provide relevant insights regarding the effectiveness of these technologies (Hermawati & Pieri, 2020). Data were collected through in-depth interviews with each teacher. The interviews were conducted in a semi-structured format, with questions designed to explore teachers' experiences in using various types of assistive technologies, their perceptions of the effectiveness of these technologies, and the challenges they encountered in their implementation (Speroni et al., 2023). Each interview lasted between 60 to 90 minutes and was conducted either in person or online, depending on the respondents' preferences. The interviews were recorded and later transcribed for analysis.

Data analysis was conducted using thematic analysis. After the interview transcripts were compiled, the researcher conducted a coding process to identify the main themes that emerged from the data. These themes were then further analyzed to uncover common patterns related to teachers' experiences, the effectiveness of assistive technologies, and the challenges encountered in their use (Neuendorf, 2018). Through this method, the research aims to provide a clear and comprehensive picture of how assistive technologies are applied in the classroom and their impact on the learning of deaf students (Yarrow et al., 2023).

RESULTS AND DISCUSSION

The Importance of Assistive Technology in Education for Deaf Students

This study found that assistive technology has a significant impact in helping deaf students overcome communication limitations. About 50% of participants reported that assistive technologies, such as mobile apps and cloud services, facilitate communication between deaf students, teachers, and classmates. This technology allows real-time access to information and enhances students' understanding of the subject matter (Kelly et al., 2022). In an in-depth interview, a teacher at Gallaudet University stated, "Technologies like mobile apps have changed how deaf students interact in the classroom. They can quickly access lesson materials and communicate their understanding more efficiently." This reinforces the argument that assistive technology is not just a tool but also an important bridge in overcoming communication barriers.

In addition to aiding communication, assistive technology also plays a crucial role in the learning process itself. About 40% of participants stated that this technology influences how deaf students learn educational content. In an interview, one teacher explained, "The use of cloud services allows students to access materials whenever they need them, which is very helpful when they need more time to grasp a concept." This technology enables deaf students to be more actively involved in learning, with easier access to lesson materials and the ability to study independently outside of school hours.

Sign language remains a primary aid in the education of deaf students. About 70% of participants reported that sign language is the most frequently used method in the classroom, although modern technology is increasingly used. One respondent said, "Although technology helps, sign language is still key for deaf students in understanding instructions and interacting with their learning environment." This indicates that despite the advancement of modern assistive technology, traditional methods like sign language remain relevant and crucial in supporting effective communication in the classroom. Furthermore, the combination of modern assistive technology and traditional methods appears to provide the best outcomes. In some cases, teachers use sign language alongside technologies like iCloud devices and mobile apps to ensure that students can access information in the way that best suits their needs. One teacher mentioned, "We use sign language as a foundation, but technologies like mobile apps help bridge

the gap between deaf students and lesson materials more quickly." This integration allows deaf students to grasp material more deeply and in a shorter time.

However, the use of assistive technology is not without challenges, particularly regarding costs. Many participants noted that the cost of acquiring and implementing assistive technology is quite high. About 70% of respondents stated that although these costs are steep, the technology significantly contributes to the academic and personal development of deaf students. One respondent said, "This technology is expensive, but its impact is priceless. Deaf students are more confident in learning and interacting because they feel more capable of overcoming their communication limitations." This suggests that investment in assistive technology, despite being burdensome, holds great potential for achieving significant academic outcomes. Additionally, around 10% of participants noted that assistive technology helps deaf students in their careers. Students who use assistive technology from early education through secondary school are more likely to be prepared for the workforce with better communication skills. One teacher stated, "I have seen many deaf students who, thanks to assistive technology, have been able to secure good job positions because they are able to communicate more effectively." This indicates that the benefits of assistive technology extend beyond formal education and have a long-term impact on students' futures.

The Impact of Assistive Technology on Academic Advancement

Assistive technology not only affects communication but also directly contributes to the academic achievement of deaf students. As many as 90% of teachers reported that the use of assistive technologies, such as translation services and mobile apps, has significantly enhanced the academic progress of deaf students. A teacher at Gallaudet University stated, "With this technology, deaf students can access lesson materials more easily and keep up with understanding the concepts taught in class." This suggests that assistive technology enables deaf students to perform on par with their non-deaf peers, narrowing the academic achievement gap.

Moreover, 80% of teachers believe that assistive technologies like iCloud services and mobile devices provide more equitable opportunities for deaf students to achieve academic results comparable to those of non-deaf students. "We have observed a tangible improvement in test scores and class participation from deaf students after they started using this technology," noted another teacher. This technology not only facilitates access to lesson materials but also allows deaf students to better manage their study time through independent access to information outside school hours.

However, not all teachers agree on the positive impact of assistive technology. Around 10% of teachers indicated that its impact is not always consistent. One teacher remarked, "Although technology helps, there are other factors influencing students' academic progress, such as limitations in school technology infrastructure or lack of teacher training." This suggests that the effectiveness of assistive technology depends not only on its availability but also on the school's readiness and teachers' skills in integrating it into the teaching process.

Several teachers emphasized that a significant challenge in supporting deaf students is the lack of teacher competency in using assistive technology, which can hinder its optimal use in classrooms. While some teachers are still uncomfortable with the technology, those familiar with it acknowledge its long-term benefits, noting that it not only enhances academic performance but also equips students with valuable skills for the workforce. Assistive technology also serves as an empowerment tool, fostering greater confidence and independence among deaf students by enabling them to communicate and participate more actively in class. These findings underscore the need for ongoing teacher training to ensure effective integration of assistive technology that supports both academic and personal development of deaf learners.

Challenges in Implementing Assistive Technology

Despite the significant benefits that assistive technology provides for deaf students, its implementation faces several challenges. One major obstacle is the high cost associated with adopting this technology. Approximately 70% of the teachers interviewed acknowledged that although this technology is very helpful, the costs for acquiring and maintaining assistive technology are quite high. “We believe this technology is essential, but school budgets often fall short of covering all the necessary technology,” said one teacher. Nonetheless, these teachers also recognized that the costs are justified by the benefits, particularly in terms of enhancing deaf students’ confidence and their career development opportunities.

However, not all participants share the same view. About 20% of the teachers involved in the interviews stated that the cost of assistive technology outweighs the perceived benefits. “Many students do not show significant improvement despite using this technology. This makes us reconsider its long-term effectiveness,” said one teacher. These teachers feel that assistive technology might not always address all the challenges faced by deaf students, especially for those who do not achieve the expected academic success despite using the technology.

Another challenge is the lack of adequate training for teachers in using assistive technology. About 30% of participants reported that they did not receive sufficient training to integrate assistive technology into the learning process. “We often have to learn on our own how to use this technology, and not all teachers have the same opportunity to master it,” said one teacher. This leads to variations in the quality of technology implementation in different classrooms, causing inconsistent benefits for deaf students.

Infrastructure at schools also poses a significant problem in the implementation of assistive technology. Some teachers expressed that their schools do not have sufficient facilities to support optimal use of assistive technology. “Our school still lacks stable internet access, which hinders the use of cloud-based applications that should help deaf students,” said another teacher. This infrastructure gap reduces the full potential of assistive technology, which should be accessible to deaf students at all times.

Additionally, there are challenges in adapting deaf students to new technology. Some teachers reported that not all deaf students feel comfortable using assistive technology,

especially digital ones. “Some students find it difficult to adjust to this new technology, particularly those who are used to traditional methods like sign language,” said one teacher. This indicates that the success of assistive technology implementation is also influenced by the students’ readiness to accept and use the technology.

Furthermore, economic disparities among deaf students also create issues in technology accessibility. Teachers noted that some students from low-income families do not have access to the technological devices needed to support their learning outside of school. “We see a gap between students who can afford to buy their own devices and those who cannot,” explained one teacher. This shows that, in addition to school-level challenges, there are individual student-level challenges that require more attention.

Despite these challenges, most teachers remain optimistic that with the right support, assistive technology can be implemented more effectively in the future. Intensive teacher training, improved school infrastructure, and supportive educational policies are expected to help maximize the potential of assistive technology. “We believe this technology is the future of inclusive education, but there needs to be more support for both teachers and students to ensure everyone can benefit fully,” said one teacher optimistically.

The Impact of Assistive Technology on the Personal Development of Students

In addition to positively affecting academic achievement, assistive technology has been shown to play a crucial role in the personal development of deaf students. Approximately 70% of teachers interviewed stated that this technology significantly helps boost the confidence of deaf students. “Students who used to be shy about speaking in front of the class are now more confident because they feel more capable of following lessons with the help of technology,” explained one teacher. Assistive technology enables deaf students to feel more equal to their peers, which directly impacts their active participation in classroom activities.

Teachers also reported that the use of assistive technology, such as mobile apps and communication-supporting devices, helps deaf students engage more in classroom discussions. “With this technology, they are no longer just passive listeners but can interact more actively with their classmates,” one teacher noted. This shows that assistive technology not only facilitates the learning process but also promotes social inclusion within the school environment. Deaf students’ ability to communicate more effectively helps them overcome the awkwardness that often arises in social interactions.

Assistive technology also plays a role in reducing the sense of isolation that deaf students often experience. Before this technology, many deaf students felt excluded due to communication barriers. However, with devices such as translation apps and hearing aids, they can more easily participate in everyday conversations at school. “Now they can talk to their friends without feeling isolated,” said one teacher, who observed a positive change in their deaf students. The use of this technology facilitates healthier and more harmonious social relationships among students.

Furthermore, assistive technology helps improve the emotional capacity of deaf students. With more active involvement in class, they can express their feelings and opinions better, which ultimately enhances their emotional well-being. “They are now more open in expressing how they feel, and this is very important for their emotional development,” added one teacher. This process contributes to the development of a stronger and more independent personality in deaf students, which is essential for their life beyond the school environment.

However, despite the clear benefits of assistive technology on personal development, some challenges remain in its application. Some teachers reported that not all deaf students can fully adapt to the technology. “There are some students who are still hesitant to use the technology, perhaps because they are used to traditional methods like sign language,” explained one teacher. This indicates that the process of adapting students to assistive technology requires a more personal and continuous approach.

Additionally, cost issues are a limiting factor in personal development through assistive technology. Some teachers noted that students from lower-income backgrounds do not have adequate access to the technological devices needed. “Students from less affluent families often can’t use this technology at home, and this becomes a barrier to their development,” said one teacher. This suggests that personal development through assistive technology needs to be supported by policies that ensure equal access for all deaf students.

Despite these challenges, the findings confirm that assistive technology plays a significant role in supporting the personal development of deaf students. With proper integration and sufficient support, this technology not only enhances their academic abilities but also strengthens their confidence and social skills. “We believe this technology is key to shaping a more independent and confident generation of deaf individuals,” one teacher said with optimism. Although still facing various challenges, assistive technology has proven to be an essential tool in helping deaf students reach their full potential, both in education and social life.

CONCLUSION

The use of assistive technology in the education of deaf students has been proven to have a significant impact on improving their communication, translation, and academic progress. The majority of participants (90%) and teachers stated that this technology, including sign language, iCloud services, and mobile devices, enables deaf students to access educational content more effectively and enhances their interactions with teachers and classmates. Assistive technology not only improves academic aspects but also supports their personal and career development, although the cost of acquisition and implementation is quite high. The majority of teachers (70%) believe that investing in this technology helps deaf students achieve academic success comparable to that of non-deaf students and provides long-term benefits, both in terms of confidence and career prospects. However, a small portion of participants still question whether these benefits justify the associated costs.

ETHICAL STATEMENT AND DISCLOSURE

This study was conducted in accordance with established ethical principles, including informed consent, protection of informants' confidentiality, and respect for local cultural values. Special consideration was given to participants from vulnerable groups to ensure their safety, comfort, and equal rights to participate. No external funding was received, and the authors declare no conflict of interest. All data and information presented were collected through valid research methods and have been verified to ensure their accuracy and reliability. The use of artificial intelligence (AI) was limited to technical assistance for writing and language editing, without influencing the scientific substance of the work. The authors express their gratitude to the informants for their valuable insights, and to the anonymous reviewers for their constructive feedback on an earlier version of this manuscript. The authors take full responsibility for the content and conclusions of this article.

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