Practices Used to Diagnose Hearing Impaired Students with Learning Difficulties in Mathematics

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Abstract

This study aimed to examine how teachers perceive the diagnostic practices used to identify mathematical learning difficulties among hearing-impaired students. This study adopted a quantitative research design, sampling 300 teachers using simple random sampling. We collected data using a self-developed questionnaire and analyzed the data using descriptive and inferential statistics in SPSS. The study highlights the importance of visual aids, non-verbal assessment, and teamwork between the audiologist and educator to identify hearing-impaired students. Teachers believe that we need to design more versatile tools in addition to norm-referenced tests. This underscores the shortcomings in the diagnostic tools. There was a lack of specialized diagnostic equipment for both hearing and learning disabilities, as reported during the observation. It also highlights the need for continuous practice improvement and excellent collaboration among all stakeholders. These findings contribute to the broader literature on inclusive education and underscore the necessity for innovation in diagnostic tools to support students with hearing impairments better. In this area, emerging technologies should be the focus of further research to improve diagnosis.

Keywords: Diagnose, Hearing Impaired, Students, Learning Difficulties, Mathematics.

Introduction

The highly entangled relationship between hearing loss and mathematical cognition makes diagnosing learning difficulties in mathematics among hearing-impaired students extremely challenging. The lack of verbal instructions makes accessing most word problems and procedural explanations difficult because they usually require language-based mathematical skills (Aftab et al., 2022). This limitation necessitates diagnostic tools appropriate for the communication demands of students with hearing impairments, focusing on visual-spatial reasoning and non-verbal problem-solving abilities (Cho & Kraemer, 2020). These learning disabilities have often been misdiagnosed by conventional assessment processes that rely heavily on auditory processing and verbal communication. Recommendations on the assessments should be linguistically accessible and culturally responsive as required. Nicholson et al. (2019), advise individuals to use tailored approaches in diagnosis due to unique challenges.

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Current researchers focus on identifying early learning difficulties so that interventions can be applied to deaf students promptly. The traditional methods of diagnosis employed are heavily based on auditory clues and fail to determine these children's mathematical learning difficulties. The visual-spatial tests, however, are very reliable assessments because they capitalize on the strengths of cognitively enhanced students who are hearing-impaired. According to Aftab et al. (2024), deaf students are more capable of these methods and resources, focusing on visual pattern recognition, concreteness in problem-solving, and generally reduced language play. However, further research reveals that deaf students are typically more vulnerable to mathematical difficulties due to their slower language assimilation, which weakens their understanding of abstract symbolic representations of mathematical information in their brains (Phan, 2021). Therefore, diagnostic procedures prioritizing spatial ability and logical reasoning with a minimal language component can effectively identify learning disabilities resulting from hearing impairment.

Despite significant advancements in diagnostic practices for hearing-impaired students, more research is needed to address these gaps. Among these is the lack of standardized diagnostic tools relating to the communication needs of deaf student who requires urgent attention (Aftab et al., 2022). The current tools utilized in mainstream education need to adequately illuminate the unique issues faced by the hearing-impaired student, thereby failing to produce results that could lead to a consistent diagnosis and subsequent intervention. Moreover, research on technology-based diagnostic solutions is only promising and may include computer-assisted diagnostic tools that offer interactive and visual learning environments (Ibrahim, 2023). Few studies have examined their effectiveness for students with hearing impairments. This paper will bridge the gaps by highlighting the need for inclusive, culturally sensitive diagnostic practices that incorporate traditional and technology-based tools. The paper demonstrates how early identification and proper differentiation of mathematical learning difficulties from the effects of hearing loss can transform diagnostic tools into learning-assistance tools for students with hearing impairments.

Objective of Study

To examine the practices used to diagnose hearing-impaired students with learning difficulties in mathematics.

Literature Review

Diagnosing learning-disabled pupils with hearing impairment is challenging because the interaction of hearing impairment and cognitive processes related to mathematical understanding tends to be a double-edged sword. Hearing impairment severely restricts access to spoken instruction, limiting the development of language-based mathematical skills such as word problems, procedural explanations, or symbolic reasoning (Aftab et al., 2022). As a result, there is an urge for specialized diagnostic practices that can effectively and accurately identify learning problems in such a population. Educational psychologists argue that it is essential to apply assessment methods that are linguistically accessible and culturally responsive (Cho & Kraemer, 2020).

For pupils with hearing impairments, timely intervention is always necessary because they need the input. On the other hand, traditional assessment procedures do not adequately diagnose students because they rely on auditory processing and verbal instructions (Nicholson et al., 2019). Current studies have promoted visual-spatial evaluation, as most assessments focus on a student's cognitive abilities, accurately pinpointing their mathematics learning challenges. These assessments include tasks such as pattern observation with visual means, non-verbal ways for problem-solving, and manipulatives in concrete ways to measure understanding of math (Bashir et al., 2024).

There is emerging evidence that children with hearing impairments risk learning difficulties in mathematics more than their hearing peers (Aftab et al., 2024). The delayed language acquisition can significantly hinder their ability to grasp abstract mathematical concepts with symbols and linguistic instructions. As a result, diagnostic tools teachers should eliminate the language element and focus on non-verbal reasoning, spatial awareness, and logical thinking. In this way, learning difficulties would be better diagnosed and discriminated from the effects of hearing loss per se (Phan, 2021).

A third primary concern is the non-standardized diagnosis approach when dealing with mathematical learning disabilities in hearing-impaired students. According to Aftab et al. (2022), general teaching settings often develop assessment tools without considering the communication challenges of the student's hearing impairments. There is, therefore, a need for much more integrated diagnostic tools—visual, tactile, and kinesthetic. According to studies, these tools necessitate additional teacher observations and student interviews for a comprehensive assessment.

One area of interest that has emerged lately is technology, with particular interest in diagnosing learning difficulties among hearing-impaired students. Researchers have discovered that computer-assisted diagnostic tools can offer immediate feedback and create an interactive, visual learning environment (Ibrahim, 2023). The pictorial representations and interactive simulations can bridge the communication gap, as learners can convey mathematical understanding by providing answers without lengthy, wordy elaborations. However, experts have warned that technology cannot replace test-based valuations but can complement them at best (Chang & Lin, 2024).

Sometimes, it can also be relatively difficult to differentiate between issues caused by hearing impairment and those that might indicate an actual mathematical learning disability, especially in identifying learning-disabled students in mathematics (Cannon et al., 2022). This is indeed critical because hearing impairments have interventions based on communication strategy, whereas mathematical learning disabilities have specific methods of instruction that must suit the corresponding cognitive challenges. Thus, extensive evaluation should be carried out by a multidisciplinary group headed by one or all of the following professionals: an educational specialist, an audiologist, and a speech-language pathologist, so an accurate diagnosis can be made.

The central thematic areas associated with mathematical difficulties observed in children with hearing impairment include delay in conceptual development, especially in number sense and problem-solving (Santos & Cordes, 2022). According to reports, this delay was caused by limited access to incidental learning opportunities associated with overhearing explanations of a mathematical concept and participating spontaneously in discussions about mathematical concepts. Diagnostic practices must identify these experiential gaps, ensuring that assessments do not penalize students for their privileges (Roy et al., 2021).

In recent years, there has been a growing call for more culturally responsive diagnostic practices sensitive to hearing-impaired students' multiple backgrounds (Wong, 2023). This again complicates the diagnostic process, as it is not only language that is at issue but also socio-economic backgrounds for several students. For example, a deaf student who primarily uses sign language for communicating might have different diagnostic needs than one who relies strictly on lip reading or a hearing aid. The research suggests that individualized assessments of a student's preference about the significance of communication and cultural import would be necessary (Hall & Ballard, 2024).

Dynamic assessment is one of the promising advances in diagnosing learning difficulties among deaf students. Dynamic assessments focus on the learning process and how students respond to instructional support in the evaluation, whereas static assessments focus only on what a student knows (Aftab et al., 2024). This approach allows educators to identify what a student knows and their potential for learning new concepts with appropriate guidance. Researchers have found that these methods are highly effective in diagnosing math learning disorders in deaf children, as they rely on solving strategies rather than memorization (Ibrahim, 2023).

Teachers play an essential role in determining whether or not a learning difficulty exists among deaf children. Their observations and formal assessments give a holistic picture of how the student learns and functions (Ismail, 2022). Teachers often notice preliminary signs of problem difficulty, such as a student's failure to follow mathematical procedures or inability to understand abstract concepts. As a result, teachers' training on effectively using diagnostic tools with learners is critical to early and accurate identification of learning difficulties (Jordan et al., 2020).

There is a sharp need for more research into how hearing impairment interacts with mathematical learning difficulties (Lambert & Tan, 2020). On the one hand, a lot of research examines the general effects of hearing loss on academic performance. Still, more research efforts need to be focused explicitly on mathematics. More research is required to establish and validate diagnostic tools sensitive to the difficulties experienced by students with disabilities in learning mathematics. In this regard, the research will help hone intervention strategies that may address both the hearing and cognitive learning problems associated with the difficulties (Biggs & Hacker, 2021).

Another challenge involved defining mathematical difficulties among students with hearing impairments since most studies' criteria for learning difficulty in operation lack a concrete definition (Cannon et al., 2022). Some contend that a hearing impairment alone poses a learning challenge. In contrast, others maintain that we should distinguish between the difficulties caused by sensory impairments and those associated with cognitive deficits. Thus, such inconsistency in the general definition of ADHD has resulted in uneven diagnostic practices in many educational settings, thereby over diagnosing some students while underdiagnosing others (Powell et al., 2022).

In most cases, diagnosing a learning difficulty in mathematics among deaf students in class entails a combination of standardized tests, informal assessments, and classroom observations (McPherson, 2024). These students may need help with tests designed for hearing students. The result is that educators use informal assessments and teacher observation as diagnostic strategies for learning difficulties. Despite their relative nature, these practices are highly flexible and can tailor their support to the student's communication needs (Krishnan et al., 2020).

Professional collaboration in education is the only way to properly diagnose learning difficulties in a deaf student (Bowen & Probst, 2023). This multidisciplinary approach includes assessing the student's general cognitive and sensory capabilities in collaboration with the audiologist, speech-language pathologist, and special education teacher. Thus, we consider all aspects of the student's learning for a more accurate diagnosis, which leads to effective intervention planning (Shipley & McAfee, 2023).

According to studies, early intervention is critical for reducing the loss resulting from hearing impairment in mathematics learning (Meinzen-Derr et al., 2020). Most deaf students diagnose themselves when facing academic challenges, which delays interventions and exacerbates learning deficits. Screening for mathematical challenges in hearing-impaired pupils during the primary grades is crucial to prevent them from falling behind in school (Kabethi, 2021).

For instance, visual supports play a crucial role in diagnosing and assisting a hearing-impaired student with difficulties in learning mathematics (Aftab et al., 2024). Such tools include diagrams, visual supports, and manipulatives that help the child understand rather than use words. Assessments with visual supports are known to better respond to students with hearing impairments, leveraging their strengths in visual-spatial reasoning (Bashir et al., 2024).

Another pertinent issue pertains to using interpreters in sign language during the diagnostic evaluation. If sign language is the primary mode of communication, it would be essential to have a qualified and competent interpreter to help make the review linguistically accessible. For the correct interpretation, the interpreters above should receive training on mathematical terms and the needs of learners with learning disabilities (Majoro, 2021).

Finally, the education personnel, including teachers, should have professional development to enrich diagnostics practice (Kramer et al., 2021). Teachers must be trained on the possible learning challenges of deaf learners and the use of accessible and culturally responsive diagnostic tools. Professional development keeps educators up-to-date with the latest research and optimal methods for diagnosing the math learning challenges faced by deaf students (Luvanga, 2021).

Research Methodology

Research Design: The study used quantitative research to gather respondents' perceptions in the education department. The objective approach of quantitative research enables one to quantify and analyze numerical data objectively, thus identifying patterns, relationships, and statistical significance from data gathered from respondents.

Population and Sample: The study's target population consisted of teachers from the education department, representing various regional schools and teaching levels. This would ensure a representative sample for the survey, giving each teacher an equal chance of selection using a simple random sampling technique. The sample consisted of 300 teachers, which was large enough for the study to generalize its findings and for the statistical tests to hold up to a certain level of reliability. Simple random sampling reduced selection bias, increasing the study's external validity.

Research Instrument: The primary data collection tool was a self-developed questionnaire, which was the primary tool for data collection. We developed the questionnaire questions based on an in-depth literature review to ensure that the measured constructs aligned with the research objectives. We incorporated closed-ended and Likert scale questions into the questionnaire to gather teachers' perceptions and experiences.

Data collection procedure: The goal is to maximize response rates and inform as many people as possible through a combination of mechanisms, including both physical and online data collection. We adopted the method of administratively distributing physical questionnaires in selected schools and created online versions of the questionnaire using tools like Google Forms. Participants also received instructions on completing the questionnaire and a deadline for submission. This included easier participation and alternatives for those individuals who could not participate physically in completing the questionnaire. We also made follow-up reminders to ensure completion within the specified time frame.

Validity and reliability: Expert educational professionals and researchers reviewed the questionnaire's content validity, ensuring that the questions adequately posed and accurately captured the constructs under study and that the items aligned with the research objectives. We also ensured construct validity to confirm that the questionnaire accurately measured the theoretical concepts it intended to measure.

Ethical considerations: This study followed strict ethical guidelines to ensure the rights and well-being of the participants. We required all respondents to provide their consent before administering the questionnaire. We informed them about the study's purpose, ensuring their voluntary participation and freedom to withdraw without negative consequences. We anonymized the data and ensured that no individual could identify their responses. Participants did not experience any harm or undue pressure during the data-gathering process.
Data Analysis: Data collected was analyzed using SPSS. The approaches used are descriptive statistics that include means, frequencies, and standard deviations to aggregate demographic characteristics and responses among the subjects. We use statistical methods like t-tests, ANOVA, and regression analysis.

Table 1: Frequency Distribution at the Basis of Demographics of Sample

Title	Description	Frequency	Percentage (%)
Gender	Male	92	30.7%
	Female	208	69.3%
		300	**100%**
Age of Respondents	21-30 Y	65	21.7%
	31-40 Y	101	33.7%
	41-50 Y	100	33.3%
	51-60 Y	34	11.3%
		300	**100%**
Designation	SSET	160	53.3%
	JSET	140	46.7%
		300	**100%**
Qualification	Master	253	84.3%
	M.Phil.	33	11.0%
	PHD	14	4.7%
		300	**100%**
Place of Posting	School	160	53.3%
	Center	140	46.7%
		300	**100%**
Area of Posting	Rural	160	53.3%
	Urban	140	46.7%
		300	**100%**
Experience	1-5 Y	136	45.3%
	6-10 Y	123	41.0%
	11-15 Y	31	10.3%
	>15 Y	10	3.3%
		300	**100%**

There are 300 samples, indicating a higher proportion of females than males, with 69.3% females and 30.7% males. The respondents in the age group 31-40 years are the highest, at 33.7%, whereas the respondents in the age group 41-50 years are also fairly high, at 33.3%. In terms of designation, we find that SSET respondents hold a marginally higher position at 53.3%, while JSET respondents hold a slightly lower position at 46.7%. More than 80% of the respondents have a master's degree. A few have an M. Phil. (11%), and only 4.7% have a PhD. In terms of work experience, 53.3% reportedly work in schools, and 53.3% are primarily posted in rural areas. In terms of experience, 45.3% reported having 1-5 years, 41% reported having 6-10 years, and 3.3% reported having more than 15 years.

Table 2: Frequency Distribution at the Basis of Objectives of Research (Questionnaire)

Sr.	Statements of Questions	SA	A	UD	DA	SDA	M	SD
1	Diagnostic tools used for hearing-impaired students in mathematics are appropriate for their communication needs.	43	239	18	0	0	4.08	0.44
		14%	80%	6%	0%	0%		
2	Visual aids are frequently incorporated into the diagnostic assessments for hearing-impaired students.	87	212	1	0	0	4.29	0.46
		29%	71%	0%	0%	0%		
3	Teachers are well-trained to recognize mathematical learning difficulties in hearing-impaired students.	102	196	1	0	1	4.33	0.52
		34%	65%	0%	0%	0%		
4	Non-verbal problem-solving tasks are a key component of diagnosing hearing-impaired students' difficulties in mathematics.	79	213	5	3	0	4.23	0.52
		26%	71%	2%	1%	0%		
5	Standardized tests are ineffective for diagnosing mathematical learning difficulties in hearing-impaired students.	42	247	7	4	0	4.09	0.46
		14%	82%	2%	1%	0%		
6	There is sufficient collaboration between audiologists and educators during the diagnostic process.	119	176	5	0	0	4.38	0.44
		40%	59%	2%	0%	0%		
7	Teachers regularly use informal assessments to complement formal diagnostic tools for hearing-impaired students.	53	245	2	0	0	4.17	0.46
		18%	82%	1%	0%	0%		
8	The use of sign language interpreters is essential during the diagnostic assessment of hearing-impaired students.	78	215	5	2	0	4.23	0.52
		26%	72%	2%	1%	0%		
9	Computer-assisted diagnostic tools are beneficial in identifying mathematical learning difficulties in hearing-impaired students.	43	256	1	0	0	4.14	0.52
		14%	85%	0%	0%	0%		
10	Dynamic assessments that adapt to the student’s learning potential are widely used for diagnosing mathematical difficulties.	87	203	9	1	0	4.25	0.46
		29%	68%	3%	0%	0%		
11	Diagnostic practices for hearing-impaired students focus too much on	119	176	5	0	0	4.38	0.52
		40%	59%	2%	0%	0%		

	verbal reasoning rather than visual-spatial skills.							
12	Diagnostic tools are tailored to the individual communication preferences of hearing-impaired students (e.g., sign language or lip reading).	119	176	5	0	0	4.38	0.39
		40%	59%	2%	0%	0%		
13	Parents of hearing-impaired students are actively involved in the diagnostic process.	53	245	2	0	0	4.17	0.39
		18%	82%	1%	0%	0%		
14	The diagnostic practices used for hearing-impaired students are regularly updated to reflect the latest research.	78	215	5	2	0	4.23	0.50
		26%	72%	2%	1%	0%		
15	There is a need for more specialized diagnostic tools that address both hearing impairments and mathematical learning difficulties.	43	256	1	0	0	4.14	0.36
		14%	85%	0%	0%	0%		
16	Diagnostic assessments for hearing-impaired students take into account their cognitive strengths in visual and spatial reasoning.	87	203	9	1	0	4.25	0.14
		29%	68%	3%	0%	0%		

As shown in table 2, most respondents have a strong agreement or agreement on the appropriate and effective diagnostic practice used for students with learning problems in math who have hearing impairment.

Table 3: Independent Sample T-Test at the Basis of Gender

Gender	N	Mean	Std. Deviation	df	T	Sig. (2-tailed)
Male	92	67.88	2.68	298	0.62	0.536
Female	208	67.68	2.58			

Table 3 reports that there is no significant difference between male and female respondents in terms of mean scores since the p-value of .536 is greater than .05.

Table 4: Independent Sample T-Test at the Basis of Designation

Designation	N	Mean	Std. Deviation	df	T	Sig. (2-tailed)
SSET	160	68.34	2.09	298	4.42	0
JSET	140	67.05	2.96			

Table 4: Comparison of the Mean score between SSET and JSET respondents, 68.34 67.05 SSET JSET p-value: 0.000 Value < 0.05.

Table 5: Independent Sample T-Test at the Basis of Place of Posting

Place of Posting	N	Mean	Std. Deviation	df	T	Sig. (2-tailed)
School	160	68.34	2.09	298	4.42	0
Center	140	67.05	2.96			

From table 5, it is evident that there was a significant difference in the responses regarding posting across the schools and centers. Consequently, the mean score for those who posted in the school was higher than that of those who posted in the center, as indicated by the p-value of 0.000, which is less than 0.05.

Table 6: Independent Sample T-Test at the Basis of Area of Posting

Area of Posting	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Rural	160	68.34	2.09	298	4.42	0
Urban	140	67.05	2.96			

As from table 6, a quite high variation exists between those posted to the rural areas and those posted in the urban areas, whereby a mean value of 68.34 was scored by the respondents from the rural area as compared to the mean value of 67.05, which was scored by the respondents from the urban area with a p-value of 0.000, which shows a statistical difference at the 99% confidence level.

Table 7: One-way ANOVA Test at the Basis of Age

Age	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	61.23	3	20.41	3.06	0.03
Within Groups	1972.49	296	6.66		
Total	2033.72	299			

Table 7 reveals a significant variation in the means between the different age groups with a p-value of 0.03, indicating that the age has a statistically significant influence on this variable under consideration.

Table 8: One-way ANOVA Test at the Basis of Qualification

Qualification	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	17.41	2	8.71	1.28	0.28
Within Groups	2016.31	297	6.79		
Total	2033.72	299			

Table 8 presents that there is no significant difference in means based on qualification because p-value is 0.28, which indicates qualification holds no statistically significant impact on variable under consideration.

Table 9: One-way ANOVA Test at the Basis of Experience

Experience	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	88.05	3	29.35	4.47	0.00
Within Groups	1945.67	296	6.57		
Total	2033.72	299			

Table 9 present a statistically significant difference in means based on experience because the p-value is 0.00; therefore, experience is proved to hold a statistically significant impact on the variable under consideration.

Findings

An examination of the information sought will reveal diagnostics that relate to some critical insights of the diagnostic tools and the current practice utilized for testing mathematics abilities in hearing-impaired students. Respondents agree that diagnostic tools currently in place are appropriate to facilitate students' communication needs, particularly visual aids. In general, teachers believe they are well-equipped to identify mathematical learning difficulties with this student population, and they widely acknowledge non-verbal problem-solving assessments as a valuable component of any diagnostic process. However, there is a growing recognition that standardized testing alone is inadequate to address the unique needs of deaf students, necessitating the use of more sensitive, specialized diagnostic tools. Moreover, they typically employ formal assessments within an informal framework. This approach broadens the scope of their assessment. Lastly, the relationship between an audiologist and an educator during a testing session is crucial as it guarantees the fulfillment of individual students' requirements.

Respondents were also eager to highlight the contribution of sign language interpreters to the diagnostic process. Respondents view computer-assisted resources as beneficial as they foster a lively, interactive evaluation of students' math challenges. Lastly, there was a general consensus among all respondents that diagnostic practices should undergo continuous reassessment and align with recent research evidence to stay current and effective. Students have rated dynamic assessment, sensitive to their learning ability, as a most useful tool in diagnosing mathematical difficulties. Respondents, on the other hand, believe that diagnostic practices currently rely too heavily on verbal reasoning, when in fact the strengths of hearing-impaired students lie with respect to visual and spatial reasoning. Such a discrepancy emphasizes the use of diagnostic tools specifically designed to match the students' cognitive profile for valid assessment.

Another thing that is emerging is a more active engagement of parents in the diagnosis. In addition, there is a requirement for more advanced tools that can identify hearing impairments as well as mathematical learning problems. Most often, we agree that diagnostic tools are fair, but we need to perfect and develop them to ensure they are ready for use across all student populations in classrooms. We also suggest that teachers understand the need to modify assessment tools based on the unique communication abilities of students, such as sign language or lip reading, to conduct tests in a way that best suits their communication skills. Generally, the results suggest the effectiveness of the diagnostic practices at present, but they also reveal areas where more or less development and fine-tuning may be required.

Discussion

This discussion highlights the significance of using diagnostic tools and practices to evaluate mathematical learning challenges in students with hearing impairments. The findings showed that teachers highly valued the effectiveness of diagnostic tools, primarily using them to meet the pupils' communication needs through visual aids and non-verbal problem-solving tasks. Visual aids play a crucial role in the education of hearing-impaired students by simplifying the processing of complex information. Consequently, a significant proportion of non-verbal tests aligns with previous research, suggesting that hearing-impaired children excel more in visual-spatial reasoning tests than verbal ones. These results confirm the need to adjust assessment practices to align with the strengths of auditory impaired students, in line with the emerging epistemological literature on inclusive education (Kamenopoulou, 2022).

The study also highlights the issue of a deficiency in standardized tests for diagnosing students' learning difficulties in mathematics, as the respondents prefer more specialized tools. This study aligns with previous research that has criticized the inflexibility of standardized tests in meeting the unique learning needs of students with hearing impairments (Aftab et al., 2024). On the contrary, the survey emphasizes dynamic and informal assessments, enabling teachers to adopt diagnostic approaches depending on the abilities of the students. Dynamic assessments, above all, have proven effective as they learn the time needed to adapt to every learner's learning potential; this is significant in handling a wide range of learning profiles (Maya et al., 2021). The findings of this study echo the general call in the literature on special education that evaluations for students with disabilities should be adjustable and student-centered.

Another critical finding includes the role that collaboration between audiologists and educators plays in diagnosis. Previous studies concerning interdisciplinary approaches in special education have shown that teachers overwhelmingly agree that collaboration between an audiologist and an educator is necessary in this aspect. According to Hansen et al. (2020), collaboration between different specialists ensures that all aspects of a student's needs are considered during diagnostic and intervention processes. Furthermore, the provision of sign language interpreters and other communication aids during testing aligns with the current best education practice for hearing-impaired students (Majoro, 2021). It is crucial to incorporate these practices into diagnostic tools, not only to enhance accessibility but also to accurately assess the students' true abilities. Therefore, the present study adds to the existing body of research in these areas by demonstrating the common use of collaborative and communicative strategies in educational settings with such children.

Although present diagnostic tools and practices are, in general, effective, further refinement is still a compelling need. There is an urgent need for highly specialized diagnostic tools to handle hearing impairments and math learning difficulties at the same time. Previous research, which has long underscored the necessity of improved diagnostic tools for special education populations, also aligns well with this requirement. Furthermore, research consistently highlights the need for regular updates in diagnostic practices, which, in light of current studies, should adapt to the evolving requirements of students with special needs. Therefore, future research should persist in exploring these areas, specifically focusing on developing more comprehensive diagnostic tools that align with the cognitive strengths of the hearing-impaired student. We can fill these gaps to better support a child's needs, enabling them to achieve higher results in mathematics and other school subjects.

Conclusion

This study's conduct has covered the effectiveness of the current tools and practices in diagnosing mathematical learning difficulties among the hearing-impaired students. The findings underscore the significant role that visual aids, non-verbal assessment, and collaboration between the audiologist and educator can play in aligning with the communication needs and strengths of students' cognitive processes. Teachers are very well-equipped to identify learning challenges; however, they call for more vibrant, dynamic, and flexible assessments other than standardized testing. They view the consistent use of informal assessment tools in conjunction with formal tools as crucial for understanding students' mathematical skills. However, it points to a significant shortfall in the provision of such niche diagnostic equipment that seems to be seeking to address both the issues of hearing and learning failure.

Further, findings highlight the need to update diagnostic procedures to incorporate results from the most recent technological advances and educational research. Though instruments are, on average, pretty effective, educators feel that more individualized and specialized services would best meet the needs of hearing-impaired students. Improvement of diagnostic tools and collaboration of educators, audiologists, and parents will optimize the outcome for students. This research feeds into the growing literature that calls for holistic and personalized education for children with disabilities, resulting in continuous innovation in the tools used in the diagnosis of learners to suit changing needs by the hearing-impaired learner.

Recommendations

1. There should be an investment by educational institutions in special diagnostic tools developed to meet the dual challenge of deafness and mathematical learning disabilities.
2. *Diagnostic techniques:* It's important to regularly update diagnostic methods to reflect the most recent research and technological advancements.
3. For the child to receive adequate school support, teachers, audiologists, and parents should coordinate more.
4. *Future research:* Emergent technologies to enhance the precision of diagnosis for deaf students in different learning environments.

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