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DEVELOPING ENGLISH READING AMONG CHILDREN WITH HEARING IMPAIRMENT: TOOLS AND TECHNIQUES FOR RELIABILITY AND PERFORMANCE EVALUATION

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Abstract
Reading ability is the basic component to get an eduction particularly for students with hearing impairment. It plays an important part in the development of linguistic, academic and social skills of individuals from their school year onwards. This study aims to assess the written expression abilities of hearing-impaired students who receive auditory-oral instruction and look into the factors influencing student performance through a multimodal approach. The subjects taken for this study include 10 third and fourth graders from Kerala's Royal School for Hearing Impaired. The multimodal intervention included tools such as fingerspelling, sign language, table writing, air writing, and the "see and say" method. A computer programme designated "Statistical Package for the Social Sciences" (SPSS) Version 20.0 was used to methodically investigate the results of both the immediate and delayed post-tests. The independent samples t-test was used to compare the experimental and control groups for the immediate and delayed post-tests for parametric samples. Key findings indicate significant improvements in students' abilities to learn the alphabet, numerals, and sight words, with post-test scores showing marked increases from pre-test levels. The multimodal approach not only enhanced reading fluency but also improved students' engagement and retention of learning material. These results are important as they demonstrate that integrating multiple sensory modalities can effectively address the unique learning needs of hearing-impaired students, thereby supporting their academic development and inclusion in mainstream education.

Keywords: English reading proficiency, sight words reading, sign language, finger spelling, multimodal approach, hearing impairment.

Developing English Reading among Children with Hearing Impairment: Tools and Techniques for Reliability and Performance Evaluation
According to 2012 WHO estimates, 78 million of the 120 million persons with hearing impairment live in developing nations. A child's capacity to acquire speech appropriately is significantly impacted by hearing impairment, which is connected to health (Kapur, 2019). It is a truth that hearing loss has an impact on academic achievement and is crucial for language development. In the current educational system, English language ability is crucial. All academic accomplishment areas are challenging for children with hearing loss, but reading and mathematical ideas are particularly challenging. Everybody in the world, especially those who are excluded, should have access to English as a language of education and employment (Nisha & Gill, 2020).
Children with hearing loss cannot rely on sound, in the same manner, to inform them of their surroundings. They must find new ways to express themselves, communicate, and learn regardless of

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how or when they first experience hearing loss. Children with Hearing Impairments (HI) who develop them before starting school, particularly if they do so before they learn any understandable spoken language, also struggle to learn to read (Serebryakova & Shishkina, 2016). A first language based on the tactile and visual senses is taught to certain HI youngsters. This language is not only sound-independent, but it also does not adhere to the same grammatical conventions as either spoken or written English (Marschark et al., 2015). These kids effectively learn a tactile, visual, and syntactically defined first language.

Recent research indicates that children with speech and language problems are becoming more common (Ravi et al., 2021). The most frequent therapeutic intervention for Speech Sound Disorder(SSD) is speech therapy, but it is also one of the most expensive and difficult non-surgical options. A half-hour of therapy may cost $50 to $100, and a speech-language examination often costs between $200 and $300, however the exact cost of speech therapy can vary based on several factors. Furthermore, it takes several sessions to see a discernible difference in the kids. For children with SSD, intensive intervention is more effective and successful (McFaul et al., 2022). To put it another way, one could need several sessions each week. Considering the costs of intervention and frequency, which are the limiting variables, the study that has been published in the literature; therefore predicts a potential increase in the number of children with SSD in the future. To reduce the prevalence of child SSD and aid these kids in managing their illness, a suitable, effective, and affordable therapy should be made accessible.

Children with hearing loss find it challenging to convey their ideas in writing while adhering to rules and a certain sequence, much as kids with normal hearing (Mascia, 2012). This is so because writing needs the simultaneous use of a variety of talents. These include deciding what to write about, planning your ideas before you start writing, and choosing words that accurately convey your ideas while paying attention to the correspondence between letters and sounds. Creating sentences that adhere to syntax rules, correctly using punctuation, and reading and modifying the content after writing are further requirements for written expression. The development of written expression abilities is seen as a process since writing requires the application of a variety of skills before, during, and after the writing process (Dostal, et al., 2015). As a result, instructional practices are centered on the writing process. For kids to create objectives for their reading and writing and to develop good attitudes towards both, the writing process method must be used (Tomblin et al., 2018). This method is crucial for generating high-quality written work, especially for kids whose language development is delayed or problematic (Tompkins, 2014). Children with hearing loss can develop their written expression abilities just like children with normal hearing by using the writing process method, which is generally considered to include prewriting, drafting, revising and editing, and publishing (Wolbers, et al., 2016).

One of the most effective ways to meet the particular educational demands of children who are deaf or hard of hearing is to help them visualise the subject they are learning. ICTs and contemporary technologies are essential in this setting for delivering course information during in-class activities and the self-study process (Guiberson & Atkins, 2012). Recent research has shown that information processing tasks based on using digital vs non-digital platforms differ in terms of the cognitive construct level of abstraction, memorization, etc. Therefore, it is debatable if employing digital learning materials rather than traditional printouts is necessary to accomplish some learning goals. When instructing pupils who have hearing impairments, another issue is choosing the right formats for the material to be presented written, graphics, and visuals. Given the unique characteristics of information perception and processing, our research is intended to provide answers to these concerns as well as recommendations for how the material should be presented when educating hearing-impaired students (McLeod et al., 2017).

By examining how the type of information carrier “digital or physical – paper” and its presentation affect perception, memorization, and emotional evaluation of the material, and how it contributes to the

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development of various mental models, the study's main goal is to create an effective learning environment for teaching students with hearing impairments.

The central issue addressed in this study is the need to develop effective and inclusive teaching strategies for improving English reading skills among students with hearing impairment. Reading proficiency is a fundamental component of academic success and personal development, yet students with hearing impairment often face significant challenges in this area due to their unique communication and learning needs. The significance of addressing this issue lies in the potential to bridge the gap in educational opportunities and outcomes for these students.

This study aims to assess the impact of a multimodal teaching approach on the English reading proficiency of children with hearing impairment. The specific objectives are to determine the effectiveness of the intervention in improving students' ability to recognize and use the alphabet, numerals, and sight words, and to evaluate the retention of these skills over time. The research questions guiding this study are:

(1) How does the multimodal approach affect the immediate reading outcomes of hearing-impaired students?

(2) What is the long-term impact of the multimodal intervention on students' reading proficiency?

By addressing these questions, the study seeks to contribute to the development of effective, inclusive educational practices for hearing-impaired students. Thus the present study contributes to the existing body of knowledge by investigating the effectiveness of a multimodal approach, combining digital tools and traditional teaching methods, in improving English reading skills among students with hearing impairment. While previous studies have explored the use of digital tools or visual aids in teaching this population, our research stands out in its comprehensive integration of multiple modalities, including fingerspelling, sign language, table writing, air writing, and the "see and say" method. Our approach differs from previous studies in several key aspects, such as multisensory integration, customized instructional tools, comprehensive evaluation, and longitudinal assessment.

Literature Review

According to earlier studies, children with impairments as well as other learners have equal opportunities to increase their language skills using multi-level approaches. Multimodal materials will improve students' English language proficiency as well as their analytical and creative thinking abilities, according to research done by Kummin et al. in 2020.When teaching emerging and starting Hearing Impaired pupils, the development of visual word identification remains a high emphasis. The justification makes it abundantly evident that combining many strategies to teach sight words results in successful learning outcomes for hearing-impaired students.

The certain research, young children with Cochlear Implants(CI) acquires vocabulary standard scores that are within the range of average. Between 50 and 58% of children got standard scores that were within 1 Standard Deviation(SD), which means (85-115) of test norms in (Geers et al. 2009)'s study of the vocabulary of 153 children aged 5-7. They found that the mean vocabulary standard scores for expressive and receptive vocabulary, respectively, were 91 and 86. Deaf or Hard of Hearing (DHH) 4-5-year-olds had an average Standard Score (SS) of 91, which was within the range but substantially lower than the average SS of 115 attained by their hearing counterparts, according to Fitzpatrick et al.'s (2011) research.

Children, who sign, exclusively use spoken language, or both were included in research done by Harris and her colleagues. According to Harris et al.'s research (2017a), DHH kids started school later and made only approximately a third as much progress as their hearing classmates over a two-year period. The most recent generation of DHH children showed greater vocabulary scores than those in their longitudinal study, but they still lagged 2 years behind their hearing classmates, according to Harris et

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al.'s (2017b) analysis of data from a fresh sample of kids.
Understanding the morbid effects of infectious illnesses and epidemics in underdeveloped nations has not received much emphasis in earlier research. These epidemics have several dangers, including the potential for neurocognitive deficits in children who survive the outbreak (Carter et al., 2012). Therefore, to provide successful patient care and go beyond simply serving a certain group, Speech-Language Pathologist(SLP)s' must be linguistically and culturally competent. Instead of phonological therapies that target speech sound systems, traditional articulation therapy approaches focus on correcting individual speech sounds (Brumbaugh & Smit, 2013). Therefore, the later approach-based approaches are the most suitable ones for speech assessment tools.

Childhood apraxia of speech has been identified as one of the most prevalent problems in children, affecting 1 in 12 children worldwide (Walenski & Love, 2018). The body of research suggests that both monolingual and multilingual populations have similar Speech Sound Disorder (SSD) prevalence rates in children. According to Jesus et al. (2019), children with SSD exhibit reduced speech clarity and delayed speech sound acquisition. To enable speech-language pathologists (SLP) to identify speech problems in children as early as feasible and launch the proper intervention, useful speech evaluation instruments must be created. This report conducts a comprehensive literature evaluation of voice assessment tool approaches for children with speech difficulties to better understand the existing situation and provide the groundwork for future research.

Previous studies have explored the use of various digital tools and visual aids in teaching students with hearing impairment, such as multimedia presentations, interactive whiteboards, and virtual learning environments (e.g., Baranovska-Vasiljeva, I., 2024; Hilzensauer & Dotter, 2011; Ikasari et al., 2019). These studies generally reported positive outcomes in terms of increased engagement, motivation, and comprehension among students with hearing impairment. However, they often focused on a single digital tool or visual aid, without considering the potential synergistic effects of integrating multiple modalities.

From the literature review, it was observed that many studies were performed among hearing impairment students. However, the study on improving English reading and factors affecting English reading among hearing impairment students has not been extensively explored yet. Despite these previous findings, there is a lack of research that comprehensively integrates various digital tools and instructional techniques to address the unique learning needs of students with hearing impairment. Our study aims to bridge this gap by exploring the effectiveness of a multimodal approach that combines fingerspelling, sign language, table writing, air writing, and the "see and say" method in improving English reading skills. Furthermore, we conduct a rigorous evaluation of the reliability and validity of the instructional tools used, which is often overlooked in previous studies.

Methodology

The experimental group was subjected to a pilot study, pretesting, multimodal intervention, and a post-test as part of this study's experimental design. The research aims to investigate the efficacy of English reading capability to deaf students learning English as a foreign language using materials and sign language. Different multimodal teaching strategies have been used to teach English to determine the most effective for these students. After teaching the selected English reading, a quick post-test was administered. The effectiveness of visual materials and sign language on students' short- and long-term retention was evaluated using test results. An immediate post-test was given after the English reading, and a delayed post-test was given two weeks later. The study aimed to determine if multimodal

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intervention is more or less successful among children with hearing impairment at beginner-level English reading capability.

Participants

Ten students from Classes 3 and 4 at the Royal School for the Hearing Impaired in Kerala were chosen to understand better various aspects of English reading proficiency among children with hearing impairment. The diagnosis of bilateral PCHL > 40 dB hearing level (dB HL) in the better ear, which was not known to be postnatally acquired, was made for the ten students in the hearing impairment group. According to the four-frequency mean of the greater ear pure-tone sensitivities at 0.5, 1, 2, and 4 kHz, the level of impairment of hearing loss was classified as moderate (40-69 dB HL), severe (70-94 dB HL), or profound (95 dB HL). The results obtained in this research are based on the ten hearing-impaired participants for whom data on tests of English reading were available at a mean age of 10.0 years. Longitudinal analyses have been performed on the same sample of children, and reading and language tests are offered at both time points.

Instructional Tools

The instructional tools used in this multimodal intervention were specifically designed and customized to address the unique challenges faced by students with hearing impairment in learning English reading skills. These tools were tailored to their specific needs, taking into account their preferred modes of communication and learning preferences. The intervention spanned over a period of six weeks, with sessions conducted five days a week, each lasting one hour.

Alphabet

The English Alphabet numbering 26 letters from A-Z, was selected. Both capital and small letter alphabet were included in the study. Fingerspelling for each alphabet was included.

Numerals

Numerals from 1-10 were included in the Tool. Fingerspelling for each numeral was incorporated into the Tool.

Sight words

The cognitive steps required to read English text posed an extra challenge to reading fluency for school-age hearing impairment students who utilize sign language. The reading process can lead to cognitive overload in hearing impairment readers, according to Easterbrooks and Huston (2008), as the reader's working memory is required to do both decodings and create a "mental visualization" of the written word's sign counterpart. Additionally, when reading "aloud," Deaf children are urged to make conceptually precise signs to show that they understand the text. According to Dolch (1936) and Fry (1980), sight words are commonly used words that readers can swiftly and automatically recognize when reading. Thanks to the automatic detection of common words, readers can focus their cognitive resources on comprehension rather than word-by-word decoding. For students reading below grade level, speed and accuracy are related to "the size of a reader's sight word vocabulary, or the proportion of words in a specific text that can be recognized by sight. According to Hudson, Pullen, Lane, and Torgesen (2009), for students reading below grade level, speed and accuracy are related to "the size of a reader's sight word vocabulary, or the proportion of words in a specific text that can be recognized by sight. In addition to reading more fluently, Pinnell and Fountas (1998) argue that children with a larger sight word vocabulary can use those words to be more productive when they have to slow down to decode every word. Two well-known lists are used to assist teachers in teaching sight words: the basic

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sight vocabulary list created by Dolch (1936) and Fry's Instant Word List (Fry, 1980). Dolch examined the most frequently used and prepared a list of 220 "service" words (pronouns, adjectives, adverbs, prepositions, conjunctions, and verbs) and 95 nouns in the 1930s. Fry created his lists after examining the word frequency issue using more recent children's books two decades later.

Thirty words were chosen here from the Dolch Kindergarten year's category of sight words. Students with hearing impairments were tested on their ability to read English using 26 alphabets, ten numbers, and 30 sight words. As a result, 66 letters, numbers, and sight words were used in the study.

Analytical Tool for the Study

The main emphasis of this study is implementing multimodality in reading comprehension instruction. The primary goal of the multimodal intervention strategies utilized in the study for the hearing impaired students is to teach Dolch sight words to elementary school students with a computer program. The specific strategies are multimodal interventions, including fingerspelling, sign language, table writing, air writing, and the "see and say" method

In education, using various instructional modalities is referred to as multi-level learning. The term multimodality describes the employment of various semiotic techniques of communication that incorporate language in various forms (Ikasari, Drajati, & Sumardi, 2019). Employing Multimodal text means it can be expressed through visual, gestural, spatial, or aural modes. While one mode may predominate over the others, these modes are integrated to create meaning through interaction with texts. In other words, a multimodal approach signals that several semiotic resources are entangled with the specific meaning of a text. Using multimodal resources in the teaching and learning process benefited the students in many ways. They claimed that using multimodal materials encouraged their imagination and inventiveness.

They also mentioned how the products would help them improve their vocabulary learning memory. As it is well known, there are many different English words, making it quite challenging for children with hearing impairments to remember them all. Therefore, using Presentation files may assist students in remembering at least a few essential, standard, and useful words. The main emphasis of this study is implementing multimodality in reading comprehension instruction. To start, the teacher's preference for using multimodal materials was primarily due to their attractive appearance, which significantly positively impacted the teaching-learning environment in the classroom. The interaction between several modes helps to create a dynamic learning environment. A universal learning design is the most efficient way to guarantee that each student receives the assistance required and is supported by multi-level intervention. The primary goal of the multimodal intervention strategies utilized in the study for the hearing impaired students is to teach Dolch sight words to elementary school students with a computer program. The specific strategies are multimodal inte*rventions are as follows:*

Finger Spelling

Fingerspelling is the first step to introducing letters, numerals, and sight words. Fingerspelling was taught manually presented in (Figure 1), and using video, which has audio support. "Fingerspelling" is used to sign each letter of a word to engage students in learning the spelling along with the words. After introducing fingerspelling to letters and numerals, fingerspelling for sight words was introduced. Fingerspelling is a representation of alphabets or numbers using hands. While finger spelling, the instructor must keep our hand above their shoulder but below the chin. The elbow must be relaxed and close to the body. We must not move our hands horizontally.

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Sign Language
Sign language is a mode of communication used to teach any concept to students with hearing impairment. After the sign for the particular sight word is shown, the concept is explained to the students using a sentence. Sign language uses non-verbal means to present an idea or feeling. This mode of communication is usually practised among the hearing-impaired community. It uses visual-manual modality to convey meaning. The concept is explained to the students and provides examples of the various components. It is a method of learning through signs. The video is played repeatedly for better retention of memory. "Sign language" takes 10 minutes in a one-hour class.

Table Writing
It is an activity method of writing sight words on a table. The students are shown the sight words in a video and simultaneously asked to write them by looking at them. The student is asked to write the sight words without looking at the sight words. This activity can be done after teaching the concept and takes 10 minutes in a one-hour class.

Air Writing
It is the method of writing a word freely in an open space in the air. Air writing is a method to improve spatial awareness and tracking skills. The student is given the sight words at first, which they are supposed to write in the air by looking at the screen showing the spelling of the video. Then, the student is encouraged to write on their own. This technique usually takes 10 minutes in a one-hour class.

See and Say
When the student is taught to read words as a whole, looking at the text, the student learns to read words quickly. 'See and say' is also an effective teaching method as it involves a visual mode of learning. The students are given videos to track and trace the letters in the word by underlining it with their fingers. The child is supposed to repeat the words a second time, all alone, without any help. This method usually takes 15 minutes in a one-hour class.

Data Collection instruments

Pilot Study
The multimodal intervention tool was presented to the experts, including Teacher educators in Special Education and Special Teachers for Students with Hearing Impairment, before undertaking the pilot study. They provided feedback and suggestions, and changes were made before a pilot study was conducted. In this study, 66 alphabets, numbers, and sight words were selected and used in 5 different manners. The intervention and post-test were given after the pretest. The Cronbach alpha of 0.88, which indicates the instrument is dependable, was judged reliable to administer to the entire group.
The reading comprehension abilities of students and youngsters with hearing impairments have been the subject of numerous studies. They were conducted in many countries and several languages. They included English (Holt, 1994), Dutch (Wauters, Van Bon, & Tellings, 2006), Persian (Rezaei, Rashedi, & Morasae, 2016), Japanese (Takahashi Isaka, Yamamoto, & Nakamura, 2017), and others. These studies collectively demonstrate that hearing children's reading comprehension abilities are significantly worse than their hearing peers. For instance, deaf adolescents frequently delay a minimum of five years in developing the capacity to read until they graduate from school.

Post Test
A post-test was given to the students using the same instrument to determine the impact of the multimodal intervention and whether it was effective, and the responses were evaluated.

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Data Analysis

A computer programme designated "Statistical Package for the Social Sciences" (SPSS) Version 20.0 was used to methodically investigate the results of both the immediate and delayed post-tests. The independent samples t-test was used to compare the experimental and control groups for the immediate and delayed post-tests for parametric samples. Additionally, the control group's immediate and delayed post-test scores performance was examined using a Paired Samples t-test. The scores of the experimental group were all examined using this test. The Independent Samples t-test was then used to examine class disparities. In order to statistically compare the usefulness of visual materials and sign language, test results for both courses were compared.

Measures to Mitigate Hawthorne Effect

In our study, we acknowledge the potential for the Hawthorne Effect, which refers to the influence of the study itself on the participants' behavior or performance. To mitigate the potential impact of the Hawthorne Effect, we implemented several measures:

- **Controlled Environment**: The study was conducted in a familiar classroom setting, with the participants being accustomed to the physical environment and the presence of their regular teacher. This familiarity helped minimize any potential novelty effects or changes in behavior due to the study conditions.
- **Gradual Introduction of Interventions:** The multimodal interventions were introduced gradually, allowing the participants to adjust to the new teaching methods and instructional tools over time. This gradual approach aimed to reduce any initial reactivity or novelty effects that could influence their performance.
- **Participant Briefing**: Before the commencement of the study, participants were briefed about the purpose and procedures of the research. They were assured that their participation would not affect their regular academic activities or evaluations, and that their performance would be treated confidentially. This briefing aimed to alleviate any potential anxiety or pressure that could influence their behavior.
- **Consistent Monitoring**: Throughout the study, the researchers consistently monitored the participants' behavior and engagement levels. Any deviations or abnormalities in behavior were documented and accounted for during the data analysis phase.

Despite these measures, we acknowledge that the Hawthorne Effect cannot be entirely eliminated in educational research settings. However, by recognizing its potential influence and implementing appropriate mitigation strategies, we aimed to minimize its impact on the study's findings.

Results and Discussions

This experimental study investigated the extent to which teaching English reading abilities to students with hearing impairments who are learning English as a second language benefits from employing analytical tools. It also intends to assess how these resources compare to just providing instructions in sign language. In this section, the teaching resources and data collection mythology represent the effectiveness of test results and are assessed concerning the study's research goals.

Reliability Measurement for Alphabet Reading

Table 1 presents the reliability statistics for the tools and techniques developed for English reading among students with hearing impairment. It represents the results of Test-retest reliability measures of the Teaching Alphabet to measure the stability of the scores as a stable construct obtained from the same students on two occasions in a gap of two weeks. The results showed that the Cronbach Alpha (the measure of test-retest reliability) is high and satisfactory ($\alpha = 0.724$) for the Intervention module

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for teaching the alphabet. Hence the intervention for teaching the alphabet has been accepted without any further changes.

The descriptive Table 2 shows the Mean and Standard Deviation of the teaching Alphabet showed significant improvement from Pre and Post Pilot Study pre (M=4.30, S.D= 0.82) to post (M= 22.03, S.D= 0.63) intervention. The paired sample t-test showed that as a result of the intervention, there was a significant improvement from pre to post by 18.50 points (95% CI, t(9)=-54.16, p= 0.00). These results suggest that the intervention significantly improves learning of the alphabet using the multimodal approach, corroborating the positive outcomes reported in previous studies (Baranovska-Vasiljeva, I., 2024; Ikasari et al., 2019).

In comparing the statistical results of our study and the study by Wicha et al. (2012), several key differences and similarities emerge. Our study, which implemented a multimodal approach including fingerspelling, sign language, and other interactive methods, reported substantial improvements in students' performance. The mean post-test scores significantly increased across all measures—alphabet (22.8), numerals (10.0), and sight words (35.0)—with highly significant t-values (-54.16 for alphabet, -11.72 for numerals, and -59.98 for sight words), all accompanied by p-values less than 0.001, indicating very strong statistical significance. In contrast, the Wicha et al. study utilized the TCAD method and observed a mean increase from 11.9 to 14.8, with a t-value of 2.306 and a p-value less than 0.025. While both studies demonstrate the efficacy of their respective interventions, our study shows a higher degree of statistical significance and greater improvement in mean scores, suggesting that the multimodal approach might be more effective in enhancing English reading skills among hearing-impaired students.

Reliability Measurement for Numerals Reading

Table 1 presents the results of Test-retest reliability measures of Teaching Numbers to measure the stability of the scores as a stable construct obtained from the same students on two occasions in a gap of two weeks. The results showed that the Cronbach Alpha (the measure of test-retest reliability) is high and satisfactory ($\alpha = 0.744$) for the Intervention module for teaching Numbers. Hence the Intervention for teaching Numbers has been accepted without any further changes.

The descriptive Table 2 shows the Mean and Standard Deviation of the teaching Number showed significant improvement from Pre and Post Pilot Study pre (M=5.7, S. D=1.15) to post (M= 10.00, S.D=0.00) intervention. The paired sample t-test showed that as a result of the intervention, there was a significant improvement from pre to post by 11.72 points (95% CI [5.12, 3.47], t (9)= -11.72, p= 0.00). These results suggest that the intervention significantly improves learning Numbers using the multimodal approach.

Reliability Measurement for Sight Words Reading

Table 1 presents the results of Test-retest reliability measures of Teaching Sight Words to measure the stability of the scores as a stable construct obtained from the same students on two occasions in a gap of two weeks. The results showed that the Cronbach Alpha (the measure of test-retest reliability) is high and satisfactory ($\alpha = 0.608$) for the Intervention module for teaching Sight words. Hence the intervention for teaching Sight Words has been accepted without any further changes.

Table 2 shows the Mean and Standard Deviation of the teaching Sight Words showed significant improvement from Pre and Post Pilot Study pre (M=2.7, S. D= 1.41) to post (M= 35.00, S. D= 1.69) intervention. The paired sample t-test showed that as a result of the intervention, there was a significant improvement from pre to post by 32.30 points (95% CI [33.51, 31.08], t (9)= -59.98, p= 0.00). These

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results suggest that the intervention significantly improves learning Sight Words using the the multimodal approach.

Discussion

Our findings corroborate previous observations, as we also found that the integration of digital tools and multimodal instructional approaches significantly improved the learning of alphabets, numerals, and sight words among our participants. However, our study goes a step further by evaluating the effectiveness of a comprehensive multimodal approach that combines various instructional tools and techniques.

Unlike previous studies that focused on a single digital tool or visual aid, our research explored the synergistic effects of fingerspelling, sign language, table writing, air writing, and the "see and say" method. This multifaceted approach allowed us to cater to diverse learning styles and reinforce the taught material through multiple sensory channels.

Furthermore, our study conducted a rigorous reliability analysis of the instructional tools used, ensuring the validity and consistency of our findings. This aspect of our research contributes to the development of evidence-based practices in the field, as it provides educators and researchers with reliable and effective instructional tools for teaching English reading skills to students with hearing impairment.

In terms of potential implications, our findings suggest that a multimodal approach that integrates digital tools and traditional teaching methods can be an effective strategy for improving English reading proficiency among students with hearing impairment. By leveraging the strengths of various instructional tools and techniques, educators can create inclusive and engaging learning environments that cater to the unique needs of this population.

Our study also highlights the importance of conducting longitudinal assessments to evaluate the long-term retention and sustainability of the acquired reading skills. This aspect of our research contributes to the understanding of effective instructional practices that not only facilitate initial learning but also promote long-term retention and skill development.

Despite the promising results, we acknowledge the potential limitations of the Hawthorne effect in our study. Although we implemented measures to mitigate its impact, such as conducting the study in a familiar classroom setting, gradually introducing interventions, briefing participants, and consistently monitoring their behavior, the effect cannot be entirely eliminated. We accounted for this limitation when interpreting the results and drawing conclusions.

Overall, our study builds upon previous findings while introducing novel elements in terms of the comprehensive integration of multimodal instructional tools and the rigorous evaluation of their effectiveness and reliability. By addressing the central issue of improving English reading skills for students with hearing impairment through an inclusive and multifaceted approach, our research contributes to the advancement of inclusive education practices and the development of evidence-based teaching strategies tailored to the unique needs of this population.

This study aim to assess the written expression abilities of hearing-impaired students who receive auditory-oral instruction and the factors that influences the student performance. It was found that the intervention significantly improves learning of the alphabet number and Sight Words using the intervention. It was acknowledged that a multimodal approach to teaching English reading increases the learning engagement of students with hearing impairment by developing their skills through the integration of instructional tools. This study supports the idea that multimodal lessons in the classroom have numerous positive effects on students. They become motivated and involved. Additionally, given

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different analytical tools, they could better understand the content. They still require the teacher's instruction when performing most tasks. In conclusion, implementing multimodality into the teaching and learning process for children with hearing impairments benefits their development of reading abilities.

Conclusion

This study investigated the effectiveness of a multimodal approach in improving English reading skills among children with hearing impairment. The findings demonstrated that integrating various instructional tools—such as fingerspelling, sign language, table writing, air writing, and the "see and say" method—significantly enhanced students' abilities to recognize and use the alphabet, numerals, and sight words. Key findings of this study are highlighted as follows.

- Alphabet Recognition: The mean score improved from 4.3 (SD = 0.82) in the pre-test to 22.8 (SD = 0.63) in the post-test, indicating a significant enhancement.
- Numerals Recognition: The mean score increased from 5.7 (SD = 1.16) in the pre-test to a perfect 10.0 (SD = 0.00) in the post-test.
- Sight Words Recognition: The mean score rose dramatically from 2.7 (SD = 1.41) in the pre-test to 35.0 (SD = 1.69) in the post-test.

These numerical findings highlight the substantial improvement in reading proficiency facilitated by the multimodal approach, with statistically significant gains across all measured areas. The significance of these results lies in the potential for multimodal teaching strategies to address the unique learning needs of hearing-impaired students, thus promoting their academic success and inclusion in mainstream education. By providing evidence-based insights into effective instructional practices, this study contributes to the advancement of inclusive education.

Future research should explore the application of multimodal approaches in diverse educational settings and with larger sample sizes to validate these findings further. Additionally, long-term studies are needed to assess the sustained impact of such interventions on academic achievement and social development.

Overall, the adoption of comprehensive multimodal teaching methods has the potential to transform educational practices for hearing-impaired students, fostering a more inclusive and supportive learning environment. These strategies can serve as a model for educators seeking to improve the educational outcomes of students with hearing impairments, ultimately leading to more equitable and effective teaching practices.

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Table 1 *Reliability Measure Using Test Retest Reliability for different Instructional Tool*

S.No.	**Instructional Tool**	**Reliability Statistics**		
		No. of Items	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items
1.	Alphabets	26	0.692	0.724
2.	Numerals	10	0.666	0.744
3.	Sight Words	30	0.582	0.608

Note: Results of Test-retest reliability measures of the Teaching Alphabet to measure the stability of the scores as a stable construct obtained from the same students on two occasions in a gap of two weeks.

Table 2 *Paired Sample Test on Pre and Post Test Teaching Instructional Tool*

Instructional Tool	**Data Collection instruments**	**N**	**Mean**	**Std. Deviation**	**T**	**Df**	**Sig. (2-tailed)**
Alphabet	Pre Test	10	4.3000	.82327	-54.16	9	0.000
	Post Test	10	22.8000	.63246			
Numerals	Pre Test	10	5.7000	1.15950	-11.72	9	0.000
	Post Test	10	10.0000	.00000			
Sight Words	Pre Test	10	2.70	1.41	-59.98	9	0.000
	Post Test	10	35.00	1.69			

Note: Table 2 shows the Mean and Standard Deviation of the teaching Alphabet and its significant improvement from Pre and Post Pilot Study

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Figure 1

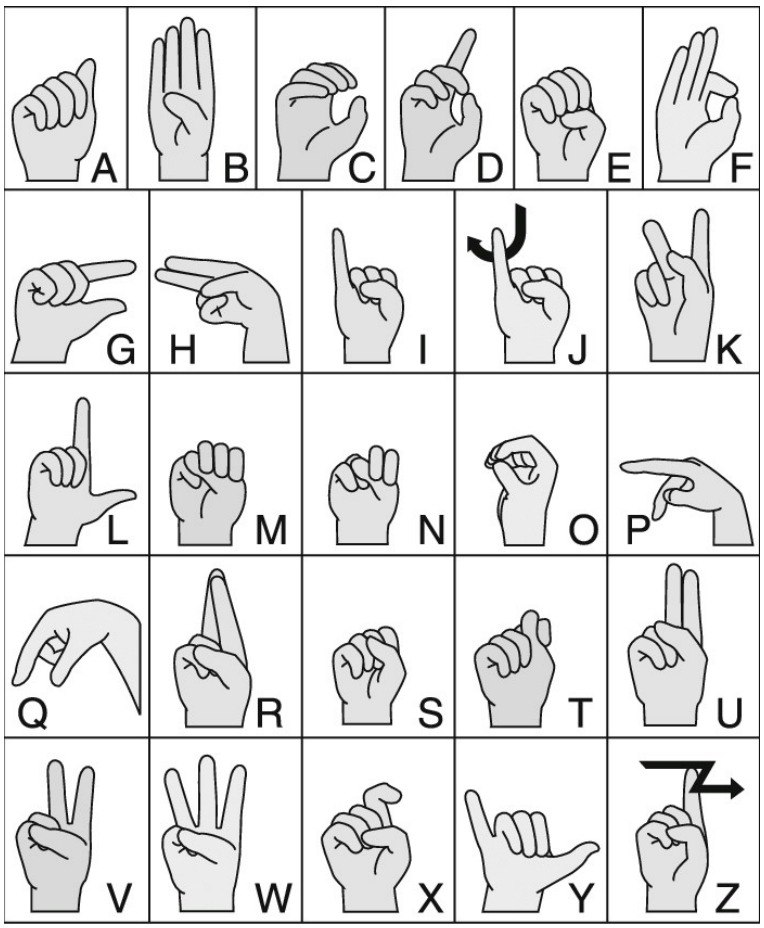

Figure.1 Fingerspelling Alphabet (Source: Pedersoli et al., 2004)