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Mobile-based speech-to-text and response application

Sangalang, Terrence Keizer M. ✉
Divine Word College of San Jose, Philippines (keizersangalang@gmail.com)
Binalla, Ma. Mhycaella R.
Francisco, Paula Francheska Y.
Garcia, Jerold Nicole M.
Salongsongan, Shiloh P.
Lopez, Adrienne Keisha Margaret D.
Viaña, Julia Xandra R.
Bautista, Josephine N.
Galay-Limos, Jenny A.
Rodil, Maria Victoria B.

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Abstract

Despite the increasing availability of assistive communication technologies, hearing-impaired individuals continue to experience communication barriers in daily interactions due to limited access to affordable, accessible, and efficient tools. This study aimed to develop and evaluate a mobile-based speech-to-text and response communication system designed to improve communication effectiveness between hearing-impaired and hearing individuals. The study utilized a developmental-evaluative research design with a one-group pre-test and post-test approach. The application was developed using Flutter and Dart, following the Agile Software Development methodology, and deployed as an offline Android application. Twenty hearing-impaired individuals from San Jose, Occidental Mindoro, participated in the evaluation. The system was assessed on text accuracy, system response time, ease of use, response selection efficiency, and question selection usefulness. Findings revealed significant improvement in communication effectiveness after using the application, particularly in message comprehension, response appropriateness, and communication speed. Statistical analysis confirmed a significant difference between pre-test and post-test results. The study concludes that integrating real-time speech recognition with preset response and question-selection features on a mobile platform provides an accessible, efficient, and inclusive communication tool that reduces barriers to communication and enhances social interaction. The system also supports offline functionality for broader accessibility in rural communities. Thus, this study recommends that developers and future researchers could develop a portable version of the system, such as a standalone device or a wearable, allowing

users to use the speech-to-text system anytime, anywhere, without relying solely on a smartphone.

Keywords: speech-to-text, hearing-impaired individuals, communication effectiveness, mobile application, assistive communication technology

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1. Introduction

In one's life, communication plays a vital role in many aspects. It expresses emotion and feeling through verbal and nonverbal language. In this fast-paced world, the mobile phone has become one of the tools used in many aspects of life. Integrating speech-to-text recognition through an application helps in different ways, making it more accessible and less costly. Poor communication can lead to conflict, as people need to convey their words clearly so they are easily understood. This problem was common among deaf people, as they cannot speak and need interpretation for every word. Some factors can be seen as reasons people have this problem: barriers between two communicators can prevent them from understanding each other.

Hearing loss is common globally and locally, affecting many people; it is estimated that nearly 2.5 billion people worldwide have hearing loss (World Health Organization, 2025). There are many different reasons for this complex condition, ranging from gender, heredity, and natural aging. According to Lin (2024), hearing loss usually begins in adulthood, and by age 60, about 2 out of 3 adults already have some hearing loss. In addition, heredity is one of the factors, accounting for about 50% of childhood cases and 66% of prelingual cases identified in genetic studies (Young & Ng, 2023). While age has been shown as one factor affecting hearing loss, it was also revealed in some studies that gender can be one too. In CALABARZON, hearing problems were dominated by women more than men, with a higher case rate among those aged 4-18 years old than older adults, as the studies have shown (Pardo et al., 2022).

The problem was evident between children with hearing problems and the people around them. It is a widespread sensory issue that affects millions of people globally and impairs communication, social relationships, and overall quality of life. Parents are usually the ones who face challenges as they raise their deaf children; they lack knowledge of their own language and have limited support in it. Communicating with others is a problem for both communicators; it becomes a bigger issue that affects their mental health and emotions. Therefore, it shows issues in different aspects of one's life, affecting both communication and overall well-being. Some studies have found that parents face many challenges in raising children with hearing impairments. Emotion was the biggest challenge the parents faced in diagnosing their children with hearing impairment (Nandini, 2025). Having this problem due to a lack of knowledge about their problem and a lack of communication makes them feel less and ignored. A study by Davids et al. (2021) indicates that hearing parents of hearing-impaired children face communication challenges, a lack of understanding, and limited support, underscoring the need for collaboration between parents and health and family practitioners in South Africa. While society faces challenges, the headteachers of special education for people with hearing impairment report distinct challenges, including a lack of speech therapists, inadequate audiometers, and a shortage of special educators (Nazir et al., 2025).

Breaking barriers will not only address the challenges they face at work, in school, and in everyday life but also help them feel included. The Filipino Sign Language Act (RA) No. 11106 (2018), as stated by the National Council on Disability Affairs, requires the use of Filipino Sign Language in schools, broadcast media, and workplaces, and declares it the official sign language of the government in all transactions involving deaf people. However, not everyone can use sign language to communicate with others. However, developing this system can create differences in the lives of both users, improving accessibility and inclusivity. As this problem continues to escalate, many experts are providing hearing aids and speech-recognition applications. However, some researchers do not integrate speech-to-text, response, and question-selection features and options when adding words they use every day. As noted in the study by Shezi and Ade-Ibijola (2020), a mobile-based tool called Deaf Chat was developed to communicate with hearing-impaired individuals and improve their lives. It showed good results, as users found it effective; however, it only integrates chat message features for daily

communication. Similarly, Elsahar et al. (2019) found that high-tech AAC systems use a range of sensing methods and machine learning to assist individuals with hearing loss; however, issues with cost, portability, and conversational effectiveness persist. This showed that even though their system helped hearing-impaired individuals, it still had problems, such as conversational effectiveness, which makes this study efficient because it supports local languages to help both English and Filipino speakers. A study by Mathur (2019) found that Google Live Transcribe uses both on-device and cloud-based recognition to translate speech into text in real time, providing deaf and hard-of-hearing users with visual feedback. While it uses some features, this study also integrates local-language, response, and question features, as well as a new phrases feature, making it unique and essential.

Existing solutions like Deaf Chat, ACC systems, and Google Live Transcribe offer helpful features; however, they lack a response-and-question feature. To address this issue, this study develops an application with features that set it apart from others. Where this cover converts spoken words into text and provides response options categorized into 10 common situations they might encounter, the same applies to question options. One of its distinguishing qualities is that it works offline and integrates other system features into a single application. Specifically, the primary goal of this study is to provide a two-way communication system that converts words into text and response options for hearing-impaired individuals in San Jose, Occidental Mindoro. Nonetheless, the goal is to alleviate issues by providing a system that enables hearing-impaired individuals to communicate more effectively and eliminate barriers to communication with hearing individuals. This device can provide a better, more efficient quality of life in our society, where inclusivity is evident in all conditions.

Statement of the Problem **-** This study aimed to develop and evaluate a mobile-based speech-to-text communication system to improve the effectiveness and efficiency of communication of hearing-impaired people. Specifically, the study sought to answer the following questions: (1) What is the level of effectiveness of the mobile-based speech-to-text communication system in converting real-time conversation into text in terms of text accuracy and system response time? (2) What is the level of performance of the system in terms of ease of use, response selection efficiency, and question selection usefulness? (3) What is the status of the communication effectiveness of users before and after using the system in terms of message comprehension, response appropriateness, and communication speed? (4) Is the communication effectiveness of users affected by text accuracy, system response time, ease of use, response selection efficiency, and question selection usefulness? (5) Is there a significant difference in communication effectiveness among users before and after using the mobile-based speech-to-text communication system?

Statement of Hypothesis **-** This study aimed to evaluate the effectiveness and performance of mobile-based speech-to-text communication systems for hearing-impaired individuals. To guide the investigation, the following null hypothesis is formulated: H01: Users' communication effectiveness is not affected by text accuracy, system response time, ease of use, response selection efficiency, and question selection usefulness. H02: There is no significant difference in communication effectiveness among users before and after using the mobile-based speech-to-text communication system.

Significance of the Study **-** This study focused on the development of mobile-based speech-to-text communication systems for the hearing-impaired. It will signify the following: First, for hearing-impaired individuals, the research substantially helped deaf individuals by facilitating real-time transcription of spoken language into text, thereby enhancing their communication efficacy. It promotes independence, confidence, and inclusivity in their daily interactions. Second, for families and friends, this study helped strengthen relationships with hearing-impaired individuals by enabling clearer communication. It reduces misunderstandings and fosters understanding, patience, and inclusivity at home and in social settings. Third, for communities, the study promotes inclusivity by enabling hearing-impaired individuals to participate in social gatherings, public events, and services without feeling excluded. It helps build stronger community connections by bridging communication gaps. Fourth, for society, this research highlights the importance of accessibility and equal participation for hearing-impaired

individuals. Advancing assistive technology promotes equality, inclusion, and broader opportunities for everyone. Fifth, for educational institutions, this study will benefit schools and universities by providing hearing-impaired students with better access to classroom discussions and lectures. It supports a more inclusive, collaborative, and empathetic learning environment for both teachers and students. In the sixth one, which is for workplaces, the application can assist hearing-impaired employees in communicating with colleagues and supervisors. It supports equal opportunities, improves productivity, and promotes inclusivity in professional environments. Seventh, for healthcare providers, this study will help them communicate more clearly with hearing-impaired individuals during consultations and basic interactions. It improves service quality and ensures better understanding between patients and providers. Lastly, for future researchers, this study will serve as a foundation for developing more advanced assistive technologies. It encourages further improvements in software, system design, and functionality to enhance accessibility and usability.

Scope and Delimitation of the Study - The research study focused primarily on developing a mobile-based speech-to-text communication system to address the challenge of effective, efficient communication between hearing-impaired and hearing people. This study developed a mobile-based speech-to-text communication system that converted spoken words into text and provided response and question options for hearing-impaired individuals. The study involved respondents from different locations in San Jose, Occidental Mindoro, selected with the help of the Municipal Social Welfare and Development (MSWD), who used this mobile-based speech-to-text communication system to test and evaluate its effectiveness and efficiency. The study was conducted in San Jose, Occidental Mindoro, during the academic year 2025 - 2026. All phases, including participant selection, system testing, and data collection, were completed within this period. The study was completed in March 2026, while the product was developed over two weeks. The application was developed iteratively using the Agile Software Development methodology and implemented with Flutter and Dart. This mobile-based system was deployed as an Android application to test its effectiveness, thereby limiting its accessibility to iOS users.

The scope of this study covered the design, development, and functionality of the application, including speech-to-text conversion, which converted spoken words into text and displayed them on screen, and chat-based messaging, which was not limited to specific words and allowed typing anything. This application covered response options and question selection, which made the conversation quick and accessible. The system also utilized local storage to save and manage message categories within the device. It provided responses and question selection in both English and Filipino, categorized into 10 common situations users might encounter in daily life. This system worked offline and was operable via chat messages, with only a response and question feature. However, this application was limited only to Android users and did not support iOS. For clarity in recognizing words, it recognized both English and Filipino words, but it did not convert highfalutin or unfamiliar words. In terms of speed, the application recognized English words easily, even when spoken quickly. However, when spoken faster in Filipino, it might not recognize some words correctly, leading to errors.

2. Methodology

Research Design - This study utilized a developmental-evaluative research design with a one-group pre-test and post-test approach. The developmental-evaluative research design, often known as developmental evaluation (DE), is an assessment method that can help social innovators create social change projects in challenging or unclear situations (Developmental Evaluation, 2021). The developmental aspect focused on designing and implementing a mobile-based speech-to-text and response-selection communication system to help hearing-impaired people communicate. The evaluation included administering a pre-test questionnaire to assess respondents' communication skills before using the application, followed by a post-test to determine the application's effectiveness in communication. This approach enabled the researchers to compare communication before and after the application's use. Furthermore, the study evaluated the application across text accuracy, system response time, ease of use, response selection efficiency, usefulness of question selection, message comprehension, response appropriateness, and communication speed. The data gathered from respondents were

analyzed using descriptive and inferential statistical tools, including the weighted mean, multiple regression, and a t-test, to determine performance levels and assess significant differences in communication effectiveness before and after using the application.

Respondents of the Study - The respondents of this study consist of twenty (20) selected hearing-impaired individuals from San Jose, Occidental Mindoro. They were identified through purposive and convenience sampling. Purposive sampling allows researchers to gain a comprehensive understanding of complex phenomena by deliberately selecting specific units (e.g., individuals, cases, or occurrences) based on their relevance to the research question (Tajik et al., 2025). According to Golzar et al. (2022), convenience sampling is a method of choosing participants from the target population based on accessibility. These respondents represented the target users of the developed speech-recognition and response application, thereby ensuring that the evaluation reflected the anticipated experiences and needs of individuals with hearing impairment. The selected respondents were involved in the performance testing and usability evaluation of the developed speech-recognition and response application. Their participation aimed to assess the application's accuracy, response efficiency, and overall effectiveness in facilitating communication in real-world contexts. The engagement of these participants guaranteed that the data gathered was not only contextually pertinent but also empirically sound, thereby aligning with the study's aim of enhancing communication accessibility and fostering inclusivity for individuals with hearing impairments.

Data Gathering Procedure - This study used a quantitative approach to evaluate the effectiveness of mobile-based speech-to-text communication systems in improving daily communication. This study primarily focused on understanding the experiences of both hearing-impaired and hearing individuals as they interact with one another. Data were collected through pre-test and post-test questionnaires administered to twenty (20) respondents, selected through purposive sampling. Ten (10) respondents were selected with the assistance of Municipal Social Worker and Development (MSWD). The remaining 10 respondents to complete the survey were recruited through convenience sampling based on their ability, willingness, and availability. Clear instructions regarding the study's purpose and the consent form were provided to ensure that respondents understood their participation requirements and felt comfortable during the evaluation.

Before testing the application, the respondents completed a pre-test questionnaire to assess their current experiences and challenges in communication without the system. This served as the foundational data for comparison with participants' experiences after using the application. The mobile-based communication system, along with an evaluation questionnaire, was provided to the respondents. The evaluation period spanned five days (5), affording respondents ample opportunity to engage with the device and complete the questionnaire. During this period, the researchers observed and recorded respondents' interactions, focusing on usability, response time, and overall device performance. After using the application, respondents completed another evaluation questionnaire designed to assess the device's functionality, efficiency, and user experience. Respondents were given adequate time to provide their answers in a stress-free environment. To ensure data integrity and accuracy, the researchers collected completed questionnaires directly from respondents. Finally, the researchers organized and analyzed the collected data to evaluate the application's effectiveness, accuracy, and potential to enhance communication for hearing-impaired users. The results revealed the application's strengths and areas for improvement, guiding future development.

Research Process

Stage 1 Preparation and Gathering of Materials

This study used free and open-source software, including Flutter, Dart, Android, and Bloc Cubit, to develop a mobile-based speech-to-text and response communication system. To evaluate the accuracy and reliability of the data gathered from respondents, twenty (20) respondents were selected through purposive and convenience sampling in San Jose, Occidental Mindoro. The researchers observed and tested the application's effectiveness in converting speech into text. The researcher properly explained the application's features to ensure a clear

understanding and accurate data. For software development: Flutter, Dart, Android Studio, and Bloc Cubit

The researcher proposed an application to enable both hearing and hearing-impaired individuals to communicate effectively. By developing this application, hearing-impaired people can communicate effectively with others, even without learning sign language. The same goes for hearing individuals, which makes the communication easier for both users in San Jose, Occidental Mindoro. This software enabled users to communicate in an accessible and efficient manner. It enabled users to save time with features such as chat, speech-to-text, category buttons, local storage, and state management. This showed how necessary this study was to both hearing-impaired individuals and hearing individuals.

Stage 2: Building and Development of the Project

The mobile-based speech-to-text and response application was developed over two weeks with the assistance of a software developer. The team designed the interface, integrated the speech-to-text engine, implemented local storage, and used Bloc Cubit state management to ensure smooth, functional operation.

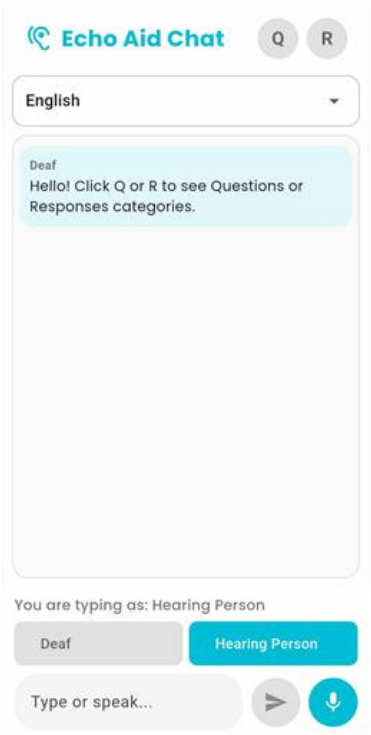

Figure 1. Actual Design of the Application

- Development of designs and layouts of the application
- Coded for the application

Stage 3: Experimental Stage, Observation and Data Recording

To evaluate the effectiveness of this application, the researchers showed it to respondents and explained, one by one, how it works. After a proper explanation, the researchers asked respondents random questions and engaged in conversations to test the effectiveness of communication in daily life. The respondents used various features of this application, such as chat-based messages, speech-to-text conversations, preset responses, question selection, and the option to add new phrases. Using the application and its features demonstrated the efficiency and necessity of this study.

In this stage, the researchers conducted the evaluation involving the selected hearing-impaired respondents. Before using the application, respondents first answered a pre-test questionnaire designed to assess their current communication experiences with their usual methods, such as gestures, writing, or lip reading. After completing the pre-test, respondents use the mobile-based speech-to-text and response-selection application in structured communication scenarios. During this activity, the researchers closely observed how respondents interacted with the application and recorded their performance in terms of communication speed, message accuracy, and response efficiency. Once testing was complete, respondents completed a post-test questionnaire that measured their experiences and perceptions after using the application. All data from both the pre-test and post-test were carefully recorded, summarized, and statistically analyzed using appropriate tools, including percentages, weighted means, multiple regression, and paired t-tests, to determine the device's overall effectiveness and performance.

Statistical Treatment of the Data **-** The researcher analyzed data collected from respondents via the questionnaire using descriptive and inferential statistical methods. They were statistically treated using the following formulas and methods to determine the effectiveness and performance of the application used by the respondents. The researcher conducted the test using the Excel Analysis ToolPak. The weighted mean was used to calculate the overall agreement for each indicator, including text accuracy, system response time, ease of use, response selection efficiency, usefulness of question selection, message comprehension, response appropriateness, and communication speed. The results showed how respondents perceived the application's efficiency and effectiveness in their experience with the device.

The researcher used a paired-samples t-test to determine whether there was a significant difference between the pre- and post-use scores. The same group of hearing-impaired individuals is evaluated under two conditions (before and after) using the application. This test is appropriate for comparing respondents' communication experiences under two conditions. If the computed t-test value exceeded the critical t-test value at the 0.05 level of significance, this indicated a statistically significant improvement in the respondents' communication experience. The study used multiple regression analysis to determine whether text accuracy, system response time, ease of use, response selection efficiency, and question selection usefulness affect users' communication efficacy. Because it enables researchers to investigate how multiple independent variables, both individually and collectively, affect a single dependent variable, this statistical method is suitable. The study could determine which of these aspects has a substantial impact on communication efficacy and how much each influences the overall performance of the speech-to-text and response application by using multiple regression. This would assist the researchers in identifying the apparatus features most important for enhancing user communication.

Ethical Considerations **-** The researchers strictly adhered to ethical guidelines to ensure the rights, safety, and well-being of all respondents. Before the study is conducted, assistance is requested from the Municipal Social Worker and Development (MSWD) to obtain permission from respondents. At the same time, the remaining respondents were selected through convenience sampling based on their willingness and ability to participate in this study. The purpose and nature of the study were clearly explained to the respondents, and their participation was entirely voluntary. Each respondent was provided with informed consent before participating in the testing and evaluation of the application, with the assurance that they could withdraw at any time without consequences. Confidentiality and privacy of all respondents were strictly maintained throughout the study. No identifying information was disclosed in any part of the research, and all data collected were used solely for academic purposes. The researchers ensured that the application would not cause any physical or psychological harm and would be used responsibly for research purposes only. Furthermore, all written outputs and references followed APA 7th edition guidelines.

3. Results and Discussions

The pre-test results related to the text accuracy of the mobile-based speech-to-text and response application in daily communication situations. This reflects the respondents' initial assessment of their ability to

communicate accurately and clearly before using the application. The results are based on their experiences and methods of communicating with others using common approaches such as sign language, lip reading, and devices like hearing aids. Overall, the result shows a weighted mean of 2.80, interpreted as Moderate-High. This suggests that before using the mobile-based system, respondents perceive their existing communication methods as moderately effective, while some still identify areas for improvement, particularly among those with moderate hearing impairments. These findings are supported by Tobin et al. (2024), who state that communication constraints, such as limited feedback, message length, and limited contextual understanding, affect message clarity and accuracy. These constraints can lead to misunderstandings and reduced effectiveness in conveying intended messages during daily interactions. The moderate-to-high pre-test results reflect the respondents' baseline communication challenges before using an assistive speech-to-text system.

Table 1

Mean Level of Performance of the Mobile-Based Speech-to-Text Communication System and the Communication Effectiveness of Users Before and After Use

INDICATORS	OVERALL WEIGHTED MEAN		INTERPRETATION	
	Pre-test	Post-test	Pre-test	Post-test
Message Accuracy/Text Accuracy	2.80	3.22	Moderate-High	Moderate-High
Response Speed/System Response Time	3.00	3.42	Moderate-High	High
Communication Comfort/Ease of Use	2.88	3.30	Moderate-High	High
Response Clarity/Response Selection Efficiency	3.08	3.38	Moderate-High	High
Question Effectiveness/Question Selection Usefulness	3.15	3.43	Moderate-High	High
Message Comprehension	2.86	3.48	Moderate-High	High
Response Appropriateness	3.25	3.37	High	High
Communication Speed	2.90	3.37	Moderate-High	High
Communication Effectiveness	2.58	3.37	Moderate-High	High

Legend: 3.25-4.00 High; 2.50 - 3.24 Moderate-High; 1.75-2.49 Moderate-Low; 1.00-1.74 Low

The first variable in the research statement of the problem presents data on the accuracy of the mobile-based speech-to-text and response system in converting speech to text. This reflects the respondents' assessment of the application's ability to accurately, completely, and understandably convert spoken words. The overall weighted mean of 3.22, interpreted as Moderate-High Level, reflects the system's ability to communicate effectively. This suggests that the speech recognition system efficiently converts spoken language into reliable, understandable text, ensuring that intended messages are conveyed to the user. This results in moderate-high due to factors that affect the system's ability to convert text accurately and its speed, based on clarity, speed, and diction, especially when speaking the Filipino language. These findings are supported by Foster (2025), who states that speech recognition systems achieve high text accuracy under optimal conditions, such as clear audio input and a well-designed system architecture. Text accuracy is critical to reliable transcription of spoken language, and the application demonstrates this by generating clear, understandable text when the audio input is clear. Even though minor inconsistencies may occur in certain situations, the system maintains a high level of accuracy. Compared to the pre-test, which had an overall weighted mean of 2.80 for message accuracy before using the mobile-based system, the post-test result of 3.22 indicates a significant improvement, demonstrating the application's effectiveness in enhancing accurate and clear communication.

The pre-test results for response speed show an overall weighted mean of 3.00, interpreted as Moderately High, indicating that the mobile-based speech-to-text system maintains an acceptable response speed, while further reducing latency could enhance communication flow. These findings align with those of Di Leo et al.

(2025), who emphasize that ultra-low latency is essential to maintaining the natural rhythm of conversation. Similarly, Dorado and Villanueva (2023) note that even slight delays disrupt synchronization and increase cognitive effort for Deaf and Hard-of-Hearing users. Hardy et al. (2022) highlight that native mobile applications can reduce round-trip latency, though real-time performance may still be affected by processing constraints. Overall, while the system demonstrates satisfactory response speed, consistently lower latency would further improve communication effectiveness. The second variable in the problem statement presents data on the effectiveness of the mobile-based speech-to-text system, specifically its response time. Overall, the variable obtains a weighted mean of 3.42, which falls under the High category. This means the mobile-based system maintains a fast response time and supports near-real-time communication. Compared with the pre-test, which had an overall weighted mean of 3.00 for response speed, the post-test results show a noticeable improvement, indicating that the mobile-based system enhances responsiveness in speech-to-text conversion and better supports continuous communication. This finding is supported by Di Leo et al. (2025), who state that ultra-low latency is necessary to simulate the natural rhythm of speech and avoid communication disruption. Similarly, Dorado and Villanueva (2023) emphasize that low-latency systems reduce cognitive fatigue among Deaf and Hard-of-Hearing individuals by preventing sync-lag between spoken words and displayed text. Furthermore, Hardy et al. (2022) explain that native mobile applications can reduce round-trip latency, enabling faster processing than web-based platforms. The results align with existing literature, showing that maintaining minimal delay is essential for effective and inclusive real-time communication.

The data gathered on the respondents' level of comfort with daily communication. The computed overall weighted mean of 2.88, interpreted as Moderate-High, indicates that respondents generally experience a comfortable level of communication in daily interactions. Although the level is not yet categorized as High (3.25–4.00), the findings indicate that mobile-based response applications positively influence ease of communication and confidence. Overall, the findings confirm that communication comfort is strengthened by accessible, user-centered, and responsive mobile applications, while continuous system improvement may further elevate comfort from Moderate-High to High. The data on respondents' ease of use of the system, focusing on usability metrics for assistive communication tools for Deaf or Hard-of-Hearing individuals. The overall weighted mean of 3.30 (High Level) confirms that the system meets core usability requirements. This aligns with research emphasizing self-sufficient usability, where intuitive design reduces reliance on external support (DeForte et al., 2020; Chemnad et al., 2024). Compared to the pre-test mean of 2.88 for communication comfort, this demonstrates improved ease of use and user confidence. Overall, the findings indicate that intuitive interface design, independent operability, and adaptive features contribute to positive user experiences, supporting accessibility and effective communication for Deaf and Hard-of-Hearing users.

The respondents' baseline communication experiences prior to the introduction of the Echo Aid mobile-based speech recognition and response application. Selecting responses in daily conversation obtains an overall weighted mean of 3.08, interpreted as Moderate-High, indicating that respondents are generally capable of managing daily conversations; however, certain aspects, such as speed and conversational efficiency, still present challenges. The lower mean for conversational speed (2.90) highlights an area where technological support could provide meaningful improvement. Establishing this baseline is essential in a developmental-evaluative research design, as it identifies the existing communication conditions against which Echo Aid's effectiveness is measured. This observation aligns with Tomanek et al. (2021), reporting that advancements in automatic speech recognition (ASR) technology show that on-device personalization of ASR models significantly improves recognition performance for individuals with atypical or disordered speech. Accurate and adaptive speech transcription supports more effective communication and enhances accessibility for users with speech differences. The results of the usability evaluation of the response selection feature of Echo Aid: A Mobile-Based Speech Recognition and Response Application. The overall weighted mean of 3.38 indicates that the response selection feature is efficient and practical, and that it supports smoother interactions for hearing-impaired users. Compared to the pre-test results, which show an overall weighted mean of 3.08 (Moderate-High) for baseline communication experiences, the post-test results indicate a clear improvement.

This demonstrates that Echo Aid improves users' ability to select responses more quickly and effectively, enhancing overall conversational flow and reducing communication delays. These findings align with prior research showing that speech-to-text and assistive communication applications significantly improve conversational accessibility and performance for users with hearing loss (Roychowdhury, 2023). The results further suggest that well-designed response selection features contribute to more independent and confident communication among hearing-impaired individuals.

The pre-test results on Question Effectiveness, which refers to how well respondents' questions support meaningful and efficient communication prior to the implementation of the mobile-based speech recognition and response application. Question effectiveness focuses on the ability of selected or commonly used questions to initiate, sustain, and enhance interaction. The overall weighted mean of 3.15, interpreted as Moderate-High, indicates that respondents are relatively capable of using questions to support communication; however, aspects such as conversational flow, spontaneity, and contextual flexibility still require improvement. These results establish the baseline level of question effectiveness before the introduction of the mobile-based system. The findings align with literature on Augmentative and Alternative Communication (AAC). According to Zangari (2025), stored or pre-stored messages are a crucial component of an AAC user's communicative repertoire and, when used appropriately, improve dialogue and interaction skills. Chen et al. (2016) explain that communication interfaces demonstrate effectiveness when they respond to inquiries accurately and competently. Similarly, the AAC Community (2025) notes that pre-stored sentences increase participation in social settings, while Elsahar et al. (2019) emphasize that preprogrammed messages contribute to faster conversational exchanges. However, Zangari (2025) also highlights that relying solely on prestored messages can be restrictive, as users are limited to previously programmed content.

Moreover, Vargas (2019) explains that difficulty navigating an extensive vocabulary during spontaneous message generation is a primary reason AAC communication can be slow. These limitations align with the Moderate-High pre-test results, showing that although respondents' questions are generally effective, there is still room for improvement in efficiency and adaptability. Overall, the pre-test findings suggest that while respondents demonstrate effective use of questions in daily communication, technological support remains necessary to enhance speed, flexibility, and overall conversational performance. Post-test results on Question Selection Usefulness after implementing the Echo Aid mobile-based speech recognition and response application. The overall weighted mean of 3.43, interpreted as High, indicates that the Echo Aid question selection feature is useful and effective in enhancing communication among respondents. The consistently high ratings reflect strong user acceptance and confirm that the preset questions are practical, relevant, and supportive of daily conversational needs. These findings are supported by existing literature on Augmentative and Alternative Communication (AAC). According to Zangari (2025), prestored messages are a crucial component of an AAC user's communicative repertoire and can significantly enhance dialogue when appropriately designed. Similarly, Elsahar et al. (2019) emphasize that preprogrammed messages improve conversational rate and facilitate quicker exchanges, while Chen et al. (2016) explain that communication systems demonstrate effectiveness when they respond to user needs accurately and competently. The High ratings in this study align with these findings, indicating that well-structured preset questions improve conversational efficiency and interaction quality. Compared to the pre-test overall weighted mean of 3.15 (Moderate-High), the post- test result of 3.43 shows a clear improvement of 0.28. This increase suggests that the organized, accessible preset questions in the mobile application strengthen conversational initiation, enhance relevance, and improve the overall flow of interaction. The results demonstrate that integrating structured question-selection features significantly enhances communication support for hearing-impaired users, consistent with prior research emphasizing the value of adaptive, user-centered AAC design.

The pre-test data gathered regarding respondents' level of message comprehension in daily communication. The computed overall weighted mean of 2.86, interpreted as Moderate-High Level, indicates that respondents demonstrate a generally effective level of message comprehension in daily communication. The result suggests that the system provides meaningful support in enhancing understanding, reducing communication barriers, and

facilitating smoother interaction. Improvements in speech signal processing, intelligibility, and noise handling directly enhance communication success (Fatehifar et al., 2024). However, transcription accuracy may still vary with model design and evaluation conditions, highlighting the need for continuous system refinement (Kuhn et al., 2024). Overall, the findings confirm that effective communication support in assistive technologies depends on integrating recognition accuracy, processing efficiency, and user-centered design. The post-test data on respondents' message comprehension is a core dimension of communication effectiveness. The computed overall weighted mean of 3.48, interpreted as High Level, indicates that respondents demonstrate a generally effective level of message comprehension when using the system. Compared with the pre-test overall weighted mean of 2.86 (Moderate-High Level), the post-test result shows a noticeable improvement of 0.62. This indicates that the system significantly enhances comprehension efficiency, minimizes confusion, and provides consistent support during real-time conversations. These findings are supported by prior research emphasizing the importance of system accuracy and clarity in communication technologies. Fatehifar et al. (2024) state that when recognition errors decrease and synthesized speech becomes clearer, users experience improved understanding and smoother interaction flow. Angdresey et al. (2021) highlight that fast processing speed and accurate text output are key determinants of communication effectiveness in real-time platforms. Berner & Alves (2021) explain that communication effectiveness significantly improves when systems are intuitive and aligned with user capabilities. Meanwhile, Pragt et al. (2022) and Kuhn et al. (2024) note that environmental noise and model design can affect ASR performance, but well-designed systems provide stable and reliable support, effectively bridging the gap between spoken input and user comprehension.

The pre-test results for Response Appropriateness had an overall weighted mean of 3.22, interpreted as High, indicating that participants generally perceived their responses as appropriate and supportive of meaningful communication before using the mobile-based speech-to-text system. These results suggest that prior to the intervention, participants were moderately capable of providing contextually appropriate responses, following conversational norms, and supporting meaningful exchanges. However, some inconsistencies or lapses in appropriateness still occur depending on the clarity of communication or situational demands. These findings align with prior research emphasizing the role of appropriateness in communication. Jurgens et al. (2023) define appropriateness as the degree to which a response fits the issue and the interaction dynamics, including relevance, naturalness, and sensitivity. Ding et al. (2023) highlight that contextual fit is crucial in evaluating appropriateness, ensuring responses are relevant and safe. Elliot (2017) notes that inaccurate speech recognition leads to misunderstandings, reducing response appropriateness. This indicates that participants demonstrate a moderately high ability to provide contextually appropriate responses prior to the intervention, although there remains potential for errors in situations involving unclear communication. The post-test results for Response Appropriateness show an overall weighted mean rise to 3.37, interpreted as High, indicating that participants provide more contextually appropriate and meaningful responses after using the mobile-based speech-to-text system. This demonstrates an improvement from the pre-test overall weighted mean of 3.22 (High), suggesting that the system enhances users' ability to respond suitably in daily communication and reduces potential lapses in appropriateness. Prior studies support these results. Tobin et al. (2020) note that misrecognized text leads to inappropriate responses, while Pragt et al. (2022) report that users with cochlear implants or hearing aids outperform ASR apps in noisy environments, indicating that technology improves response appropriateness when it accurately represents spoken input. Kocaballi et al. (2020) also find that responses that combine directive and empathetic content are judged appropriate in human-agent communication. These studies indicate that mobile-based systems enhance response appropriateness by providing accurate, contextually relevant output, supporting clearer and more effective communication.

The respondents' level of communication speed before using the mobile-based system. The overall weighted mean is 2.90, interpreted as Moderately High, suggesting that communication speed before using the system is noticeably affected by slower exchanges and interruptions. Prior studies support these findings. Sakuma et al. (2023) explain that poor response timing interrupts conversational flow and creates communication gaps. Similarly, Deng et al. (2024) state that slow response times disrupt rhythm and reduce the

quality of communication. These studies confirm that delayed exchanges negatively affect everyday communication, as evidenced by post-test results for Communication Speed after using the mobile-based speech-to-text system. The overall weighted mean is 3.37, which is interpreted as High, indicating that respondents experience faster, smoother communication with the system. The increase from the pre-test overall weighted mean of 2.90 (Moderately High) demonstrates that the system significantly improves communication speed, reduces waiting time, and supports smoother message exchanges compared to daily communication without technological assistance. These findings are consistent with prior studies. Rathna et al. (2024) report that low-latency speech recognition systems enable near real-time communication. Spehar and Calabrese (2016) find that real-time captioning improves understanding and responsiveness in conversations. Furthermore, Shangguan et al. (2021) emphasize that emission latency strongly influences user-perceived responsiveness. These studies indicate that improving response timing and reducing delays enhances communication flow, supporting the conclusion that faster system responsiveness leads to better conversational experiences.

The pre-test results for Communication Effectiveness among respondents show an overall weighted mean of 2.58, interpreted as Moderate-Low, indicating that respondents generally experience difficulty in clearly communicating ideas, feeling confident that others understand them, and avoiding misunderstandings during daily interactions without the mobile-based system. These results suggest that, prior to the intervention, communication effectiveness is limited, with challenges in clarity, confidence, and comprehension affecting conversational outcomes. The findings are supported by existing literature. Communication effectiveness in assistive technology refers to the extent to which a system enables users with hearing impairments to successfully exchange information in real-world contexts, beyond transcription accuracy alone. It includes output clarity, response timeliness, reliability, usability, error reduction, and overall interaction quality. Advances in automatic speech recognition (ASR) show that personalized models for disordered speech improve recognition performance, reduce word error rates, and enhance comprehension (Green et al., 2021). Real-world performance is influenced by environmental noise, device quality, and usage conditions, highlighting the importance of reliability and usability (Pragt et al., 2022). Studies further emphasize that intuitive, responsive, and human-centered designs improve independence, participation, and the quality of interaction (Berner & Alves, 2021; Angdresey et al., 2021). Improvements in speech signal processing, noise handling, and output intelligibility directly strengthen communication success and user understanding (Fatehifar et al., 2024; Kuhn et al., 2024). Overall, these studies indicate that communication effectiveness depends not only on accurate transcription but also on system responsiveness, interface design, and user-centered optimization. The low-to-moderate pre-test results demonstrate the need for an intervention that enhances clarity, reduces misunderstandings, and supports confident, efficient communication among hearing-impaired users in real-life interactions—the post-test results for Communication Effectiveness after using the mobile-based speech-to-text system. The overall weighted mean is 3.37, interpreted as High, indicating that respondents communicate their ideas more clearly, express their thoughts effectively, and experience easier and more efficient interactions while using the system. Compared to the pre-test overall weighted mean of 2.58 (Moderate-High), the post-test results show a notable improvement of 0.79 points. This indicates that the mobile-based system significantly enhances communication effectiveness by increasing clarity, confidence, and efficiency in daily interactions, reducing misunderstandings, and supporting smoother conversational exchanges. These results align with prior studies on assistive technology. Communication effectiveness encompasses not only transcription accuracy but also output clarity, response timeliness, system reliability, usability, error reduction, and overall interaction quality. Personalized ASR models improve recognition performance, reduce word error rates, and enhance comprehension, particularly for users with atypical or impaired speech (Green et al., 2021). Real-world performance depends on environmental noise, device quality, and usage conditions, highlighting the importance of system reliability and contextual usability (Pragt et al., 2022). Intuitive and responsive systems improve independence, participation, and the quality of interaction (Berner & Alves, 2021; Angdresey et al., 2021), while improvements in speech signal processing, noise handling, and output intelligibility directly enhance communication success (Fatehifar et al., 2024; Kuhn et al., 2024). The post-test results show that the Echo Aid system enhances comprehension, reduces communication barriers, and supports effective, independent

participation for hearing-impaired users.

Table 2

Multiple Regression Analysis on the Effect of Text Accuracy, System Response Time, Ease of Use, Response Selection Efficiency, and Question Selection Usefulness on Users' Communication Effectiveness

Predictor	p-value
Text Accuracy	0.661
Response Time	0.974
Ease of Use	0.697
Response Selection Efficiency	0.361
Question Selection Usefulness	0.600
Regression Statistics	
Multiple R	0.343
R Square	0.118
Adjusted R-Square	-0.198
F-value	0.373
Significance F (p-value)	0.859

Note. p-values indicate whether each predictor significantly affects Communication Effectiveness. The overall regression model was not statistically significant, $F(5, 14) = 0.37$, $p = 0.859$, $R = 0.343$, $R^2 = 0.118$, Adjusted $R^2 = -0.198$.

The results of the multiple regression analysis conducted to determine whether text accuracy, system response time, ease of use, response selection efficiency, and question selection usefulness significantly predict communication effectiveness. The overall regression model is not statistically significant, $F(5, 14) = 0.37$, $p = 0.859$. The predictors collectively explain only 11.8% of the variance in communication effectiveness ($R^2 = 0.118$, Adjusted $R^2 = –0.198$), indicating a weak explanatory power of the model. Furthermore, none of the individual predictors significantly contributed to communication effectiveness, as all p-values were greater than 0.05 (Text Accuracy: $p = 0.661$; System Response Time: $p = 0.974$; Ease of Use: $p = 0.697$; Response Selection Efficiency: $p = 0.361$; Question Selection Usefulness: $p = 0.600$). Previous studies reported that text accuracy, responsiveness, and usability improve communication outcomes. Green et al. (2021) reported that personalized ASR models improved recognition accuracy. Angdresey et al. (2021) found that fast processing speed and accurate real-time output enhanced interaction quality. Berner and Alves (2021) concluded that improvements in usability and accessibility increased participation among individuals with disabilities, while Fatehifar et al. (2024) explained that improvements in speech processing enhanced communication success. However, the present findings do not show significant predictive effects when these variables are analyzed simultaneously. This may be attributed to the small sample size ($n = 20$), which limits statistical power in multiple regression analysis. Despite the non-significant regression results, earlier findings show a significant improvement in communication effectiveness after system use, suggesting that the overall system experience contributes to enhanced communication.

Table 3

t-Test: Paired Two-Sample for Means

Test	Mean	T comp	T crit	P(two-tailed)	Interpretation
Pre-test	2.21				
Post-test	3.09	-20.14	2.09	<0.001	Highly Significant

Note. A paired-samples t-test showed a significant increase in Communication Effectiveness from pre-test ($M = 2.21$) to post-test ($M = 3.09$), $t(19) = -20.14$, $p < 0.001$.

The table presents the results of a paired-samples t-test assessing whether there is a significant difference in communication effectiveness before and after using the mobile-based speech-to-text system. The results reveal a

significant increase in communication effectiveness from pre-test (M = 2.21) to post-test (M = 3.09), t(19) = -20.14, p < 0.001. Since the computed p-value (2.81E-14) is significantly lower than the 0.05 level of significance, the null hypothesis is rejected. This indicates that the mobile-based system significantly improves communication effectiveness among the respondents. These findings align with prior research, which emphasizes that communication effectiveness in assistive technologies depends not only on transcription accuracy but also on clarity of output, timeliness of responses, system reliability, usability, error reduction, and overall interaction quality. Personalized automatic speech recognition (ASR) models enhance recognition performance, reduce word error rates, and improve comprehension, particularly for users with atypical or impaired speech (Green et al., 2021). System performance is influenced by environmental noise, device quality, and contextual usability, highlighting the importance of reliability and user-centered design (Pragt et al., 2022). Intuitive and responsive systems promote independence, participation, and the quality of interaction (Berner & Alves, 2021; Angdresey et al., 2021), while improvements in speech signal processing, noise handling, and output intelligibility further enhance communication success (Fatehifar et al., 2024; Kuhn et al., 2024). The highly significant improvement observed in the post-test demonstrates that the Echo Aid system effectively enhances clarity, reduces misunderstandings, and supports more efficient, confident communication for hearing-impaired users.

4. Conclusions

Based on the summary of the findings from the collected data, the following conclusions are drawn from the study's results regarding the stated problem: The effectiveness of mobile-based speech-to-text communication systems in converting real-time conversations is high, with low system response time, indicating efficient user interaction with the system. Meanwhile, in terms of text accuracy, it falls into the moderately high range, which is above good accuracy for converting text and was helpful for communication, though some errors occurred. The system's performance in terms of ease of use, response-selection efficiency, and question-selection usefulness was highly rated by users. It showed how easy it is to navigate and operate the system. The system has reliable and effective response and question features that make the communication efficient. The status of users' communication effectiveness before and after using the application, in terms of message comprehension, response appropriateness, and communication speed, is high. That indicates the system made communication easier and more effective, enabling faster responses. Users' communication effectiveness was not significantly influenced by text accuracy, system response time, ease of use, response selection efficiency, or the usefulness of question selection. While no individual feature was found to be a significant predictor of communication effectiveness, users reported marked improvements in their understanding, interaction quality, and overall confidence when using the system. There is a significant difference in users' communication effectiveness before and after using the mobile-based speech-to-text system.

Recommendations **-** With the results of the data interpreted, these are the recommendations of the researcher for further development and enhancement of the application as follows: To further improve text accuracy, educational institutions, tech companies, app platform providers, developers, and future researchers could enhance the system's speech recognition algorithm to handle clarity issues better, unfamiliar words, and language variations, ensuring precise conversion in the application. To understand the full history of the communication, the researcher recommended that the history feature store users' text and past communication, making the communication more accurate and reliable. To further answer whether the communication effectiveness was affected by certain indicators, educational institutions, developers, and future researchers could develop or add features that integrate multiple functions, such as combining text accuracy improvements, quick response options, and preset questions in one interface, so that the collective effect of these features on user communication can be measured. To expand accessibility across devices, educational institutions, governments (such as LGUs), healthcare providers, developers, telecommunications providers, and future researchers could make the application available on all types of mobile phones, including iOS devices, so that more users can benefit from the mobile-based speech-to-text system regardless of their device. To support hearing-impaired

users, educational institutions, governments (such as LGUs), healthcare providers, deaf advocacy groups, non-governmental organizations, developers, and future researchers could integrate a sign language feature into the application, allowing non-readers and hearing-impaired users to communicate effectively through gestures or visual representations. To increase convenience and flexibility for users, educational institutions, healthcare providers, field workers, and remote workers. Developers and future researchers could create a portable version of the system, such as a standalone device or a wearable, enabling users to access the speech-to-text system anytime, anywhere, without relying solely on a smartphone.

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