

**A MOBILE-BASED AMERICAN SIGN LANGUAGE LEARNING APPLICATION
WITH INTERACTIVE FEATURES FOR THE HEARING AND SPEECH IMPAIRED****Ronald B. Fernandez****ORCID ID - 0009-0007-0979-6315**

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ABSTRACT

Despite the fact that communication is a basic human right, millions of people throughout the world struggle because of speech and hearing problems. The World Health Organization estimates that 700 million individuals will have substantial hearing loss by 2050, up from the present level of about 430 million. In order to reduce communication barriers between the hearing and the Deaf communities, American Sign Language (ASL) is essential. However, the absence of qualified teachers and standardized resources makes traditional American Sign Language (ASL) learning approaches costly, inaccessible, and constrained. While some answers are offered by current mobile applications, they sometimes lack interactive elements, customization options, and real-time feedback—all of which are critical for successful and interesting language learning.

This aimed to design and developed a mobile-based American Sign Language Learning Application integrated with Artificial Intelligence (AI) and interactive features to provide a flexible, self-paced, and engaging learning experience. The Application incorporates video tutorials, gamification elements such as quizzes and progress tracker, and a real-time hand gesture recognition system for finger spelling practice.

Evaluation results demonstrated that the application significantly improved user engagement, accessibility, and motivation among the target community. Both hearing-impaired, speech-impaired and hearing community users reported high satisfaction with its user-friendly interface, interactive features, and comprehensive lessons. This research highlights the potential of AI-driven mobile technology to bridge communication gaps, promote inclusivity, and support equal opportunities for education and social participation. Future work includes expanding the app to support other sign languages, incorporating offline features for low-connectivity areas, and exploring augmented reality (AR) for immersive learning experiences.

Keywords:

American Sign Language (ASL), Artificial Intelligence, Mobile Learning, hearing-impaired, speech-impaired, finger spelling, gesture recognition, Inclusive Education, Gamification, accessibility, Deaf Community Empowerment, Machine Learning.

INTRODUCTION

Language serves as the foundation of human connection, enabling individuals to share ideas, express emotions, and build meaningful relationships. For the Deaf and speech-impaired communities, sign language plays a vital role as their primary medium of communication. Among the many sign languages used worldwide,

American Sign Language (ASL) has become one of the most recognized and standardized systems, offering a visual and gestural framework that facilitates communication without spoken words (Bragg et al., 2019).

Despite its importance, access to quality ASL education remains a significant challenge. According to the World Health Organization (WHO, 2021), over 430 million people worldwide suffer from disabling hearing loss, with this figure projected to rise to 700 million by 2050. Many of these individuals depend on sign language for communication, yet they often face barriers to learning due to a lack of resources, limited trained educators, and insufficient inclusive materials (WHO, 2021). These barriers are particularly visible in developing countries like the Philippines, where Deaf individuals are frequently excluded from mainstream education due to insufficient sign language instruction and limited interpreter availability (Philippine Federation of the Deaf, 2020).

Families with Deaf members also face difficulties in learning sign language. Without access to affordable and structured lessons, communication between hearing family members and Deaf individuals remains limited, which can lead to feelings of isolation and misunderstanding (National Institute on Deafness and Other Communication Disorders [NIDCD], 2022). In everyday settings such as churches, workplaces, and healthcare facilities, the absence of interpreters often prevents Deaf individuals from fully participating in community life, perpetuating systemic inequality (World Federation of the Deaf, 2019).

The advancement of mobile technology and artificial intelligence (AI) offers new opportunities to address these challenges. Smartphones are now widely available, even in low-resource communities, making them a practical platform for delivering accessible educational content (Tran et al., 2023). Language learning apps have already revolutionized traditional education by offering self-paced, flexible, and interactive tools for learners (Mayer, 2019). However, existing ASL learning apps are often limited in scope and interactivity, focusing on static video libraries or simple dictionaries rather than providing adaptive feedback or gamified learning experiences (Bragg et al., 2019).

Research on educational technology emphasizes the value of interactive learning and gamification in increasing motivation and retention. Mayer's Cognitive Theory of Multimedia Learning highlights that learners benefit most when instructional materials combine visual and auditory elements with interactive practice (Mayer, 2024). Similarly, Bragg et al. (2019) found that Deaf learners engage more effectively when technology offers real-time feedback and culturally relevant content.

This study was inspired by the lived experiences of the Deaf community at Imus Cathedral, where Ms. Analiza B. Lacdang, a volunteer interpreter and mother of two Deaf children, provides sign language interpretation during church services. Through observations and interviews, the researchers identified several key challenges: the lack of structured ASL resources, the high cost of formal classes, the difficulty of sustaining consistent learning without interactive tools, and the limited availability of interpreters to support communication in daily activities. These issues highlight the urgent need for a scalable, accessible, and affordable solution that empowers both Deaf individuals and hearing members of their communities to learn ASL effectively.

The study aims to design and evaluate a mobile-based ASL learning application that integrates AI-driven gesture recognition, gamified quizzes, and interactive lessons. By leveraging technology, the application seeks to enhance communication, foster inclusivity, and provide Deaf and hearing individuals with the means to engage more meaningfully. Furthermore, this project aligns with the United Nations Sustainable Development Goal (SDG) 10, which emphasizes reducing inequalities and promoting social inclusion (United Nations, 2020).

OBJECTIVES

The study aims to solve the following problems by developing a mobile American Sign Language learning application that uses interactive features and Artificial-Intelligence to make learning easier and more engaging. It is designed to help both hearing community, speech-impaired, and hearing-impaired users to communicate better and be more confident. By talking to American Sign Language professionals, advocates, and members of the hearing-impaired community, this study makes sure the app addresses real-life needs and encourages more people to learn and use sign language in their everyday lives.

METHODOLOGY

This chapter presents the structured approach employed to guide the development and evaluation of the system. It outlines the research design, development framework, and data collection strategies applied to ensure that each

phase of the project was systematically executed and aligned with its objectives. By adopting the Agile methodology, the study emphasized iterative development, continuous feedback, and flexibility, thereby ensuring the system was developed efficiently and effectively while addressing the needs of its target users.

Agile is a flexible and collaborative approach to system development that emphasizes completing tasks in small, manageable phases. Unlike traditional models, the process is divided into iterative cycles in which planning, designing, developing, testing, deployment, evaluation, and refinement are carried out continuously rather than sequentially. This approach allows the proponents to incorporate frequent user and stakeholder feedback, identify and address problems early, and adapt quickly to improvements and changing requirements. At the same time, it ensures steady and consistent progress toward the final deliverable. By following this methodology, the system evolved dynamically while remaining aligned with the overall objectives of the project.



Figure 1: Agile Methodology

1) **Planning:** During the requirements phase, the proponents conducted both surveys and interviews with members of the Deaf community and related stakeholders. A physical interaction was held at AMPIES Café, where Deaf employees responded to survey questionnaires, while online interviews were carried out with a professional, a volunteer interpreter, and a mother of two Deaf children to capture broader perspectives. Results revealed that 80% of respondents first learned ASL through family and friends, while 15% gained knowledge from formal schooling. Most or 80% of the participants emphasized the importance of facial expressions and body language, and 90% strongly believed ASL should be taught as a second language in schools. In addition, 70% noted that technology has already improved communication within the community. These findings provided critical guidance for defining the application's functional requirements, such as interactive lessons, gesture recognition, and quizzes, as well as non-functional requirements focusing on accessibility, usability, and inclusivity.

2) **Design:** The proponents created workflows and interface prototypes to visualize the overall functionality and layout of the ASL learning application. The home screen provides users with clear navigation options such as Lessons, Assessment, Fingerspelling, and Profile, making it simple for learners to access the key features of the app. The interface was carefully designed with large buttons, high-contrast colors, and minimal text to ensure accessibility for the Deaf and speech-impaired community.

3) **Implementation:** The implementation phase involved the actual development of the application based on the finalized design.

4) **Testing:** As the proponents developed the ASL learning application, a survey was conducted among Deaf community members, interpreters, and other stakeholders to gather feedback and suggestions for further enhancement of the system. The recommendations provided by participants were carefully reviewed and considered during the evaluation process to ensure that the application addressed the needs of its intended users. During this stage, several minor issues were identified and promptly resolved by the developers, ensuring that the system operated smoothly and reliably. This process guaranteed that the application remained aligned with its

primary purpose of supporting ASL learning and communication, while avoiding errors that could confuse or mislead users.

5) Deployment: The deployment of the application was initially focused on the Church Community in Imus Cathedral, where Mrs. Analiza B. Lacdang serves as a volunteer Sign Language Interpreter. This specific setting was chosen because it provided direct access to both Deaf and hearing individuals who could serve as initial users of the system. By limiting the pilot deployment to this community, the proponents were able to observe real-world usage in a controlled environment, gather feedback from actual learners and interpreters, and make adjustments before considering a broader rollout. This targeted deployment not only ensured the application's stability and functionality but also allowed the team to validate its effectiveness in promoting inclusive communication within a community actively engaged in sign language practices.

6) Maintenance: Following the initial deployment in the Imus Cathedral church community, the proponents committed to maintaining and improving the application to ensure its long-term reliability and relevance. Maintenance activities included monitoring system performance, addressing technical issues reported by users, and releasing timely updates to fix bugs and improve functionality. Content updates were also prioritized, such as adding new ASL lessons and refining gesture recognition models to improve accuracy and inclusivity. Feedback gathered from the pilot community, particularly from Deaf members and the volunteer interpreter, was continuously reviewed and integrated into the system to enhance user experience. This proactive approach to maintenance ensured that the application remained user-centered, secure, and adaptable to the evolving needs of its target audience.

RESULTS AND DISCUSSION

This section introduces and discusses the analysis findings based on the questionnaire created according to the ISO/IEC 25010 standard. A total of 100 users and responses were gathered to evaluate the application, with the primary focus on testing its functionality and performance. The survey results showed that most respondents rated the app positively across content, usability, design, and security. Users agreed that the lessons and translations were accurate, the interactive features supported learning, and the interface was simple to use. While some suggested the addition of more advanced content and varied activities, the overall findings confirm that the application is functional, reliable, and effective as an ASL learning tool.

Functional Suitability

Of the total of 100 respondents, the majority expressed positive feedback regarding the functional suitability of the ASL learning application. For Q1, almost all users agreed or strongly agreed that the app includes essential ASL lessons and topics, confirming its relevance as a foundational tool. In Q2, most respondents agreed that both basic and advanced ASL content were covered, though a small portion suggested that the app could be expanded with more advanced lessons. For Q3 and Q4, users highlighted the value of interactive features and activities that enhance learning and skill improvement, showing that the app goes beyond static content by providing engaging experiences. Finally, Q5 responses revealed that the majority of users believed the app met their expectations as a complete ASL learning tool. Overall, the results confirm that the application functions effectively and provides content that aligns with the learning needs of its users, with only minor suggestions improvement in expanding advanced content.

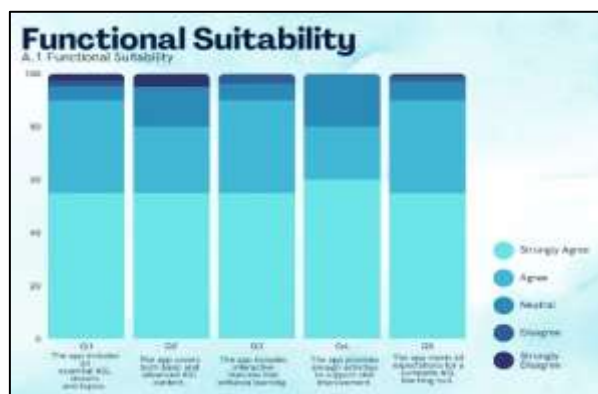
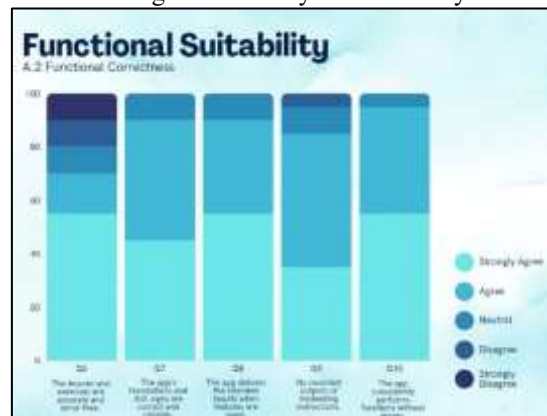


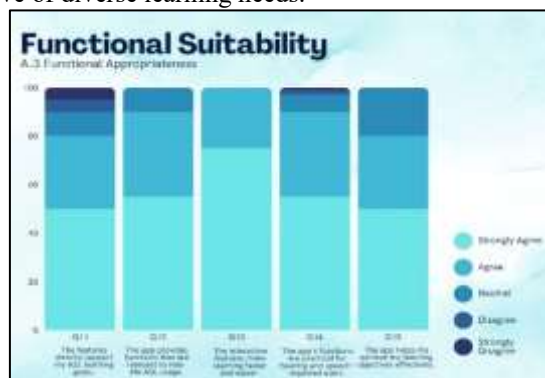
Figure 2 Functional Suitability

Functional Correctness

According to the findings of 100 respondents, the ASL learning application demonstrates a high level of functional correctness. Most users strongly agreed that the lessons and exercises were accurate and error-free (Q6), and that the app's translations and ASL signs were correct and reliable (Q7). Results also showed that the application delivered the intended outcomes when features were used (Q8) and that there were no misleading outputs or instructions (Q9). Furthermore, respondents confirmed that the app consistently performed its functions without errors (Q10). These findings suggest that the application is technically stable and dependable, with only minimal refinements needed to further strengthen accuracy and reliability.

*Figure 3 Functional Correctness***Functional Appropriateness**

According to the findings, the ASL learning application showed strong functional appropriateness. Users agreed that its features directly supported their ASL learning goals (Q11) and that the functions were relevant for real-life communication (Q12). The interactive components (Q13) were also highlighted as effective in making learning faster and more engaging. In Q14, many noted that the app's functions were practical for both hearing and speech-impaired individuals, reflecting inclusivity in design. Finally, results from Q15 confirmed that the app effectively helped learners achieve their objectives. Overall, the application's functions were perceived as purposeful, practical, and supportive of diverse learning needs.

*Figure 4 Functional Appropriateness***Learnability**

According to the findings, the application demonstrated strong usability, particularly in terms of learnability. Q16 and Q17 results showed that most users found the app easy to use after only a single attempt and appreciated the clear instructions provided for new users. In Q18, respondents agreed that the interface was intuitive enough to allow easy recall even after periods of non-use, highlighting its user-friendly design. Q19 emphasized that the app was simple to learn even without prior ASL knowledge, making it accessible to beginners. Lastly, Q20 confirmed that learning how to use the app did not require extra effort, reinforcing its overall ease of

use. These results indicate that the system is designed with accessibility and user convenience in mind, allowing both new and experienced users to navigate and learn effectively.



Figure 5 Learnability

Operability

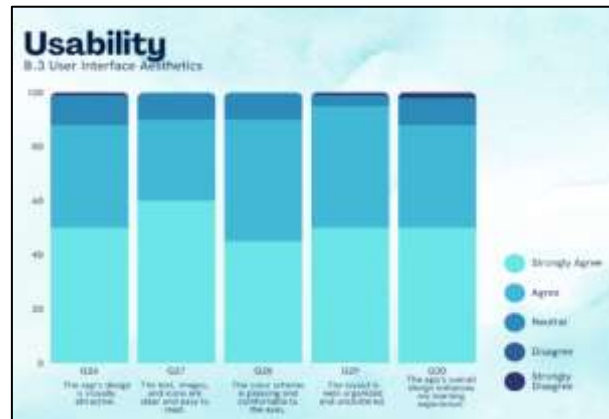
According to the findings, the application performed well in terms of operability. Q21 and Q22 showed that users found the app easy to navigate and considered its controls and buttons intuitive, making it simple to move between features. In Q23, the majority agreed that the app responded quickly to commands, which indicates smooth and responsive functionality. Q24 results highlighted that users were able to correct errors efficiently while using the system, minimizing confusion or disruption during tasks. Finally, Q25 confirmed that the app allowed users to complete tasks without difficulty. Overall, these findings demonstrate that the application is highly operable, with an intuitive design and responsive performance that enables users to accomplish tasks effectively.



Figure 6 Operability

User Interface Aesthetics

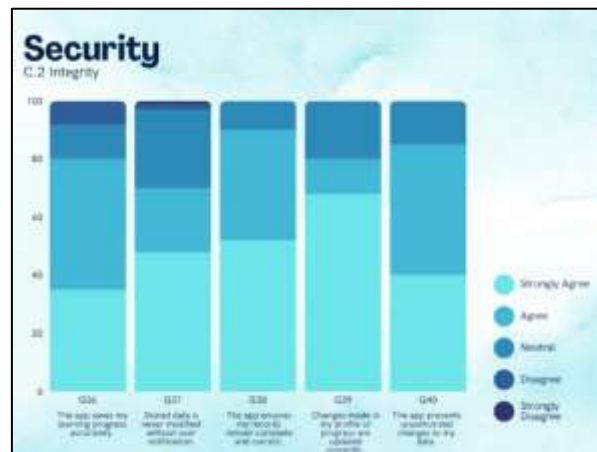
According to the findings, the application's user interface aesthetics were highly appreciated by respondents. In Q26, many strongly agreed that the app's design was visually attractive, while Q27 highlighted that text, images, and icons were clear and easy to read. Q28 and Q29 results confirmed that the color scheme was comfortable to the eyes and that the layout was well-organized and uncluttered, ensuring a smooth user experience. Finally, Q30 showed that the app's overall design enhanced the learning experience, demonstrating the importance of both functionality and appearance. These results indicate that the system not only performs effectively but also provides a visually appealing and user-friendly environment that supports learning.

**Figure 7 User Interface Aesthetics****Confidentiality**

According to the findings, the application was positively evaluated in terms of confidentiality. In Q31, most respondents strongly agreed that the app ensured the privacy of their personal information, while Q32 indicated trust that data would not be shared without permission. Q33 showed that users considered the app to provide a secure environment for data storage, and Q34 confirmed that it protected learning progress from unauthorized access. Finally, Q35 highlighted that the application was viewed as reliable for maintaining overall information confidentiality. These results demonstrate that users had confidence in the system's ability to safeguard their data, reinforcing its credibility as a secure learning tool.

**Figure 8 Confidentiality****Integrity**

According to the findings, the application demonstrated strong integrity in managing user data. Q36 indicated that users agreed the app accurately saved their learning progress, ensuring reliability in tracking performance. In Q37, respondents noted confidence that stored data was not modified without notification, supporting trust in the system's transparency. Q38 showed that records were perceived as complete and correct, while Q39 confirmed that updates to profiles or progress were reflected accurately. Finally, Q40 highlighted that the app effectively prevented unauthorized changes to data. These results suggest that the system maintained a high standard of data accuracy and reliability, reinforcing its role as a dependable platform for ASL learning.

*Figure 9 Integrity***Authentication**

According to the findings, the application demonstrated strong reliability in protecting user accounts through authentication. Q41 indicated that respondents agreed the app requires secure login to access their accounts, reflecting confidence in its login process. In Q42, participants confirmed that only authorized users are able to access the learning content, strengthening trust in the system's security. Q43 revealed that users recognized the presence of identity verification prior to saving or modifying progress, while Q44 showed that the app consistently verifies identity before allowing important changes. Finally, Q45 emphasized that the application guarantees exclusive account access to authenticated users. These results suggest that the system provides dependable authentication measures, ensuring user data is protected and accessible only to legitimate users.

*Figure 10 Authentication*

The findings of this study confirm that the mobile-based ASL learning application effectively addressed its objectives of accessibility, reliability, and inclusivity. Across all evaluation dimensions, content, functionality, usability, design, and security, results consistently indicated high user satisfaction, with strong agreement that the app provided accurate lessons, reliable features, and an intuitive interface.

The positive ratings on **functional suitability, correctness, and appropriateness** suggest that the application not only provided accurate ASL content but also ensured that these features aligned with real-life communication needs. Respondents valued the interactive lessons and activities that supported engagement and skill development, confirming that the app went beyond static learning to deliver a dynamic learning experience.

In terms of **usability**, the app performed well in both learnability and operability. Most users were able to use the app with minimal effort and reported smooth navigation between features. These results validate the developers' design choices in prioritizing simplicity and intuitiveness, which are particularly important for beginner learners of ASL. The positive evaluation of **user interface aesthetics** further reinforces the app's effectiveness in combining function and form, ensuring that the system was both practical and visually supportive of learning.

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Security was also recognized as a significant strength of the application. Findings under **confidentiality, integrity, and authentication** confirmed that users trusted the system to safeguard personal information and maintain accurate records of their progress. This reinforces the application's credibility as a safe environment for learning and personal data management.

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CONCLUSION

The development and evaluation of the mobile-based ASL learning application demonstrated that the system effectively addressed its objectives of accessibility, reliability, and inclusivity. Results from 100 respondents confirmed that the application provided accurate ASL lessons, reliable translations, interactive features, and a user-friendly interface that supported diverse learners, including Deaf individuals, parents, interpreters, and the wider community.

While the application was positively received, feedback also highlighted areas for improvement, particularly in the inclusion of more advanced ASL lessons and additional interactive activities to enrich learning. Nevertheless, the overall conclusion is that the application succeeded in providing a practical, inclusive, and secure platform that contributes to promoting Deaf awareness and inclusive communication.

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