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DEVELOPMENT OF THE SIGNLINGUA APPLICATION FOR LEARNING MALAY SIGN LANGUAGE

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ABSTRACT

SignLingua is a mobile application designed to facilitate the learning of Malay Sign Language (MySL), specifically addressing the significant communication barriers between the deaf community and the hearing population in Malaysia. Despite MySL being a key communication method among the deaf, limited resources, lack of awareness, and low engagement among hearing individuals have led to a persistent communication gap. This study aims to bridge that gap by developing an interactive, localized, and user-friendly learning platform that incorporates gamified modules, quizzes, and a camera-based prototype for real-time sign language recognition. Developed using Agile methodology and the Software Development Life Cycle (SDLC), the app leverages tools such as Android Studio, Firebase, and TensorFlow Lite. The key contribution of the study lies in the integration of MySL content with gamification and emerging AI-based features, offering a more engaging and inclusive learning experience. Findings show that SignLingua enhances user engagement and learning outcomes through its multimodal and localized approach. Future improvements should focus on refining the gesture recognition component, expanding vocabulary coverage, and increasing accessibility to cater to a broader audience.

1. Introduction

Effective communication is a fundamental human right, yet many individuals in the deaf community face persistent challenges due to limited accessibility and awareness of sign language, particularly Malay Sign Language (MySL). As MySL is the primary communication method among the deaf in Malaysia, its broader adoption and understanding among hearing individuals are crucial to fostering inclusion (Persekutuan Orang Pekak Malaysia, 2016). However, most educational environments and public platforms in Malaysia lack accessible resources that support the learning of MySL, resulting in a communication divide that affects education, employment, and social participation.

In recent years, the global landscape has seen the emergence of several mobile applications

aimed at teaching sign language, such as Duolingo and Lingvano. While these platforms demonstrate the potential of mobile learning, they are often limited to American Sign Language (ASL) or general sign language structures, which are not contextually appropriate for Malaysian learners (Hope, Anne, & Irene, 2000; von Ahn, 2011). Additionally, traditional printed resources and offline tutorials often fail to engage digital-native learners or provide interactive and real-time feedback mechanisms.

To address these gaps, SignLingua was developed as a locally contextualized mobile application to support the learning of MySL. The project leverages Agile software development principles and the Software Development Life Cycle (SDLC) to ensure iterative design, user-centered functionality, and modular scalability. By utilizing technologies such as Android Studio, Firebase, OpenCV, and TensorFlow Lite, the app integrates gamified learning modules, quizzes, and an experimental gesture recognition prototype aimed at recognizing hand gestures through a mobile camera interface (Mednieks et al., 2011; TensorFlow, 2023).

This paper aims to describe the development, features, and evaluation of the SignLingua application. It outlines the methods used in its creation, analyses survey and testing results and discusses how the platform contributes to digital inclusion and quality education under Sustainable Development Goal 4 (United Nations, 2015). The principal conclusion highlights the effectiveness of gamification and localized content in enhancing learner engagement while emphasizing the future potential of artificial intelligence for gesture recognition in sign language learning.

2. Methodology

The development of the SignLingua application adopted a hybrid methodology that combined Agile development practices with the structured phases of the Software Development Life Cycle (SDLC). This combination was chosen to balance iterative flexibility with a well-defined process framework suitable for a 14-week academic development timeline. Agile allowed for continuous adaptation and stakeholder feedback, while SDLC provided a clear roadmap from requirements to maintenance.

Agile methodology was particularly valuable in ensuring that the application evolved in alignment with user expectations. The team conducted development in multiple short sprints, during which core features such as learning modules and quizzes were implemented and tested. Feedback was gathered at the end of each sprint to refine functionality and improve the user experience. This iterative approach enabled the team to address usability issues early, which significantly contributed to the project's overall quality.

Complementing Agile, the SDLC approach provided structure through its five main stages: requirement analysis, system design, implementation, testing, and maintenance. During the requirement analysis stage, the team conducted surveys and interviews with potential users, including educators and members of the deaf community. These activities helped identify both functional needs—such as sign language modules and quizzes—and non-functional requirements like usability and accessibility.

In the system design phase, the team developed logical and physical designs, including Entity Relationship Diagrams (ERD), Data Flow Diagrams (DFD), and interface wireframes. Firebase was selected as the backend to store and manage learning content, quiz data, and user performance records. This design ensured a scalable and cloud-based infrastructure for mobile learning.

The implementation phase was carried out using Android Studio and Java. Features such as module navigation, real-time data retrieval, and interactive quizzes were built using RecyclerView, ImageView, and Firebase APIs. A prototype for gesture recognition was developed using the device's camera, though its performance was limited due to the lack of robust machine learning models and training data.

In the testing and maintenance stages, unit testing, integration testing, and user acceptance testing were conducted. Most core features functioned as expected, while the gesture recognition feature did not meet performance expectations. User feedback indicated strong satisfaction with the app's learning features but also highlighted areas for future improvement. Post-release, the team planned enhancements including advanced sign detection, expanded content, and accessibility refinements to support broader user needs.

3. Results

The SignLingua application was evaluated through both Unit Testing and Integration Testing phases to verify its functional robustness and component interaction. These tests assessed features including user registration, login, module access, quizzes, and the prototype gesture recognition system.

3.1 Unit Testing Plan (UTP)

Unit testing focused on evaluating individual modules in isolation to ensure each function as intended. As shown in Table 1, all core modules including registration, login, learning content, and quizzes passed successfully. However, the camera-based gesture recognition prototype failed to perform consistently under test conditions.

Table 1: Unit Testing Plan (UTP)

No.	Feature / Module	Test Description	Pre-Condition	Expected Result	Result
1	Register	User enters valid username, email, and password; submits registration	All fields filled; email valid; passwords match	Successful registration prompt	Pass
2	Login	User logs in using previously registered credentials	Valid registered username and password	Successful login prompt	Pass

3	Learning Modules	User navigates alphabet, number, and greeting modules	All buttons/images from Firebase load correctly	Functional A-Z and 1-9 navigation	Pass
4	Quizzes & Leaderboard	User plays quiz; receives feedback and sees leaderboard	Quiz content and sounds load from Firebase	Marks recorded; leaderboard updated	Pass
5	Camera Gesture Prototype	User activates camera to detect hand sign	Camera is accessible and active	Hand sign recognized and matched	Fail

3.2 Integration Testing Plan (ITP)

Integration testing examined how modules interact within the full application system. As reflected in Table 2, features like registration, login, and content transitions are integrated well with Firebase. However, the gesture recognition features again failed, indicating it is not yet production ready.

Table 2: Integration Testing Plan (ITP)

No.	Feature / Module	Integration Scenario	Pre-Condition	Expected System Behavior	Result
1	Register	Register component integrates with Firebase user data	Network and database connections active	Account created and synced	Pass
2	Login	Login component validates users from Firebase database	Correct credentials entered	User session authenticated	Pass
3	Learning Modules	Data from Firebase loads images across three modules	Images and text data stored in Firebase	Smooth transition and UI response	Pass
4	Camera Gesture Prototype	Gesture recognition integrates with camera and processing logic	Camera module initialized	Real-time sign recognition successful	Fail

4. Discussion

The main contribution of this study is the development of a contextualized mobile learning application that combines gamification, cloud-based architecture, and sign language content tailored to Malaysian users. By focusing on Malay Sign Language (MySL) rather than global variants like ASL, SignLingua addresses a critical gap in local educational tools. Additionally, by integrating quizzes, leaderboards, and Firebase analytics, the app not only promotes inclusive learning but also demonstrates how technology can support the United Nations Sustainable Development Goal: ensuring inclusive and equitable quality education for all.

5. Conclusion

In conclusion, this study contributes to the field of inclusive digital education by offering a locally relevant, gamified, and technically robust solution for learning Malay Sign Language. SignLingua serves as a proof of concept for how mobile technologies and AI can be utilized to support the deaf community while promoting cross-community communication. Most features performed reliably during testing, except for the gesture recognition prototype, which requires further development. Future enhancements will include expanding the vocabulary library, improving gesture detection accuracy, and integrating broader accessibility features to strengthen the application's educational and assistive value.

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