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Learning Malaysian Sign Language with AR

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Abstract

This project investigates the potential of Augmented Reality (AR) to enhance independent learning of Malaysian Sign Language (MSL). Traditional methods often require teacher assistance, making self-learning challenging. This project explores AR as a solution, aiming to create a more interactive and engaging experience. A user-centered design methodology approach was employed throughout the project, adhering to the Multimedia Development Life Cycle (MDLC) framework. This ensured the AR application catered specifically to the needs and preferences of MSL learners. The development process followed the MDLC framework, encompassing stages from concept, design, material collecting, assembly to testing, and distribution. Unity was chosen as the platform for the AR application due to its capabilities in integrating 3D elements and interactive features. The resulting AR application utilizes 3D hand models and interactive quizzes. These features enable users to visualize and practice MSL signs in a more immersive and effective manner. Additionally, a companion MSL book (focusing on days and months) was created to complement the AR application. This bridges the gap between physical and digital learning resources. This combined approach aims to improve the accessibility and effectiveness of MSL education. The project emphasizes the potential of AR in educational contexts and highlights the importance of user-centered design. Future work can expand the content library and ensure broader device compatibility, further maximizing accessibility and paving the way for AR as a valuable tool for MSL learning.

1. Introduction

Sign language is an essential form of communication for the deaf and hearing-impaired community, enabling them to interact and comprehend the world around them [1]. In Malaysia, Malaysian Sign Language (MSL) is the primary language used by this community [2]. Traditional methods of learning MSL, particularly through existing books, lack multimedia elements, limiting effective learning experiences for deaf and hearing-impaired individuals [1]. This demographic, known for preferring computer-based learning, emphasizes the importance of interactive educational tools [1]. Augmented Reality (AR) technology, a cost-effective innovation, can be utilized to enhance educational settings by integrating multimedia elements [3]. This project seeks to develop a basic MSL book with AR, focusing on days and months, to provide a more interactive and engaging learning experience.

For the deaf and hearing-impaired community, sign language is a vital communication tool, with MSL being the main language used in Malaysia. Conventional learning methods, particularly existing MSL books, lack multimedia aspects, hindering effective learning for deaf and hearing-impaired individuals who prefer interactive, computer-based learning [1]. The absence of multimedia components in books makes it challenging for learners to understand sign language fully but with emerged digital technology, this educational challenge can be minimize [4]. To address these limitations, a basic book on MSL incorporating AR technology is proposed. This integration aims to make learning more engaging and personalized, aligning with the community's preferences and enhancing their educational experience.

The project has three primary objectives. First, to create an MSL book focused on days and months, incorporating AR functionality to enhance learning. Second, to develop a mobile application that enables seamless communication between the book's content and multimedia elements, bringing the book to life through interactive AR features. Third, to enhance the interactive learning experience by integrating a quiz feature within the mobile application, allowing learners to test their knowledge and reinforce their understanding of the signs for days and months.

The primary audience for this project includes individuals interested in acquiring basic sign language skills, such as students, educators, parents, and enthusiasts. The book will focus on teaching signs for days and months in MSL, featuring a diverse range of visual elements like images, animations, and graphics to facilitate engaging and interactive learning experiences [5]. AR components will provide three-dimensional (3D) visualizations of sign language gestures, offering immersive and lifelike representations. The mobile application will enable users to interact with the book's content through AR and include a quiz feature to enhance learning. The content will ensure cultural relevance and authenticity by aligning with the Malaysian context.

In conclusion, this project aims to revolutionize the teaching and learning of MSL by incorporating AR technology into an educational book and mobile application focused on days and months. By addressing the limitations of conventional methods and catering to the deaf and hearing-impaired community's preference for computer-based learning, the project seeks to create an inclusive and accessible learning experience. Despite potential accessibility issues, the linguistic exclusivity of MSL, and technological barriers, the multimedia content and AR capabilities offer an engaging and dynamic learning environment. This project can significantly enhance the effectiveness, accessibility, and engagement of MSL education for a diverse range of learners.

2. Literature Review

Sign Language learning provides a general idea of the advantages and needs of studying sign language. It targets a diverse audience, including students looking to enhance their cultural awareness and communication skills, educators aiming to establish inclusive learning environments, parents seeking effective communication with their hard-of-hearing or deaf children, and professionals in healthcare, customer service, or education, where sign language proficiency can improve interactions with the Deaf community [6]. It promotes inclusive communication, leading to a wide range of professional options, particularly in professions that involve working with deaf people. Additionally, it promotes cultural appreciation and strengthens social connections by reducing communication barriers. The demand for sign language learning is clear among individuals with hearing impairments, professionals looking to enhance their career prospects, students and educators working to create inclusive learning environments, and parents wanting to communicate effectively with deaf family members or friends.

There are several ways to learn sign language, including in-person instruction, websites, videos, and books. Learning sign language in a classroom is not only easier to understand but also helps deaf students master the material [7]. It allows deaf learners to ask questions and express their opinions or ideas. Furthermore, sign language boosts their confidence in communication and improves their concentration in the classroom [8]. Meanwhile, video-based instruction enables learners to observe the handshapes, movements, and facial expressions used in signing visually [9]. This visual element is crucial for accurately understanding and replicating signs. Alternatively, websites are primarily used by self-learners for learning sign language. This is because they allow individuals to set their own goals, determine what is valuable to learn, and take initiative and responsibility for their learning [10]. Sign language books provide an in-depth exploration of visual-manual communication, covering the grammar, vocabulary, and cultural importance of signed languages. With detailed analysis and practical insights, they aim to give readers a nuanced understanding of sign language, appealing to both learners and enthusiasts.

AR is the integration of virtual elements into the real world to enhance sensory experiences, including visual, auditory, tactile, and olfactory sensations [11]. This aligns with the idea that AR enriches user perception by adding digital elements to their physical surroundings. Users can interact with AR objects through haptic feedback, such as touching their mobile device screens, to seamlessly manipulate virtual content [12]. In essence, AR combines digital information with the real world in real-time, overlaying virtual images onto our physical

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environment [13]. Furthermore, AR shows significant potential for pedagogical applications in education. It has been utilized as an educational tool for various purposes, including collaboration, cultural exploration, digital storytelling, and interactive learning [14].

Multimedia elements are crucial for facilitating sign language learning. Students can learn more effectively and actively when multimedia teaching tools such as pictures, videos, music, and interactive elements are used [15]. Video is a key multimedia element that provides text, animation, and visuals for learners [16]. By carefully observing hand shapes, body placement, and facial expressions, learners can follow along with instructors demonstrating sign language. Additionally, videos allow individuals to watch real communication scenarios, helping them better understand the context. Despite the availability of various multimedia elements for learning sign language, they are often insufficient and lack certain components, making learning challenging for some individuals. Therefore, it is necessary to develop an application that incorporates comprehensive multimedia elements to make learning sign language more efficient and interactive.

Assessment in learning is a process that generates feedback on an individual's knowledge after completing the learning process [17]. It encourages active thinking in learners. Various assessment methods, such as exams, presentations, and quizzes, can be used to evaluate individual knowledge. A quiz is a game or competition in which people answer questions to test their knowledge. Students are highly engaged with online quizzes because they view them as a motivational tool to keep up with assigned readings [18]. Similarly, a quiz designed specifically for sign language learners can be a valuable tool to reinforce and assess their understanding. An examination is more formal than a quiz and can determine whether a student passes or fails a class. Unlike quizzes, examinations are typically longer, cover the entire course material, and are held in specific locations [19]. They also contain more questions and can include various formats such as multiple-choice, fill-in- the-blank, and true/false questions [19].

3. Methodology

The Multimedia Development Life Cycle (MDLC) is a systematic approach to developing multimedia applications [20]. This project was developed based on MDLC methodology with comprising six phases: Concept, Design, Material Collection, Assembly, Testing, and Distribution phases.

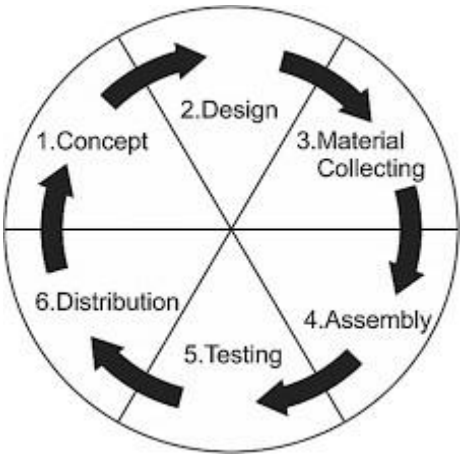

Fig. 1 *The Method Phases of MDLC [20]*

In the initial phase, the project team outlined the broad concept for the AR app, focusing on understanding its objectives and target audience. The app aimed to simplify MSL learning, especially focusing on days and months, using interactive AR technology. The target audience included beginners to advanced learners, such as students, educators, and MSL professionals.

During the design phase, the project team creates the visual style, flow diagrams, user interface, and quiz features for the AR application. Flow diagrams illustrated user navigation and integration of MSL book content, while the user interface focused on enhancing engagement. This phase serves as a reference for subsequent development stages, aligning with project objectives and user requirements.

Fig. 2 shows MSL Book with AR (English - Malay), which served as the target for AR interactions within the application. This book was developed to enhance the learning experience of users.

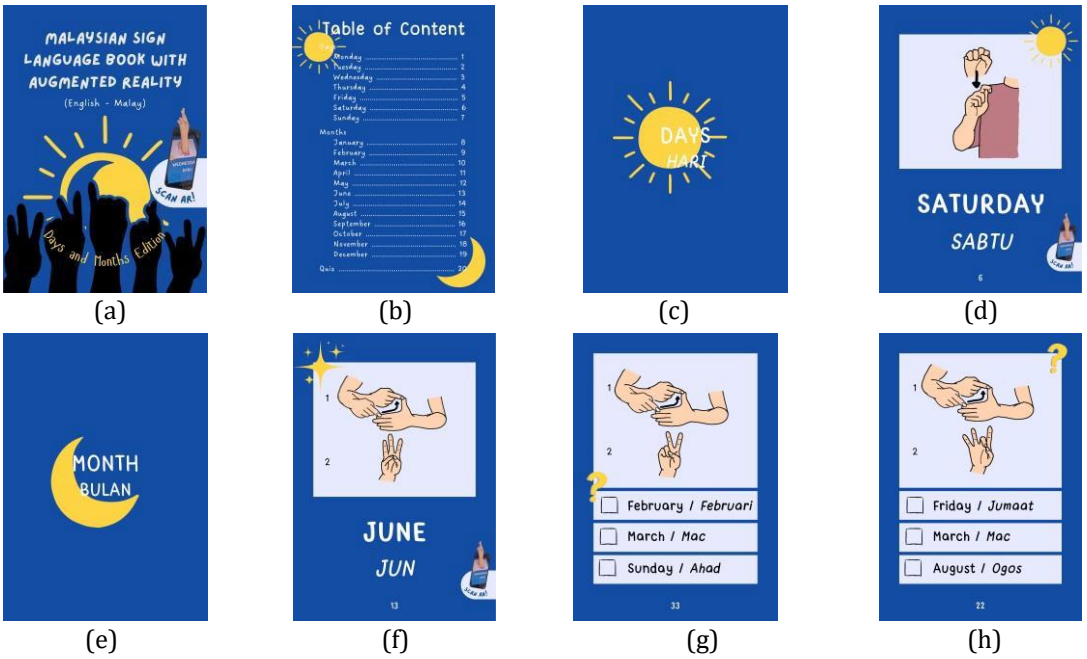

Fig. 2 *MSL Book with AR (English - Malay) (a) Cover Page; (b) Table of Contents; (c) Days Intro; (d) Sign Example; (e) Months Intro; (f) Sign Example; (g) Quiz Page; (h) Quiz Page*

Fig. 3 shows the app interface, which prioritizes simplicity and usability. It included intuitive navigation menus and clear visual cues, facilitating easy navigation through different sections.

Fig. 3 *MalARSign App (a) Main Menu; (b) Instructions Menu; (c) AR Scanning; (d) Quiz Categories; (e) Quiz Question; (f) Dictionary Menu; (g) Month Selection; (h)* Days Selection

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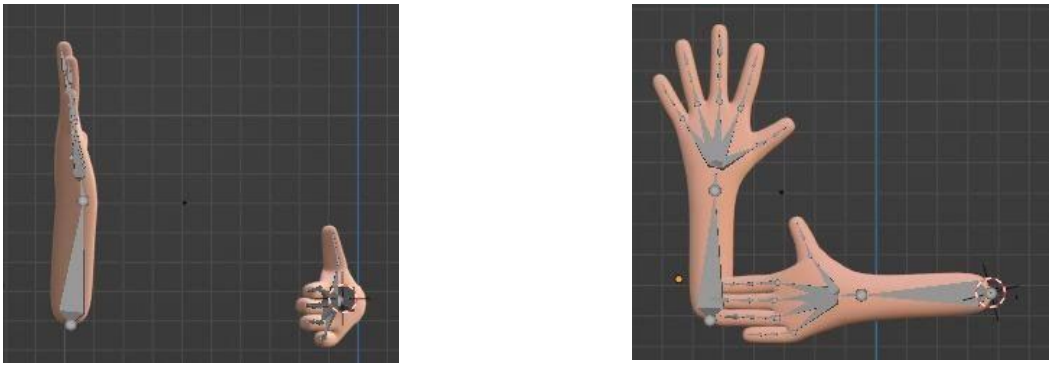
After the design phase, material collection began to gather resources essential for crafting 3D hand models, designing the book, and developing the application. Thorough documentation and expert consultations ensured the accuracy and usefulness of the collected materials, laying a solid foundation for subsequent development phases and the final AR application for learning MSL. Fig. 4 shows a 3D model created by our team using Blender. This model served as a crucial element within our AR application.



(a) (b)

Fig. 4 *3D hand Model (a) Forearm model; (b) Arm Rigging*

During the assembly stage, integration with the MSL book content ensures a seamless learning experience. Blender was used to craft accurate 3D hand models with proper rigging and animation while Vuforia provided reliable AR tracking. In Fig. 5, Unity served as a flexible framework for integrating 3D models, animations, and AR features, with an intuitive user interface for quizzes and MSL sign access.

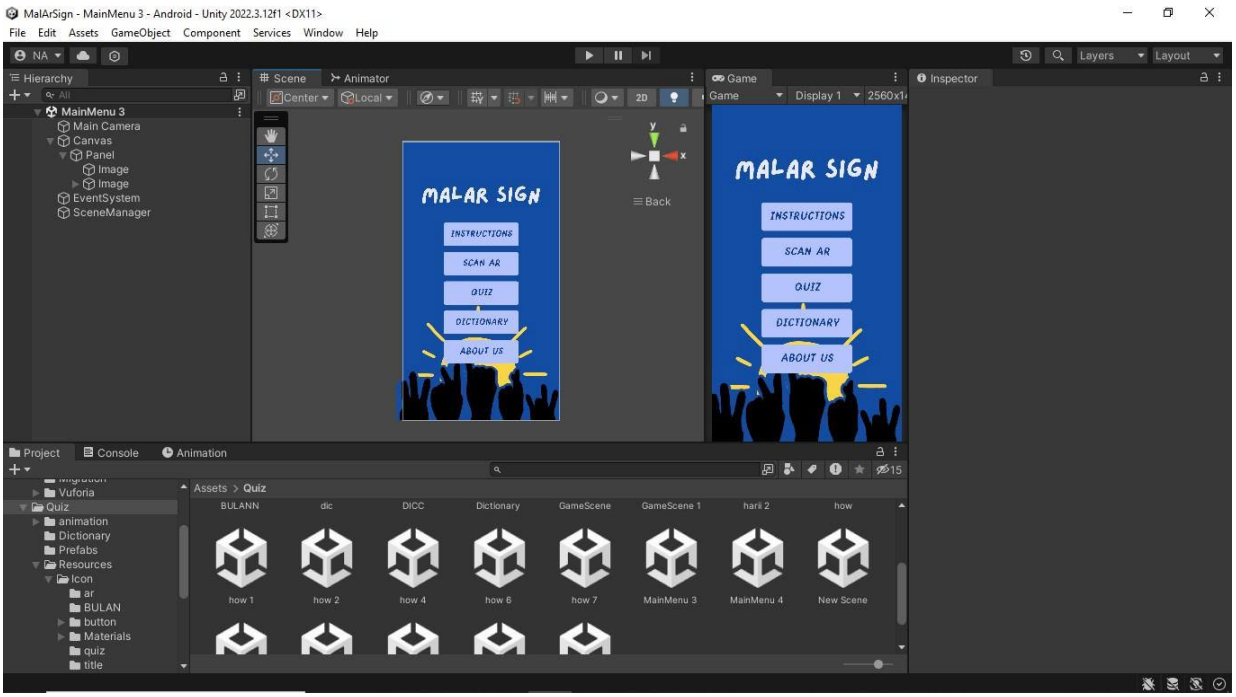


Fig. 5 *Unity software*

After creating the AR application, it underwent thorough testing to ensure it ran smoothly. User feedback was collected via questionnaires to identify issues. Alpha testing focused on internal checks for severe issues, while Beta testing gathered real-world feedback. Feedback drove incremental improvements to optimize the user experience, interface, and educational content. Final validation ensured performance and quality meet project objectives and user expectations.

In the final stage, the MSL book and completed AR application were packaged together as an Application Package File (APK) file. A final quality assurance check ensured the application was error-free. This final stage was essential for maximizing the reach and impact of the educational tool within the target audience.

4. Results and Discussion

This MSL book and application underwent testing by 13 users, as outlined in Table 1. While this sample size may appear small, Nielsen indicates that 5-20 users are typically sufficient to identify the majority of usability issues within a system or application [21]. Before the testing session, users received a briefing on the background of the book and the application. It was essential to provide this context to ensure users had a clear understanding before they engaged with the book and tested the application. Following this briefing, the users proceeded to test the pre-developed application, navigating through its features and functionalities. They then shared their feedback and opinions via a prepared Google Form, providing valuable insights for further development.

Table 1 displays the overall satisfaction percentage rating for the Malaysian Sign Language Book with AR Days and Months Edition. The ratings are based on a scale from strongly disagreement to strongly agree. Overall, most respondents expressed high satisfaction with the concept of the MSL book with AR features and the combination of conventional book elements with AR technology. However, there is still a portion who rated their satisfaction lower, indicating room for potential improvements or further enhancements in future editions.

Table 1 *Overall Satisfaction Percentage Rating*

No	Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1.	The concept of a Malaysian Sign Language (MSL) book with AR features helps learn basic signs.	0%	0%	7.69%	30.77%	61.54%
2.	The combination of traditional book elements and AR technology enhances my understanding of MSL.	0%	0%	7.69%	38.46%	53.85%

Table 2 presents the percentage ratings of user experience with MSL AR features, assessed on a scale from strongly disagree to strongly agree. This section details the key findings and outcomes achieved through the project's combined learning approach, which utilizes an AR application alongside a companion MSL book.

Table 2 *AR features Percentage Rating*

No	Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1.	The 3D visualization of MSL gestures is clear and helpful.	0%	0%	0%	61.54%	38.46%
2.	Using AR technology makes learning MSL more interactive and enjoyable.	0%	0%	0%	38.46%	61.54%
3.	I can easily connect the MSL application with the book's AR features.	0%	0%	7.69%	61.54%	30.77%
4.	The AR features help to learn MSL better than just going through the book.	0%	0%	15.38%	30.77%	53.85%

The results and findings on combined learning approach are below:

i) **Enhanced User Engagement**
User testing revealed a significant increase in user engagement compared to traditional MSL learning methods. The interactive elements of the AR application (3D models, quizzes) fostered a more stimulating learning experience. Table 2 indicates that 61.54% of users agreed and 38.46% strongly agreed that the 3D visualization of MSL gestures is clear and helpful, demonstrating high engagement levels with the AR features.

ii) **Improved Learning Outcomes**
Data from the interactive quizzes within the AR application indicated a positive correlation between engagement and knowledge retention. Users who actively participated in the quizzes demonstrated a deeper understanding of the presented MSL signs. As shown in Table 2, 38.46% of users agreed and 61.54% strongly agreed that using AR technology makes learning MSL more interactive and enjoyable, which is likely to enhance learning outcomes.

iii) **Bridging Physical and Digital Learning**
The complementary nature of the MSL book (focusing on days and months) and the AR application was well-received by users. The book provided foundational knowledge, while the AR application offered a more interactive way to practice and solidify learning. According to Table 2, 61.54% of users agreed and 30.77% strongly agreed that they could easily connect the MSL application with the book's AR features, indicating effective integration of physical and digital learning tools.

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iv) **User-Centered Design Benefits**
By adhering to user-centered design principles, the AR application effectively catered to the specific needs of MSL learners. User feedback gathered during testing phases played a crucial role in refining the application's features and ensuring its usability. The positive feedback on the AR features, with 30.77% of users agreeing and 53.85% strongly agreeing that AR features help learn MSL better than just going through the book (Table 2), underscores the benefits of a user-centered design.

v) **Potential for Accessibility Improvement**
The combined approach demonstrates the potential of AR to enhance the accessibility of MSL education. The visual nature of the AR application can be particularly beneficial for learners with auditory processing difficulties. The high ratings for the AR features (Table 2) suggest the AR application is well- received and can improve accessibility in MSL education. The current iteration of the AR application focuses on a limited vocabulary set (days and months). Future development is needed to expand the content library and cater to a wider range of learning objectives. Device compatibility considerations are ongoing. While the project prioritized accessibility, ensuring broader compatibility across various devices will further enhance inclusivity.

Overall, the combined learning approach utilizing an AR application and a companion book has yielded promising results. The project successfully demonstrates the potential of AR to create a more engaging and effective learning experience for MSL, paving the way for further exploration and development in this field.

5. Conclusion

In conclusion, this project successfully achieved its objectives by creating an MSL book focused on days and months, developing a complementary mobile application with AR functionality, and enhancing interactive learning through a quiz feature. The project focuses on developing an AR application to enhance the learning of MSL. Key achievements include creating a multimedia-rich MSL book and a mobile application that bridges physical and digital learning resources using AR technology. This innovative approach aims to address the limitations of conventional MSL learning methods by offering interactive 3D models, animations, and quizzes. Future recommendations include expanding the content beyond days and months and ensuring broader device compatibility to maximize accessibility.

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Conflict of Interest

The authors declare there is no conflict of interests regarding the paper's publication.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Basirah binti Ayob Ali;* ***data collection:*** *Nur Basirah binti Ayob Ali; Nurin Batrisyia binti Bohanuddin, Wan Nur Amni Humaira binti Wan Mohd Nasrudin;* ***analysis and interpretation of results:*** *Nurin Batrisyia binti Bohanuddin;* ***draft manuscript preparation:*** *Nur Basirah binti Ayob Ali, Nurin Batrisyia binti Bohanuddin, Wan Nur Amni Humaira binti Wan Mohd Nasrudin. All authors reviewed the results and approved the final version of the manuscript.*

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