International Journal of Creative Multimedia

Developing an Augmented Reality Animation Prototype for Teaching Hijaiyah Letters for Deaf Children: A Preliminary Study

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Abstract

Teaching Hijaiyah letters to deaf children presents unique challenges due to limited access to specialised educators and appropriate instructional tools. This study explores the development of a prototype teaching aid that integrates Augmented Reality (AR) and animation to support Islamic education among hearing-impaired children in Malaysia. Every deaf individual must acquire sign language proficiency in order to effectively interact with other deaf individuals. Introducing individuals, particularly children, to sign language and Hijaiyah letters at an early age is crucial. This knowledge is essential for every Muslim individual to acquire before they can read the Al-Quran. Introducing Hijaiyah letters through sign language at an early age may support comprehension among deaf children, who often face difficulties in conventional classroom setting. The research employed a qualitative and quantitative approach, involving semi-structured interviews with two experts in Islamic education and special needs, as well as questionnaire completed by 30 teachers experienced in teaching sign language. Findings indicate that the visual and interactive elements of AR and animation have strong potential to enhance engagement and comprehension among deaf learners. Respondents expressed positive feedback toward

International Journal of Creative Multimedia (2025) 6, 1, 135-160
doi: https://doi.org/10.33093/ijcm.2025.6.1.9

Published by MMU PRESS. URL: https://journals.mmupress.com/index.php/ijcm

the design, particularly in terms of colour schemes, character style and the sing-along concept adapted for children with hearing aids. However, the study acknowledges limitations in sample size, the absence of classroom-based testing and a lack of alignment with formal instructional design models. This study contributes to inclusive education discourse by offering design insight for culturally and linguistically appropriate teaching aids. While the project is at a prototype stage, it lays the groundwork for further development and evaluation of an AR-integrated Islamic learning tool for deaf children in formal and informal educational settings.

Keywords Sign language; Deaf children; Hijaiyah letters; Animation; Augmented reality
Received: 8 October 2024, **Accepted:** 16 April 2025, **Published:** 30 April 2025

Introduction

The integration of augmented reality (AR) technology into educational tools for deaf children represents a significant advancement in facilitating learning, particularly for subjects like Hijaiyah letters. AR allows users to interact with both virtual and real elements simultaneously by overlaying digital content onto the real world, thus creating an immersive learning experience. Studies have shown that AR can significantly improve student performance by offering more authentic and interactive learning opportunities (Azhar et al., 2022).

Animation, a dynamic visual medium, plays a crucial role in education by enhancing the comprehension and engagement of learning materials (Mansor et al., 2020). Animation in teaching aids for Arabic Sign Language (ArSL) can improve the learning experience for deaf students by providing visual representations of sign language, which is essential for their understanding of the Quran and other Islamic studies. Research indicates that combining animation with AR can transform traditional classroom settings into dynamic and interactive learning environments, thereby improving student motivation and learning outcomes (Tambi & Awang, 2020). This approach aligns with the educational needs of deaf children, who benefit from visual and interactive teaching methods. Despite the potential of AR and animation, challenges to their implementation in education include limited accessibility and the need for specialised teaching aids. This study addresses these issues by developing an AR animation teaching aid for deaf children to learn Hijaiyah letters.

The project aims to bridge the gap in resources and provide an effective learning tool accessible via smartphones and tablets. The teaching aid prototype is designed to create an inclusive and engaging environment by focusing on foundational Hijaiyah letters with AR and animation elements intended to enhance visual learning (Abu Bakar et al., 2019).

Figure 1. A Scene from the Animation

Literature Review

Sign Language

Sign language is the primary communication tool for deaf or hearing-impaired individuals, encompassing a range of hand shapes, motion profiles, and positions of the hand, face, and body parts. Non-manual signals, such as movement of the brows, mouth, head, shoulders, and eyes, are also critical. Even the slightest movements of the brows, mouth, head, shoulders, and eyes can have a significant effect (Bragg et al., 2019). For clear communication, one must accurately perform the five (5) parameters of sign language, which include hand shape, palm orientation, movement, location, and expression or non-manual signals (Rastgoo et al., 2021).

In 2019, the World Health Organisation reported that approximately 466 million people, including 34 million children, have hearing disabilities. These numbers are expected to double over the next three decades. This underscores the importance of sign language in facilitating communication between hearing impaired individuals and the broader population. Various countries and cultures have developed and standardised different sign languages, such as American Sign Language (ASL), British Sign Language (BSL), and Arabic Sign Language. However, there is no universal sign language for global use (Saleh & Issa, 2020).

In Malaysia, sign language is divided into two types: Bahasa Isyarat Malaysia (BIM) and Kod Tangan Bahasa Melayu (KTBM). Mr. Tan Yap introduced BIM in the early 1960s, and the deaf-mute community uses it as their primary sign language for daily communication (Dayana & Rana, 2022; Khan et al., 2021). ASL has influenced BIM, but it differs from Indonesian Sign Language. In educational settings, KTBM serves as the formal language for teaching students with hearing disabilities, assisting them in completing the Sijil Peperiksaan Malaysia (SPM) (Zaini & Che Ahmad, 2023).

Arabic Sign Language

In Arab countries, where approximately 4% of the population experiences hearing impairment, Arabic Sign Language (ArSL) serves as the primary sign language. ArSL is completely distinct and independent from spoken and written Arabic, which has its own unique grammatical rules, syntax, and structure. However, ArSL connects to Arabic through the use of Hijaiyah letters. These thirty letters are essential for reading the Al-Quran and are a foundational element of a Muslim's religious practice.

Proficiency in Hijaiyah letters is crucial for religious purposes, as well as for the development and use of ArSL. This familiarity with Hijaiyah letters creates a unique bridge between ArSL and written Arabic, enhancing the communicative and educational experiences for those who are deaf or

hard of hearing in the Arab world. The shared knowledge of Hijaiyah letters provides a common linguistic ground that enriches the learning process, which facilitates the connection between ArSL and written Arabic.

Furthermore, this connection serves to foster a deeper cultural and religious integration for deaf individuals, ensuring they have access to the same religious texts and practices as their hearing counterparts. It also aids in educational settings, where understanding Hijaiyah letters can facilitate the learning of both Arabic and ArSL, thus promoting bilingual proficiency. Educators and communicators can create a more inclusive environment that respects and incorporates the linguistic and cultural heritage of Arabic-speaking communities by integrating these letters into ArSL. This dual literacy not only enhances communication but also supports the personal and academic growth of deaf individuals, allowing for greater community participation.

Animation

Animation in education has emerged as an effective tool for presenting multimedia materials, significantly aiding students' understanding and retention of knowledge. Interactive animations provide an engaging learning medium, contrasting the often monotonous traditional classroom environment where students passively listen to teachers. Animation captivates learners with the combination of visual motion and audio explanations, effectively conveying complex lesson content. As a key multimedia element, animation can enhance the teaching and learning process by transforming human imagination into tangible experiences.

This study references existing animation-based Arabic language tools and examines their potential relevance for special needs education, particularly for Hijaiyah instruction. Integrating animation technologies with language teaching aids can positively impact student performance, learning environments, and motivation. Furthermore, animations can cater to different learning styles, enhancing the accessibility and inclusivity of lessons. They also can break down complex topics into manageable segments, making it easier for students to grasp difficult concepts.

Additionally, the dynamic nature of animation helps in sustaining student interest and engagement for extended periods, which is crucial for effective learning. Incorporating animation into educational strategies enables educators to create a more stimulating and interactive learning environment that supports academic achievement and fosters a love for learning.

Education

Education is a fundamental right for all individuals, including those with disabilities, regardless of their background. The education system in Malaysia is committed to ensuring that all students receive equal attention, including those with special needs, known as Murid Berkeperluan Khas (MBK). MBK encompasses various categories such as visual impairments, hearing impairments, and learning disabilities. Research emphasises the importance of dynamic and adaptive mechanisms to keep pace with global changes, which are essential for both general and special education.

Special education programs specifically cater to the unique needs of MBK students. These programs are designed to accommodate children who are intellectually, physically, socially, or emotionally different from their peers and do not exhibit typical development. According to the Ministry of Education Malaysia (MOE), children with learning difficulties are characterised by low mental abilities and behaviour modification challenges.

Behaviour modification issues refer to the inability to perform daily tasks and meet social expectations appropriate for their age. This includes difficulties in adapting to social norms, managing personal care, and effectively interacting with others. Low mental capacity is defined as a reduced ability to learn or respond to educational stimuli, in which is characterised by slower cognitive processing, difficulties in understanding and applying new information, and challenges in problem-solving. These combined factors affect their educational outcomes, understanding the need for differentiated instruction and supportive learning environments.

Special education programs are crucial in providing these students with the tools, resources, and environments that cater to their specific developmental needs. These programs help students with disabilities achieve their full potential, fostering greater independence and more fulfilling lives. This includes individualised education plans (IEPs) that outline specific learning goals and the strategies to achieve them, as well as the integration of assistive technologies and specialised teaching methods.

Furthermore, special education emphasises the development of life skills and social competencies, in addition to academic achievement. This holistic approach ensures that students with disabilities can navigate daily life with greater confidence and participate more fully in their communities. In this way, special education programs are essential in promoting inclusivity and equal opportunities for all students, regardless of their abilities.

Teaching Aid

Teaching aids include various technologies such as computers and DVDs, instructional tools such as books, chalkboards, and pictures, as well as objects such as specimens, maps, and globes. These aids assist teachers in streamlining the teaching-learning process, making it more effective and efficient. According to (Mohd Herrow & Azraai, 2023), modern technology serves as an innovative tool for teaching and learning, allowing educators to enhance the teaching and learning experience by providing interactive study materials. Educators can enhance classroom instruction, capture students' attention, and motivate them to learn by utilising teaching aids. Instructional materials improve the learning process by increasing engagement and saving time. Teaching aids have the potential to support comprehension, clarify abstract concepts and adapt instruction to various learning preferences, alleviating anxiety or boredom by presenting information in an innovative and engaging manner.

Expanding on this, teaching aids can cater to various learning styles, ensuring that the instruction is beneficial to visual, auditory, and kinesthetic learners. For instance, visual learners can better understand and retain information by utilising charts, diagrams, and videos, while auditory learners can benefit from audio recordings and discussions. On the other hand, kinesthetic learners engage more effectively through hands-on activities and real-life specimens. Additionally, teaching aids can bridge the gap between abstract concepts and real-world applications, making learning more relevant and meaningful. They also encourage interactive learning, enabling students to actively participate in the lesson rather than passively receiving information.

The significance of this research lies in its ability to teach students in a way that is enjoyable, interactive, and engaging. Implementing simulation types will undoubtedly serve as an effective teaching aid to university students (Zainurin et al., 2024). This active participation fosters a deeper understanding and retention of the material. Moreover, inclusive classrooms can greatly benefit from the adaptation of teaching aids to cater to the diverse needs of all students, including those with special educational needs. Educators can create a dynamic and supportive learning environment that promotes curiosity, critical thinking, and a lifelong love of learning by integrating a variety of teaching aids.

Augmented Reality (AR)

Recently, the incorporation of technology in education has seen a significant rise. Technology in classrooms can enhance learning experiences and make them more enjoyable for students. Interactive multimedia, which includes elements such as text, music, animation, video, and graphics, is particularly beneficial as a teaching tool for students with disabilities. These interactive tools can greatly improve the learning skills of students with disabilities. Augmented reality (AR) and flash cards are additional methods that facilitate interactive learning. The implementation of AR in educational settings provides

various learning advantages and boosts overall academic performance. According to Jamaludin et al. (2025), augmented reality offers an engaging and interactive learning experience that enhances understanding, improves retention, and fosters greater interest among youth, making cultural education more accessible and impactful.

In the current technological era, AR has become an increasingly popular research topic in education, as it is used to enhance and facilitate learning and teaching processes. AR is the process of enhancing the real-world environment by overlaying virtual information onto it, such as 3D animations or images, using a camera that is seamlessly linked with the AR application. Utilising AR in education can improve students' memory recall and make learning more engaging. Research has shown that the use of AR applications to study prayer can enhance student engagement and comprehension of the material, as evidenced by improved scores before and after the application was implemented.

AR also enhances language abilities and academic performance. Additionally, AR encourages creative thinking, collaboration, and active participation, while alleviating fear. The utilisation of AR as a teaching aid, especially for students with special needs, can significantly improve their education. Categorical vocabularies and languages are often challenging for individuals with special needs to acquire and apply in various contexts (Cakir & Korkmaz, 2018). AR has a substantial impact on children, who are highly attracted to visual stimuli. Hence, AR can be employed as a teaching aid for deaf children to facilitate their early education in Hijaiyah letters, as supported by preliminary studies highlighting AR's potential benefits for learners with disabilities. Integrating AR into educational programs for deaf children creates an immersive and interactive learning environment that captures their attention and aids in the retention and understanding of Hijaiyah letters, thus enhancing their educational experience.

Flash Cards

Flashcards are a widely recognised tool in language learning, particularly for understanding, learning, and memorising letter sounds, forms, and vocabulary. Using flashcards as a teaching aid is particularly beneficial for students with disabilities because they help them better comprehend teachers' instructions. The vibrant colours and interactive nature of flashcards can capture children's attention and improve their understanding of the material presented.

Many educators and researchers have validated the effectiveness of flashcards in helping students memorise and recall letters long-term. Consequently, employing flashcards as a teaching tool for deaf children is highly effective, as it helps them identify Hijaiyah letters and understand their meanings. This method not only supports the recognition of individual letters but also enhances the

overall learning experience by fostering a more engaging and interactive environment. Flashcards provide a practical and enjoyable way for deaf children to learn and retain new information, as they may rely more on visual stimuli. The consistent use of flashcards can also build a solid foundation for literacy skills, making them an invaluable resource in special education settings.

Previous Teaching Aid

Table 1 summarizes previous sign language-related applications targeted at individuals with hearing impairments. Quran Isyarat is an interactive educational software that aims to help the Muslim deaf community in understanding the essential aspects of Islam. The Faculty of Quran and Sunnah created the curriculum to ensure equal educational opportunities for deaf children, adhering to the standards set by KAFA (Kelas al-Quran dan Fardu Ain) and other Islamic institutions. Quran Isyarat solely focuses on surah in the Al-Quran, whereas our project solely concentrates on the Hijaiyah letters, as our target audience differs.

Table 1. Previous research products for sign language

Product	Description	Advantage	Disadvantage
Quran Isyarat (USIM) (Ramli et al., 2022)	The first application for the hearing-impaired community in Malaysia. Offers all *surah* in Al-Quran.	Visual reference for users to follow throughout the *surah*.	Videos of the *surah* did not have translation for each sign language word.
Mushir (Alnasif, et al., 2022)	To support children who are deaf and hard of hearing in learning the basics.	Children can interact with the learning material through the image-processing feature and games.	Only available on Android.
Lingvano (Kore et al., 2023)	An online platform for learning sign languages with interactive lessons.	Learn conversational dialogues that can be applied in real-life situations.	Only consists of American Sign Language (ASL), British Sign Language (BSL), and Austrian Sign Language (EOGS). Only get a 7-day free trial to learn sign language.
ASL Kids (ASL Kids, 2015)	Provides a collection of American Sign Language (ASL) to facilitate the learning of hard-of-hearing children.	The Internet is not needed, and there are no external links or ads.	Need to purchase the premium version to access additional words.

Figure 2. Quran Isyarat Application

The Mushir application aims to facilitate the learning of essential knowledge in Arabic Sign Language (ArSL), including letters, numbers, shapes, and colours, for youngsters who are deaf or hard of hearing. The enhancement of program interactivity is accomplished by employing image processing techniques. This application is exclusively accessible to Android users, but our product is compatible with both Android and iOS platforms.

Figure 3. Lingvano Application

Lingvano is an online platform for learning sign languages, with interactive lessons to help users develop the skills needed for real-life communication. Lingvano only offered American Sign Language (ASL), British Sign Language (BSL), and Austrian Sign Language (EOGS). Lingvano also features numerous dialogue clips where individuals use sign language, accompanied by English subtitles. It includes a sign language mirror option, enabling users to replicate signs while viewing their image for feedback. Although it aids learning, it does not translate signs into text or audio. The service offers a seven-day free trial period for customers to take advantage of. Our project does not provide users with a free trial. However, people can watch at any time without incurring any charges. Users can listen to the pronunciation of words while learning Hijaiyah sign language.

Figure 4. ASL Kids Application

ASL Kids is an application that provides a collection of American Sign Language (ASL) resources to facilitate the learning and assessment of deaf and hard-of-hearing children. This application involves fingerspelling letters, allowing the child to see the letters and their corresponding hand signs.

Unlike ASL Kids, which limits free access to vocabulary, the proposed prototype offers unrestricted educational access to Hijaiyah letters in sign language for deaf children to learn.

Methodology

This research employed semi-structured interviews and a two-part questionnaire to gather user and expert insights for the development of the teaching aid in Islamic education for deaf students. Semi-structured interviews were conducted with two experts: the Director of the University Education Centre at University Sains Islam Malaysia and a teacher specialising in Islamic education for students with special needs. Their responses were analysed using content analysis to identify key themes and insights.

The first questionnaire was intended to facilitate the design of an interactive AR animation as a teaching aid for deaf children. The second questionnaire focused on collecting personal information and feedback on the animation and flashcards to assess their effectiveness in improving communication skills among deaf youngsters. Both questionnaires were analysed descriptively.

Semi-Structured Interview

The interview was conducted with two (2) different individuals. The first interviewee is a Professor Madya from Pusat Penyelidikan Ibnu Ummi Maktum (UMMI) at Universiti Sains Islam Malaysia, who holds a Ph.D. in Islamic Studies and has been serving as the Director of the University Education Centre since November 2023. The second interviewee is a teacher who specialises in Islamic education for students with special needs. He holds a master's degree in Islamic education from Universiti Kebangsaan Malaysia (UKM) and has been teaching since 2012.

The purpose of these semi-structured interviews was to gain a deeper understanding of sign language and Hijaiyah letters. The questions were divided into sections: getting to know the interviewees and enquiring about sign language. Both interviews utilised content analysis to examine the responses.

Content analysis was used to extract key themes and insights from the expert interviews, topics, or concepts in qualitative data. The responses of the professor and the teacher to questions about sign language in Malaysia were thoroughly analysed. The researcher carefully examined each word uttered by the interviewees to derive meaningful insights.

Quantitative

Two structured questionnaires were distributed to 30 teachers specializing in Islamic education and sign language. The first questionnaire is divided into five sections: personal information, animation,

augmented reality (AR), sign language, and concept. It focuses on the design of an interactive AR animation as a teaching aid for deaf children. The second questionnaire has sections on personal information and feedback on the animation and flashcards used in improving communication skills among deaf youngsters. Both questionnaires employ descriptive statistics for analysis.

The questionnaire results were analysed using descriptive statistics to summarize teacher feedback on visual and interaction design preferences. This involves statistical measures like mean, median mode, standard deviation, and range, which help understand the central tendency, variability, and overall distribution of the data. Tables, graphs, and charts often display the findings, facilitating in visualisation and interpretation of the data.

This study examines responses from teachers who specialise in sign language for students with special needs. The first questionnaire aims to design an AR animation teaching aid, while the second assesses its effectiveness. This approach helps analyse and summarise the teacher's feedback, potentially assisting children with hearing impairments in learning Hijaiyah letters using animation and flashcards.

Product Development

The development process involved concept ideation, stakeholder feedback, iterative prototyping and design refinement informed by survey responses, organising technical aspects and resource allocation, producing prototypes or storyboards to visualise concepts, making repeated attempts based on feedback and testing, refining visual and narrative elements, working together with fellow students and teachers, presenting final animations for evaluation and approval, preparing assets for production, and improving storytelling and technical execution by refining animations based on feedback throughout the project.

To ensure a structured and pedagogically grounded development process, this project was conceptually aligned with the ADDIE instructional design framework, which consists of five iterative phases: Analysis, Design, Development, Implementation and Evaluation. In the Analysis phase, expert interviews and teacher questionnaires were conducted to identify learner needs, visual preferences and pedagogical challenges specific to deaf children learning Hijaiyah letters. During the Design phase, key educational and visual elements such as colour schemes, character styles and animation cues were planned in accordance with the collected feedback. The Development phase involved producing storyboards, character turnarounds and an interactive AR prototype. While the formal Implementation and Evaluation phases were not executed in classroom settings due to the project's early stage, teacher feedback on usability and effectiveness served as formative evaluation input. Aligning with ADDIE

ensures that the tool development remains adaptable, learner-centred and ready for future testing in authentic instructional context (Branch, 2009; Aldoobie, 2015).

Pre-production

In the pre-production phase, the project begins with identifying the idea of the animation by writing the script of the story, storyboard, concept art, characters, and background design. The storyboard plays a key role in this project because it will show the flow of the animation. In addition, concept art will help to visualise the animation.

Idea

The animation concept involves choosing an appealing topic that attracts the audience's attention and addresses an issue in current resources. The objective of this project is to develop a new solution to support the education of hearing-impaired or deaf children by teaching them Hijaiyah letters using sign language. Despite the increasing use of AR and animation in education, few initiatives specifically address the teaching of Hijaiyah letters to deaf learners. The purpose of establishing this concept is twofold: to provide an exceptional educational resource and to raise awareness of the significance of providing fair education for those who are deaf. This project aims to highlight the importance of granting deaf individuals equal access to high-quality education, similar to that of hearing individuals.

Script

The next step after establishing the concept for the animation is to develop a detailed script. The script will function as a detailed plan for the animation, defining the storyline, conversation, visual components, and educational materials. This script should be meticulously crafted to effectively teach Hijaiyah letters through sign language, engage the target audience, and raise awareness about the educational needs of deaf individuals. The animation can provide a thorough and fun learning experience for hearing-impaired youngsters by including captivating graphics, detailed sign language examples, and interactive features.

Storyboard

A storyboard is a visual representation of a narrative, laid out in sequence of drawings or images, typically with accompanying notes. It serves as a blueprint for a project, which is often used in animation. Storyboards break down narratives from the script into individual frames. The storyboard allows creators to explore and refine the story's pacing, visual composition, and overall structure.

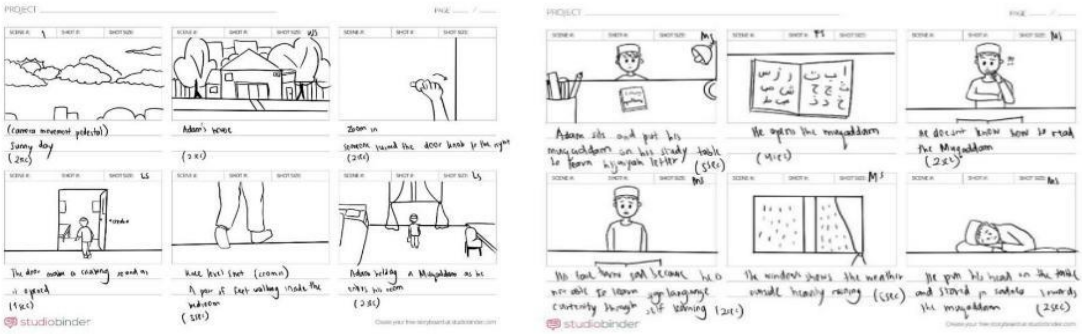

Figure 5. Storyboard Design Process

Characters and Background Design

The characters and background design for this animation were carefully created based on the information gathered from the questionnaire responses. This method guarantees that the project closely complies with the respondents' expectations and preferences. The input specifically dictated the character's visual design, indicating a preference for a chibi-style characterised by its charming and exaggerated features over a semi-realistic one. Furthermore, the respondents' feedback was taken into consideration when choosing the colour palette for the characters, indicating a definite preference for cool colours over warm ones.

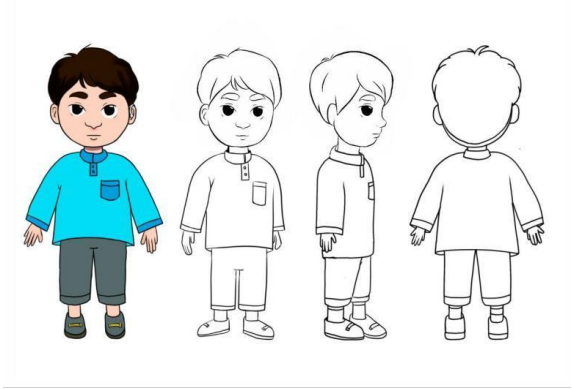

Figure 6. Character Turn Around - Adam

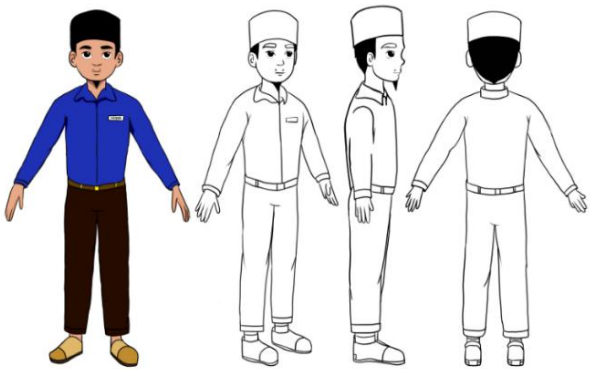

Figure 7. Character Turn Around - Ustaz

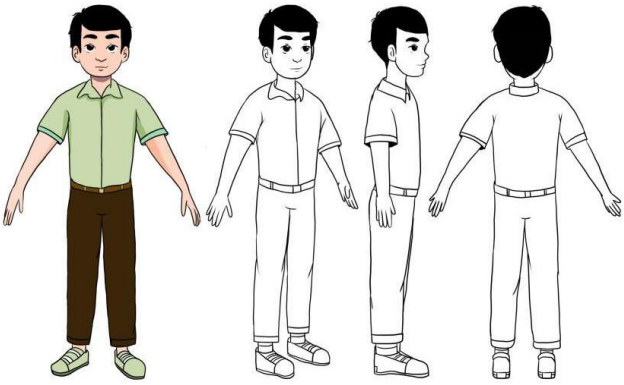

Figure 8. Character Turn Around - Adam's Dad

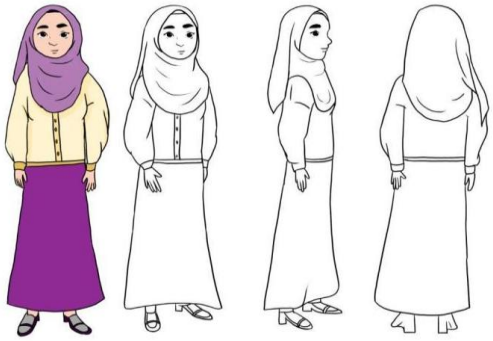

Figure 9. Character Turn Around - Adam's Mother

A total of 17 respondents, or 56.7%, preferred a classroom setting as the background design. A minimalistic bedroom style was another popular choice among the respondents. This indicates a strong preference for educational environments that resemble traditional learning spaces, while also appreciating the simplicity and comfort of a minimalistic bedroom design. The classroom setting likely appeals due to its familiar and structured environment that is conducive to learning, whereas the minimalistic bedroom style offers a clean, distraction-free space that can enhance focus.

Figure 10. 3D Background Design

Production

The production process starts with a rough sketch of the animation, inbetweening key poses to create a smooth motion. This is then followed by the clean-up process to refine and polish the animation drawing. The 3D background was designed based on the respondents' feedback, emphasising a minimalistic approach. This involved creating a background that is simple yet effective, focusing on essential elements to maintain clarity and aesthetic appeal. The design ensures that the background complements the overall visual style of the project while aligning with the preferences and requirements expressed by the respondents.

Rough Sketch and Clean-Up Process

During the animation process, an initial rough sketch of the animation is created to outline the basic shapes, movements, and overall flow of the scenes. Rough sketches captured the initial motion and structure of each animation scene before being refined during the clean-up phase. The next step is to clean up the rough sketch once it is complete. This involves refining the lines, adding details, and ensuring consistency across frames. The clean-up process transforms the rough, preliminary drawings into polished, precise artwork that forms the foundation for the final animation. This meticulous refinement is crucial for achieving a smooth and visually appealing animation.

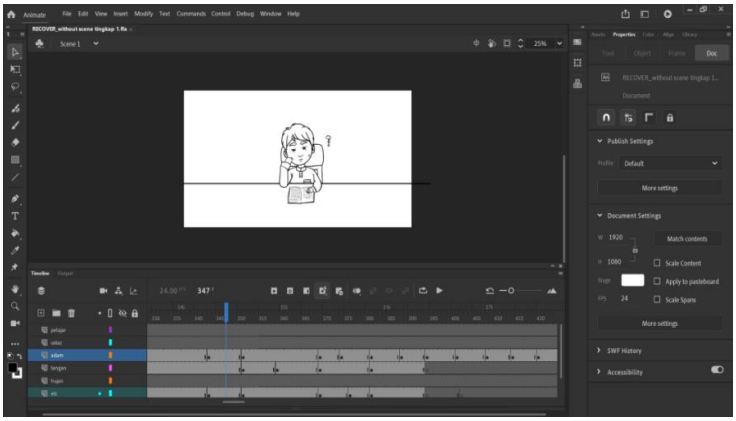

Figure 11. Rough Sketch and Clean-Up Process

Colouring

Following the clean-up phase in the animation process, the next steps involve colouring and shading the refined sketches. During the colouring stages, the clean-up drawings are filled with appropriate colours to bring the characters and background to life. This step adds vibrancy and helps to distinguish different elements within the animation. Shading introduces depth and dimension after applying the base colours. Shading involves applying different tones and shadows to highlight light sources and create a more realistic and dynamic visual effect. Together, they contribute to the overall aesthetic and realism of the animation, thereby enhancing its engagement and visual appeal.

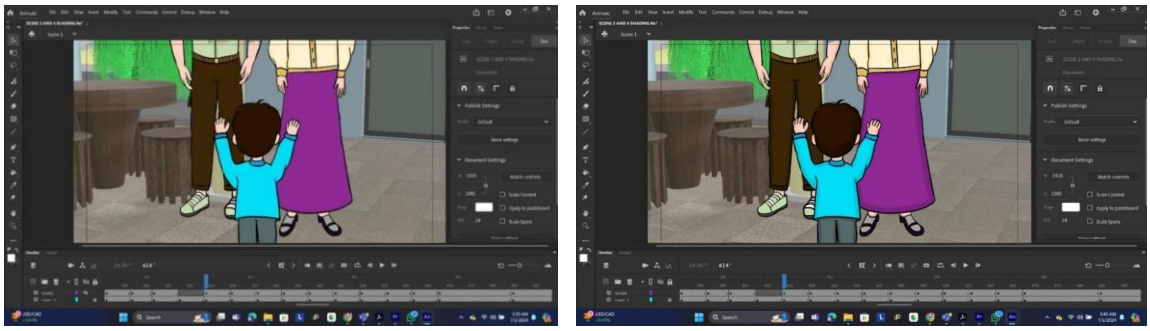

Figure 12. Colouring and Shading Process

Post-production

Post-production in animation involves the final stages of refining and preparing the animated projects for distribution or presentation. During this phase, editors integrate and synchronise all animated sequences, sound effects, music, and dialogue to ensure coherence and narrative flow. Post-production steps such as colour correction and the addition of visual effects were carried out to enhance the visual appeal of the animation.

Visual Effect

This animation uses visual effects in specific scenes to enhance the overall impact and immersion. These effects have been meticulously crafted using Adobe After Effects. By incorporating VFX, the animation achieves a higher level of detail and realism, bringing to life elements that would be difficult or impossible to capture through traditional animation techniques alone. Adobe After Effects allows for the creation of dynamic and visually striking scenes, seamlessly blending various visual elements to enrich the storytelling and captivate the audience.

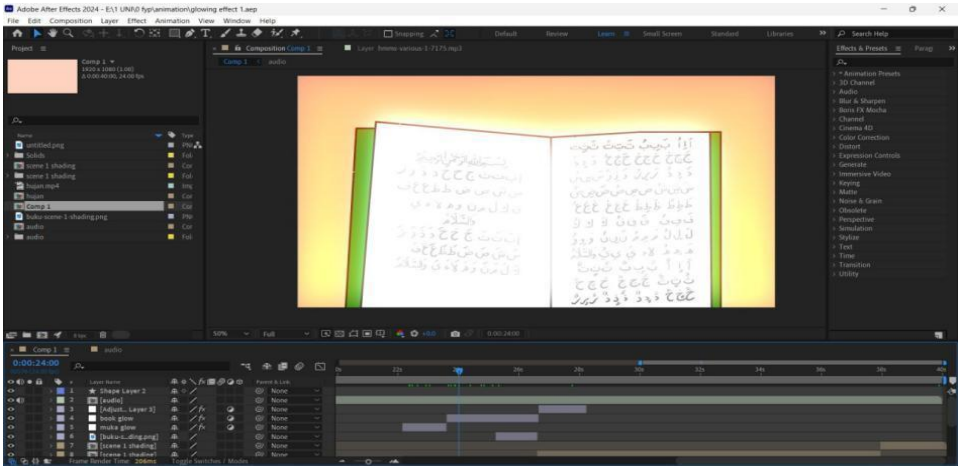

Figure 13. Creating Visual Effects using Adobe After Effects

Compositing

Compositing, an essential step in animation, involves compiling all the scenes in the animation. Compositing integrated character animations, background scenes and effects into coherent sequences using Adobe Premier Pro.

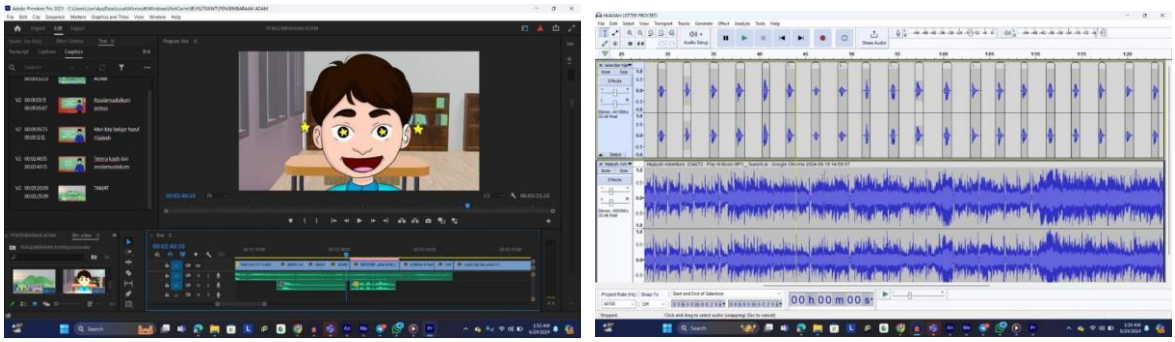

Figure 14. Compositing the Animation and the Hijaiyah Letters Song

Findings

Table 2 summarise the expert responses collected via semi-structured interviews with the Director of the University Education Centre at Universiti Sains Islam Malaysia (Expert A) and a special needs teacher for Islamic education (Expert B).

Table 2. Data Collection from Semi-Structured Interviews

Data Collection from Semi-Structured Interviews	Expert A	Expert B
What is sign language?	Sign language is a visual language. We need to harness the strengths of person with hearing disabilities through what they see with facial expression and body movements.	Sign language is a communication medium for individuals with hearing impairments, consisting of hand gestures of signs related to the words they wish to convey.
Can learning methods that use visual aids like animations in sign language help deaf people?	Yes, if we understand the agenda of inclusive education in the country, it means education should provide quality and inclusive access. Simply put, what we learn, they should learn too. Whatever technology exists, they should have access to it as well. So, in my opinion, what you are developing is a good thing. It will further address the material needs in the context of learning for person with disabilities.	It's very helpful because deaf children rely heavily on their vision. Visual stimuli have a significant impact on them.
Generally, at what age is it suitable to teach them?	From a young age, between 4 years old to 10 years old.	At preschool.
What elements are suitable to put in the animation?	Just like typical children, but in this context, the needs of deaf children include having sign language interpreters who can explain using simple and easily understood words in Malay because all persons with disabilities (OKU) in Malaysia, including those of Chinese and Indian descent, use Malay as their sign language.	Colours are important. For deaf individuals, the window box is crucial, hand signs need to be in the appropriate position. Facial expressions and lip movements are essential for learning the Arabic alphabet.

The interview findings showed agreement between participants on the visual nature and importance of sign language in early education. Expert A emphasised its visual nature and the use of facial expressions and body movement, whereas Expert B highlighted hand gestures as key components. In terms of the importance of visual aids in learning, both interviewees agreed that visual aids, like animation, can significantly help deaf individuals. Expert A spoke about inclusivity and material needs, while Expert B focused on the significant impact of visual stimuli on deaf children. In addition, both interviewees suggested that teaching sign language should begin at a young age. Expert A mentioned "a young age, like us," and Expert B specified "at preschool."

Based on the interview, there are differences between Expert A and Expert B. For elements suitable for animation, Expert A emphasised the need for sign language interpreters to explain simple and easily understood words in Malay, considering the diverse linguistic background of persons with disabilities (OKU) in Malaysia. Expert B highlighted the importance of colours, window box positioning for hand signs, facial expressions, and lip movement for learning the Arabic alphabet. In the educational philosophy question, Expert A stressed inclusive education and the importance of access to quality education through technology and visual aids. On the other hand, Expert B focused on deaf children's reliance on their vision and the significant impact of visual stimuli on their learning process.

Based on the teacher feedback visualised in Figure 16, highlighted several key elements crucial for designing an interactive augmented reality (AR) animation. According to the questionnaire data, 18 respondents (60%) preferred using a triadic colour scheme for the characters in the animation. Additionally, 19 respondents (63.3%) favoured cool colours for the character animation's colour temperature. Out of the 30 respondents, 23 (76.7%) chose the sing along concept for the animation, noting that even though the children may not hear the sound, they can still perceive the beats when wearing hearing aids. Lastly, 13 out of the 30 respondents (43.3%) selected the chibi style for the character, believing it would be particularly appealing to children. These insights underscore the importance of carefully considering colour schemes, auditory elements, and character design styles to create engaging and effective AR animations for children with hearing impairments.

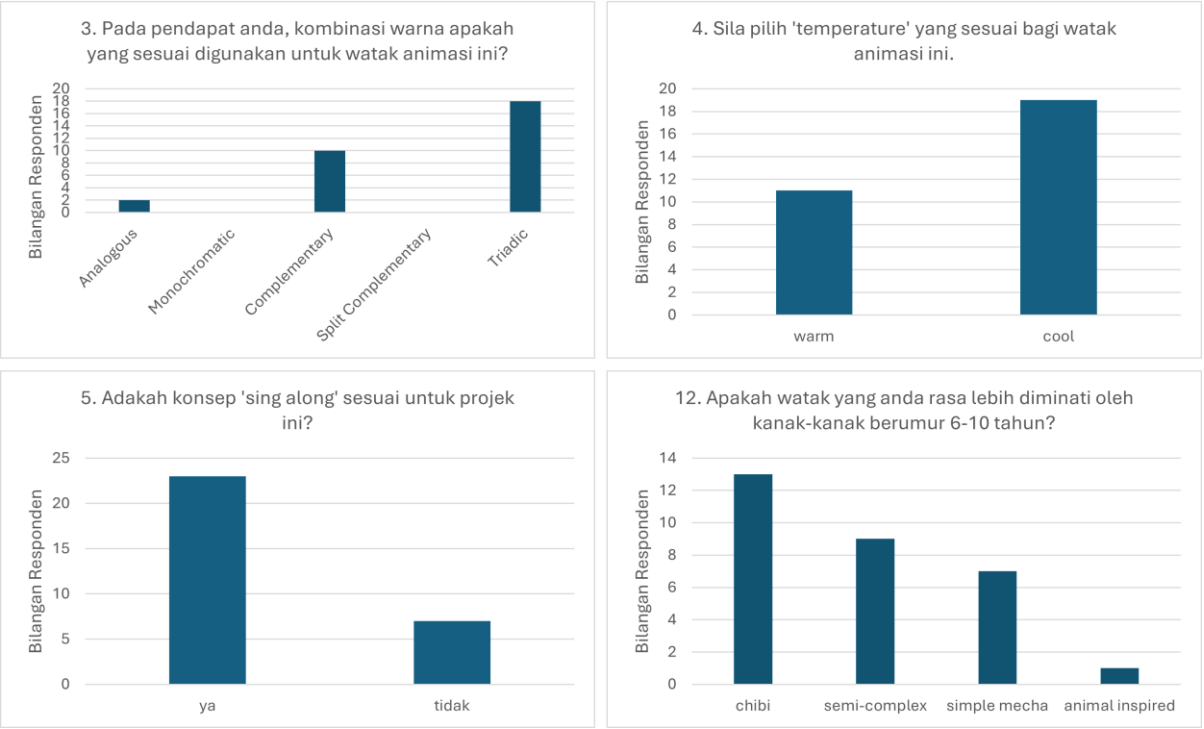

Figure 15. Audience Feedback Regarding Animation Elements

Based on the feedback presented in Figure 4.2, 21 respondents agreed that the animation could significantly aid children aged 6 to 10 years in understanding Hijaiyah letters. This underscores the animation's effectiveness as an educational tool, particularly for young deaf learners, providing them with a valuable resource to grasp fundamental concepts.

Additionally, 52.4% of respondents reported that the animation met or exceeded their expectations in terms of production quality. This indicates that the content fulfils their expectations in terms of engagement while also holding educational value. The high production quality plays a crucial role in maintaining the interest and attention of young learners, thereby enhancing the overall learning experience.

Importantly, all 21 respondents unanimously agreed that they would recommend this animation to others. This unanimous recommendation highlights the animation's perceived value and its potential to positively impact the learning experiences of other children in similar educational contexts. The respondents' endorsement suggests that the animation could serve as a beneficial tool for a broader audience, promoting effective learning and engagement among young learners.

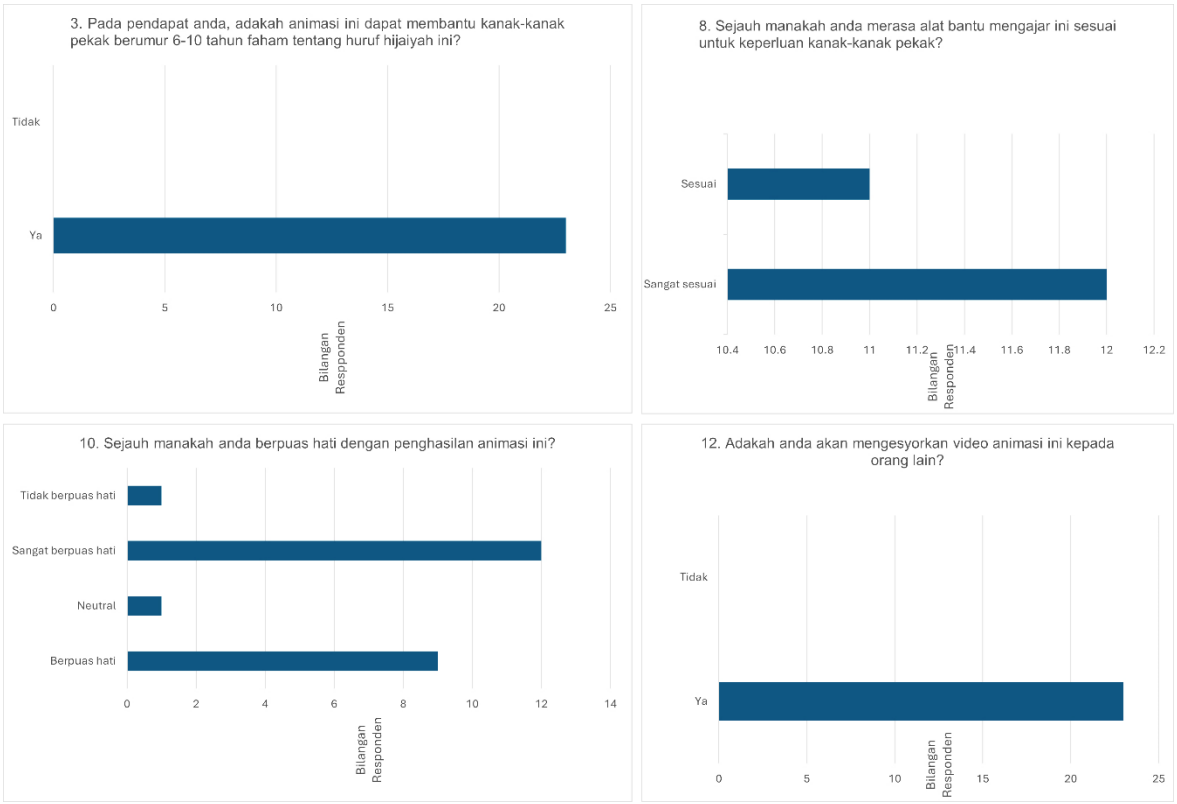

Figure 16. Audience Feedback Regarding the Effectiveness of the Animation Product

Discussion

This study aimed to address the pedagogical challenges faced by deaf children in learning Hijaiyah letters by developing a prototype educational tool that integrates Augmented Reality (AR) and animation. The results from expert interviews and teacher questionnaires indicated promising perceptions of the prototype's design and its potential impact on learner engagement, particularly through visually enriched and culturally relevant content.

Respondents identified key elements that contributed to the tool's appeal: use of cool colours, chibi-style characters and sing-along features that align with the sensory preferences and cognitive styles of deaf learners. The findings align with prior research by Azhar et al. (2022) and Cakir & Korkmaz (2018), which show that AR can significantly enhance motivation, recall and interactive learning in special needs contexts.

Compared to existing tools such as Mushir, Quran Isyarat and Lingvano, the prototype uniquely focuses on the foundational teaching of Hijaiyah letters in Arabic Sign Language (ArSL) and area that remains underserved. While tools like Quran Isyarat focus on Quranic verses and Lingvano emphasizes

conversational ASL, this project provides a culturally specific learning aid that fills a clear pedagogical gap.

The project development was conceptually aligned with the ADDIE instructional design framework, particularly during the *Analysis*, *Design*, and *Development* phases. Although full classroom implementation and evaluation phases were not conducted, formative feedback from teachers was incorporated. This structured approach ensured that the content and interface remained learner-centred and pedagogically informed. However, future research is required to fully implement and evaluate the final two phases of ADDIE (Implementation and Evaluation) in authentic classroom settings, thereby generating stronger evidence of educational impact.

In summary, the prototype shows promise as an inclusive educational aid for deaf children. Its design, guided by stakeholder input, demonstrates the importance of tailoring technology-enhanced tools to both cultural and linguistic contexts. With further refinement and implementation, AR animation may offer a scalable for enhancing Islamic education among underserved learner groups. This endorsement suggests a positive reception to the prototype, warranting further development and testing in real educational setting.

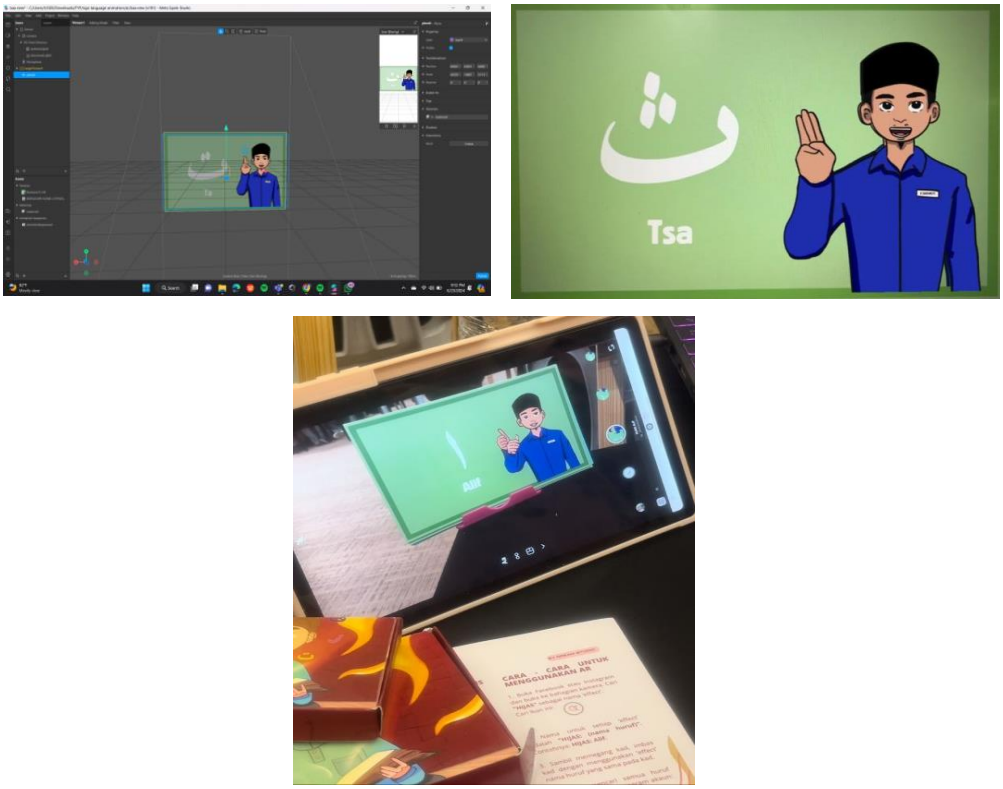

Figure 17. Process of Making and Testing the Product

Limitations and Future Work

While this study demonstrates the potential of integrating Augmented Reality (AR) and animation as a teaching ai for Hijaiyah letters among deaf learners, several limitations must be acknowledged. First, the study was conducted at a prototype stage and did not include real-world classroom implementation or longitudinal testing. As a result, the findings primarily reflect user perceptions and preliminary feedback rather than measured learning outcomes or behavioural change over time.

Second, the sample size was relatively small, with only two expert interviews and 30 teacher respondents participating in the survey. While their feedback was informative, the results may not be generalisable across diverse educational contexts or geographical regions. Additionally, participants were selected using non-random sampling, which may introduce selection bias. Third, although the ADDIE model was used in the development process, the study has not yet executed the *Implementation* and *Evaluation* stages in real-world settings. Future research should complete the full ADDIE cycle to assess learning efficacy and retention in formal classroom environments.

Finally, the questionnaire used in the study was not reported to have undergone validity or reliability testing, which may affect the strength of the data interpretation. Future research should incorporate a validated instructional design approach, larger and more diverse participant groups and quantitative measures of educational impact through

Conclusion

In conclusion, this project developed an augmented reality (AR) teaching aid for Hijaiyah letters to support deaf children's learning. The lack of comprehensive resources and trained teachers who are proficient in Arabic Sign Language (ArSL) presents significant challenges for deaf individuals in learning Quranic recitation. The inadequacy of traditional methods, such as sign language and fingerspelling, highlights the need for innovative solutions like AR and animation.

A multi-phase approach was adopted, involving qualitative and quantitative data collection through interviews and questionnaires. Experts and user feedback ensured the AR animation was effective and user-friendly. The design consideration was based on user preferences and focused on creating characters and background that were engaging. The integration of AR and animation technologies enhanced student engagement and understanding, providing an interactive and visually appealing learning experience.

The findings showed that AR and animation significantly improved learning outcomes for deaf children studying Hijaiyah letters. These technologies offer advantages such as increased motivation,

creativity, and authentic learning experiences. The AR teaching aid received a positive response and demonstrated its potential as a valuable educational source, promoting equitable access to quality education for deaf individuals.

Incorporating AR and animation into teaching aids enhances educational experiences for deaf children. This project underscores the importance of innovative technologies in addressing the limitations of traditional methods, emphasising the need for continuous technological integration in education.

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Acknowledgment

The authors wish to express their deepest gratitude to Mohd Firdaus Mohd Herrow for his invaluable contributions as a supervisor throughout the research. The successful completion of this study was made possible by his exceptional guidance, support, and encouragement. The authors also extend their heartfelt thanks to all those who offered their assistance, both directly and indirectly, during this research. Thank you.

Funding Information

The authors received no funding from any party for the research and publication of this article.

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