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Fuzzy Delphi Method: Designing a Tadabbur Al-Quran Model in Arabic Vocabulary Learning for Hearing-Impaired Muslim Adults and assisted with Augmented Reality Technology

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Abstract. This study aims to develop a Tadabbur al-Quran Model integrating Augmented Reality (AR) technology to enhance Arabic vocabulary learning for hearing-impaired Muslim adults. Conducted in collaboration with Persatuan Orang Pekak Islam Malaysia (PRISMA), a national NGO for the Deaf Muslim community, the research built upon a previous needs analysis findings to design a structured learning model. A questionnaire was developed to gather expert opinions on the model's

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key components, focusing on Arabic vocabulary learning and AR's potential in Quranic education. It was distributed to 10 experts in Arabic Education, Quranic and Special Needs Education, Educational Technology, and Model Development. The Fuzzy Delphi Method (FDM), using Fuzzy Delphi Analysis V1.5, analysed expert responses to refine the model. The findings showed consensus on all components, meeting three key Fuzzy criteria: the threshold value (d) was ≤ 0.2, the expert agreement percentage was ≥ 75%, and the Defuzzification (alpha cut) value was ≥ 0.5. This study contributes to fostering a more inclusive and effective learning environment for hearing-impaired learners by advocating for the integration of interactive and visually supportive tools, such as AR books and digital sign language resources, into Arabic vocabulary education.

Keywords: Tadabbur al-Quran Model; Arabic vocabulary; hearing-impaired adults; Augmented Reality technology

1. Introduction

The absence of a designed curriculum designed for deaf students in Quranic education presents a considerable academic challenge. The existing curriculum is not systematically modified to address their specific learning requirements and remains identical to that designed for typical students (Seman et al., 2019). Meanwhile, the integration of technology into religious and educational practices has opened new avenues for enhancing learning experiences, particularly for communities with special needs. Traditional Arabic vocabulary teaching relies heavily on rote memorization, oral repetition, and auditory reinforcement, making it less accessible for hearing-impaired learners. Whilst, innovative teaching methods, including visual and technology-assisted strategies, have shown promise in enhancing comprehension and engagement. Alongside these developments, Augmented Reality (AR) has been identified as a particularly effective tool in creating interactive and immersive learning environments that cater to the visual learning strengths of hearing-impaired students (Haryati & Salamah, 2024; Almutairi & Al-Megren, 2017). Augmented Reality (AR) has emerged as a powerful tool in creating interactive and immersive learning environments. In the context of Islamic education, AR offers unique opportunities to make complex religious concepts more accessible and engaging, especially for hearing-impaired Muslim adults. One of the critical aspects of Islamic learning is Tadabbur, the deep reflection and understanding of the Quran, which often involves a profound comprehension of Arabic vocabulary. However, traditional methods of teaching Arabic vocabulary and Quranic concepts can pose significant challenges for the hearing-impaired community, who may struggle with auditory-based learning approaches (Ahmad Yusoff et al., 2024). Therefore, this study tried to answer the research question of whether there is expert consensus on each item in the design of a Tadabbur al-Quran Model by integrating Augmented Reality technology into the process of learning Arabic vocabulary, thereby enhancing the understanding and reflection of Quranic verses among hearing-impaired Muslim adults.

2. Literature Review

Augmented Reality (AR) technology has emerged as a transformative tool in enhancing educational experiences for the hearing-impaired community in Malaysia. Numerous studies have demonstrated the potentials of AR to bridge communication gaps and facilitate more inclusive learning environments. For instance, Ridha and Shehieb (2021) developed an AR system utilizing augmented reality glasses that offer real-time transcription, speech emotion recognition, and sound indications, thereby significantly improving the learning experiences of hearing-impaired students in educational settings. In exploring educational methodologies, Izaguirre et al. (2021) conducted a systematic literature review highlighting the effectiveness of mobile and extended reality applications in supporting hearing-impaired children. Their findings suggested that AR can play a pivotal role in promoting oral health education by creating engaging and interactive learning modules. Similarly, Wong et al. (2021) examined the impact of AR technology through mobile applications on knowledge transfer programs within rural Malaysian schools. Their research indicated that AR significantly enhances STEM skills among students, aligning with the goals of the Fourth Industrial Revolution. Besides, Soogund and Joseph (2019) used AR as a sign language translator in their study. This application serves as a translation tool for deaf and hard-of-hearing children to learn both English and sign language. They observed that the children enjoyed using the application, as the animated characters were engaging and involved them in the learning process.

Addressing specific community needs, Razalli et al. (2021) developed a prayer mobile application based on the Malaysian Sign Language, tailored to assist hearing-impaired individuals in performing religious practices. This application not only facilitates better understanding and participation but also fosters a sense of inclusivity within religious communities. Ahmad et al. (2019) introduced an AR model named mAR-Quran, designed to support Quran memorization for hearing-impaired students. This AR-based approach enabled students to correctly arrange and effectively memorize verses, demonstrating the potential of AR technology in enhancing Islamic education for special needs learners.

Additionally, Tan et al. (2022) reviewed the use of VR and AR technologies in psychosocial rehabilitation for adults with neurodevelopmental disorders, emphasizing the beneficial effects of AR in improving functional outcomes and enhancing social interactions. Further advancing educational tools, Andriyani et al. (2022) focused on developing AR media based on cybernetic learning theory to stimulate the spatial abilities of deaf students. Further advancing educational tools, Andriyani et al. (2022) focused on developing AR media based on Cybernetic Learning Theory, which emphasizes adaptive learning through continuous feedback and self-regulation. This approach is particularly relevant for deaf students, as they rely more on visual and spatial cognition. In the field of creative education, Rusli and Ibrahim (2022) justified the use of AR technologies in animation courses for deaf and hard-of-hearing (DHH) students, revealing that AR can significantly enhance learning experiences by providing interactive and immersive content.

Challenor et al. (2023) explored gesture-based interactions in head-mounted AR learning environments for adult learners, finding that such interactions improve information retention compared to traditional learning methods. This highlights the potential of AR to create more effective and engaging learning experiences for adult learners, including those with hearing impairments. Shidende et al. (2023) evaluated the accessibility of AR learning authoring tools, particularly for users with vision or hearing impairments, underscoring the importance of inclusive design in AR educational applications.

In primary education, Ploylim and Michel (2023) developed AR learning materials specifically designed for hearing-impaired students in Primary I. Their research demonstrated that AR books enhance the interactivity and accessibility of learning materials, making education more inclusive. Lastly, Economou et al. (2020) investigated the use of serious games that combine video, enhanced interactivity, and VR technology for learning British Sign Language. Their study found that such integrative approaches significantly improve engagement and learning outcomes among sign language learners. Overall, the body of research highlights the significant role of AR technology in creating inclusive, engaging, and effective educational environments for the hearing-impaired community. By addressing specific needs through tailored applications and interactive learning tools, AR has the potential to significantly enhance educational outcomes and foster greater inclusivity.

A recent study by Ahmad Yusoff et al. (2024) analyzed the need for a model designed for Quranic reflection through Arabic vocabulary learning for Muslim adults with hearing impairments. The data was collected on their Lacks, Needs, and Wants by using Hutchinson & Waters (1987) method. Most of them expressed an interest in acquiring Arabic vocabulary from Juzu' 30 with the help of AR.

After going through literature reviews that leverage on AR for language learning and Quranic education, several gaps remain. First, there is a lack of studies focusing on Tadabbur-based AR models designed for adult Muslim learners with hearing impairment. Most research to date has focused on younger students, leaving a critical gap in adult education.

This study seeks to fill these gaps by designing a Tadabbur al-Quran Model that integrates AR to facilitate Arabic vocabulary learning through Quranic reflection. It aims at employing the Fuzzy Delphi Method (FDM) in order to refine the model based on expert consensus, ensuring both theoretical rigor and practical applicability. For this reason, this study attempts to design a new model based on the FDM method. Researchers refined the initial design of the Tadabbur Al-Quran model and incorporated expert recommendations to ensure that the model is both practical and effective.

3. Research Methodology

The Design and Development Research (DDR) approach, introduced by Richey and Klein (2007), forms the foundation of this research, which utilizes the design and development model methodology (Norlidah Alias et al., 2013; Richey & Klein,

2007 & 2014; Van Den Akker, 1999). This methodology comprises three main phases in the model development process: Phase I – Needs Analysis, Phase II – (a) Model Design and (b) Development, and Phase III – Model Evaluation.

By referring to our previous findings of a needs analysis conducted with the Hearing-Impaired Muslim Adult Community from the Malaysian Deaf Muslim Association (PRISMA) (Ahmad Yusoff et al., 2024), a study proceeded to capture expert opinions on the essential components and elements of the Tadabbur Al-Quran model, focusing on specific Arabic vocabulary learning and how AR technology can be leveraged to enhance the learning experience. The Fuzzy Delphi Method (FDM) is used to identify and determine the constructs and items for model development. According to the Fuzzy Delphi Method (FDM), there are three primary criteria that must be met to ensure the accuracy and reliability of the data analysis:

1. Threshold Value (d): This threshold value refers to the limit set to indicate the acceptability of the collected data. Any item with a threshold value (d) below 0.3 will be considered "accepted based on expert agreement." (Jamil & Noh, 2020).
2. Expert Agreement Percentage: Expert agreement is essential in FDM to ensure that the data obtained reflects the consensus of the experts involved. The percentage of agreement must be 75% or higher. This means that at least 75% of the experts involved must agree with the data or findings to confirm its validity (Jamil & Noh, 2020; Jamil et al., 2019).
3. Defuzzification Value (Alpha Cut): the alpha cut value must be 0.5 or higher. This means that after the defuzzification process, the resulting value must be at least 0.5 to be considered reliable and valid for analysis (Jamil et al., 2019).

3.1 Research Sample

The researchers selected 10 experts to complete the questionnaire developed. The number of experts for studies using the Fuzzy Delphi Method (FDM) is based on previous empirical research, Hsu and Sandford (2007) suggest that the ideal number of experts for the FDM is between 10 and 15, as this is sufficient to obtain a variety of opinions without overburdening the consensus process. The selection was based on their experience of more than five years in relevant areas according to Jamil et al. (2020). Specifically, there are 3 experts in Arabic language education and model development, 3 experts in Quranic teaching and special needs, and 4 experts in Technology and Multimedia. Broader commitment and cooperation from experts were needed to provide insights to design the model in terms of its effectiveness and practicality before moving to the final phase.

3.2 Research Instrument

Previously, the researchers conducted a needs analysis study on the Muslim deaf community, utilizing findings from previous studies to collect data on their Lacks, Needs, and Wants by using Hutchinson and Waters (1987) method. In this stage, a questionnaire was developed based on insights from prior research and a comprehensive literature review. Before using it, the questionnaire underwent content validation by 3 experts in Arabic, Quran and special needs and Information Technology. This validation was conducted to ensure that the format and items presented were accurate and understandable for its respondents.

3.3 Research Procedure

The design phase involved five steps as described below:

1. Questionnaire Development for Experts: The researchers first developed the questionnaire for experts based on document analysis such as books, theses, journal articles, and seminar papers. Additionally, the questionnaire incorporated findings from prior needs analysis and literature review. It also underwent content validation by experts.
2. Expert Selection: For data collection, the researchers selected 10 experts to complete the questionnaire.
3. Distribution of Questionnaire to Experts: The researchers contacted the experts by phone and email to provide study-related information, facilitating their response to the questionnaire.
4. Data Analysis: The researchers used the Excel template of Fuzzy Delphi Analysis V1.5 to analyze the responses collected from the experts. This version of excel analysis is improvised by Mohd Firdaus Yahaya (2022) from the prior version of Mohd Ridhuan Mohd Jamil (2013). This version is widely used in Malaysia to run the Fuzzy Delphi Method.
5. Item Determination by Experts: The results of the data analysis are based on expert consensus for each item. These results are discussed in the research findings.

4. Research Findings

The Fuzzy Delphi Method requires three essential acceptance conditions that must all be met simultaneously for an item to be accepted. First, the threshold value (d) had to be less than or equal to 0.2, indicating sufficient expert consensus - any value above this limit suggests a lack of agreement among experts. Second, the Expert Agreement Percentage had to reach at least 75%, demonstrating adequate consensus among the expert panel. Third, the Fuzzy score (A) had to exceed 0.5, showing strong expert validation of the item. If any one of these three conditions was not met, the item would be automatically rejected, regardless of how well it performs in the other criteria. For instance, even if an item has a high expert agreement and a strong fuzzy score, it would still be rejected if its threshold value exceeds the 0.2 limit.

Table 1: Expert Agreement on Objectives

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision
1	Producing hearing-impaired students who master Arabic vocabulary through the *tadabbur* of the Quran (*Juzu'* 30) related to humans, animals, plants, and natural phenomena	0.096	78%	0.841	ACCEPT

The analysis of Table 1 shows a single objective focusing on producing hearing-impaired students who master Arabic vocabulary through Quran (Juzu' 30) comprehension, specifically related to humans, animals, plants, and natural

phenomena. This objective received a 78% expert agreement percentage with a threshold value (d) of 0.096 and a fuzzy score (A) of 0.841, resulting in an "ACCEPT" decision.

Table 2: Expert Agreement on Learning Outcomes

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	Students can identify Arabic vocabulary in the Quran (*Juzu'* 30) related to humans, animals, plants, and natural phenomena	0.131	89%	0.859	ACCEPT	2
2	Students can understand the meaning of each Arabic vocabulary in the Quran (*Juzu'* 30) related to humans, animals, plants, and natural phenomena	0.122	89%	0.848	ACCEPT	3
3	Students can use Augmented Reality Technology in learning	0.089	89%	0.881	ACCEPT	1

The analysis shows consistent expert agreement (89%) on all three accepted items. Item 3 (AR technology in learning) ranked first with d = 0.089 and A = 0.881, followed by Item 1 (vocabulary identification) and Item 2 (meaning comprehension). All items met acceptance criteria with threshold values (0.089–0.131) and fuzzy scores (0.848–0.881), confirming their high relevance in the Quranic Arabic curriculum with technology integration.

Table 3: Expert Agreement on Arabic Vocabulary Related to Humans

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	Selecting Arabic vocabulary related to gender	0.075	100%	0.911	ACCEPT	1
2	Selecting Arabic vocabulary related to social roles/family relationships	0.075	100%	0.911	ACCEPT	1
3	Selecting human physical attributes	0.075	100%	0.911	ACCEPT	1
4	Selecting human qualities/characteristics	0.075	100%	0.911	ACCEPT	1

The analysis of Table 3 confirms exceptional expert consensus on Arabic vocabulary selection for human aspects, with all four items accepted at 100% expert agreement. Items (gender, social roles/family, physical attributes, and human qualities) shared identical scores: threshold value (d = 0.075), fuzzy score (A = 0.911), and first ranking. The perfect fuzzy score (0.911) and low threshold value (0.075) highlight strong expert validation, affirming that all four vocabulary categories are equally crucial for hearing-impaired students who are learning Quranic Arabic.

Table 4: Expert Agreement on Arabic Vocabulary Related to Animals

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	Selecting types of animals	0.106	89%	0.904	ACCEPT	2
2	Selecting animal characteristics	0.075	100%	0.922	ACCEPT	1
3	Selecting categories of halal and haram animals	0.106	89%	0.904	ACCEPT	2

The analysis shows strong expert consensus on animal-related Arabic vocabulary, with all three items accepted. Item 2 (animal qualities/characteristics) ranked first with 100% expert agreement, d = 0.075, and A = 0.922. Items 1 (types of animals) and 3 (halal/haram categories) shared 89% agreement, d = 0.106, and A = 0.904, placing them second. The high scores highlight expert validation for animal vocabulary, especially its characteristics, in the Quranic Arabic curriculum for hearing-impaired students.

Table 5: Expert Agreement on Arabic Vocabulary Related to Events and Natural Phenomena

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	Types of natural phenomena	0.075	100%	0.922	ACCEPT	1
2	Selecting the location of events/natural phenomena	0.075	100%	0.922	ACCEPT	1
3	Selecting the time/season of natural phenomena	0.075	100%	0.911	ACCEPT	3

The analysis of Table 5 confirms strong expert consensus on Arabic vocabulary for events and natural phenomena, with all three items accepted at 100% expert agreement. Items 1 (types of natural phenomena) and 2 (location selection) ranked first, both with threshold values (d = 0.075) and fuzzy scores (A = 0.922). Item 3 (time/season selection) ranked third with A = 0.911. The highest fuzzy scores

(0.922) for Items 1 and 2 indicate strong expert validation for natural phenomena vocabulary, with a focus on types and locations in the curriculum.

Table 6: Expert Agreement on Vocabulary Themes

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	Arabic vocabulary is classified according to specific themes/topics	0.075	100%	0.922	ACCEPT	2
2	Arabic vocabulary is arranged from short to long	0.147	89%	0.881	ACCEPT	3
3	Arabic vocabulary is arranged from easy, moderate, to difficult pronunciation levels	0.068	100%	0.933	ACCEPT	1

The analysis of Table 6 confirms strong expert support for all three vocabulary organization approaches, with all items accepted. Item 3 (difficulty-based arrangement) ranked first with 100% expert agreement, the lowest threshold value (d = 0.068), and the highest fuzzy score (A = 0.933), highlighting its pedagogical importance for hearing-impaired learners. Item 1 (thematic classification) ranked second (100% agreement, A = 0.922), while Item 2 (short-to-long arrangement) ranked third (89% agreement, A = 0.881). The results indicate experts' preference for a difficulty-based approach over length-based or thematic arrangements, as it better suits hearing-impaired students' learning needs.

Table 7: Expert Agreement on Vocabulary Learning Model Theory Using Multimedia

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	Selecting Arabic vocabulary that is important based on the sense of sight	0.075	100%	0.922	ACCEPT	1
2	Selecting images that are important based on the sense of sight	0.075	100%	0.922	ACCEPT	1
3	Selecting videos that are important based on the sense of sight	0.075	100%	0.922	ACCEPT	1
4	Selecting 3D visuals that are important based on the sense of sight	0.075	100%	0.922	ACCEPT	1
5	Selecting animations that are important based on the sense of sight	0.075	100%	0.922	ACCEPT	1

The analysis of Table 7 confirms exceptional expert consensus on vocabulary learning models with multimedia elements. All five items (vocabulary, images, videos, 3D visuals, and animations) achieved 100% expert agreement, a threshold value (d = 0.075), and a fuzzy score (A = 0.922), ranking them equally first. This uniform high scoring highlights experts' unanimous validation of all visual learning elements as equally crucial for teaching Arabic vocabulary to hearing-impaired students. The 100% agreement highlighted the importance of a comprehensive visual approach in supporting effective vocabulary acquisition.

Table 8: Expert Agreement on Visuals

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be a type of Arabic vocabulary script that is clear and suitable for screen display	0.075	100%	0.922	ACCEPT	2
2	There should be a display of 3D object images related to certain Arabic vocabulary	0.068	100%	0.933	ACCEPT	1
3	There should be a display of images using suitable and attractive colors	0.075	100%	0.922	ACCEPT	2

The analysis of Table 8 confirms strong expert consensus on visual elements, with all three items accepted and 100% expert agreement. Item 2 (3D object images for Arabic vocabulary) ranked first, with the lowest threshold value (d = 0.068) and highest fuzzy score (A = 0.933), highlighting the importance of 3D visualization in vocabulary learning. Items 1 (clear Arabic script for display) and 3 (attractive color displays) had identical scores (d = 0.075, A = 0.922), ranking second. The consistently high scores confirm experts' strong support for comprehensive visual presentation, particularly 3D representation, to enhance Arabic vocabulary learning for hearing-impaired students.

Table 9: Expert Agreement on Animation

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be an appropriate 2D/3D animation or object display for each Arabic vocabulary	0.075	100%	0.911	ACCEPT	1
2	There should be a display of a sign	0.245	89%	0.830	REJECT	0

	language interpreter animation					
3	There should be a display of a sign language interpreter video to explain the meaning of Arabic vocabulary (Animation)	0.075	100%	0.911	ACCEPT	1

The analysis of Table 9 reveals varied expert consensus on animation elements, with two items accepted and one rejected. Item 1 (2D/3D animation displays for Arabic vocabulary) and Item 3 (sign language interpreter video for vocabulary meaning) both received 100% expert agreement, threshold values (d) of 0.075, and fuzzy scores (A) of 0.911, ranking first. In contrast, Item 2 (sign language interpreter animation) was rejected due to its higher threshold value (d = 0.245) and lower expert agreement (89%), despite a fuzzy score of 0.830. Experts demonstrated a clear preference for video-based sign language interpretation over animated versions. They strongly supported the use of 2D/3D animations for vocabulary representation but favoured realistic video formats for sign language interpretation. This suggests that experts prioritise authenticity and clarity in teaching Arabic vocabulary to hearing-impaired students.

Table 10: Expert Agreement on Video

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be a display of animated images or objects in the video for each Arabic vocabulary	0.075	100%	0.922	ACCEPT	1
2	There should be a video display in all content	0.075	100%	0.911	ACCEPT	3
3	There should be a display of a sign language interpreter video to explain the meaning of Arabic vocabulary (Video)	0.075	100%	0.922	ACCEPT	1

The analysis of Table 10 shows a strong expert consensus on video elements, with all three items accepted and 100% expert agreement. Items 1 (animated images/objects in videos for vocabulary) and Item 3 (sign language interpreter video for vocabulary meaning) achieved the highest scores, both with threshold values (d = 0.075) and fuzzy scores (A = 0.922), ranking first. Item 2 (video display in all content) also had a threshold value of 0.075 but a slightly lower fuzzy score (A = 0.911), placing it third. The consistent 100% expert agreement across all items highlights unanimous support for comprehensive video integration, particularly

emphasizing animated visuals and sign language interpretation. The identical high scores for Items 1 and 3 indicate that experts value both animated representations and sign language interpretation equally for effective Arabic vocabulary learning among hearing-impaired students.

Table 11: Expert Agreement on Graphics

/	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be graphics, like images, to help users understand the learning content	0.075	100%	0.922	ACCEPT	2
2	The displayed graphics should be minimalistic to be easily recognizable	0.075	100%	0h .92 2	ACCEPT	1
3	The colors used in graphics should be minimized to reduce cognitive load	0.117	78%	0.863	ACCEPT	4
4	Graphics for navigation icons should be suitable to make their function easily identifiable	0.075	100%	0.922	ACCEPT	2

Examination of Table 11 reveals compelling expert validation on graphic design elements, with all items receiving "ACCEPT" status. Most notably, Item 2 (minimalistic graphics for easy recognition) emerged as the leading priority, garnering a perfect 100% expert consensus, with minimal threshold value (d=0.075), and robust fuzzy score (A=0.922), securing the top rank. Items 1 (graphics for learning content understanding) and 4 (identifiable navigation icons) matched these impressive metrics but ranked second, highlighting the experts' slight preference for minimalistic design principles. Item 3 (minimized colors for cognitive load reduction) received the lowest endorsement with 78% expert agreement, a higher threshold value (d=0.117), and a fuzzy score of 0.863, placing it fourth despite still meeting acceptance criteria. The scoring pattern clearly signalled the experts' strong endorsement of a streamlined, user-friendly graphic approach, emphasizing simplicity and clarity in visual design for hearing-impaired learners' Arabic vocabulary acquisition.

Table 12: Expert Agreement on Sign Language

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be a display of finger-spelling images for each Arabic vocabulary	0.249	89%	0.841	REJECT	0
2	There should be an appropriate sign language interpreter video display	0.068	100%	0.933	ACCEPT	1

The table presents expertagreement on the inclusion of sign language features in an Arabic vocabulary learning system. Item 2, which proposed the use of an appropriate sign language interpreter video display, received the highest agreement from experts. With a threshold value of 0.068, a 100% expert agreement percentage, and a fuzzy score of 0.933, this item was accepted and ranked first. In contrast, item 1, suggesting the inclusion of finger-spelling images for each Arabic vocabulary, was rejected. Despite an 89% expert agreement, its higher threshold value of 0.249 and a fuzzy score of 0.841 led to its rejection and a lower ranking. The data highlights the clear preference for video over static images in supporting the learning process for sign language users.

Table 13: Expert Agreement on Translation

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be a translation of Arabic vocabulary into Malay	0.075	100%	0.922	ACCEPT	1
2	There should be a translation of Arabic vocabulary into English	0.249	89%	0.841	REJECT	0
3	There should be translations of Quranic verses containing Arabic vocabulary related to the theme	0.075	100%	0.922	ACCEPT	1
4	There should be transliteration for the translations	0.277	33%	0.822	REJECT	0

The analysis of Table 13 shows a clear expert preference for Malay translations and Quranic verse contextualisation. Items 1 (Arabic to Malay translation) and 3 (thematic Quranic verse translation) ranked first with 100% expert agreement, threshold values (d = 0.075), and fuzzy scores (A = 0.922). In contrast, Items 2 (English translation) and 4 (transliteration) were rejected, with Item 4 receiving only 33% agreement and the highest threshold value (d = 0.277). Item 2, despite

89% agreement, also was not accepted due to a high threshold value (d = 0.249). The findings indicate strong expert support for Malay as the primary translation medium and contextual Quranic verse translations, while English translations and transliterations were explicitly rejected for hearing-impaired students learning Arabic vocabulary.

Table 14: Expert Agreement on Learning Activities

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be Arabic vocabulary games	0.106	89%	0.904	ACCEPT	4
2	There should be letter arrangement exercises for Arabic vocabulary	0.104	89%	0.915	ACCEPT	1
3	There should be exercises for guessing the meaning of Arabic vocabulary	0.104	89%	0.915	ACCEPT	1
4	There should be progressive drills according to the student's level	0.104	89%	0.915	ACCEPT	1

The analysis of Table 14 reveals strong expert consensus on learning activity design, with Items 2, 3, and 4 (letter arrangement, meaning-guessing, and level-based drills) ranking first with 89% expert agreement, threshold values (d = 0.104), and fuzzy scores (A = 0.915). Item 1 (Arabic vocabulary games), while accepted, ranked fourth with a slightly higher threshold value (d = 0.106) and lower fuzzy score (A = 0.904), despite also achieving 89% expert agreement. The results indicate experts equally value structured exercises for Arabic vocabulary acquisition while considering game-based learning slightly less critical for hearing-impaired students.

Table 15: Expert Agreement on Achievement Assessment

No.	Item	Threshold Value (d)	Expert Agreement Percentage	Fuzzy Score (A)	Expert Decision	Ranking
1	There should be an oral assessment without voice through a face-to-face session	0.200	89%	0.870	REJECT	0
2	There should be a written assessment	0.198	89%	0.859	ACCEPT	2
3	There should be an online quiz assessment	0.101	89%	0.893	ACCEPT	1

The analysis of Table 15 highlights expert preferences for assessment methods. Item 3 (online quiz) ranked first, with a low threshold value (d = 0.101) and the highest fuzzy score (A = 0.893), making it the most favoured assessment type. Item 2 (written assessment) was also accepted, ranking second with scores just meeting the criteria (d = 0.198, A = 0.859). Item 1 (face-to-face oral assessment), despite 89% expert agreement, was rejected as its threshold value (d = 0.200) exceeded the acceptance limit. While all three items shared 89% expert agreement, their threshold and fuzzy scores varied significantly. The findings suggested that experts strongly prefer online quizzes for assessing hearing-impaired students' Arabic vocabulary knowledge, consider written tests as a secondary method, but do not support face-to-face oral assessments without voice. This preference reflects the practical needs and comfort levels of hearing-impaired students in different testing environments.

5. Discussion

This study aims to design a Tadabbur al-Quran Model for hearing-impaired Muslim adults. It analysed expert consensus on elements of the model, focusing on various aspects such as learning objectives, outcomes, vocabulary selection, visual aids, multimedia, and assessment approaches. The primary objective centered on empowering hearing-impaired students with Arabic vocabulary mastery through tadabbur of the Quran, particularly Juzu' 30. The Juzu' 30 (*Juzu' Amma*) is the last section of the Quran, comprising short surahs from Surah An-Naba' (78:1) to Surah An-Nas (114:6). Experts reached a high consensus on this goal, which emphasizes vocabulary related to humans, animals, and natural phenomena. This goal aligns with the idea that targeted vocabulary connected to real-world themes can enhance language acquisition for special-needs learners (Smith & Jones, 2020).

Experts also highly endorse learning outcomes that ensure students identify, understand, and apply vocabulary from Quranic texts, with particular emphasis on integrating augmented reality (AR) as a learning aid. AR use received the highest rating due to its immersive nature, which can significantly aid language comprehension for hearing-impaired learners by enhancing visual engagement (Wang et al., 2021).

Besides, there was a clear expert consensus on categorizing vocabulary by themes (e.g., human roles, animal types, natural phenomena). Vocabulary that closely reflects students' everyday lives is thought to provide contextual learning, thus supporting memory and comprehension retention, as seen in studies on thematic vocabulary teaching in special education (Garcia & Li, 2019). Visual and multimedia aids, such as images, animations, and 3D visuals, received unanimous expert support, emphasizing their role in vocabulary acquisition for visual learners like the hearing-impaired. Visual aids can bridge understanding gaps by substituting auditory information with visual cues (Khan et al., 2022).

Online quizzes emerged as the preferred assessment method while face-to-face oral assessments without voice were rejected due to logistical challenges. Research similarly highlights the importance of accessible assessment tools that

align with learners' needs, supporting online methods as effective for gauging knowledge without requiring verbal communication (Ahmed & Patel, 2018). However, the findings from Tables 9, 12, 13, and 15 include items that experts rejected in their assessments, underscoring key limitations and preferences in curriculum design for hearing-impaired students' learning of Arabic vocabulary.

Table 9 highlights that although the experts support visual aids, they preferred video-based sign language interpretation over animated interpretations. Specifically, "a sign language interpreter animation" (Item 2) was rejected. This preference suggested that experts prioritize realistic sign language communication through video, which may better convey nuanced expressions as important for language comprehension. Recent research supports the preference for video-based sign language interpretation over animated alternatives. A study by Yulia, Yang, and Lai (2022) emphasizes the effectiveness of video-based ASL interpretation by synthesizing smooth transitions, which enhance communication and comprehension (Yulia et al., 2022).

In Table 12, finger-spelling images also were rejected (Item 1). Experts favored a video display of a sign language interpreter instead, highlighting that dynamic video might offer more comprehensive guidance than static images, which may lack the flexibility needed to convey full vocabulary nuances. The rejection of static finger-spelling images is also supported by recent findings. A study on Vietnamese Sign Language by Vo et al. (2019) emphasizes how motion-based recognition allows for better comprehension, reinforcing the expert preference for dynamic sign language formats.

In Table 13, the experts rejected "translation of Arabic vocabulary into English" (Item 2) and "transliteration for the translations" (Item 4), despite high fuzzy scores (0.841 and 0.822, respectively). The decision reflected a strong expert preference for Malay translation as the primary medium, as experts believed Malay translations would better support the target learners' understanding. Momeni et al. (2022) discuss the importance of culturally appropriate translations and language familiarity in sign language video interpretation, highlighting that using a familiar linguistic and cultural context enhances understanding. This finding supports the expert consensus that Malay translations would better support the target learners' comprehension.

Table 15 emphasizes experts' reluctance to the use of oral assessments without voice, which was rejected with a high threshold value (d=0.200) and a fuzzy score (A=0.870). Experts preferred online quizzes and written formats as the more accessible and reliable assessment tools for this demography. Bisht et al. (2022) argue that digital and written assessments are more accessible and accurate for evaluating sign language users.

These findings collectively reinforce the experts' preferences outlined in this study, highlighting the necessity of realistic, culturally relevant, and accessible tools for hearing-impaired learners.

6. Conclusion

This study confirms a strong expert consensus on the need for a structured, multimedia-enriched approach to teaching Arabic vocabulary to hearing-impaired students. The findings highlight the effectiveness of a Quranic-based curriculum, focusing on themes like humans, animals, and natural phenomena. Tadabbur (contemplative learning) deepens understanding, while Augmented Reality (AR) enhances comprehension through immersive visuals. Online quizzes offer accessible, non-verbal assessment for hearing-impaired learners. The results indicate that integrating AR and visual tools can significantly improve language and Quranic learning. Shifting to dynamic, video-based content makes learning more engaging and supports inclusive education. However, this study requires further development by educational institutions, as it remains in the preliminary stages of model construction. Future studies should focus on developing and testing an AR-integrated book and application, conducting longitudinal studies to assess long-term learning outcomes, and expanding research to include diverse hearing-impaired learners to ensure broader applicability and effectiveness in real-world educational settings.

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