

Augmented reality framework for Arabic literacy in special needs learners

Saipolbarin Ramli, Mohd Zawawi Awang Hamat, Mohammad Taufiq Abdul Ghani,
Nur Hanim Hassan, Siti Rahmah Borham

Department of Modern Languages, Faculty of Languages and Communication, Universiti Pendidikan Sultan Idris, Perak, Malaysia

Article Info

Article history:

Received Jun 28, 2025

Revised May 29, 2026

Accepted Jun 8, 2026

Keywords:

Arabic reading literacy

Augmented reality

Inclusive education

Special needs learners

Usability evaluation

ABSTRACT

This study develops and evaluates an augmented reality (AR) instructional framework designed to improve Arabic reading literacy among *murid berkeperluan khas* or students with special educational needs (MBK). These learners, particularly those with mild cognitive and processing difficulties, face challenges in recognizing *Hijaiyyah* or Arabic alphabet letters, producing accurate makhraj, and decoding basic vowels due to limited access to structured and accessible Arabic literacy instruction. The framework was developed using multimodal AR components that combine visual, auditory, and kinaesthetic interactions to support foundational Arabic reading skills. Usability evaluation was conducted with five experts in Arabic language pedagogy, special education, and educational technology using the validated usefulness, satisfaction, and ease of use (USE) questionnaire. Results show strong expert agreement across all dimensions: usefulness (93.2%), ease of use (89.4%), ease of learning (87.9%), and satisfaction (92.7%). The framework was considered practical, easy to implement, and capable of enhancing teacher support for MBK learners. The findings indicate that the AR framework has the potential to increase learner engagement, strengthen instructional effectiveness, and promote more inclusive Arabic literacy practices in special education classrooms.

This is an open access article under the [CC BY-SA](#) license.



Corresponding Author:

Saipolbarin Ramli

Department of Modern Languages, Faculty of Languages and Communication

Universiti Pendidikan Sultan Idris

35900 Tanjung Malim, Perak, Malaysia

Email: saipolbarin@fbk.upsi.edu.my

1. INTRODUCTION

Arabic literacy is a central component of Islamic education in Malaysia, particularly in enabling learners to read and comprehend the Quran, religious texts, and related instructional materials [1], [2]. Proficiency in Arabic not only strengthens religious identity but also provides access to broader linguistic and cultural knowledge. Although the Ministry of Education Malaysia (MOE) has introduced initiatives such as the j-QAF program to improve literacy in Jawi, Quranic studies, Arabic and Fardu Ain, these efforts have largely benefited mainstream learners.

Despite its importance, Arabic literacy remains challenging for many students due to the phonological, orthographic, and morphological differences between Arabic and Malay [3], [4]. *Murid berkeperluan khas* or students with special educational needs (MBK), particularly slow learners, face even greater difficulties because of limitations in working memory, attention and processing speed [5]. Conventional teacher-centered approaches, which emphasize memorization and repetitive drills, offer limited opportunities for multisensory and interactive learning [6], [7]. Consequently, MBK learners are often left behind in Arabic classrooms,

experiencing frustration, reduced motivation, and restricted access to foundational literacy skills [8]. This underscores the urgent need for inclusive and adaptive instructional strategies.

Although previous research has explored the use of educational technology tools such as multimedia platforms and mobile applications in Arabic language instruction [9], [10], few studies have documented the systematic design of an augmented reality (AR) literacy framework tailored specifically for MBK. Existing studies predominantly focus on general learners or vocabulary acquisition and rarely address special needs contexts [11], [12]. The limited availability of documented frameworks, design models, and empirical validation further restricts the replicability and scalability of technology-assisted innovations in special education. This highlights the need for research that explains how AR can be systematically designed, represented, and evaluated to support Arabic literacy for MBK learners.

Therefore, this study aims to develop and evaluate an AR-based instructional framework to enhance Arabic literacy among MBK learners. It provides a clear definition of the learner group, documents the AR framework through structured components and instructional sequences, and examines its usability through expert evaluation using the usefulness, satisfaction, and ease of use (USE) questionnaire. The study offers a theoretical contribution by addressing gaps in technology-enhanced Arabic literacy research for MBK, and a practical contribution by providing educators with a usable, replicable framework that supports inclusive instructional practice. This study contributes by developing the first structured AR framework tailored specifically for Arabic literacy among MBK. The framework integrates accessibility principles, instructional design components, and AR interaction features that address motor, cognitive, and perceptual challenges faced by MBK.

2. LITERATURE REVIEW

2.1. Arabic literacy among MBK

Arabic literacy is essential for enabling learners to access Quranic texts and broader Islamic knowledge. However, MBK, particularly slow learners, face considerable challenges in acquiring foundational Arabic reading skills. Their difficulties stem from limitations in working memory, attention span, and cognitive processing, which affect their ability to recognize *Hijaiyyah* or Arabic alphabet letters, apply vowel rules, and decode words accurately. Studies indicate that MBK learners require extended time, structured guidance, and repeated exposure to develop basic reading and writing skills [13]. Without adaptive instructional strategies, they risk being excluded from meaningful learning experiences and may experience decreased motivation and self-esteem [14].

2.2. Instructional challenges in Arabic teaching for MBK

Traditional instructional approaches in Malaysian Arabic classrooms often emphasize memorization and teacher-centered practices. While such methods may benefit average learners, they are insufficient for MBK students who require interactive, multisensory, and learner-centered instruction [15]. Teachers may also struggle to differentiate instruction due to limited training, constraints in classroom resources, and insufficient exposure to specialized pedagogical tools. This misalignment between instructional practice and learner needs contributes to MBK learners falling behind in literacy development, reinforcing the need for inclusive strategies that integrate both pedagogy and technology [16].

2.3. AR in special education and language learning

AR has emerged as a promising educational technology capable of supporting interactive learning environments. By overlaying digital content such as visuals, audio, animations, and 3D models onto the physical world, AR creates multimodal experiences that enhance learner engagement and comprehension [17]. In language learning, AR applications have demonstrated effectiveness in improving vocabulary acquisition, pronunciation, and learner motivation through immersive, visually enriched tasks [18]. Within special education, AR offers distinct advantages for learners with cognitive and attentional challenges by providing real-time scaffolding, controlled visual focus, and adaptive support [19]. Despite these benefits, limited research has explored AR frameworks specifically designed for Arabic literacy among MBK learners. Existing studies often target general populations or focus narrowly on vocabulary learning without offering comprehensive instructional frameworks [20].

2.4. Research gap summary

The literature identifies three major gaps: MBK learners continue to face persistent difficulties in mastering Arabic literacy due to cognitive constraints and limited instructional support; prevailing pedagogical practices in Arabic classrooms remain inadequate for inclusive learning; and there is a lack of structured, empirically validated AR frameworks tailored to Arabic literacy for MBK learners. Although previous studies

have acknowledged these issues, the evidence base remains fragmented and insufficient to guide systematic instructional innovation. These gaps collectively highlight the need for research that develops, documents, and evaluates a comprehensive AR-based instructional framework with clear components, visual models, and usability evidence to advance inclusive Arabic language teaching.

2.5. Overview of the framework

The AR-based Arabic literacy framework was developed to address the recurring challenges faced by MBK, particularly slow learners, in acquiring foundational Arabic reading skills. The framework integrates four major constructs such as MBK learner characteristics, Arabic reading literacy content, AR technology features, and teaching strategies into a coherent instructional model [21]. The development was guided by a needs analysis and expert validation to ensure alignment with learner needs, pedagogical principles, and usability standards.

2.6. Framework constructs

The AR-based Arabic literacy framework comprises four main constructs that guide instructional design for MBK learners. The first construct, MBK learner characteristics, highlights learner-specific challenges, including difficulties in distinguishing Arabic letters, limited memory retention, and reduced ability to differentiate letter sounds when combined with short vowels. The second construct, Arabic reading literacy, documents instructional approaches traditionally used in Malaysian classrooms, such as the *Hijaiyah* method, *Iqra'* approach, pyramid sequencing, word-sound blending, Malay articulation-based strategies, and phonetic (*sawti*) methods. The third construct, AR technology, outlines the technological elements integrated into the framework, including learning devices, physical instructional materials, multimedia components, and AR modalities, whether marker-based or markerless. The fourth construct, teaching strategies, focuses on pedagogical approaches that scaffold learning within the framework, incorporating learner-centered instruction, guided scaffolding, experiential learning, repetitive practice, gamification, and teacher-led support. The constructs of the AR literacy framework for MBK learners are illustrated in Figure 1.

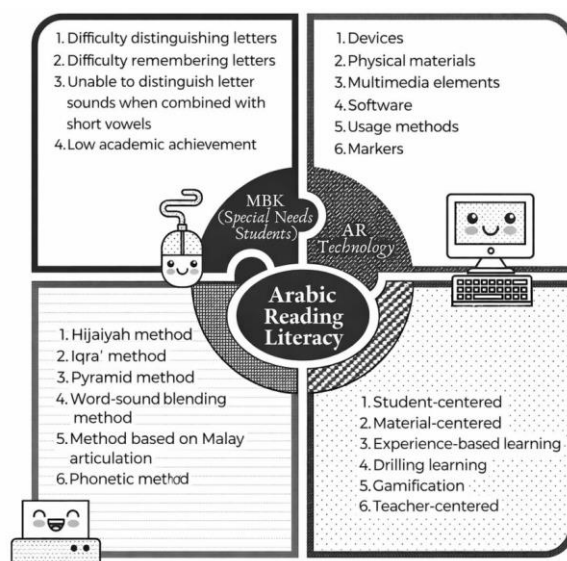


Figure 1. The AR literacy framework constructs for MBK learners

2.7. Instructional flow

The framework follows a sequential instructional process designed to facilitate Arabic literacy acquisition among MBK learners. Initially, learners are introduced to Arabic letters and sounds using conventional instructional materials, providing a foundation for subsequent learning activities. This is followed by AR engagement, in which interactive AR features reinforce learning through visualization and audio-supported pronunciation. Learners then participate in guided practice activities, including interactive and gamified exercises, to consolidate acquired skills. Teacher scaffolding is provided throughout, offering corrective feedback and guided support tailored to learner needs. Finally, continuous reinforcement is implemented through structured repetition, ensuring gradual mastery and retention of Arabic literacy skills.

2.8. Expert validation

The framework was reviewed by experts to ensure that its constructs, instructional components, and learning sequence were relevant and appropriate for supporting Arabic literacy among MBK learners. Expert feedback contributed to the refinement of the framework and confirmed its suitability for practical classroom implementation. The usability of the framework was subsequently evaluated using the USE questionnaire.

3. METHOD

3.1. Research design

This study employed a quantitative research design to evaluate the usability of an AR-based instructional framework developed to support Arabic reading literacy among MBK learners in Malaysia. Specifically, the study focused on expert-based usability evaluation at the framework development stage, rather than classroom implementation or learner outcome measurement. This design is appropriate for early-stage instructional framework validation, where expert judgment is required to assess clarity, structure, and practical applicability. The expert review method was employed to examine both the internal elements of the framework, including content organization and structural coherence, as well as its external usability, thereby enabling systematic and informed feedback from specialists in the relevant domains [22]. This approach is particularly suitable for preliminary framework validation prior to classroom implementation.

3.2. Research instrument

The primary instrument used in this study was the validated USE questionnaire, which measures user perceptions across four constructs: usefulness, ease of use, ease of learning, and satisfaction [23]. The questionnaire items were rated on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The USE questionnaire was selected due to its established reliability and widespread application in evaluating usability and user experience of educational technologies and instructional frameworks. The questionnaire consisted of two sections. Section A collected demographic information related to the experts' professional background and experience. Section B comprised items addressing the four usability constructs in relation to the proposed AR-based Arabic literacy framework.

3.3. Participants and expert selection

A purposive sampling technique was employed to select experts for framework validation. A total of five experts participated in the study, each possessing a minimum of five to seven years of professional experience in at least one of the following domains: Arabic language pedagogy, special education, or educational technology. This sample size aligns with usability evaluation standards, which suggest that five to ten experts are sufficient to identify core usability issues and validate instructional frameworks during early development stages [24], [25]. Experts were formally invited via email and provided with detailed information regarding the study objectives, procedures, and ethical considerations prior to participation.

3.4. Data collection procedure

Data collection was conducted through an expert review process. Following consent, the experts were provided with access to the AR-based Arabic literacy framework, including its conceptual model, instructional components, and learning sequence. A preliminary briefing session was conducted to familiarize the experts with the framework and clarify its intended pedagogical function. Experts were given two weeks to evaluate the framework using the USE questionnaire. Data were collected electronically via Google Forms, allowing flexibility for online or face-to-face engagement based on expert availability.

3.5. Data analysis

Data analysis was conducted using the percentage calculation method (PCM) to determine the level of expert agreement for each questionnaire item. Each response was converted into a percentage score based on the total possible score, and a benchmark value of 70% was established as the minimum threshold for acceptance [26]. Items exceeding this threshold were retained, while items falling below were reviewed for potential refinement based on expert feedback. The PCM approach is widely used in expert-based evaluations of instructional frameworks and educational technologies, particularly during conceptual validation phases, as it provides a clear and interpretable measure of consensus [27]. The formula (1) shows the procedure for calculating the percentage of calculation method (PCM) employed in this study.

$$PCM = \frac{\text{Total expert score}}{\text{Full score}} \times 100 \quad (1)$$

4. RESULTS AND DISCUSSION

4.1. Usefulness of the AR-based Arabic literacy framework

The findings revealed strong expert consensus regarding the usefulness of the AR-assisted Arabic literacy framework for MBK learners, with all eight items surpassing the 70% PCM benchmark. The highest agreement (97.1%) indicated that the framework effectively supports teaching needs and provides relevant instructional aids. Experts also affirmed its ability to enhance teacher productivity and reduce preparation time (94.3%), while facilitating classroom management and goal achievement (91.4%). Although the lowest-rated item (85.7%) concerned meeting overall teacher expectations, it still exceeded the acceptance threshold. The average usefulness score across all items was 93.2%. Table 1 presents the detailed results.

Table 1. Usefulness of the AR-based Arabic literacy framework

Construct	No.	Item	Expert agreement percentage (%)	Total percentage (%)
Usefulness	1	The AR-assisted Arabic text reading literacy framework enhances the effectiveness of MBK and Islamic education (IE) teachers in delivering Arabic reading instruction.	94.3	93.2
	2	The AR-assisted Arabic text reading literacy framework increases the productivity of MBK and IE teachers in teaching Arabic reading literacy.	94.3	
	3	The framework supported by AR technology proves to be useful in facilitating the teaching of Arabic reading literacy.	97.1	
	4	The AR-assisted Arabic reading literacy framework provides MBK/IE teachers with improved control over student engagement during literacy instruction.	91.4	
	5	The AR-assisted Arabic reading literacy framework enables MBK and IE teachers to achieve instructional objectives more efficiently.	91.4	
	6	The use of an AR-assisted Arabic reading literacy framework reduces the time required by MBK/IE teachers to prepare teaching materials.	94.3	
	7	The framework supported by AR technology fulfils teaching aid requirements for effective Arabic reading literacy instruction.	97.1	
	8	The framework supported by AR technology aligns with the instructional expectations of MBK teachers for effective Arabic reading literacy teaching.	85.7	

4.2. Ease of use of the AR-based Arabic literacy framework

The ease-of-use construct recorded an average of 89.4%. Experts emphasized the framework's practicality for daily teaching (94.2%) and its compatibility with Malaysia's Dokumen Standard Kurikulum dan Pentaksiran (DSKP) (91.4%). The lowest-rated item (77.1%) suggested that while the framework is intuitive, user manuals or tutorials would further support adoption. Table 2 presents the detailed results.

Table 2. Ease of use of the AR-based Arabic literacy framework

Construct	No	Item	Expert agreement percentage (%)	Total percentage (%)
Ease of use	1	The Arabic text reading literacy framework assisted by AR technology is easy to use.	91.4	89.4
	2	The Arabic text reading literacy framework with AR technology is practical to use in teaching.	94.2	
	3	The literacy framework for reading Arabic texts with AR technology is designed to be user-friendly for effective classroom use.	91.4	
	4	The literacy framework for reading Arabic texts is supported by flexible AR technology that facilitates its use in various teaching contexts.	91.4	
	5	The use of the AR-assisted Arabic literacy framework does not burden MBK or IE teachers.	88.6	
	6	The AR-assisted Arabic text reading literacy framework can be used by MBK/IE teachers independently, even without a user manual.	77.1	
	7	The use of the AR-assisted Arabic text reading literacy framework is aligned with the Ministry of Education's DSKP.	91.4	
	8	MBK/IE teachers will appreciate the AR-assisted Arabic text reading literacy framework.	88.6	
	9	MBK/IE teachers are able to promptly resolve errors encountered while using the literacy framework.	88.6	
	10	MBK/IE teachers are able to implement the AR-assisted Arabic text reading literacy framework effectively in their teaching.	91.4	

4.3. Ease of learning of the AR-based Arabic literacy framework

The average score for ease of learning was 87.9%. Experts agreed (88.6%) that teachers could quickly learn to use the framework through structured workshops and retain skills with minimal difficulty. A slightly lower score (85.7%) indicated that proficiency increases with classroom practice, confirming a manageable learning curve. Table 3 summarizes the results.

Table 3. Ease of learning of the AR-based Arabic literacy framework

Construct	No	Item	Expert agreement percentage (%)	Total percentage (%)
Ease of learning	1	MBK/IE teachers can learn to use the Arabic text reading literacy framework assisted by AR technology through a brief training workshop.	88.6	87.9
	2	MBK/IE teachers can easily remember how to use the Arabic text reading literacy framework assisted by AR technology	88.6	
	3	The literacy framework for reading Arabic texts assisted by AR technology is easy to learn.	88.6	
	4	MBK/IE teachers can quickly become proficient in using the AR-assisted Arabic text reading literacy framework.	85.7	

4.4. Satisfaction with the AR-based Arabic literacy framework

The satisfaction construct achieved an overall agreement of 92.7%. Experts valued the interactive features, such as 3D visualizations, audio, and gamified elements, which were engaging (94.3%). The framework's potential for peer recommendation (91.4%) indicates scalability and diffusion within the teaching community. Table 4 shows the results.

Table 4. Satisfaction of the AR-based Arabic literacy framework

Construct	No	Item	Expert agreement percentage (%)	Total percentage (%)
Satisfaction	1	MBK/IE teachers will be satisfied with the use of the AR-assisted Arabic text reading literacy framework.	91.4	92.7
	2	MBK/IE teachers will recommend the AR-assisted Arabic text reading literacy framework to other MBK/IE teachers.	91.4	
	3	Using the AR-assisted Arabic text reading literacy framework is enjoyable for MBK/IE teachers.	94.3	
	4	The AR-assisted Arabic text reading literacy framework functions in accordance with what MBK/IE teachers expect as effective instructional material for teaching Arabic text reading literacy.	94.3	
	5	Using the AR-assisted Arabic text reading literacy framework is considered a good idea for supporting Arabic literacy instruction.	97.1	
	6	MBK/IE teachers find it necessary to have access to a literacy framework for reading Arabic texts assisted by AR technology.	91.4	
	7	The use of the Arabic text reading literacy framework assisted by AR technology facilitates the implementation of Arabic text reading literacy teaching and learning.	88.6	
	8	MBK/IE teachers will be satisfied with the use of the AR-assisted Arabic text reading literacy framework.	91.4	

4.5. Overall validation

Across all four constructs, the AR-based Arabic literacy framework achieved an average agreement score of 91.0%. This percentage reflects consistent approval from expert evaluators for aspects assessed by the validation instrument. These findings indicate that the framework meets the minimum criteria for practicality, curriculum alignment, and usability for MBK learners.

4.6. Discussion

The validation results indicate that the AR-based Arabic literacy framework for MBK learners is highly acceptable, with an overall expert agreement of 91.0% across the four constructs such as usefulness, ease of use, ease of learning, and satisfaction, which each exceeding the 70% acceptance threshold. These findings confirm that the framework is both relevant and practical for classroom application. The results also

highlight shortcomings in conventional Arabic instruction for MBK learners, which often relies on one-size-fits-all methods that fail to address cognitive and sensory diversity, leading to low engagement and poor literacy outcomes [28], [29]. The high usefulness score (93.2%) demonstrates the framework's potential as a viable alternative, enhancing instructional effectiveness, reducing teacher workload, and aligning with the DSKP. This supports evidence that sequencing literacy instruction according to learners' phonological readiness improves learning outcomes [30].

With regard to ease of use (89.4%), experts emphasized that the framework is intuitive, flexible, and teacher-friendly, requiring minimal technical adjustments. This aligns with literature that identifies usability as a key determinant in the adoption of educational technologies [31]. The integration of AR features further embodies multisensory learning principles, whereby visual, auditory, and kinesthetic stimuli enhance information processing and retention for learners with cognitive impairments [32]. The ease of learning construct (87.9%) indicates that teachers can quickly acquire and retain the necessary skills through brief training sessions. This finding aligns with previous research showing that targeted professional development enables even non-digital-native educators to integrate AR effectively into teaching [33], [34]. Consequently, the structured design of the framework supports sustainable teacher confidence without requiring extensive technical expertise.

Satisfaction (92.7%) underscores the motivational impact of the framework's interactive and gamified features, including 3D visualizations, audio, and animations. Experts highlighted that enjoyment drives teacher endorsement and learner engagement, consistent with studies emphasizing the role of positive emotions in sustaining MBK learners' persistence in literacy tasks [35], [36]. Overall, this study contributes to the field of assistive technology by providing a validated, curriculum-aligned framework tailored for MBK learners. Beyond empirical validation, the framework aligns with the goals of the Malaysian Education Blueprint (2020–2025) and Education for All (EFA), promoting inclusive and innovative practices in Arabic literacy instruction.

Despite the high level of expert consensus, the absence of formative testing with MBK learners represents a methodological limitation that constrains generalizability to actual classroom settings. While expert evaluation is valuable for refining structure, clarity, and usability, it cannot fully capture learner behaviors, engagement patterns, or cognitive and sensory responses. Future research should incorporate iterative prototype testing and classroom pilots to assess how learners interact with the multimodal AR environment, the framework's effectiveness in supporting letter recognition and phonological decoding, and the feasibility of teacher implementation within differentiated instruction. Such empirical evidence will enhance the ecological validity and practical impact of the framework in inclusive education contexts.

5. CONCLUSION

This study validates an AR-based Arabic literacy framework for MBK learners, demonstrating strong expert consensus regarding usefulness, ease of use, ease of learning, and satisfaction. By addressing learner-specific challenges and incorporating evidence-based literacy methods, AR tools, and inclusive teaching strategies, the framework offers a structured and scalable model that improves teacher effectiveness and learner engagement while aligning with curriculum standards. Despite limitations such as a small expert panel and the absence of classroom testing, the study underscores the framework's potential for practical application. Future research should broaden validation with larger samples, classroom implementation, and adaptive technologies to further personalize instruction. Beyond Malaysia, this framework contributes to inclusive education globally, illustrating how AR can support literacy development for marginalized learners and advance sustainable development goal 4: quality education. The framework demonstrates how AR can serve as a practical inclusive learning solution that modernizes Arabic literacy instruction for special needs learners and supports the broader digital transformation of language education.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to Universiti Pendidikan Sultan Idris, Tanjung Malim, Perak, Malaysia, for its support, research facilitation throughout this study. Special appreciation is also extended to the MBK and IE teachers in Malaysia for their invaluable contributions to this study.

FUNDING INFORMATION

This research has been carried out under fundamental research grant scheme (FRGS2020-0247-107-029FRGS/1/2020/SS10/UPSI/02/46) provided by Ministry of Higher Education Malaysia.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Saipolbarin Ramli	✓		✓			✓	✓	✓	✓	✓		✓	✓	✓
Mohd Zawawi Awang Hamat	✓		✓	✓		✓	✓		✓		✓		✓	✓
Mohammad Taufiq Abdul Ghani		✓	✓			✓	✓	✓	✓		✓	✓		✓
Nur Hanim Hassan	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			
Siti Rahmah Borham		✓	✓			✓		✓	✓	✓	✓			

C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research involving human participants was conducted in compliance with all relevant national regulations and institutional policies, in accordance with the guidelines approved by the Research Ethics Committee (JKEPU), Universiti Pendidikan Sultan Idris, Malaysia.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [SR], upon reasonable request.

REFERENCES

- [1] A. Amin and M. A. Musa, "The role of education to enhance literacy in Islam," *Al-Risalah: Journal of Islamic Revealed Knowledge and Human Sciences (ARJIHS)*, vol. 6, no. 2, pp. 478–494, 2022.
- [2] A. R. Zulkifli, S. C. Haron, and N. S. Ahmad Nasaruddin, "Integrating augmented reality in primary arabic vocabulary instruction: teachers' acceptance, readiness, and pedagogical implications," *International Journal of Academic Research in Progressive Education and Development*, vol. 15, no. 1, pp. 1448–1467, 2026, doi: 10.6007/IJARPED/v15-i1/27649.
- [3] S. Y. Husein, N. Hasaniyah, M. Murdiono, and A. Akmaluddin, "Teaching methods, challenges, and strategies for improving students' Arabic linguistic competence," *IJAZ ARABI: Journal of Arabic Learning*, vol. 6, no. 3, 2023, doi: 10.18860/ijazarabi.v6i3.23558.
- [4] N. Ali, N. E. A. Rahman, N. A. Awang, A. H. A. Rahman, and A. H. Embong, "A preliminary study of Arabic text reading skills instruction based on effective reading strategies," *Journal for Educators, Teachers and Trainers*, vol. 14, no. 3, pp. 228–236, 2023.
- [5] N. J. Jamil *et al.*, "Bridging gaps in online Arabic language instruction: addressing key challenges in higher education institutions," *Global Journal Al-Thaqafah*, Special Issue, pp. 115–129, Dec. 2024, doi: 10.7187/GJATS1122024-8.
- [6] S. A. Alahmari, M. J. Aftab, and F. Amjad, "Challenges in literacy skills development in early childhood special education in inclusive setting," *American Journal of Psychiatric Rehabilitation*, vol. 28, no. 1, pp. 661–671, 2025.
- [7] G. Cosentino, M. Gelsomini, K. Sharma, and M. Giannakos, "Students' experience and learning outcomes in multisensory environments: the moderating role of interaction modalities," *Smart Learning Environments*, vol. 12, no. 47, 2025, doi: 10.1186/s40561-025-00402-4.
- [8] M. S. Khair, "Student-centered learning and collaborative learning in Arabic language education," *An Nazhair: Journal of Arabic Education*, vol. 2, no. 1, pp. 45–54, Jun. 2025, doi: 10.20414/nazhair.v2i1.63.
- [9] M. Subkhi and D. A. H. Tyas, "Enhancing Arabic vocabulary mastery through digital literacy: overcoming challenges and implementing effective strategies," *Language, Technology, and Social Media*, vol. 2, no. 1, pp. 11–24, 2024, doi: 10.70211/ltsm.v2i1.38.
- [10] M. K. A. Zulkupli, M. Z. Abd Hamid, and B. A. S. Dajani, "The impact of mobile applications on Arabic language acquisition: a pedagogical perspective," *International Journal of Research and Innovation in Social Science*, vol. 8, no. 8, 2024, doi: 10.47772/ijriss.2024.8080340.
- [11] E. Morfidi and G. Iatraki, "Improving reading ability using augmented reality," *Education Sciences*, vol. 15, no. 10, pp. 1–24, 2025, doi: 10.3390/educsci15101280.

- [12] L. H. Asbulah, N. S. I. Azihan, H. Nordin, and M. Sahrim, "Enhancing Arabic vocabulary mastery through augmented reality: a study on AR-Mufradat application for primary school students," *International Journal of Advanced Research*, vol. 12, no. 10, pp. 283–291, 2024, doi: 10.21474/IJAR01/19640.
- [13] S. Ramli, M. Z. A. Hamat, M. T. A. Ghani, N. H. Hassan, and S. R. Borham, "AR-based Arabic literacy framework for special needs learners," *OEIL Research Journal*, vol. 24, no. 6, pp. 1–13, 2026, doi: 10.14148/ORJ.2026.V24.I6.191.
- [14] M. Sahrim, N. F. A. Mohamad Soad, and L. H. Asbulah, "Augmented reality technology in learning arabic vocabulary from the perception of university students," *International Journal of Interactive Mobile Technologies*, vol. 17, no. 21, 2023, doi: 10.3991/ijim.v17i21.41277.
- [15] B. Y. Yenioglu, F. Ergulec, and S. Yenioglu, "Augmented reality for learning in special education: a systematic literature review," *Interactive Learning Environments*, vol. 31, no. 7, pp. 4572–4588, 2021, doi: 10.1080/10494820.2021.1976802.
- [16] M. A. Mustofa and R. Rini, "Learning Arabic for children with special needs," *Ijaz Arabi Journal of Arabic Learning*, vol. 8, no. 2, May 2025, doi: 10.18860/ijazarabi.v8i2.31843.
- [17] S. Ramli, M. Z. A. Hamat, S. R. Borham, and M. Z. Ismail, "Design and development of Pro-Tadris: a multilevel reflective assessment framework for pre-service Arabic language teachers," *International Journal of Research and Innovation in Social Science (IJRISS)*, vol. 9, no. 7, pp. 4869–4877, 2025, doi: 10.47772/IJRISS.2025.907000394.
- [18] M. T. A. Ghani and W. A. A. W. Daud, "The impact of digital game-based learning towards Arabic language communication," *Jurnal Komunikasi: Malaysian Journal of Communication*, vol. 39, no. 1, pp. 407–424, Mar. 2023, doi: 10.17576/jkmjc-2023-3901-23.
- [19] J. Garzón, Kinshuk, S. Baldiris, J. Gutiérrez, and J. Pavón, "How do pedagogical approaches affect the impact of augmented reality on education? A meta-analysis and research synthesis," *Educational Research Review*, vol. 31, 2020, doi: 10.1016/j.edurev.2020.100334.
- [20] M. L. A. H. M. Md Noor *et al.*, "Design and development of an augmented reality module for learning Arabic collocations," *Ijaz Arabi Journal of Arabic Learning*, vol. 8, no. 3, 2025, doi: 10.18860/ijazarabi.v8i3.32514.
- [21] M. F. B. Putra, O. S. Salsabila, S. R. Siregar, I. A. Akbar, and I. Syaifiah, "Augmented reality and virtual reality in Arabic speaking skills instruction: a systematic review of pedagogical contributions," *Alsina : Journal of Arabic Studies*, vol. 8, no. 1, pp. 131–164, Feb. 2026, doi: 10.21580/alsina.8.1.27660.
- [22] J. Kollmorgen, A. Hinderks, and J. Thomaschewski, "Selecting the appropriate user experience questionnaire and guidance for interpretation: the UEQ family," *International Journal of Interactive Multimedia and Artificial Intelligence*, vol. 9, no. 4, pp. 126–139, Aug. 2025, doi: 10.9781/ijimai.2024.08.005.
- [23] J. Nielsen, *Usability engineering*. San Francisco, USA: Morgan Kaufmann, 1993.
- [24] J. Feng, B. Yu, W. H. Tan, Z. Dai, and Z. Li, "Key factors influencing educational technology adoption in higher education: a systematic review," *PLOS Digital Health*, vol. 4, no. 4, p. e0000764, Apr. 2025, doi: 10.1371/journal.pdig.0000764.
- [25] L. Liu, M. R. Mohd Jamil, and N. Idris, "Fuzzy Delphi method (FDM) for developing components of the classroom activity-based instructional design (CAID) model in teaching Chinese as a foreign language," *International Journal of Modern Education*, vol. 6, no. 23, pp. 284–298, Dec. 2024, doi: 10.35631/ijmoe.623020.
- [26] Y. Siyam, N. Siyam, M. Hussain, and O. Alqaryouti, "Evaluating technology integration in education: a framework for professional development," *Discover Education*, vol. 4, no. 1, Mar. 2025, doi: 10.1007/s44217-025-00448-z.
- [27] C. Jacobs, G. Foote, and M. Williams, "Evaluating user experience with immersive technology in simulation-based education: a modified Delphi study with qualitative analysis," *PLOS ONE*, vol. 18, no. 8, p. e0275766, Aug. 2023, doi: 10.1371/journal.pone.0275766.
- [28] H. Köse and N. Güner-Yildiz, "Augmented reality (AR) as a learning material in special needs education," *Education and Information Technologies*, vol. 26, no. 2, pp. 1921–1936, 2020, doi: 10.1007/s10639-020-10326-w.
- [29] J. H. Lumbantoruan and E. Deliviana, "Development of a logarithmic module equipped with a jigsaw cooperative model," *Jurnal Elemen*, vol. 9, no. 2, pp. 616–629, 2023, doi: 10.29408/jel.v9i2.17520.
- [30] J. Wu and Y. Shen, "Design and evaluation of an augmented reality and generative AI-driven English speaking training system," *International Journal of Interactive Mobile Technologies (IJIM)*, vol. 19, no. 21, pp. 34–48, Nov. 2025, doi: 10.3991/ijim.v19i21.58851.
- [31] H. Na, K. B. Staudt Willet, and C. Kim, "Investigating the impact of AR technologies on geometric learning in primary school: a comparison between marker-based and markerless AR," *British Journal of Educational Technology*, vol. 56, no. 6, 2025, doi: 10.1111/bjet.13584.
- [32] R. M. I. Khan, A. Ali, T. Kumar, and A. Venugopal, "Assessing the efficacy of augmented reality in enhancing EFL vocabulary," *Cogent Arts & Humanities*, vol. 10, no. 1, pp. 1–14, 2023, doi: 10.1080/23311983.2023.2223010.
- [33] B. Uysal and H. Bicen, "Evaluating teachers' readiness and perceptions of augmented reality in STEM education: considerations for sustainable teaching practices," *Sustainability*, vol. 18, no. 15, pp. 1–17, 2026, doi: 10.3390/su18157694.
- [34] F. Aslam, H. Rahman, S. A. Wahid, S. A. Wahid, and N. Ali, "Enhancing children's learning experience through alphabet AR-game: a usability and acceptability assessment of augmented reality game-based learning," *Multimedia Tools and Applications*, vol. 84, no. 25, pp. 29183–29205, 2025, doi: 10.1007/s11042-024-20346-0.
- [35] F. N. Tarigan, A. F. Nasution, F. I. Fauzi, S. A. Hasibuan, A. Jidah, and A. I. Halawa, "The effects of genially-based interactive media through flipped learning on literacy and writing skills of students with autism spectrum disorder," *Forum for Linguistic Studies*, vol. 7, no. 12, pp. 1957–1968, Dec. 2025, doi: 10.30564/fls.v7i12.11845.
- [36] A. D. Einsthendhi, M. I. A. Rasyid, and J. B. Wicaksono, "Augmented reality: impact on student engagement and learning," *Hipkin Journal of Educational Research*, vol. 1, no. 2, pp. 239–250, Aug. 2024, doi: 10.64014/hipkin-jer.v1i2.22.

BIOGRAPHIES OF AUTHORS



Saipolbarin Ramli    is an associate professor at the Faculty of Languages and Communication, Universiti Pendidikan Sultan Idris, Malaysia. He holds a Ph.D. and master's degree from the University of Malaya, with academic expertise in Arabic lexicography, discourse analysis, Arabic pedagogy, and Qur'anic botanical studies. He has supervised postgraduate research and published actively in his field. He has led several innovation-based projects and received multiple awards, including Gold for the "Transformative Lifelong Learning (PSH) Module for Takmir Teachers", "ITaR for Special Needs Learners," "E-Muhadathah Digital Kit", and gamified Arabic learning tools such as Jawlah Perak, Aps-REHLAH, and A-Smart Lu'bah. He has also received UPSI's Excellent Service Award, Academic Advisor Award, and Teaching Innovation Award. He can be contacted at email: saipolbarin@fbk.upsi.edu.my.



Mohd Zawawi Awang Hamat    is an experienced lecturer at the Faculty of Languages and Communication, Universiti Pendidikan Sultan Idris, Malaysia. He holds academic qualifications from Al al-Bayt University (Jordan), the Institute of Teacher Education, and Universiti Kebangsaan Malaysia (UKM). His specialization is in teaching Arabic as a second language, with research interests in Arabic syntax, gamification for tourism, corpus development for translation, and the use of augmented reality (AR) to support Arabic reading literacy for MBK. He has actively contributed to research grants at institutional and national levels and has co-authored multiple publications in indexed journals. His work is recognized for its focus on developing digital tools and interactive modules that enhance Arabic language teaching and learning in Malaysia. He can be contacted at email: mohd.zawawi@pbmpu.upsi.edu.my.



Mohammad Taufiq Abdul Ghani    is deputy dean (Industry Network and Commercialization) at the Faculty of Languages and Communication, Universiti Pendidikan Sultan Idris, Malaysia. He holds a Ph.D. in Instructional Technology and specializes in Teaching Arabic as a Second Language (TASL), digital pedagogy, AR, and gamification. His research focuses on technology integration in Arabic education, inclusive learning, and curriculum enhancement, particularly in KAFA and Arabic for specific purposes. He has contributed to various national and international projects and developed several award-winning innovations including Puzzlead-AR, ARabic-KAFA, A-Smart Lu'bah, and i-Suyyiah recognized by ITEX, PECIPTA, IUCEL, and Innozilla. Mohammad Taufiq is passionate about transforming Arabic language teaching through engaging, accessible, and future-ready technological solutions. He can be contacted at email: taufiq@fbk.upsi.edu.my.



Nur Hanim Hassan    is a master's graduate from Universiti Pendidikan Sultan Idris, Malaysia, and currently works as an Arabic language teacher at Sekolah Menengah Agama Al-Madrasah Al-Alawiyah Ad-Diniyah (SMA Al-MAAD), Perlis. Her research centers on the development of AR frameworks to support Arabic reading literacy among students with special educational needs (MBK). Passionate about educational innovation, she is actively involved in designing and developing AR-based learning applications for primary school students in Malaysia, aiming to enhance engagement, accessibility, and inclusion in Arabic language education. Nur Hanim has authored academic publications and has presented her work at both national and international conferences. Notably, her innovation “!TaR: Arabic Reading Literacy for Student with Special Needs” was awarded the Gold Award in an academic innovation competition. She can be contacted at email: ilmihanim26@gmail.com.



Siti Rahmah Borham    is a passionate educator and researcher in Arabic Language Education. She holds a Ph.D. from Universiti Pendidikan Sultan Idris, Malaysia. Her scholarly work focuses on innovative Arabic pedagogy and the integration of technology, including AI-based tools, in language teaching and learning. With experience as a lecturer at Universiti Tun Hussein Onn Malaysia (UTHM) and Institut Tadbiran Islam Perak (INTIM)-Darul Quran JAKIM, she has also served as a research assistant in Arabic language innovation projects at UPSI. Siti Rahmah actively presents at conferences and contributes to academic publications. Her innovation, the “E-Muhadathah Digital Kit”, which incorporates artificial intelligence (AI) elements, received a Gold Award and the Best Video Design Award for enhancing digital Arabic communication learning. She remains committed to advancing Arabic education through research, innovation, and collaboration. She can be contacted at email: rahmahborham@gmail.com.