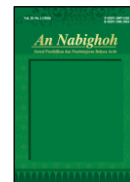




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VIRTUAL REALITY AND ARABIC LANGUAGE LEARNING: A GLOBAL SYSTEMATIC LITERATURE REVIEW

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Abstract

Background: Virtual Reality (VR) has recently gained attention in language education. It offers interactive, immersive, and contextual learning experiences that cannot be provided by traditional learning media. Despite this growing interest, the use and development of virtual reality in Arabic language learning remains limited and severely underexplored. **Research Objectives:** This study aims to synthesize the current state of virtual reality as it relates to Arabic language learning. **Methodology:** This study was conducted using PRISMA 2020 to make a systematic literature review. Studies were collected with a range of publications from 2021 to 2025, sourced from five different databases. The studies were filtered using the built-in filter of the respective databases and screened further by the author. The methodological quality of these studies was evaluated using the Mixed Methods Appraisal Tool (MMAT). **Results:** Six studies met the criteria for analysis and synthesis. The limited number of articles shows that current VR-based Arabic language learning has an imited focus. Different forms of technology were deployed and designed, including self-developed tools and external sources. Participants reported clear benefits and limitations of the virtual reality utilization. **Unique Contribution:** This review contributes to mapping VR-based Arabic language learning media according to targeted skills, educational context, technological approaches, and methodological limitations, thereby offering a structured research agenda for future immersive Arabic language instruction. **Conclusion:** The review showed that virtual reality in Arabic language learning remains developmental and has yet to be utilized further. The main aspect of further development needs to be conducted in the long term and on a wider scale and range. **Recommendations:** Further research should deploy gamification and LLM to implement personalized learning. Future research should prioritize the implementation of rigorous, longitudinal research designs, aim to develop a broader range of language skills, and incorporate diverse educational environments and learner populations.

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Keywords:

Arabic Language Learning; Immersive Learning; Systematic Literature Review; Virtual Reality.

Introduction

Virtual reality has been growing exponentially and has created a significant impact on the world of language education. The various applications of virtual reality have created a promising path for immersive and contextual learning.¹ This is in line with modern education requirements for language learning that encourage learner engagement. It is also supported by the effectiveness of audio-visual media in enhancing learning outcomes.² Despite growing attention to virtual technologies in language education, there remains a lack of studies supporting the effectiveness of virtual reality, especially in Arabic language learning.

In the past five years, research has explored the use of virtual reality in both conceptual and applied fields. The research results have shown positive effects on various aspects of language learning.³ Systematic reviews have found that the utilization of virtual reality is particularly beneficial for contextual and immersive learning in higher education and English as a Foreign Language (EFL).⁴ Studies across disciplines have shown that virtual reality enhances learners' engagement and spatial understanding by allowing them to interact with content that is traditionally difficult to access.⁵ Large-scale implementations of virtual reality suggested that the supporting factors for success lie within a good instructional design and the teacher's readiness.⁶

¹ Mario Vallarino et al., "Effects of Using Depth and Motion in Virtual Reality to Enhance Language Learning," *Virtual Reality* 29, no. 3 (2025): 127, <https://doi.org/10.1007/s10055-025-01203-3>.

² Ali Farhan and Asep Sopian, "Ta'tsir al-wasilah as-sam'iyah al-bashariyyah fi ta'allum maharah al-istima' li al-lughah al-'arabiyyah 'ala mukhtalif al-mustawayat.," *Al-Arabi: Journal of Teaching Arabic as a Foreign Language* 8, no. 2 (2024), <https://journal2.um.ac.id/index.php/alarabi/article/view/56285>.

³ Neil Cowie and Mehrasa Alizadeh, "Virtual Reality for Language Learning," *ELT Journal*, July 4, 2025, ccdf025, <https://doi.org/10.1093/elt/ccdf025>; Zarifa Sadigzade, "Immersive and Gamified Approaches: VR/AR in Language Learning," *Porta Universorum* 1, no. 6 (2025): 15–24, <https://doi.org/10.69760/portuni.0106002>; Eefa Binte Tariq and Hareem Ahmad, "The Use of Virtual Reality (VR) for Language Acquisition: A Comprehensive Analysis with Scientific and Practical Consequences," *American Journal of Education and Practice* 9, no. 1 (2025): 22–31, <https://doi.org/10.47672/ajep.2627>.

⁴ Sajjadllah Alhawsawi and Faten Alzaid, "Systematic Review of Virtual Reality's Uses on Vocabulary Learning in Higher Education," *Smart Learning Environments* 12, no. 1 (2025): 60, <https://doi.org/10.1186/s40561-025-00414-0>; Cheng-Ji Lai, "Enhancing Multimodal Output in CLIL Education: The Impact of VR Games on Fourth-Grade Students' English Poster Designs and Presentations in Taiwan," *Humanities and Social Sciences Communications* 11, no. 1 (2024): 1465, <https://doi.org/10.1057/s41599-024-03999-y>; Hsin-Yun Wang and Jerry Chih-Yuan Sun, "Real-Time Virtual Reality Co-Creation: Collective Intelligence and Consciousness for Student Engagement and Focused Attention within Online Communities," *Interactive Learning Environments* 31, no. 6 (2023): 3422–35, <https://doi.org/10.1080/10494820.2021.1928711>.

⁵ Yunus Emre Avcu and Yavuz Yaman, "The Effect of Virtual Reality (VR) Settings on Nature Relatedness and Attitudes Towards Environment in Gifted Students," *Journal of Science Education and Technology* 34, no. 2 (2025): 327–45, <https://doi.org/10.1007/s10956-024-10194-w>; Yu-Ju Lin and Hung-chun Wang, "Using Virtual Reality to Facilitate Learners' Creative Self-Efficacy and Intrinsic Motivation in an EFL Classroom," *Education and Information Technologies* 26, no. 4 (2021): 4487–505, <https://doi.org/10.1007/s10639-021-10472-9>.

⁶ Tricia Thrasher et al., "Implementing Large-Scale Virtual Reality in K-12 Education: A Report on Lessons Learned from Practice," *TechTrends* 70, no. 2 (2026): 426–40, <https://doi.org/10.1007/s11528->

Immersion in virtual reality has shown potential to enhance motivation and engagement. Some studies even suggest using gamification in virtual reality to support learning.⁷ With that as a focus, the development of virtual reality is better designed as task-based and interaction-focused.⁸ Conversely, a poorly designed educational process can include cognitive burden and distract from the original goal of language learning.⁹ Additionally, studies on user experience and learning behaviors reveal differences in how learners adopt these technologies, their interaction patterns, and their perceptions of usefulness. These factors suggest the difficulty of achieving consistent outcomes across different settings and contexts.¹⁰

Virtual reality studies in other languages have been flourishing in comparison to the studies specifically targeted at Arabic language learning. Awang and Ghalib conducted a needs analysis to use virtual reality as a medium to enhance Arabic grammar learning.¹¹ Although the study suggests the use of VR could overcome many difficulties in Arabic language learning, it still does not result in applied outcomes that support the field. Furthermore, research on VR-based Arabic language learning remained in a limited context, which make it hard to define the pedagogical implications of virtual reality in Arabic language learning globally.

A thorough review of the current literature highlights a notable gap in evidence synthesis. While recent systematic reviews have explored VR in EFL and broader language-learning contexts, none have examined VR applications in Arabic language learning on a global scale. The existing literature reviews for Arabic language learning are targeted towards integrating Large Language Models

025-01159-w; Shu-Hao Wu et al., "Effects of Teacher-Developed Spherical Video-Based Virtual Reality Types on Student Learning Engagement: A Hierarchical Linear Modeling Approach," *Education and Information Technologies* 30, no. 7 (2025): 8847–76, <https://doi.org/10.1007/s10639-024-13142-8>.

⁷ Andreas Maroukakis et al., "An Adaptive Virtual Reality Game for Programming Education Using Fuzzy Cognitive Maps and Pedagogical Models," *Smart Learning Environments* 12, no. 1 (2025): 62, <https://doi.org/10.1186/s40561-025-00392-3>.

⁸ Georgios Lampropoulos and Kinshuk, "Virtual Reality and Gamification in Education: A Systematic Review," *Educational Technology Research and Development* 72, no. 3 (2024): 1691–785, <https://doi.org/10.1007/s11423-024-10351-3>; Yalun Zhou and Rahul Divekar, "Immersive, Task-Based Language Learning Through XR and AI: From Design Thinking to Deployment," *TechTrends* 69, no. 2 (2025): 427–46, <https://doi.org/10.1007/s11528-025-01048-2>.

⁹ Xiaoqing Hong and Li Guo, "Effects of AI-Enhanced Multi-Display Language Teaching Systems on Learning Motivation, Cognitive Load Management, and Learner Autonomy," *Education and Information Technologies* 30, no. 12 (2025): 17155–89, <https://doi.org/10.1007/s10639-025-13472-1>; Chiao Ling Huang et al., "Influence of Students' Learning Style, Sense of Presence, and Cognitive Load on Learning Outcomes in an Immersive Virtual Reality Learning Environment," *Journal of Educational Computing Research* 58, no. 3 (2020): 596–615, <https://doi.org/10.1177/0735633119867422>; Nafiseh Salehi, "Teaching Vocabulary with Augmented Reality: Voices from Junior High School English Teachers," *Discover Education* 4, no. 1 (2025): 230, <https://doi.org/10.1007/s44217-025-00673-6>.

¹⁰ Bin Shen et al., "Can SVVR Help with Student Engagement in an Online EFL Writing Class? A Chinese Case Study," *The Asia-Pacific Education Researcher* 33, no. 4 (2024): 1011–21, <https://doi.org/10.1007/s40299-023-00774-6>.

¹¹ Mohammad Amnan Awang Ali and Mohd. Feham Md Ghalib, "Developing Virtual Reality (VR) Technology in Learning Arabic Grammar: An Insight on Needs Analysis for Arabic-VR Application," *Ulum Islamiyyah* 36, no. 03 (2024): 15–25, <https://doi.org/10.33102/uij.vol36no03.601>.

(LLMs).¹² Another study also focused on AI in immersive learning with no linguistic targets.¹³ As a result, there is a lack of comprehensive evidence on research trends, instructional strategies, VR technologies, targeted language skills, and learning outcomes specific to Arabic. This limits the ability to determine the strengths and weaknesses of existing studies, compare findings, and identify an advancement route for future studies.

In line with the identified gap, this study conducted a systematic literature review (SLR) following PRISMA 2020 guidelines to ensure a thorough, transparent selection process and to synthesize the existing literature systematically. This was done to provide a structured review in order to identify the standing of virtual reality in the field of Arabic language learning. The process consists of identifying, screening, and assessing peer-reviewed studies published between 2021 and 2025.

This review aims to provide a clear overview of recent studies on the use of virtual reality in Arabic language learning. The studies will then be categorized according to the educational settings, targeted language proficiency, and the employment of virtual reality in the studies. It will then identify the benefits and limitations of the existing studies, followed by the research gap and general advancement route for the development of virtual reality in Arabic language learning. Based on this, this research has three (3) main questions. First, what are the characteristics of recent studies on virtual reality-supported Arabic language learning in terms of educational context, research design, and VR technologies used? Second, which Arabic language skills and learning outcomes are addressed through virtual reality-based instruction, and what benefits and challenges are reported? Third, what methodological limitations and research gaps can be identified in existing studies on virtual reality and Arabic language learning?

The results of the study will provide a comprehensive overview of virtual reality's position in the field of Arabic language learning, thereby acting as a foundational reference in further developing virtual reality utilization in Arabic language learning.

¹² Samia Haboussi et al., "Arabic Speech Recognition Using Neural Networks: Concepts, Literature Review and Challenges," *Journal of Umm Al-Qura University for Applied Sciences*, ahead of print, February 11, 2025, <https://doi.org/10.1007/s43994-025-00213-w>; Haneh Rhei and Dmitri Roussinov, "Large Language Models and Arabic Content: A Review," version 1, preprint, arXiv, 2025, <https://doi.org/10.48550/ARXIV.2505.08004>; Sultan Almelhes, "A Systematic Review and Meta-Analysis on Artificial Intelligence and Its Utilization in Arabic Learning," in *Proceedings of The 11th International Conference on Frontiers of Educational Technologies 2025*, ed. Anu Gokhale, Lecture Notes in Educational Technology (Springer Nature Singapore, 2026), https://doi.org/10.1007/978-981-95-2521-8_16; Islamiyah Sulaeman et al., "ChatGPT as a New Frontier in Arabic Education Technology," *Al-Arabi: Journal of Teaching Arabic as a Foreign Language* 7, no. 1 (2023): 83, <https://doi.org/10.17977/um056v7i1p83-105>.

¹³ Yun Wen et al., "Trends and Applications of AI in Immersive Learning Environments: A Systematic Review of Empirical Research," *Interactive Learning Environments* 34, no. 3 (2026): 1544–62, <https://doi.org/10.1080/10494820.2025.2524029>.

Method

This study used a systematic literature review (SLR) to find, evaluate, and combine peer-reviewed research on virtual reality (VR) in Arabic language learning. The systematic approach was chosen to ensure transparency, consistency, and clear procedures in identifying relevant evidence, especially since research in this area is considered limited and emerging. The review followed the PRISMA 2020 guidelines maintain rigor and clarity.¹⁴

Table 1. SPIDER analysis to determine research inclusion criteria

Element	Description
Sample	Learners of Arabic as a foreign language
Phenomenon of Interest	Virtual reality used in Arabic language learning
Design	Published literature of a research article with a learning outcome or instructional design
Evaluation	Characteristics, targeted skills, limitations
Research Type	Qualitative, quantitative, and mixed methods

Data Source: Processed by author, 2026

The framework for this study is built on the SPIDER framework. The target population for this review comprises learners of Arabic as a foreign language, with the phenomenon of interest being the use of virtual reality in Arabic language instruction. The review design included published literature that reports either learning outcomes or instructional design in virtual reality. Every study will then be evaluated according to the characteristics, skills targeted, and limitations, respectively. This can be seen in Table 1.

Table 2. Search strings used in databases to collect literature

Database	Search String
Springer Nature Link	'Virtual Reality' AND 'Immersive Learning' AND 'Arabic Language Learning'
ScienceDirect	'Virtual Reality' AND 'Immersive Learning' AND 'Arabic Language Learning'
SagePub	'Virtual Reality' AND 'Immersive Learning' AND 'Arabic Language Learning'
Taylor & Francis	'Virtual Reality' AND 'Immersive Learning' AND 'Arabic Language Learning'
Semantic Scholar	'Virtual Reality' AND 'Arabic Language Learning'

Data Source: Processed by author, 2026

There are five databases used in this study, namely Springer Nature Link, ScienceDirect, SagePub, Taylor & Francis, and Semantic Scholar. The search was conducted on 27-31 January 2026. The search strategy followed the procedures outlined in Table 2. The Springer Nature Link, ScienceDirect, SagePub, and Taylor & Francis searches used broader pedagogical keywords to ensure a comprehensive collection of VR-based language-learning studies, with the search string ("") 'Virtual Reality' AND 'Immersive Learning' AND 'Arabic Language Learning'." In contrast, the Semantic Scholar search used a more specific string to directly locate Arabic-focused VR language-learning research, using the search terms ""'Virtual Reality' AND 'Arabic Language Learning'." The difference in search strategy was based on the system of

¹⁴ Matthew J. Page et al., "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews," *BMJ*, March 29, 2021, n71, <https://doi.org/10.1136/bmj.n71>.

each database, where the first group yielded results based on the combination of keywords, whereas Semantic Scholar yielded results for each keyword individually, resulting in unnecessarily broad results. The search also used every possible alternate keyword, such as “Arabic instruction” and “extended reality”. However, due to the lack of utilization of the term, the use of alternate keywords resulted in fewer or even zero results. During the screening process, only studies explicitly addressing Arabic language learning were retained. Studies targeting other languages were excluded.

Table 3. Inclusion and exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria
Publication Type	Peer-reviewed journal articles	Conference papers, book chapters, theses, dissertations
Publication Year	Published between 2021 and 2025	Published in 2020 or earlier
Language of Publication	English or Arabic	Publications in languages other than English or Arabic
Technology	Use of virtual reality or immersive VR environments	Augmented reality only, non-immersive simulations, or general multimedia tools
Learning Focus	Arabic language learning or instruction	Language learning targeting non-Arabic languages
Outcomes	Reports on Arabic language learning outcomes or instructional design	No learning-related outcomes or instructional design reported
Research scope	Empirically or pedagogically grounded studies	Technical system descriptions or UX-only studies

Data Source: Processed by author, 2026

Table 3 presents the clear inclusion and exclusion criteria used to screen the literature for assessment. Given that virtual reality is relatively new, this study limits the time period to 2021-2025. Articles published in languages other than English and Arabic will be excluded to avoid mistranslation and misinterpretation. The studies included will be those that have learning outcomes or instructional designs. Included studies will be within the scope of empirically or pedagogically grounded studies, which are limited to conceptual design studies and instructional results that encompass needs analysis, class action research, and development.

The methodological quality of included studies was assessed with the latest 2018 version of the Mixed Methods Appraisal Tool (MMAT).¹⁵ This assessment was conducted to systematically evaluate the studies that deployed different methodological approaches. Each study was first categorized based on its methodological approach and then evaluated against five key criteria relevant to that approach. According to the guidelines, the five criteria were then assessed for each study with “Yes”, “No”, or “Can’t tell”. This is done to ensure transparency in reporting the studies reviewed in this article. As a result, it helps in deriving the context, strength, and weakness of the studies assessed. Following that, the data analysis was in accordance with the research question.

¹⁵ Quan Nha Hong et al., “The Mixed Methods Appraisal Tool (MMAT) Version 2018 for Information Professionals and Researchers,” *Education for Information* 34, no. 4 (2018): 285–91, <https://doi.org/10.3233/EFI-180221>.

Result and Discussion

Literature review, especially one using PRISMA, has strict screening procedures. This was done to ensure that the studies used to synthesize a literature review will be of appropriate quality. The procedures went through a strict identification, screening, and inclusion process as follows:

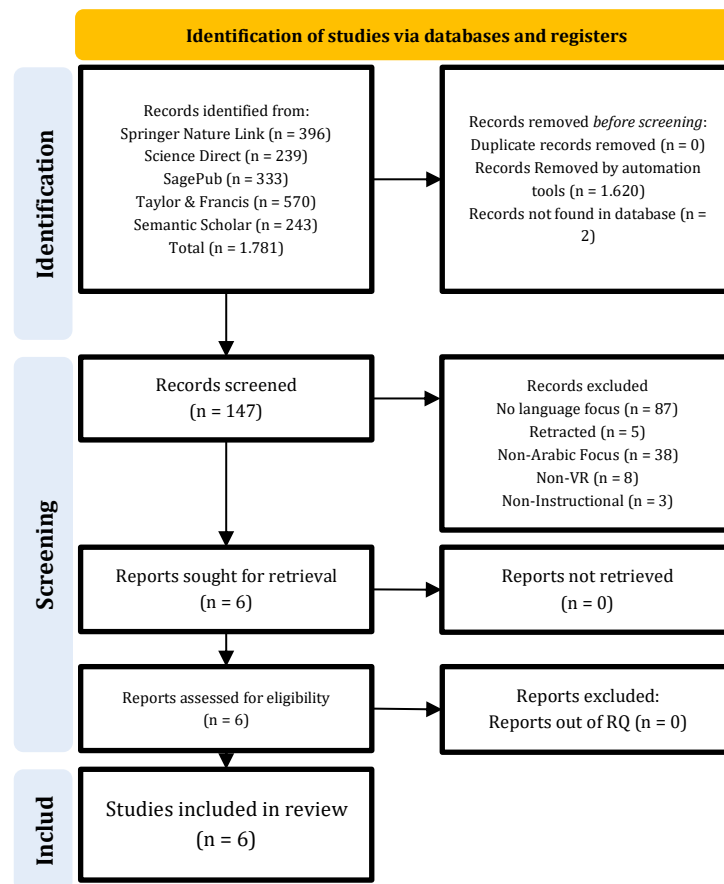


Figure 1. PRISMA literature screening flow

The thorough identification, screening, and assessment process is shown in Figure 1. The articles in this review were identified, screened, and assessed rigorously using five databases: Springer Nature Link, ScienceDirect, SagePub, Taylor & Francis, and Semantic Scholar. The identification in Springer Nature Link returned 396 articles, ScienceDirect returned 239 articles, SagePub returned 333 articles, Taylor and Francis returned 570 articles, and Semantic Scholar provided 243, resulting in a total of 1,781 records. The identified record was then further filtered using the database's built-in filters.

According to the inclusion and exclusion criteria in Table 3, Springer Nature was first filtered by publication year, eliminating 154 articles published before 2021. The next filter applied was content type, limiting results to "research article" only, which screened out 64 irrelevant records. Lastly, the subjects filter checks boxes of "virtual and augmented reality", "educational research", and "immersive virtual reality applications in education," screening out 49 research articles.

ScienceDirect was first filtered using the publication year filter, removing 105 papers. Next, the article type filter was applied, removing 51 non-research articles. Lastly, the subject areas filtered out 40 articles that do not belong to the “social sciences”, “computer sciences”, and “arts and humanities.” The total number of papers filtered is 196. SagePub was first filtered using the article type to limit to research articles, removing a total of 148 papers. Publication years filter further removed 123 articles. Subjects filter further eliminated a total of 37 articles that do not belong to “education”, “engineering & computing”, and “language & linguistics,” which makes the final number 25.

Taylor and Francis was first filtered by the article type, which removed 158 papers. The year filter further excluded 230 articles. The subject filter then removed articles that did not fall within "Education" and "Language and Literature," leaving 7 articles. For Semantic Scholar, the first one is the year range filter that eliminated 124 articles. The next filter is fields of study, only checking the “education” and “linguistics” boxes, screening 88 articles. In total, all filters applied across all databases resulted in the removal of 553 articles. After filtering, 2 articles that appeared in the search results were no longer accessible in the databases.

No duplication was found across databases, as every database uses their own journal database. The remaining articles to be screened totaled 147 articles. At the screening stage, a total of 141 articles were removed due to differing disciplinary focus (87 articles), retraction by the publisher (5 articles), lack of an Arabic language focus (38 articles), absence of a virtual reality application (8 articles), and irrelevance to language acquisition (3 articles). The remaining articles eligible for synthesis numbered six. None of the six studies was excluded for being irrelevant to the research questions.

Table 4. MMAT Evaluation Table

Study	Research Methods	C1	C2	C3	C4	C5
Syafri and Ramli ¹⁶	Quantitative	Yes	Yes	Yes	Yes	Yes
Barkahoum and Fatima ¹⁷	Qualitative	Yes	No	Yes	Yes	Yes
Humayrah et al. ¹⁸	Mixed Methods	Yes	Yes	Yes	Yes	Yes

¹⁶ Norazman Bin Ahmat Syafri and Saipolbarin bin Ramli, “Design Development of Arabic-Roman Transliteration Module with Virtual Reality Concept (eTARRiM) to Improve Primary School Students’ Arabic Reading Skills: Needs Analysis,” *Journal of Electrical Systems* 20, no. 4s (2024): 954–60, <https://doi.org/10.52783/jes.2136>.

¹⁷ Tria Barkahoum and Guellal Fatima, “Integrating Extended Reality (XR) Technologies in the Analysis of Arabic Sounds and the Teaching of Articulation Points: A Contemporary Digital Approach,” *Lex Localis - Journal of Local Self-Government* 23, no. 11 (2025): 2721–30, <https://doi.org/10.52152/kqmx6b33>.

¹⁸ Alifka Humayrah Humayrah et al., “Application of Virtual Reality Via the Delightex Platform for Enhancing Proficiency in Arabic Speaking Skills,” *Al-Ta’rib : Jurnal Ilmiah Program Studi Pendidikan Bahasa Arab IAIN Palangka Raya* 13, no. 2 (2025): 443–60, <https://doi.org/10.23971/altarib.v13i2.10556>.

Study	Research Methods	C1	C2	C3	C4	C5
Yasmin, et al. ¹⁹	Quantitative	Yes	Yes	No	Yes	Yes
Nordin, et al. ²⁰	Quantitative	Yes	Yes	No	Yes	Yes
Ali Syed, et al. ²¹	Quantitative	Yes	Yes	Yes	Yes	Yes

Note: C1 = Clear Objectives; C2 = Appropriate Design; C3 = Adequate Data and Analysis; C4 = Findings Support Conclusion; C5 = Transparent Reporting.

MMAT (Mixed Methods Appraisal Tool) is used with five criteria. The first criterion (C1) is the clarity of the objectives clarities of each article to make sure the articles selected are reporting on learning outcomes or instructional design. The second criterion (C2) is the appropriate research design to ensure that the article used was of high quality. The third criterion (C3) is adequate data and analysis, as some studies might use a strong framework but lack data or analysis to support their hypotheses. The fourth criterion (C4) is the cohesion of findings and conclusions to ensure the conclusions align with the findings. The last criterion (C5) is transparent reporting to see the reproducibility, advantages, and limitations of the eligible research. As shown in Table 4, most of the studies fulfilled the categories of each criterion except for two studies that showed inadequate data and analysis. The distribution of research types is 1 mixed-method article, 1 qualitative article, and 4 quantitative articles, with the latter being the most dominant.

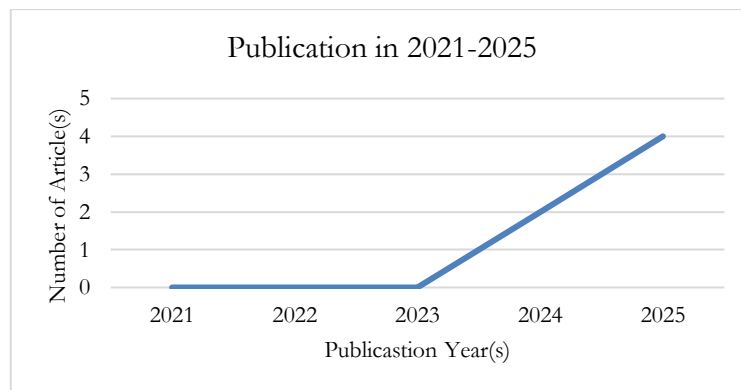


Figure 2. Research trend of virtual reality for Arabic language learning

According to the six studies collected, the integration of virtual reality into Arabic language learning has gained attention in recent years. This is evident in publications from 2024 and 2025. Contrarily, there was no research in the field of

¹⁹ Niswah Hijja Yasmin et al., "The Development of Virtual Reality Media to Enhance Vocabulary Learning for Madrasah Ibtidaiyyah Students," *Jurnal Al-Fikrah* 13, no. 2 (2024): 248–64, <https://doi.org/10.54621/jiaf.v13i2.901>.

²⁰ Fitri Nurul'ain Nordin et al., "Immersive Learning for Arabic as a Foreign Language: A VR Game-Based Model for Vocabulary Acquisition," *International Journal of Research and Innovation in Social Science* 9, no. 24 (2025): 688–700, <https://doi.org/10.47772/IJRISS.2025.924ILEIID0073>.

²¹ Toqeer Ali Syed et al., "Revolutionizing Arabic Learning: GNT and AI-Enhanced Metaverse Environments," *Frontiers in Computer Science* 7 (September 2025): 1626092, <https://doi.org/10.3389/fcomp.2025.1626092>.

VR-based Arabic language learning in the year before that. This may be attributed to the limitations of facilities and access to virtual reality. Overall, the pattern indicates an upward trend in recent years, as seen in Figure 2.

Characteristics of Virtual Reality-Supported Arabic Language Learning Studies

To identify the current condition of virtual reality used in Arabic language learning, there is a need to define and compare the educational context, methodological approach, and VR technologies' employment or design across six eligible studies. This will then help in identifying the benefits, strengths, difficulties, and weaknesses present in the six studies of virtual reality.

Table 5. Country distribution and research type

Author	Country	Target Level	Research Type
Syafri & Ramli (2024)	Malaysia	Primary School	Needs Analysis
Barkahoum & Fatima (2025)	Algeria	Not Specified	Literature Review
Humayrah et al. (2025)	Indonesia	Intermediate School	Research and Development
Yasmin et al. (2024)	Indonesia	Primary School	Design-Based Research
Nordin et al. (2025)	Malaysia	University	Research and Development
Syed, et al. (2025)	Saudi Arabia	University	Research and Development

In general, all of the assessed studies were conducted in a formal setting, with the sole exception of Syed. The studies included in this synthesis were conducted in Indonesia, Malaysia, Algeria, and Saudi Arabia with varying degrees of education. This can be seen in Table 5. There is a variety of methods employed across the differing research types. Syafri and Ramli employed a quantitative method to support the needs analysis research. This research mainly targets supporting a VR-based module to help integrate the technology into Arabic language learning. The data gathering was conducted using a questionnaire with a five-point Likert scale. Barkahoum and Fatima approached virtual reality with a qualitative method of literature review. They synthesized a targeted approach to development for virtual reality in Arabic language learning. This was done by reframing the utilization of virtual reality applied in other language learning contexts.

The remaining four studies used research and development approaches, with all using pure quantitative approaches, with the sole exception of Humayrah et al., which used mixed methods. More specifically, Humayrah et al. and Nordin et al. employed ADDIE to develop their virtual reality learning media. On the other hand, Yasmin et al. and Syed et al. employed design-based research. While Yasmin et al. developed a media using an existing platform, Syed et al. were developing an entirely new system for virtual reality in Arabic language learning. From the group of methods employed, it can be inferred that the development of virtual reality in Arabic language learning is still at the initial stage. This can be seen from the type of studies that consist of needs analysis, literature review, and research and development. The needs analysis offered a concept based on the analysis of teachers' needs. The literature review was built upon the virtual reality literature of other languages' applications. Furthermore, the research and development did not delve into longitudinal data collection.

Table 6. Demographic Distribution of Each Study

Author	Gender		Prior Knowledge Background
	Male	Female	
Syafri & Ramli (2024)	21	79	Arabic language teachers
Barkahoum & Fatima (2025)	-	-	Literature Study
Humayrah et al. (2025)	-	30	Had prior exposure
Yasmin et al. (2024)	-	-	Not Specified
Nordin et al. (2025)	32	37	Not Specified
Syed, et al. (2025)	30	20	Beginner to Intermediate

After examining the methods, there is a need to review the variety of samples used in every research as seen in Table 6. Syafri and Ramli's research mainly synthesized a virtual platform design targeting Arabic-Roman transliteration. Barkahoum and Fatima mainly target the study of Arabic sounds and the articulation point in their research. The samples of this synthesis are not limited to research articles, but also include proceedings. No specific education level was targeted in this study. Humayrah et al. cover a seventh-grade student with the range of age for the participants being 14-16 years, with prior exposure of the Arabic language. Yasmin et al., who also employed research and development, differ from Humayrah et al. in terms of the participants picked. This research used a questionnaire for experts and teachers of the Arabic language. The effectiveness of the media was measured by the teachers, with no evidence gathered from the students. Nordin et al. included university students aged 18–23 years. No further elaboration on the respondents' knowledge background was provided for this study. Syed et al., while more focused on media development, have a sample with the age range of 18-32, with the average age of 22.6 years. The participants also have varying degrees of VR experience, with 68% having no prior experience, 20% with minimal experience, and 12% with moderate to advanced experience. Based on the data written above, the variety of participants across six studies encompasses a wide range of groups. However, the number of participants remained limited because the various studies are at the developmental level.

Table 7. Targeted Skills, Implemented Model, and Model Design

Author	Targeted Skills	Implemented Model	Designed Model
Syafri & Ramli (2024)	Transliteration	-	eTARRiM
Barkahoum & Fatima (2025)	Speaking	-	Gamification and Self-Regulated Learning (SLR)
Humayrah et al. (2025)	Speaking	Delightex	-
Yasmin et al. (2024)	Vocabulary	LAPENTOR	-
Nordin et al. (2025)	Vocabulary	LAPENTOR	-
Syed, et al. (2025)	Vocabulary	LingVerse	-

Another difference in the characteristics of each study is related to the target of linguistic skill and the virtual model implemented or designed, as seen on Table 7. The design of eTARRiM targets deficiencies in reading skill through an Arabic-Roman transliteration module implemented for VR. The study, however, did not

specify a more detailed design further. It only specified the target and the module name. Barkahoum and Fatima proposed a design based on gamification and self-regulated learning (SLR) that targets the learning of Arabic sounds and articulation points. Much like the previous study, this study provides no further detail on the application or design of the media.

For the implemented model, there are several types. The Delightex platform was implemented as a fully 3D-rendered virtual environment. In the virtual environment, the residents speak and converse using the Arabic language, prompting users to also converse with Arabic language. LAPENTOR, on the other hand, utilized real-world images. The images are presented at a 360-degree angle and integrated with sound and hotspots to make the experience more immersive, interesting, and interactive. By preparing several images of connected areas, the transition between learning materials can stay immersive with the help of interactive points. LAPENTOR also targeted vocabulary as one of the primary needs in language acquisition. LingVerse also targeted vocabulary with the development of an entirely new virtual model. This media focused on utilizing Generalized NeRF Transformers (GNT) that enable 3D generation of realistic objects. The media were also further enhanced with AI-enhanced environments that allowed personalized learning based on users' feedback. The descriptions of each model provided a better understanding of existing media and platforms utilized for Arabic language learning. However, some of the studies provided limited design instructions on developing the proposed virtual platform. This condition might further postpone the development of the targeted media.

Reported Outcomes, Benefits, and Challenges of Virtual Reality-Supported Arabic Language Learning

Some studies provided evidence of the feasibility of integration and the effectiveness of using an existing platform to develop a virtual environment for Arabic language learning. Some also provided learners, teachers, and experts' perceptions on the development of virtual reality media for Arabic language learning. The focus of the six studies is on various stages of Arabic language learning. One study did not specify the targeted degree of the learner. Two studies reported the orientation to develop a medium for beginner or primary education students. One study reported the target of intermediate education. The remaining two studies reported samples of university learners. Of the last three studies targeting intermediate education and higher, one did not report participants' background in the Arabic language, while the other two reported participants' prior exposure to the Arabic language. For a more specific description, refer to Table 5 of the previous section.

While every study shows differences in the target of learning degree. Every study also reported different outcomes due to the differences in methods used. Syafri and Ramli, who conducted a needs analysis, reported on the outcomes of the questionnaire. They employed eight indicators for the questionnaire. The distribution of levels was high (3.68-5.00), moderate (2.34-3.67), and low (1.00-2.33). The reported means for each indicator is high, with the lowest being A7 with a mean of 4.45. Nordin et al. only reported students' perceptions. The reported mean of the seven indicators is high, with the lowest being 4.35 on the fourth and

fifth indicators. Yasmin et al., which focuses on developing, only reported the evaluation of design experts, learning materials experts, and teachers. The reported score for design compatibility of the media was 97%, with minor shortfalls in the clarity and attractiveness of the image as reported by the second expert and in the appropriateness of line color and image as reported by the first expert. For the learning materials, compatibility scored a perfect 100%. Lastly, for teacher evaluation, the media scored an average of 92% of the overall indicators. There is no score of applied trials on students for this study.

Barkahoum and Fatima are the only ones who conducted a literature review and reported the feasibility of gamification and AI-enhanced learning for virtual reality in Arabic language learning. However, this study remains a synthesis of potential developments for VR in Arabic language learning, leading to minimal observable outcomes in terms of instructional design or learning outcomes. Humayrah et al. reported the effectiveness of virtual media integration in improving speaking skill proficiency. This is evident from the difference between the pre-test and the post-test scores. In the pre-test, only 30% of the participants (9 students) achieved passing marks. In the post-test, the number of students who passed significantly increased to 98% (28 students). The respective average scores of the pre-test and the post-test are 66.1 and 85.5. Syed et al. reported on the performance of the GNT-based object generation time of each session. The reported results were a decrease in latency of object generation despite the ascending trend in the first three sessions. The study also reported improved vocabulary engagement, retention, and satisfaction compared to traditional media. Each study reported different aspects of the VR development in Arabic language learning. This further proves the limitations of scarce material in virtual reality development for Arabic language learning.

The six included studies listed various advantages and challenges of virtual reality use. A frequently noted advantage was the increase in learner engagement and motivation. The increase in engagement and motivation was evident in the study of Humayrah et al., as stated by the prompt of a non-player character (NPC) in the virtual space that asked the opinion of users about the virtual library. Syed et al. also provided evidence in the engagement score of the virtual condition as 4.6. This is also supported by the interaction time on the same study, which reached 43.5 minutes as opposed to 34.2 minutes for traditional learning. Nordin et al. reported students' increase in motivation through the distributed questionnaire, specifically the second indicator, with a mean of 4.38. Although they vary in degrees, the advantages remain valid. Compared to traditional media, virtual reality has been deemed more inviting. Another advantage was the contextual support for learning. Humayrah et al. reported an interview with one of the participants describing how her interaction with the objects really helped her in memorizing new vocabulary. In Syed et al.'s study, virtual environments provided context that is hard to access during learning hours. This was evident in the rating of the GPT 3.5 Turbo-based response, which received a rating with the mean at 4.5 out of 5, with one of the highlights of the participants being the contextual accuracy. Barkahoum and Fatima emphasized that various immersive technologies can be adapted for different targets. The third advantage is the increased vocabulary retention. Syed et al.

reported an increased retention by one week's delay, with the score of 87% compared to traditional learning, with the score of 61%. The advantages stated mainly focused on increased engagement, contextualization, and increased retention. More research needs to be explored on long-term learning outcomes.

Alongside the advantages, there are also challenges. The challenges encompass methodological and practical aspects. The common issue involved technical and infrastructural limitations. Several studies pointed out obstacles related to hardware availability and software compatibility. This was attributed to the limited resources of the environment. Delightex could be used for solutions regarding human resources. Barkahoum and Fatima explicitly noted that immersive technologies require careful instructional design to avoid superficial use that emphasizes novelty over pedagogical value.

Methodological Limitations and Emerging Research Gaps in VR-Based Arabic Language Learning

Several reviewed studies have shown methodological gaps in the current research. Due to a systematic literature review, the gaps have become clear through comparison.²² This is attributed to the limitations of the methods used in the various studies reviewed. Most studies focused on small samples to identify development success. This is evident in the research and development studies. Humayra et al.'s research was conducted with only 30 participants. Syed et al., while having more participants, still only numbered 50. They have yet to reach an extensive experimental design for implementation. This is done to align with the set educational goal.

The second limitation is that most of the studies were conducted in short-term intervals. Setting aside the needs analysis that only needs a one-time questionnaire, all the development studies were conducted in relatively short intervals. Humayrah et al. did not report the span of time the research was conducted. Yasmin et al., while also a development study, never put the media on a field trial. Syed et al. reported a one-week delayed test for retention and acknowledged the need for longitudinal research of the same nature. Nordin et al. also stated the need for longitudinal research. This leaves the issue of long-lasting learning unaddressed. The key point lies in the research design and duration. The study of virtual reality has rarely been conducted over long-term examinations.²³ This is also true for Arabic language learning. The study concluded with short-term reports without follow-up. This highlights the lack of reports on the retention of language acquisition. Therefore, it restricts the understanding of long-term use of virtual reality.

²² Jaziar Radianti et al., "A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda," *Computers & Education* 147 (April 2020): 103778, <https://doi.org/10.1016/j.compedu.2019.103778>.

²³ Tao Xie et al., "Effect of Immersive Virtual Reality Based upon Input Processing Model for Second Language Vocabulary Retention," *Education and Information Technologies* 30, no. 9 (2025): 12365–85, <https://doi.org/10.1007/s10639-025-13333-x>; Yuting Deng et al., "Investigating Learning Behaviors in Desktop-Based Simulated and vr Headset-Based Immersive 3D Learning Environments: A Cross-Media Comparative Study," *Education and Information Technologies* 30, no. 11 (2025): 15441–65, <https://doi.org/10.1007/s10639-025-13411-0>.

Another limitation for Arabic language learning research was the lack of research focusing on linguistic output.²⁴ Most of the studies focus on student engagement and learning motivation. This occurred in Nordin et al., whereas the measurement of improved vocabulary acquisition was not done through pre-test and post-test, but rather through students' perception questionnaire. This results in the lack of focus on the instructional outcomes for language learning. Lastly, teacher readiness and the virtual reality implementation method remain critical points.

Additional gaps remain in conceptual clarity and instructional grounding. Recent reviews of immersive and metaverse-based learning highlight the lack of definition for virtual reality. Often, these technologies are used in ways that are driven more by technological capabilities than by instructional design.²⁵ This challenge is especially important for Arabic language learning, which requires complex preparations. This is based on the difference in the Arabic language, such as the effect of vowel length to the transformation of meaning.²⁶ There is also a different focus of motion verbs in comparison to English language.²⁷ This may reduce virtual reality's use as a pedagogical instrument.²⁸

Issues related to contextual diversity and scalability remain insufficiently explored. Empirical VR studies often depend on small, homogeneous samples within controlled learning environments, limiting insights into how immersive instruction performs across diverse learner groups and institutional contexts. While research on CAVE-based and large-scale immersive learning environments emphasizes the importance of infrastructure, instructional support, and implementation fidelity,

²⁴ Qi Zhang, "The Impact of Ludicization on Technology-Initiated and Learner-Initiated Interactions in Language Learning: A Person-Centered Approach Using LPA and One-Way ANCOVA," *Education and Information Technologies* 30, no. 18 (2025): 26057–96, <https://doi.org/10.1007/s10639-025-13782-4>; Davy Tsz Kit Ng et al., "Engaging Students in Virtual Tours to Learn Language and Digital Literacy," *Journal of Computers in Education* 10, no. 3 (2023): 575–602, <https://doi.org/10.1007/s40692-023-00262-2>.

²⁵ Shihui Feng et al., "Is Metaverse a Buzzword in Education? Insights from a Systematic Review," *Educational Technology Research and Development* 72, no. 6 (2024): 3349–90, <https://doi.org/10.1007/s11423-024-10398-2>; Mohammed Ali Mohsen and Tahani Salman Alangari, "Analyzing Two Decades of Immersive Technology Research in Education: Trends, Clusters, and Future Directions," *Education and Information Technologies* 29, no. 3 (2024): 3571–87, <https://doi.org/10.1007/s10639-023-11968-2>.

²⁶ Wafa Abu Hatab et al., "A Cross-Linguistic Investigation of Consonant and Vowel Distinctive Features: A Comparative Analysis between English and Arabic Sounds," in *Business Resilience and Business Innovation for Sustainability*, vol. 587, ed. Abdalmuttaleb M. A. Musleh Al-Sartawi et al., Studies in Systems, Decision and Control (Springer Nature Switzerland, 2025), https://doi.org/10.1007/978-3-031-87584-7_93.

²⁷ Wafa Abu Hatab et al., "The Difference Between Motion Verbs Behavior in English and Arabic," in *Business Resilience and Business Innovation for Sustainability*, vol. 587, ed. Abdalmuttaleb M. A. Musleh Al-Sartawi et al., Studies in Systems, Decision and Control (Springer Nature Switzerland, 2025), https://doi.org/10.1007/978-3-031-87584-7_84.

²⁸ Nikolaos Pellas et al., "Immersive Virtual Reality in K-12 and Higher Education: A Systematic Review of the Last Decade Scientific Literature," *Virtual Reality* 25, no. 3 (2021): 835–61, <https://doi.org/10.1007/s10055-020-00489-9>.

these aspects are seldom examined systematically in language-focused VR studies.²⁹ Another important area that remains underexplored is the advantages of VR in maintaining context while allowing students to interact with the learning materials. The utilization of VR interactive and immersive traits has shown a significant effect on students' language acquisition.

Conclusion

Across the six eligible Arabic VR studies, common methodological gaps include short intervention durations, reliance on immediate post-intervention measures, and limited use of validated Arabic language assessments. While these studies show that instruction is feasible and learners are positively engaged, they do not systematically explore long-term learning effects, establish clear pedagogical frameworks, or address scalability across different instructional settings. These findings reflect broader trends in immersive learning research. This is due to the preliminary stage of development and methodologically limited research. This study has presented the gap and direction of development for future research.

This review highlights that VR-supported Arabic language learning is an emerging yet limited field of study, predominantly focusing on early-stage language skills and often conducted within formal educational settings. Although immersive technologies demonstrate significant potential in boosting learner engagement and overcoming various pedagogical challenges, the majority of existing research remains exploratory in nature, frequently characterized by methodological limitations such as small sample sizes and short-term intervention periods. This does not fully address the needs for media to leverage the complexity of the Arabic language, especially for foreign learners. To truly advance this promising field, further research should encompass the framework of gamification and large language models (LLMs) to implement personalized learning by machine learning. Future research should prioritize the implementation of rigorous, longitudinal research designs, aim to develop a broader range of language skills, and incorporate diverse educational environments and learner populations. Such efforts will help establish a more solid foundation for the development of effective, scalable, and immersive language instruction methodologies that can enhance the availability of Arabic language learning and mitigate the problem of linguistic complexity of the Arabic language. This approach can also expand the current educational settings to not be limited to class and increase further competence in Arabic language learners.

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²⁹ Tycho T. De Back et al., "CAVE-Based Immersive Learning in Undergraduate Courses: Examining the Effect of Group Size and Time of Application," *International Journal of Educational Technology in Higher Education* 18, no. 1 (2021): 56, <https://doi.org/10.1186/s41239-021-00288-5>.

Author Contribution Statement

RK designed the study framework, collected the records needed, and conducted the main synthesis. KW and MA contributed to the synthesis of the study and screened the records. MF and MAI contributed to the research idea and supervised the overall research. MG assisted in reviewing and selecting the records included.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

AI Writing Statement

During the preparation of this manuscript, the authors used Grammarly to assist with language editing and grammar checking. The authors carefully reviewed and edited the content generated with the assistance of AI and take full responsibility for the final content of this manuscript.

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