Immersive Learning for Arabic as a Foreign Language: A VR Game-Based Model for Vocabulary Acquisition

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ABSTRACT

This study discusses the development of Arabic vocabulary learning through virtual reality (VR) technology to enhance vocabulary acquisition among students. The project focuses on 20 Arabic vocabulary items commonly found around the Academy of Language Studies (APB) University Technology MARA Shah Alam building, employing the ADDIE instructional design model. A 360° immersive environment was created by integrating text, audio, and visual icons to guide learners effectively. The study employed purposive sampling and involved 69 university students, comprising 37 female and 32 male participants, primarily aged 21–23 years. A structured questionnaire was used to evaluate the usability and effectiveness of the Arabic-VR application. The results showed consistently high mean scores across all items, indicating strong agreement that the application enhanced motivation, engagement, and comprehension. Findings suggest that the use of VR in Arabic language learning significantly increases students' interest, motivation, and understanding of vocabulary, making it a promising tool for modern language instruction.

Keywords: virtual reality, arabic, learning, language

INTRODUCTION

Virtual Reality (VR) technology is a digital innovation that provides an immersive experience in simulated environments. In education, VR has been widely used to enrich teaching and learning methods, including in language learning. Recent studies from 2020 to 2025 show increasing effectiveness of VR use in foreign language education due to its ability to create real-life contexts that aid vocabulary comprehension and practical usage (Chen et al., 2021; Alghamdi, 2023).

VR is particularly useful in education because it enhances experiential learning and allows students to engage in environments that are difficult to replicate in traditional classroom settings. For instance, VR has been used in medical training, engineering simulations, historical reconstructions, and language acquisition. According to Radianti et al. (2020), immersive learning environments created through VR can improve learner motivation, retention, and engagement. In language learning, VR enables contextual interaction with vocabulary, which supports deeper cognitive processing and memory retention. Moreover, Makransky and Mayer (2022) argue that VR provides spatial presence and embodiment that are beneficial for second language learners, particularly in grasping cultural and situational nuances.

Research Questions and Hypotheses

To guide this study, the following research questions (RQs) and hypotheses (Hs) were formulated:

Research Questions (RQs):

1. Does the use of a VR-based application improve students' motivation to learn Arabic vocabulary?
2. How does the VR application influence students' comprehension and retention of Arabic vocabulary?
3. What are students' perceptions of the usability and effectiveness of the Arabic-VR application?

Hypotheses (Hs):

H1: Students who use the Arabic-VR application will report higher levels of motivation in learning Arabic vocabulary.

H2: Students will demonstrate improved comprehension and visualization of vocabulary when learning through VR compared to traditional methods.

H3: Students will perceive the VR application as an effective, engaging, and user-friendly tool for learning Arabic vocabulary. Literature Review

Advantages of Using VR in Education

A study by Xu and Ke (2020) found that VR use in language learning helps improve students' focus and motivation. Meanwhile, Zhang et al. (2022) reported that students remember vocabulary better when associated with visual objects they can explore virtually. In the context of Arabic learning, Alshammari and Mahzari (2024) suggest that VR is an effective medium for mastering vocabulary and sentence structure, especially when combined with synchronized audio and text. Similarly, Alghamdi (2023) found that Arabic language learners exposed to VR environments showed improved vocabulary recall and application.

The use of virtual reality (VR) technology in language learning provides many benefits, especially in improving speaking and listening skills. With VR, students can directly interact with situations that simulate the real world, providing opportunities for in-depth training in a more vivid and realistic context. In terms of speaking skills, VR allows students to practice pronunciation and conversation with native speakers in a more relaxed and pressure-free environment. This experience helps students feel more confident and prepared when faced with real-world situations (Chen, 2021).

For listening skills, VR provides students with the opportunity to hear a variety of accents and styles of speech in Arabic, increasing their understanding of different sound variations and pronunciations. The technology also allows students to listen to and understand conversations in a variety of situations, such as in the market, at school, or in social settings, which strengthens their understanding of the context and use of language in real life (Kuo & Yang, 2020).

Another benefit of VR is its ability to provide immediate feedback. During speaking practice sessions, students can see how accurate their pronunciation is, help them correct mistakes directly, and improve their listening skills by hearing their own pronunciation compared to correct examples (Wang et al., 2021).

Implementation of VR in Language Education

Content development techniques using virtual reality (VR) in language education provide opportunities to create more immersive and interactive learning experiences. In the context of language education, VR content development involves using technology to create virtual environments that simulate real-life situations, where students can interact with objects, environments, and speakers in the target language.

One of the key techniques in developing VR content for language education is the use of contextual scenarios. This involves creating situations that depict social or cultural situations relevant to the language being studied, such as a market, a restaurant, or a conversation between friends. Through these scenarios, students can practice speaking in a more realistic context, increasing their understanding of language use in real-life situations (Dünser et al., 2012).

The use of interactive avatars is another technique used in VR content development. These avatars act as "native speakers" or guides who help students practice pronunciation and grammar. Interacting with these avatars using voice commands helps students master correct pronunciation and improve their speaking skills (Freina & Ott, 2015).

In addition, direct feedback techniques are also being implemented in VR content. In many VR applications, students receive immediate feedback on errors in their pronunciation or sentence structure. This feedback gives students the opportunity to correct their mistakes quickly, making learning more effective (Bailenson et al., 2008).

Finally, the integration of multimedia elements such as audio, video, and text into VR content can enrich the learning experience. This allows students to hear conversations in a variety of accents and situations, as well as see text that supports their understanding of what they are hearing or seeing in the scenario at hand (Schneider et al., 2020).

Constraints of VR Usage in Education

Although virtual reality (VR) technology offers many benefits in language education, there are some constraints that need to be considered in its use. Here are some of the main constraints identified in the use of VR for language education:

1. High Cost

The cost of developing and implementing VR technology is one of the main constraints. The development of quality VR content requires expensive software, as well as VR hardware such as headsets and high-powered computers. In addition, the cost of training teachers and students to master the use of VR also needs to be considered (Freina & Ott, 2015). These financial constraints can limit access to this technology, especially in educational institutions with limited budgets.

2. The Need for a Strong Technology Infrastructure

The use of VR requires a sophisticated and stable technological infrastructure. Schools or universities that do not have high-speed internet facilities, suitable space, and sufficient VR equipment will face challenges in integrating VR into language learning. Technical issues such as lag or connection interruptions can also disrupt the learning experience and reduce its effectiveness (Rizzo et al., 2015).

3. Physical Discomfort

For some users, the VR experience can cause physical discomfort such as headaches, dizziness, or nausea (Cyprien et al., 2016). This problem is known as "motion sickness" and can occur when the movements seen in the virtual environment do not align with the user's physical movements. This can affect learning effectiveness and cause long-term discomfort.

4. Lack of Adaptation to Student Needs

Although VR provides an interactive learning experience, it may not be fully adaptable to the individual needs of each student. Some students may be more likely to learn through traditional methods or more easily distracted while using VR. Therefore, VR may not be suitable for all types of students or all learning styles (Slater & Wilbur, 1997).

5. Lack of Resources and Quality Content

Although there are several VR applications for language learning, quality content that fits a particular curriculum may still be limited. The development of content relevant to Arabic language learning, for example, requires significant effort to ensure that it is accurate, authentic, and pedagogically sound. Without sufficient, quality content, VR may not be able to provide a beneficial learning experience (Dünser et al., 2012).

6. Lack of Training for Instructors

The use of VR in education requires instructors to understand how to use this technology effectively. Adequate training for instructors is essential so that they can effectively integrate VR into the teaching process. Without appropriate training, instructors may find it difficult to fully utilize the potential of VR in enhancing language learning (Bailenson et al., 2008).

Lapentor As a Tool for Virtual Reality-Based Language Learning

Virtual Reality (VR) is increasingly recognized in educational research as a transformative tool capable of enhancing learning through immersive and interactive environments. In language education, VR supports deeper engagement, better contextual understanding, and improved vocabulary retention (Parmaxi, 2020). Among several platforms available, Lapentor has emerged as a practical solution for educators aiming to design VR content without the need for coding or complex development tools.

Lapentor is a web-based platform designed for the creation of 360-degree virtual tours, which can be easily customized with embedded hotspots, text, audio, and scene transitions. This feature makes it suitable for language learning environments that require visual and spatial contextualization. Educators can embed vocabulary items, audio pronunciation, and multilingual labels directly into panoramic images, providing learners with a context-rich, multimodal experience.

This approach aligns with Mayer's (2009) Cognitive Theory of Multimedia Learning, which posits that learners understand and retain information better when it is presented in both verbal and visual formats. Through Lapentor, vocabulary learning can occur in simulated real-world settings, such as virtual walkthroughs of a school building, where learners associate Arabic terms with visible physical objects (e.g., noticeboard, staircase, fire extinguisher).

Furthermore, Lapentor's browser-based accessibility allows students to experience VR modules on smartphones, tablets, or computers without requiring headsets or high-spec devices. According to Rahmat and Zaini (2023), such accessibility enhances learner autonomy and motivation, particularly among digital-native students.

In conclusion, Lapentor provides an effective, scalable, and pedagogically sound platform for developing VR-based language learning modules. Its ease of use and immersive capabilities support authentic learning experiences, making it a valuable tool in modern Arabic vocabulary instruction.

METHODOLOGY

This study adopts the ADDIE instructional design model, a systematic and iterative framework for designing effective learning experiences. ADDIE stands for Analyze, Design, Develop, Implement, and Evaluate—five interrelated phases that ensure learning solutions are learner-centered, pedagogically sound, and technologically feasible. Given the nature of this project, which involves integrating Virtual Reality (VR) technology into Arabic vocabulary learning, ADDIE was chosen for its flexibility and instructional rigor.

1. Analyze Phase

In the first phase, a detailed needs analysis was conducted to determine the relevance of VR in Arabic language education, particularly for non-native speakers who often face challenges in vocabulary retention due to the lack of contextual and experiential learning opportunities. A survey was administered to Arabic language learners at University Technology MARA (UiTM) to assess their current difficulties, learning styles, and openness to technology-based learning.

Findings showed that many students lacked consistent exposure to real-life Arabic vocabulary use, especially within physical learning environments. Hence, it was deemed appropriate to simulate an Arabic learning context by integrating 20 essential vocabulary terms found in the physical setting of Academy Pengajian

Bahasa (APB). Words selected included items like “signboard,” “meeting room,” “fire extinguisher,” and “photo gallery,” all frequently encountered by students.

The analysis also reviewed current literature and past research on VR in language learning, affirming its potential to increase learner motivation, contextualize abstract concepts, and facilitate long-term memory retention. Learning objectives were established, focusing on vocabulary recognition, pronunciation accuracy, contextual association, and interactive engagement.

2. Design Phase

In this phase, the learning experience was carefully mapped out. The vocabulary items were chosen not only for their relevance but also for their ability to be visually represented in a 360° environment. The structure of the learning module was developed as a virtual guided tour of APB, where each stop introduces a new vocabulary item within its authentic location.

Key design activities included:

1. 360° image collection using the 360 Photo Sphere Camera app to capture high-resolution visuals of APB's physical locations.

2. Audio development using TTSMaker, which generated high-quality voiceovers in Modern Standard Arabic for each vocabulary item. This ensured accurate pronunciation and clear articulation.

3. Graphic design of intuitive icons, hotspot indicators, and directional arrows, enhancing user navigation and visual appeal.

4. Instructional layout that allows learners to follow a path through various APB spaces—entrance, offices, staircases, corridors—experiencing vocabulary in real-world situational context.

5. Accessibility and multilingual considerations, where interface clarity, audio control, and optional English/Malay translations were included for inclusivity.

6. The instructional strategy relied on multimodal learning, with a combination of auditory (voiceover), visual (360° images), textual (word display), and interactive (hotspots) elements. This aligns with dual coding theory and cognitive load theory, supporting better comprehension and cognitive processing of new vocabulary.

3. Develop Phase

During this phase, the virtual learning module was constructed based on the assets and plan from the design stage. The Lapentor platform was chosen for development due to its intuitive interface, mobile compatibility, and VR functionality without requiring headsets.

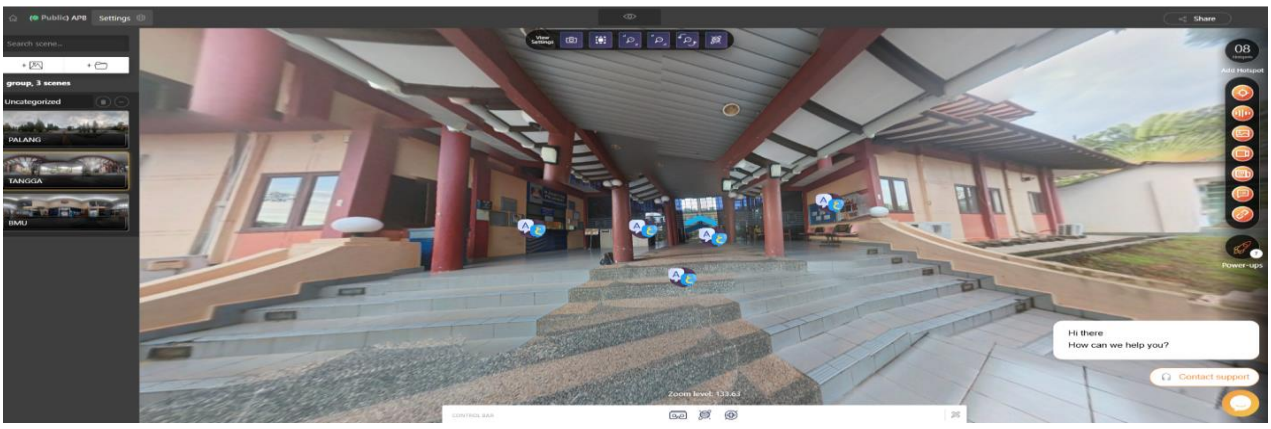

Figure 1 The development process using Lapentor for the first panorama image

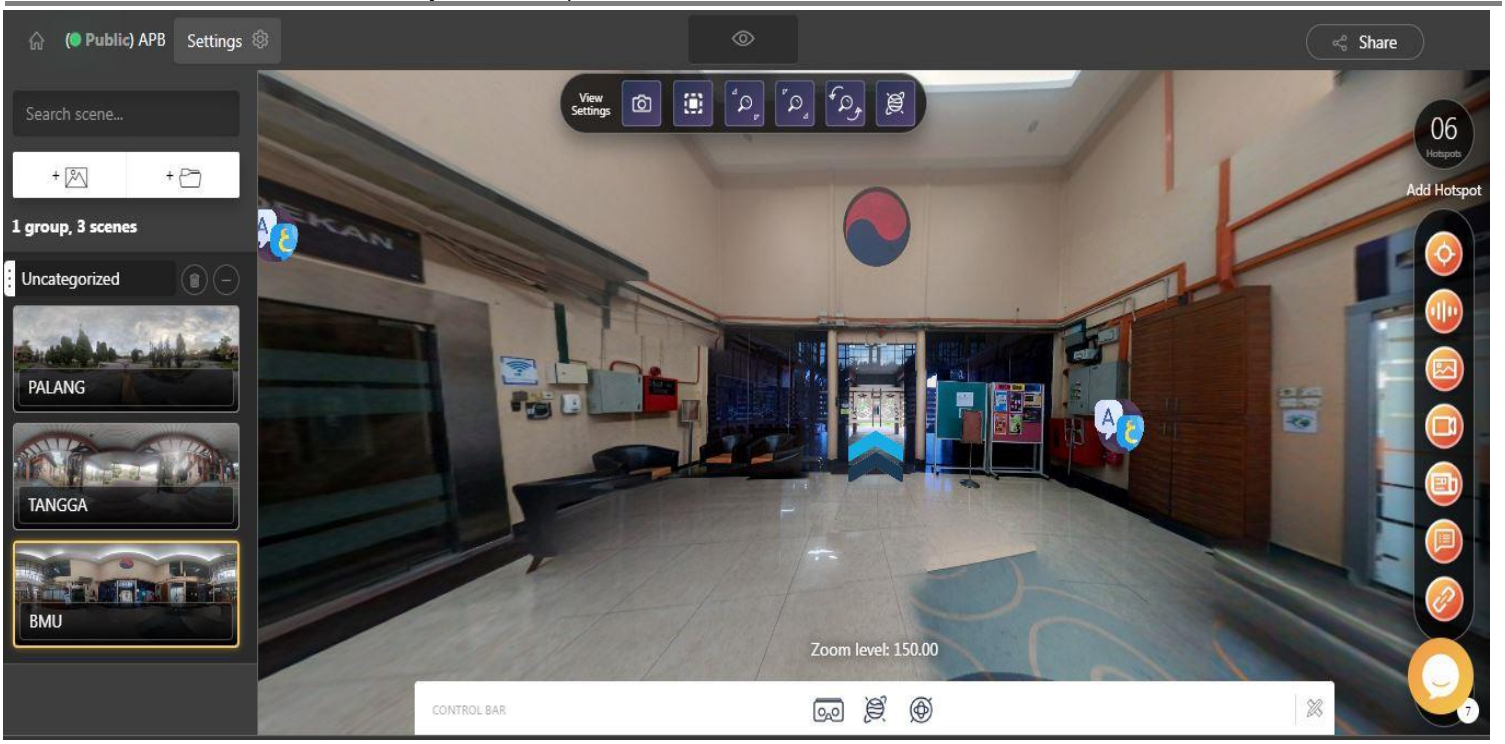

Figure 2 The development process using Lapentor or the second panorama image

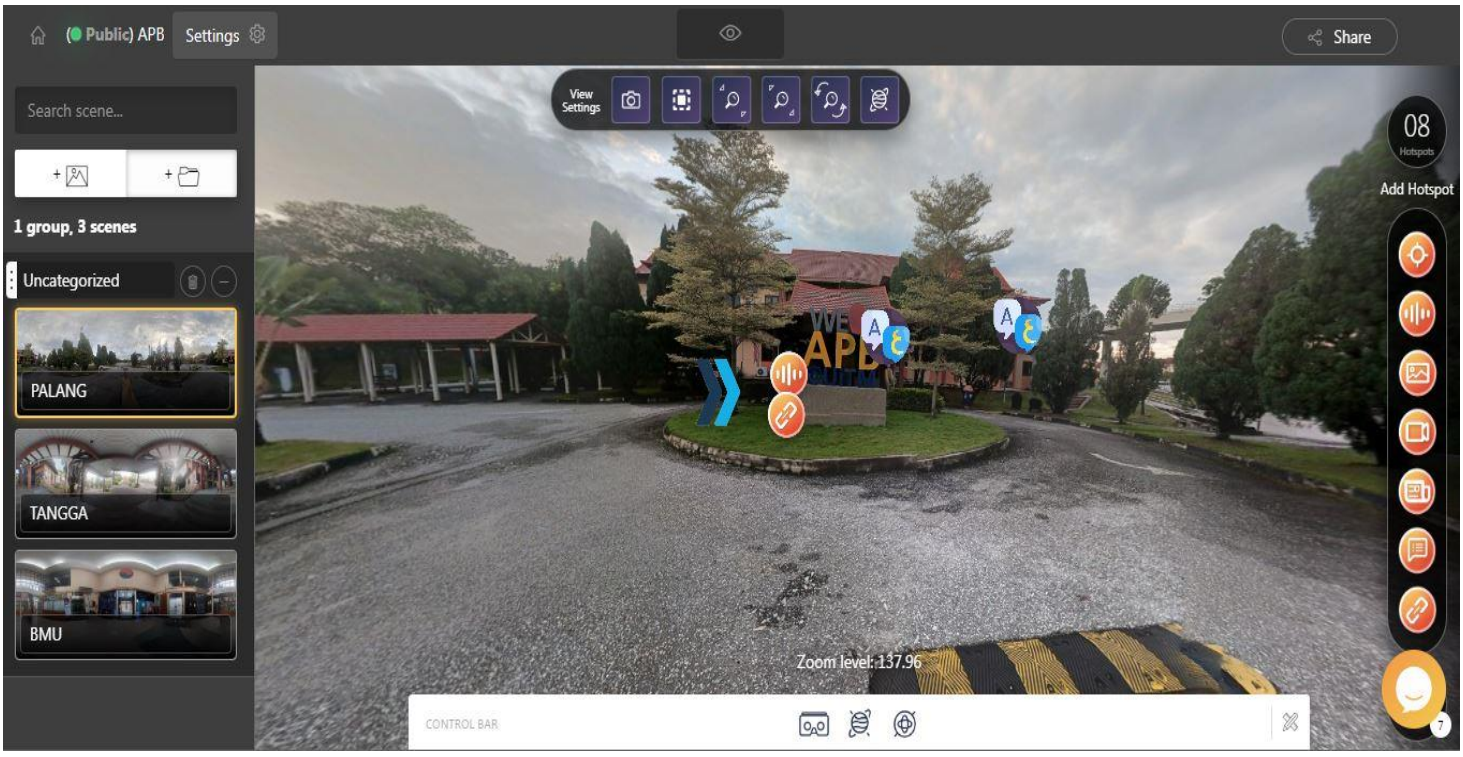

Figure 3 The development process using Lapentor for the third panorama image

Development tasks included:

1. Creating multiple scenes representing actual locations in the APB building, each embedded with a hotspot containing a vocabulary term.

2. Adding synchronized voiceovers and text pop-ups for each hotspot, allowing users to see, hear, and interact with each word.

3. Linking scenes with directional arrows, enabling smooth user navigation and a coherent tour structure.

4. Ensuring that learners could freely revisit any scene, repeat audio, or interact at their own pace—supporting self-paced and learner-controlled instruction.

5. The VR module was tested on multiple devices and browsers to ensure cross-platform functionality. Revisions were made to adjust hotspot sensitivity, audio timing, and text positioning for optimal clarity and user experience.

Implement Phase

The implementation phase involved piloting the VR module with a group of 69 undergraduate students enrolled in an Arabic language course. These students participated in an interactive learning session where they explored the virtual APB environment via their personal devices.

The session was facilitated by the instructor, who introduced the platform, guided learners through the interface, and provided pre- and post-viewing instructions. Students interacted with the hotspots, listened to vocabulary pronunciations, and completed self-paced navigation tasks.

The link to the developed product was shared openly: https://app.lapentor.com/sphere/apb

This link allowed access to the virtual tour from any browser-enabled device, encouraging independent exploration beyond the structured class session. The implementation revealed the tool's potential to bridge classroom learning with real-world applications, providing learners with an immersive, context-rich vocabulary acquisition experience.

5. Evaluate Phase

Evaluation was conducted through both expert reviews and student feedback to determine the effectiveness, usability, and pedagogical value of the Arabic-VR application.

Expert Evaluation: Three experts—two in Arabic language education and one in educational technology—were invited to review the virtual module. Their feedback focused on language accuracy, instructional flow, cultural appropriateness, and user interface. Suggestions included adding a vocabulary review summary at the end and increasing interactivity by incorporating simple comprehension checks.

Student Feedback: Students completed a post-session questionnaire comprising Likert-scale items evaluating their experience with the VR application. The questionnaire items were adapted from previous studies on gamified and technology-enhanced Arabic vocabulary learning (Alqahtani & Rajab, 2022; Saidon, Zulkefli, & Mohamad, 2023). The survey explored perceptions of enjoyment, motivation, understanding, and ease of use. As reported in the descriptive analysis section, all items scored above 4.30 on average, indicating strong student approval and engagement.

In addition to quantitative data, qualitative responses were collected. Students expressed appreciation for the immersive environment, contextual learning, and clear pronunciation guides. Some suggested improvements such as adding game-like elements or quizzes for reinforcement.

Both forms of evaluation served to guide future refinements of the product and confirmed that Arabic-VR offers a meaningful alternative to traditional vocabulary instruction.

By following the ADDIE model, this project was able to systematically plan, design, and develop a technology-enhanced language learning module tailored to the needs of Arabic language learners. Each phase contributed significantly to building an interactive, student-centered virtual learning experience.

- The analysis clarified learner challenges and goals.
- The design provided the pedagogical and technological framework.

- The development transformed assets into a functional VR product.
- The implementation allowed real-world testing with learners.
- The evaluation validated the module's effectiveness and suggested avenues for improvement.

The integration of Virtual Reality through a structured instructional model like ADDIE demonstrates how educational technology can be harnessed not just to digitize content, but to fundamentally enrich and reimagine the language learning process.

Reflection On the Development and Educational Impact of Arabic-Vr Using Lapentor

The development of the Arabic-VR module using the Lapentor platform represents a significant innovation in Arabic vocabulary instruction. This module was designed to allow learners to explore a 360-degree virtual environment based on the real layout of Academy Pengajian Bahasa (APB) at University Technology MARA. Through this immersive simulation, students interact with vocabulary terms placed within actual spaces such as staircases, signboards, the dean's office, noticeboards, and galleries.

As seen in the VR view and illustrated in the screenshot, the user interface contains clickable hotspots embedded within the panoramic scene. Each hotspot features an Arabic vocabulary item, its audio pronunciation, and contextual placement. This allows learners to connect the written form, auditory input, and visual context of each term—providing a multi-sensory learning experience that supports better vocabulary retention.

Key Features and Educational Tools Integrated

To enhance learning engagement and accessibility, several plugins and technical features were integrated during development:

Audio Plugin (Voice Integration)

Each vocabulary term is accompanied by a voiceover generated using TTSMaker, which pronounces the word in Modern Standard Arabic (Fusha). This feature allows students to hear and imitate correct pronunciation, supporting listening and speaking skills. The sound feature is especially helpful for auditory learners and promotes self-directed repetition, as users can replay audio at their own pace.

Gyroscope Plugin

For mobile users, the gyroscope sensor enables an intuitive VR experience by allowing learners to move their device and automatically adjust the viewing direction. This creates a more natural and immersive navigation, simulating real-life physical movement through the environment. It increases engagement and spatial memory, which is critical when learning location-based vocabulary.

Little Planet View

This plugin was utilized to provide learners with a miniature, globe-like overview of the entire VR scene before entering the detailed walkthrough. The "little planet" projection visually orients the user and gives a unique macro view of the APB space, preparing them for deeper exploration. Though more aesthetic than functional, it adds a creative touch that attracts attention and curiosity.

VR Headset Compatibility

The module is also optimized for use with basic VR headsets such as Google Cardboard. This compatibility enhances the immersive experience by allowing learners to fully immerse themselves in the virtual world without distractions. Using a headset enhances the learner's sense of presence, which is known to improve focus and memory retention in VR-based language learning environments.

Educational Impact and Pedagogical Relevance

The core learning principle behind this project is contextualized vocabulary acquisition—where learners understand and remember words not just through definition or translation, but by seeing the word in use within its actual environment. This approach supports theories such as Dual Coding Theory and Situated Learning Theory, which emphasize learning through meaningful context and multimodal representation.

By combining visual cues, audio pronunciation, and interactive exploration, this VR module aligns well with contemporary language pedagogy. It allows learners to:

- See the vocabulary in authentic settings
- Hear native-like pronunciation
- Actively engage with content at their own pace

Such an approach is particularly effective for non-native learners who may struggle with abstract memorization. The VR tour transforms passive learning into an active, immersive experience that supports long-term vocabulary retention and boosts learner motivation.

Results and Discussion

The following is the data that has been analyzed from the survey questions that have been distributed to the sample.

Table 1: Respondent Demographics

Category	Number (Gender)	Number (Age)
Female	37	–
Male	32	–
21–23 years	–	50
18–20 years	–	19
TOTAL	69	69

A total of 69 respondents participated in this study, comprising 37 female students and 32 male students. In terms of age, the majority of respondents were within the 21–23 years age group (50 individuals), while the remaining were aged 18–20 years (19 individuals). This indicates that the target group consisted of university students in a younger age range who are generally more receptive to new technologies such as Virtual Reality (VR) in the learning process.

Table 2: Students perception towards using VR in learning Arabic Vocabulary

No	Item	Min
1	Using the Arabic-VR application makes learning more interesting.	4.41
2	Using the Arabic-VR application has increased my motivation to learn Arabic vocabulary.	4.38
3	Learning Arabic vocabulary using the Arabic-VR application is fun.	4.43
4	Learning Arabic vocabulary using the Arabic-VR application helps me understand and visualize the meaning.	4.35
5	Learning Arabic vocabulary using the Arabic-VR application provides me with an immersive learning experience.	4.35

6	Using the Arabic-VR application is a very good idea for learning.	4.44
7	I have a positive attitude towards the use of the Arabic-VR application in learning.	4.41

This study provides a detailed descriptive analysis of student responses regarding the use of the Arabic-VR application in Arabic vocabulary learning. Arabic-VR is a virtual reality tool developed to enhance vocabulary acquisition by providing an immersive and interactive learning environment. The integration of this technology represents a growing trend in educational innovation, where immersive learning platforms are utilized to improve student engagement, motivation, and cognitive understanding, particularly in second language acquisition.

The analysis was conducted using responses collected through a structured questionnaire. The instrument comprised several items measured using a five-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." The purpose of this analysis was to calculate the mean score for each item to gain insight into students' perceptions and experiences when using the Arabic-VR application.

The results showed that students responded very positively to the use of Arabic-VR in learning Arabic vocabulary. The item "Using the Arabic-VR application is a good idea in learning" recorded the highest mean score of 4.45. This suggests a strong consensus among students that the application is an appropriate and effective tool in modern learning. It reflects an increasing acceptance of virtual reality as a mainstream educational medium and highlights its potential for language instruction, where engagement and contextualization are key components of successful learning.

Another item, "Learning Arabic vocabulary using Arabic-VR is fun," scored a mean of 4.43, further demonstrating that learners find the experience fun and engaging. Enjoyment in the learning process has been widely acknowledged as a significant factor contributing to sustained student interest and improved academic outcomes. When students enjoy what they are learning, they are more likely to retain information and continue learning independently. This item confirms that Arabic-VR offers an enjoyable experience that can reduce the monotony often associated with traditional vocabulary learning.

The item "Using the Arabic-VR application makes learning more interesting" received a mean score of 4.41. This high score suggests that students find the content and presentation of material through Arabic-VR more stimulating than conventional methods. The visual, auditory, and spatial interactivity of VR allows for multi-sensory learning, which can significantly enhance the educational experience. For language learners, especially, such stimulation helps build stronger associations between words and their meanings.

Moreover, the item "I have a positive attitude towards using Arabic-VR in learning" also scored 4.41, indicating that students are open-minded and supportive of integrating technological tools into their educational journey. This positive attitude is important because the success of any educational innovation depends greatly on how it is received by learners. When students perceive a tool as beneficial and easy to use, they are more likely to engage with it and apply it meaningfully in their learning.

Another important finding was related to student motivation. The item "Using Arabic-VR has increased my motivation to learn Arabic vocabulary" had a mean score of 4.38. Motivation is one of the most influential factors in language learning success. High motivation often leads to greater persistence, more frequent practice, and better academic performance. The fact that Arabic-VR can enhance motivation suggests that it supports both cognitive and affective aspects of learning, making the process more effective and enjoyable.

In terms of comprehension, the item "Arabic-VR helps me understand and visualize the meanings of words" achieved a mean of 4.35. This is a crucial aspect of vocabulary learning because understanding goes beyond rote memorization. Through VR, students can encounter words in meaningful contexts, observe their use in simulated environments, and link them to visual representations. This method supports dual-coding theory, which posits that combining verbal and visual information improves memory and recall.

The immersive experience of the Arabic-VR application was also rated positively. The item "Learning vocabulary using Arabic-VR provides an immersive learning experience" recorded a mean of 4.35. Immersion is one of the distinctive features of VR, and it plays a major role in creating an environment where learners feel physically and emotionally involved in the content. When students feel immersed, they are more likely to develop authentic connections with the learning material, which can improve both language acquisition and retention.

Taken together, the overall pattern of responses suggests that students value the use of VR in their language learning process. All items recorded mean scores above 4.30, which is considered high on the Likert scale. These results point to the effectiveness of Arabic-VR in addressing various learning needs: increasing motivation, enhancing interest, improving comprehension, and offering enjoyable and immersive experiences.

From a pedagogical perspective, these findings carry significant implications. Firstly, they validate the use of emerging technologies like VR in language classrooms, especially for skills like vocabulary acquisition that benefit from contextualized and multisensory input. Secondly, they suggest that VR can bridge the gap between passive learning and active engagement. Rather than merely reading lists of words or watching videos, students interact with the content in real-time, make decisions, and receive instant feedback.

In conclusion, the descriptive analysis of student responses reveals that the Arabic-VR application is a promising and well-received educational tool for Arabic vocabulary learning. With high mean scores across all indicators, it is evident that students perceive the tool as enjoyable, motivational, useful, and effective. The immersive nature of VR, combined with its ability to contextualize vocabulary, offers a valuable enhancement to conventional learning methods.

It is therefore recommended that educators and institutions consider integrating VR-based applications like Arabic-VR into their curriculum, especially in language learning programs. Further research may also explore its impact on long-term vocabulary retention, speaking proficiency, and student autonomy. With ongoing improvements in technology and pedagogy, Arabic-VR has the potential to transform not only how vocabulary is taught but also how students experience language learning in a digital age.

Limitations And Future Research

Future research should consider expanding the sample size to include participants from multiple institutions and varying proficiency levels. Longitudinal studies could also be conducted to examine long-term retention of vocabulary learned through VR. Comparative studies between VR-based learning and traditional or mobile-based learning approaches could provide further insights into the most effective tools for language instruction. Additional exploration of instructor training models and accessibility features in VR learning platforms would also be beneficial.

While the findings of this study are encouraging, several limitations should be acknowledged. The study involved a relatively small sample size of 69 students from a single institution. This limits the generalizability of the findings to broader populations. Furthermore, the study focused solely on vocabulary acquisition; other aspects of language learning such as grammar, reading comprehension, and fluency were not addressed.

Accessibility, Teacher Training, and Scalability

While the positive findings are encouraging, three additional aspects must be considered for sustainable implementation:

1. Accessibility – Although VR can be accessed on mobile devices and web browsers (as in this study), high-quality immersive experiences often require VR headsets and stable internet connections. Institutions with limited budgets or students from disadvantaged backgrounds may face barriers to accessing such tools. Therefore, ensuring device compatibility across smartphones, tablets, and low-spec laptops is crucial to avoid widening the digital divide.

2. Teacher Training – The success of VR integration depends not only on student readiness but also on teacher preparedness. Many language instructors may not have prior experience with immersive technologies. Without adequate training, they may underutilize or even resist adopting VR. Professional development programs focusing on both technical skills and pedagogical integration strategies are necessary to empower teachers to effectively incorporate VR into their lessons.
3. Scalability – For VR-based learning tools like Arabic-VR to be adopted widely, they must be scalable across institutions and contexts. While small-scale trials show promise, scaling requires standardized content development processes, technical support, and institutional investment. Moreover, scalability depends on the adaptability of VR modules to different curricula, learner proficiency levels, and cultural contexts. Ensuring modular, customizable design will make VR solutions more versatile and sustainable for larger learner populations.

CONCLUSION

The use of VR in Arabic vocabulary learning proves to enhance instructional effectiveness through engaging and immersive learning experiences. This system helps students recognize objects more realistically and reinforces memory through integrated text, audio, and visuals. This study suggests exploring more innovative approaches like this in language education.

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