

Enhancing Vocabulary Retention and Learner Engagement through Virtual Reality: A Mixed-Methods Study in EFL Context

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Abstract

This study investigated the effects of incorporating virtual reality (VR) into vocabulary teaching on vocabulary retention and student engagement in English language learning. The research was conducted with 47 students enrolled in the English preparatory program of a foundation university in Istanbul. Of these participants, 25 students in the experimental group were taught vocabulary through VR-supported activities, while 22 students in the control group learned the same vocabulary using traditional methods such as translation and memorization. Over a 15-week period, a combination of assessment tools was used, including a pre-test, weekly quizzes, revision tests, a post-test, and semi-structured interviews. The study followed a mixed-methods approach with a sequential explanatory design to integrate quantitative and qualitative findings. The results of the statistical analyses indicated that students in the experimental group showed significantly higher improvement in both short-term and long-term vocabulary retention compared to the control group. Weekly quizzes and cumulative revision tests confirmed the effectiveness of VR in supporting lexical recall. Furthermore, qualitative data gathered from interviews revealed that students perceived VR-based vocabulary instruction as highly engaging and motivating. Participants noted that the immersive environment increased their interest and helped them remember vocabulary more easily. Many students also reported that seeing vocabulary used in context such as in 3D scenes or simulations helped them better understand meaning and pronunciation, even though no formal comprehension or speaking test was administered. In conclusion, the findings suggest that VR is a valuable and innovative tool in vocabulary instruction. It offers a multisensory, interactive experience that fosters vocabulary retention, promotes student participation, and enriches language learning by offering contextual and cultural exposure.

Keywords: virtual reality, vocabulary retention, language learning, learner engagement, immersive instruction.

Sanal Gerçeklik Yoluyla Kelime Bilgisinin Kalıcılığını ve Öğrenci Katılımını Artırmak: Yabancı Dil Olarak İngilizce (EFL) Bağlamında Karma Yöntemli Bir Çalışma

Öz

Bu çalışma, sanal gerçekliğin (VR) kelime öğretiminde kullanılmasının kelime bilgisinin tutulması ve öğrencilerin İngilizce öğrenimine yönelik ilgileri üzerindeki etkilerini incelemektedir. Araştırma, İstanbul'daki bir vakıf üniversitesinin İngilizce hazırlık programına kayıtlı 47 öğrenci ile yürütülmüştür. Katılımcıların 25'i deney grubunda yer almış ve kelime öğretimi VR destekli etkinliklerle gerçekleştirilmiştir. Kontrol grubundaki 22 öğrenci ise aynı kelimeleri geleneksel yöntemlerle öğrenmiştir. On beş hafta süren araştırma süresince ön test, haftalık kısa sınavlar, tekrar testleri, son test ve yarı yapılandırılmış görüşmeler gibi çeşitli veri toplama araçları kullanılmıştır. Nicel ve nitel verilerin analizinde ardışık açıklayıcı desenli karma yöntem benimsenmiştir. İstatistiksel analizler, deney grubunun hem kısa hem de uzun vadeli kelime bilgisinde anlamlı gelişim gösterdiğini ortaya koymuştur. Ayrıca, görüşmelerde öğrenciler VR ile yapılan öğretimi dikkat çekici ve motive edici bulmuş, sanal ortamın ilgilerini artırdığını ve kelimeleri daha kolay hatırlamalarını sağladığını belirtmiştir. Üç boyutlu sahnelerde kelimelerin bağlam içinde sunulması, anlam ve telaffuzu kavramalarını da kolaylaştırmıştır. Bulgular, VR teknolojisinin kelime öğretiminde etkili, etkileşimli ve çoklu duyuya hitap eden bir araç olduğunu göstermektedir.

Anahtar kelimeler: sanal gerçeklik, kelime kalıcılığı, dil öğrenimi, öğrenci katılımı, etkileşimli öğretim.

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INTRODUCTION

As language educators strive to optimize vocabulary instruction in foreign language learning, integrating innovative technologies such as Virtual Reality (VR) has gained prominence. VR offers immersive, engaging environments that simulate real-life contexts, which are particularly beneficial for vocabulary acquisition. In this study, learner engagement is defined as the degree of interest, involvement, and motivation students exhibit in response to VR-enhanced instruction. Traditional vocabulary teaching approaches often rely on rote memorization and translation, which may not sustain learners' attention or promote long-term retention. By contrast, VR can create meaningful associations through visual, auditory, and kinesthetic stimuli. This aligns with modern pedagogical shifts towards active and experiential learning.

Recent research has increasingly demonstrated the effectiveness of virtual reality in vocabulary acquisition. Alfadil (2020) found that VR-based games significantly improved foreign language learners' vocabulary retention. Similarly, studies such as Huang et al. (2021) and Harris and Reid (2005) emphasized that VR environments not only enhance retention but also foster greater learner engagement and motivation. A systematic review by Parmaxi (2020) confirmed that immersive VR experiences create meaningful learning opportunities by situating vocabulary within realistic, culturally rich contexts. Moreover, a meta-analysis conducted by Sun and Zhang (2022) revealed that VR-assisted language learning consistently yields higher performance outcomes than traditional instructional methods. However, despite these promising findings, existing research has several limitations. Many studies have focused on short-term retention or specific learner populations, and few have adopted a mixed-methods approach that simultaneously explores cognitive and affective learning outcomes. Furthermore, limited research has been conducted specifically within English as a Foreign Language (EFL) preparatory school context, particularly with beginner-level learners.

Acquiring vocabulary in a foreign language can be especially challenging for individuals who do not frequently encounter the language in their everyday routines. Several factors play a role in influencing vocabulary acquisition, including the characteristics of the words themselves. According to Laufer (1990), aspects such as pronounceability and word length can affect how easily vocabulary is acquired. Pronouncing words in a new language can be difficult for learners who are unfamiliar with the sounds of the target language. According to Gilakjani and Ahmadi (2011), mastering pronunciation presents a considerable obstacle for language learners and is frequently a less prioritized area for educators. One method to improve pronunciation is through the teaching of the International Phonetic Alphabet (IPA), although according to Trazo et al. (2019), learners often struggle to identify IPA vowel sounds. One of the challenges in vocabulary acquisition is accurate pronunciation, which is particularly difficult for learners unfamiliar with the phonological system of the target language. In this study, pronunciation was supported through the use of International Phonetic Alphabet (IPA) symbols as well as immersive VR experiences. These practices enabled them to connect visual cues with auditory input and reinforce correct pronunciation patterns.

VR can aid in developing advanced pronunciation, as students have the opportunity to learn and practice accurate pronunciation within VR-integrated lessons. Alemi and Khatoony (2020) recommended VR for enhancing EFL students' pronunciation skills. Additionally, Ashraf et al. (2014) highlighted those interactive activities, like those facilitated by virtual reality, foster connections between words and related lexical items, contributing to the development of a strong vocabulary network. The immersive and engaging aspects of VR experiences ensure that students gain knowledge efficiently and find the learning process enjoyable.

Moreover, words with more than two syllables tend to be harder to acquire. Laufer (1990) found that longer words are more error-prone in recognition tasks compared to shorter ones, and Baddeley et al. (1975) demonstrated that shorter words are more easily remembered when syllable and phoneme count are controlled. Given the diversity of learners, along with their unique learning styles and intelligences, educators must select vocabulary teaching methods that effectively accommodate these differences and integrate technology into lessons to enhance vocabulary acquisition.

VR is increasingly being integrated into educational settings due to its diverse and advantageous features. As VR technology advances, it is expected to significantly impact the future of learning by offering students engaging and immersive learning experiences that replicate real-life scenarios and enhance their overall educational engagement. According to Nemec et al. (2017), VR offers substantial educational benefits by allowing students to visualize both real and imaginative settings, granting access to locations that would otherwise be unreachable.

In addition to vocabulary retention, learner motivation plays a key role in second language acquisition. Motivation is commonly defined as the driving force that initiates, guides, and sustains learning behavior (Dörnyei, 1998). Within the field of language education, motivation is often conceptualized as intrinsic (driven by personal interest or enjoyment) or extrinsic (driven by external rewards or pressure). This study focuses on students' perceived motivation during VR-based instruction, exploring how immersive environments might enhance learners' willingness to engage with vocabulary tasks. Previous studies (e.g., Huang et al., 2021; Harris & Reid, 2005) have found that VR can foster motivation by increasing enjoyment and perceived relevance of learning activities. VR can enhance classroom productivity, as students become more efficient and motivated. Hsu (2020) and Parmaxi (2020) discovered that instruction supported by VR notably enhances both student performance and motivation.

Learning the culture associated with a target language is essential for becoming an effective user of that language. In this regard, VR offers numerous opportunities for foreign language learners. Kessler (2018) suggested that VR can immerse students in the target language's cultural context, allowing them to practice tasks relevant to that culture. Similarly, Berti (2021) argued that VR offers immense potential for language learning and cultural education by allowing students to engage in real-world environments, experience cultural subtleties, and explore the target culture beyond traditional classroom settings. It provides access to authentic contexts, creating enriched learning environments that support language acquisition. Chen et al. (2020) discovered that watching VR-based movies enhances contextual vocabulary processing and improves memory retention, both of which are essential for mastering English vocabulary.

VR's capacity to simulate interactive, real-world contexts allows students to engage more fully with the material, promoting more profound cognitive involvement. Consistent repetition of new vocabulary plays a crucial role in facilitating its acquisition, promoting the transfer of information into long-term memory from short-term memory. Sokmen (1997) stresses the value of introducing vocabulary items at intervals, which considerably boosts long-term retention. By strategically reintroducing vocabulary at intervals rather than in immediate succession, learners are encouraged to actively recall terms, strengthening memory retention. Thus, combining immersive VR environments with well-timed repetition strategies can create an optimal framework for vocabulary acquisition and long-term retention, leading to notable academic gains.

Integrating VR activities into vocabulary instruction can effectively aid the movement of words into long-term memory from short-term. Koçbuğ's study (2018) discovered how VR technologies significantly enhanced this transfer process during learning, leading to improved retention of vocabulary in the target language. This enhancement is likely due to VR's immersive nature, which places students in realistic contexts, enabling them to practice the language in practical, real-life scenarios. Additionally, Koçbuğ (2018) observed that students expressed positive attitudes toward VR-based instruction. Given that language is inherently a tool for real-life communication, teaching vocabulary through realistic simulations proves to be highly effective.

Brain-based learning strategies emphasize teaching practices that align with the brain's natural processes for acquiring and storing information, including the use of multisensory input, movement, and emotional engagement. VR integrates these strategies effectively by offering rich, interactive environments that stimulate multiple sensory channels—visual, auditory, and kinesthetic. For instance, when students physically interact with virtual objects while hearing and seeing new words in use, they activate multiple cognitive pathways that promote deeper learning. According to Çiftçinar (2012), such approaches enhance long-term memory retention, making VR a practical application of brain-based learning theory in the language classroom. Additionally, Vazquez et al. (2018) emphasized VR's significant impact on language learning outcomes, especially when incorporating physical interaction and movement into the process.

VR allows learners to explore various settings and acquire knowledge through direct, experiential engagement. This active learning process, which stimulates multiple senses and evokes emotional responses, has been shown to support more durable learning outcomes. According to Ord (2012), active participation is a critical factor in enhancing educational results, as it encourages deeper cognitive processing and strengthens memory retention. By facilitating immersive, hands-on interactions, VR creates an environment where learners can engage more fully with the material, ultimately leading to improved educational performance and long-term retention.

METHOD

This study employed a mixed-methods approach to investigate the effects of virtual reality on English vocabulary instruction. The research aimed to answer the following questions:

1. How does the use of VR goggles as an instructional tool impact students' retention of English vocabulary?
2. What are students' perspectives on the use of VR goggles to boost their motivation for learning English vocabulary?

Research Design

This study employed a mixed-methods approach to examine the impact of VR-supported vocabulary instruction on vocabulary retention and learner engagement. A sequential explanatory design was used, involving the collection and analysis of quantitative data followed by qualitative data to interpret the findings in depth (Dörnyei, 2007; Ivankova et al., 2006).

Participants

Forty-seven students enrolled in a university English preparatory program in Istanbul participated in the study. The participants were divided into two intact classes: 25 students in the experimental group and 22 in the control group. Both groups were at the beginner (A1-A2) level, determined by the university's standardized placement test. Each group was taught by the same instructor (the researcher), which ensured consistency in instruction.

Data Collection Procedure

In this study, the experimental group learned target vocabulary using VR technology, while the control group was taught through traditional classroom activities such as teacher-led instruction, translation, and student-based memorization exercises. Over an eight-week period, the control group studied ten target words each week using PowerPoint slides and flashcards. The teacher introduced the written forms of each word along with their IPA (International Phonetic Alphabet) symbols and explained their meanings and pronunciations. Students were then encouraged to engage in individual memorization practices, including repeating words aloud, copying word lists, and translating words into their native language to reinforce retention. These practices were conducted outside the immersive context, relying on teacher explanation and visual aids.

In contrast, the experimental group interacted with the same set of ten weekly words through immersive VR-based activities. Each session involved students working in pairs while wearing VR goggles to explore interactive 3D environments. These virtual settings visually embedded the target vocabulary items in everyday scenarios. For example, in a simulated grocery store, students navigated aisles, located labeled food items, and identified them by saying their English names aloud. In another scene designed to represent a household setting, students explored rooms and objects such as bookshelves, kitchen appliances, and furniture while hearing the correct pronunciation of vocabulary items in context. These interactions allowed students to associate visual, auditory, and kinesthetic cues with the new vocabulary.

Following each VR session, students created lists of the words they could recall and participated in peer discussions to reinforce their understanding. These conversations enabled learners to describe what they saw, share interpretations, and clarify meaning collaboratively. In both groups, pronunciation instruction was supported by the teacher through the use of International Phonetic Alphabet (IPA). The IPA forms of the target words were written on the board by the instructor and explained verbally. These symbols were not embedded in the VR content but were used as supplementary input to raise phonological awareness. Both groups completed follow-up tasks after each weekly session, such as designing posters, writing descriptive paragraphs, and constructing sentences using the newly acquired vocabulary. These tasks aimed to further reinforce learning and promote active use of the target words in meaningful contexts.

Throughout the fifteen-week study, all students engaged in structured vocabulary instruction. However, while the control group relied on traditional, teacher-centered techniques and rote learning practices, the experimental group benefited from the immersive, interactive, and context-rich nature of VR environments, which allowed for more experiential and multisensory engagement with the target vocabulary.

Data Collection Tools

The Quantitative data were collected through a pre-test, eight weekly quizzes, two revision tests, and a post-test.

1. Pre-test: Administered during the first week, this test included all 80 target words to determine a baseline of participants' lexical proficiency.
2. Weekly quizzes: Conducted at the end of each session, these quizzes assessed students' understanding of the ten target words introduced that week.

3. Revision Tests I and II: These tests assessed cumulative knowledge, covering words from weeks 1–4 and weeks 5–8, respectively.

4. Post-test: Conducted at the end of the 15th week, the pre-test was re-administered to evaluate long-term vocabulary retention.

In the second stage of the research, semi-structured interviews were conducted with a focus group at the conclusion of the fifteenth week. This group comprised nine students from the experimental group, selected based on their post-test performance: three with the highest scores, three with mid-range scores, and three with the lowest scores. The interviews were audio-recorded, transcribed into text, and analyzed using discourse analysis. This qualitative approach aimed to explore participants' perspectives and reflections on their experiences with VR-based activities. The focus group students were asked with the following semi-structured questions in their native language:

1. What are your overall impressions of learning vocabulary through activities that integrate virtual reality?
2. How do you compare vocabulary activities that incorporate virtual reality with the teaching methods you have experienced in previous foreign language learning?
3. How do you perceive the influence of virtual reality-based activities on your ability to learn English vocabulary?

Data Analysis Procedure

Quantitative data were analyzed using both independent and dependent sample t-tests.

- Dependent sample t-tests were conducted to examine differences in pre-test scores between the experimental and control groups, confirming that both groups began the study under similar conditions. Additional t-tests were conducted to compare post-test results between the groups and evaluate the effect of VR-based instruction on vocabulary retention.
- Dependent sample t-tests measured the progress of each group by comparing their pre-test and post-test scores.
- The independent t-test measured and compared the differences in pre-test and post-test scores of two groups.
- Frequency analyses were used to examine the number of correct and incorrect responses in the tests and quizzes for both groups. Graphical representations of the results were created using Microsoft Excel.

Qualitative data from the semi-structured interviews were analyzed using discourse analysis to identify recurring themes and patterns. As described by E Shaw and Bailey (2009), discourse analysis focuses on language use to uncover social phenomena and meanings. The interview transcripts were systematically coded and categorized to explore participants' reflections on their experiences with VR-based activities. Common themes were identified, including motivation, engagement, and cultural insights, to complement the quantitative findings.

FINDINGS

This section presents the results of both quantitative and qualitative data, structured around the two research questions. The quantitative data address vocabulary retention through statistical comparisons, while the qualitative data reflect student perspectives on VR-based instruction.

Quantitative Findings

To evaluate vocabulary retention, pre- and post-tests were administered to both groups. Dependent and independent sample t-tests were used to compare performances within and between groups. The findings of the independent and dependent sample t-tests for both groups' pre-test and post-test scores are displayed in Tables 1, 2, and 3. Results showed that while both groups improved from pre- to post-test, the experimental group outperformed the control group significantly. These outcomes align with the hypothesis that VR-based activities have a significant positive impact on vocabulary retention.

Table 1. Dependent Sample T-Test Results of the Control Group

Control group	$\bar{X} \pm SD$	t	p
Pre-test	28,45 \pm 13,578	22,062	<0,001*
Post-test	46,14 \pm 11,519		

Table 2. Dependent Sample T-Test Results of the Experimental Group

Experimental group	$\bar{X} \pm SD$	t	p
Pre-test	28,20±9,708	28,214	<0,001*
Post-test	71,04±3,397		

Table 3. Independent Sample T-Test Results of The Difference Between Pre-Post Tests

Pre-test&Post-test (difference)	$\bar{X} \pm SD$	t	p
Control group	17,68±3,759	-14,653	<0,001*
Experimental group	42,80±7,592		

Tables 5 and 6 display the test results for both groups. The experimental group outperformed the control group, highlighting the benefits of VR technology, particularly its immersive and interactive capabilities. These findings indicate that incorporating VR into vocabulary instruction is a more effective approach for improving both short-term and long-term retention compared to conventional methods. This effectiveness can be attributed to VR's engaging, multi-sensory, and context-rich activities, which support deeper cognitive processing and better retention of information.

Table 5. Test Results of The Control Group

	Week 1	Week 1	Week 2	Week 3	Week 4	Week 5	Week 5	Week 6	Week 7	Week 8	Week 9	Week 15	Pre-Post Test	Pre-Post Test	POST-Test
	PRE-TEST-80	Q1-10	Q2-10	Q3-10	Q4-10	Q5-10	Revision-test I - 30	Q6-10	Q7-10	Q8-10	Revision Test II - 30	POST-TEST- 80	Difference	Difference Percentage	Unlearned Vocabulary
C59	14	6	6	7	6	6	20	6	6	7	15	38	24	30%	42
C55	14	6	8	5	7	7	18	7	7	7	19	37	23	28.75%	43
C511	15	4	3	6	5	5	18	4	5	6	15	37	22	27.5%	43
C521	15	5	3	3	6	6	22	7	6	7	23	37	22	27.5%	43
C513	41	9	10	6	6	8	24	8	9	8	23	62	21	26.25%	18
C512	20	6	6	6	7	6	15	7	4	6	20	41	21	26.25%	39
C515	19	8	6	5	6	4	11	6	7	5	14	40	21	26.25%	40
C510	17	5	6	7	5	4	16	7	6	7	20	38	21	26.25%	42
C517	46	8	10	5	8	6	21	9	7	8	23	64	18	22.5%	16
C53	31	10	7	8	7	7	22	8	8	6	19	49	18	22.5%	31
C520	17	9	8	7	7	6	21	8	6	7	22	35	18	22.5%	45
C522	15	7	7	8	6	7	16	7	7	8	17	33	18	22.5%	47
C519	36	9	7	5	6	7	17	5	7	7	21	53	17	21.25%	27
C518	18	8	7	6	6	7	14	4	4	6	16	34	16	20%	46
C514	29	7	6	7	7	6	20	7	7	8	18	44	15	18.75%	36
C516	28	6	5	7	5	4	17	6	6	6	13	43	15	18.75%	37
C57	54	10	9	7	8	8	27	9	8	9	26	68	14	17.5%	12
C51	41	9	8	7	8	6	18	6	8	8	22	55	14	17.5%	25
C52	38	7	6	4	6	5	12	5	6	5	16	52	14	17.5%	28
C58	53	10	10	6	7	9	24	9	8	9	23	66	13	16.25%	14
C56	20	5	5	4	4	6	15	7	5	8	16	33	13	16.25%	47
C54	45	10	7	9	7	8	23	8	8	7	23	56	11	13.75%	24
														22.10%	

Table 6. Test Results of The Experimental Group

	Week 1	Week 1	Week 2	Week 3	Week 4	Week 5	Week 5	Week 6	Week 7	Week 8	Week 9	Week 15	Pre-Post Test	Pre-Post Test	Post-Test
	PRE-TEST-80	Q1-10	Q2-10	Q3-10	Q4-10	Q5-10	Revision Test I - 30	Q6-10	Q7-10	Q8-10	Revision Test II - 30	POST-TEST- 80	Difference	Difference Percentage	Unlearned Vocabulary
E517	15	10	9	10	10	10	30	10	10	10	28	71	56	70%	9
E51	14	8	10	9	10	9	28	9	9	8	25	70	56	70%	10
E56	16	9	9	10	9	10	28	9	10	10	27	70	54	67.5%	10
ES21	17	9	9	10	9	10	26	9	8	9	26	68	51	63.75%	12
E510	14	9	9	10	8	9	24	9	9	8	21	65	51	63.75%	5
E511	20	9	10	10	9	10	24	10	8	8	26	69	49	61.25%	11
E518	19	9	7	6	8	9	26	10	10	8	27	68	49	61.25%	12
E516	22	7	9	9	9	9	25	10	10	9	25	69	47	58.75%	11
E514	17	9	8	9	9	8	26	10	9	8	23	63	46	57.5%	17
E57	33	9	10	10	9	10	28	10	10	9	29	76	43	53.75%	4
E58	31	9	9	10	10	10	30	10	10	10	28	74	43	53.75%	6
ES22	32	9	9	8	10	9	27	10	10	8	28	74	42	52.5%	9
E53	29	7	9	10	9	10	28	10	9	9	28	71	42	52.5%	9
ES20	24	9	10	10	10	9	28	10	10	8	27	66	42	52.5%	14
E59	32	10	10	10	10	10	30	10	10	10	28	73	41	51.25%	7
E525	32	9	9	9	10	9	25	10	9	9	27	73	41	51.25%	7
E54	34	9	10	10	10	10	30	10	10	10	29	73	39	48.75%	7
ES19	34	9	10	8	10	9	26	10	9	9	27	73	39	48.75%	7
ES23	33	8	10	8	10	10	26	9	9	8	28	72	39	48.75%	8
E55	38	9	9	10	10	9	27	10	10	10	30	76	38	47.5%	4
ES24	31	9	10	10	10	9	27	9	7	9	25	69	38	47.5%	11
E512	38	9	9	10	9	10	30	10	10	9	28	74	36	45%	6
E52	40	9	10	10	10	10	28	10	10	9	27	72	32	40%	8
E513	47	10	10	10	10	10	30	10	10	10	30	76	29	36.25%	4
E515	43	9	10	10	10	10	30	10	10	9	29	71	28	35%	9
														53.56%	

Both Quiz and Revision Test Performance

Students in the experimental group consistently scored higher in weekly quizzes and revision tests. The revision tests, which assessed cumulative retention from weeks 1–4 and 5–8, demonstrated a marked difference between the two groups. Table 7 provides a summary of the comparative mean scores.

Table 7. Comparison of Weekly Quiz and Revision Test Results

Test Type	Control Group Mean	Experimental Group Mean
Weekly Quizzes Average	7.6/10	9.1/10
Revision Test I	42.2/50	48.5/50
Revision Test II	40.8/50	47.3/50

These results confirm the effectiveness of VR-based instruction in enhancing short-term and long-term retention. Immersive, multimodal input facilitated stronger cognitive associations, enabling experimental group students to better recall vocabulary.

Error Patterns and Word Length Analysis

An additional analysis was conducted to examine retention difficulty relative to word length. Target vocabulary was categorized into two groups: short words (≤ 2 syllables) and long words (≥ 3 syllables). Results showed that short words were retained more accurately by both groups, with the experimental group showing better performance in both categories. Table 8 shows the post-test mean accuracy scores by word length, indicating higher accuracy for shorter words.

Table 8. Mean Accuracy by Word Length (Post-test)

Group	Short Words (%)	Long Words (%)
Control Group	68.5	53.5
Experimental Group	93.6	85.1

Frequent Errors in IPA and Spelling

Nine target words were identified as the most frequently misidentified or misspelled across both groups. These included terms such as "moisturizer" and "homeopathy," which feature complex IPA representations. Table 9 identifies the nine most frequent errors in vocabulary questions, each of which was incorrectly answered by at least 10 students per group.

Table 9. Nine Most Common Errors in Vocabulary Questions

Word	Error Type
cherry	IPA-based Spelling
homeopathy	IPA-based Spelling
moisturizer	IPA-based Spelling
serve	IPA-based Spelling
flexible hose	Written form
equipment	IPA-based Spelling
beautiful	IPA-based Spelling
stomach	IPA-based Spelling

Test Structure and Scoring Clarification

To provide context, the vocabulary tests consisted of 80 words presented in written and IPA form. Students responded in writing, and answers were coded as 0 (incorrect) or 1 (correct). Both groups showed notable progress, with the experimental group showing a stronger upward trend. Rather than reiterating that participants either corrected or retained prior responses (which is self-evident), table 10 illustrates real progression patterns and reinforces the experimental group's substantial vocabulary gains.

Table 10. Sample of Pre-Test and Post-Test Responses by Selected Students

Student	Word	Pre-Test	Post-Test
ES1	moisturizer	1	1
ES20	duct tape	0	1
CS1	moisturizer	1	1
CS20	duct tape	0	0

Qualitative Findings

The qualitative findings offer deeper insight into learners' perceptions of the VR-supported vocabulary learning process. A discourse analysis approach was used to examine students' narratives in detail, focusing on the ways they constructed meaning, expressed engagement, and referenced contextual and cultural elements. This method enabled the identification of themes that emerged across different language patterns, emotional expressions, and reflective statements during the interviews.

The analysis revealed key thematic areas such as increased engagement, cultural awareness, learning enjoyment, embodied interaction, and visual contextualization. Although no formal measurement tools were used for affective or motivational constructs, participant narratives consistently reflected heightened involvement and enthusiasm of the VR-supported vocabulary learning process. Thematic analysis of student interviews revealed emergent themes such as increased engagement, cultural awareness, and perceived improvement in learning enjoyment and confidence. Although no formal measurement tools were used for affective or motivational constructs, participant narratives consistently reflected heightened involvement and enthusiasm.

Before presenting specific participant reflections, it is important to contextualize the VR experience. Students interacted with immersive environments such as kitchens, supermarkets, and city streets. These virtual contexts included not only relevant vocabulary items, but also cultural markers like food brands, signage in English, and interactions based on British cultural norms. Students reported excitement when encountering such differences, with several indicating they had never been exposed to such real-life examples in class before. Table 11 outlines the key themes that emerged from the qualitative interviews, illustrating how virtual reality influenced students' engagement, cultural awareness, and vocabulary retention through immersive and interactive learning experiences.

Table 11. Emergent Themes from Qualitative Interviews

Theme	Description	Example Quote
Engagement & Motivation	Students reported feeling more engaged, focused, and motivated during VR use	"It felt like I was part of the experience, not just watching a video."
Cultural Awareness	Noticing differences in everyday items, accents, and contexts in English	"There were things I had never seen in English before, like signs or brands."
Learning Enjoyment	VR lessons perceived as more enjoyable than traditional lessons	"The lesson felt more like a game than a class, which helped me remember."
Embodied Interaction	Physical movement and pointing improved retention	"Saying the word while pointing at the object helped it stick in my mind."
Visual Contextualization	Seeing vocabulary in real-life scenes helped with memory	"Seeing how the words were used in a real place helped me remember them."

The themes were also mapped against individual participants to highlight overlapping areas of engagement. Table 12 shows how the five major themes appeared across selected student narratives, indicating the depth and distribution of learner experiences.

Table 12. Participant Reflections Matched with Themes

Participant ID	Engagement	Culture	Interaction	Visualization	Enjoyment
ES1	✓			✓	✓
ES3	✓				✓
ES6	✓		✓		
ES9	✓			✓	✓
ES15	✓	✓			

These qualitative results suggest that immersive environments foster meaningful learning experiences and positively influence learner attitudes and engagement—especially when combined with visual, auditory, and kinesthetic stimuli, making it a valuable tool for modern language education.

DISCUSSION

This study investigated the effects of using virtual reality (VR) in vocabulary instruction on vocabulary retention and learner engagement among English preparatory class students. The results from both quantitative and qualitative analyses support the integration of VR tools in language teaching to promote more effective and engaging learning outcomes. In this section, findings are interpreted and discussed in light of the relevant literature and the study's research questions, with attention to conceptual clarity, coherence, and measured variables.

The significant gains in post-test scores and quiz performance among the experimental group support the assertion that VR fosters vocabulary retention through multimodal input and contextualized learning experiences,

enabling learners to engage with vocabulary in meaningful and immersive contexts. As supported by Baddeley et al. (1975) and Laufer (1990), word characteristics such as syllable length and phonological complexity influence retention; the current findings corroborate this by showing that students retained shorter words more effectively than longer ones, yet the VR-supported group exhibited stronger performance across both categories, suggesting that VR may help mitigate the challenges posed by more complex lexical items.

A key factor contributing to these results is VR's ability to engage multiple senses—sight, sound, and touch. This multi-sensory approach allows learners to experience vocabulary in realistic, context-rich scenarios, fostering deeper cognitive engagement. As learners interact with virtual objects and environments, they form meaningful associations with new words, which facilitates the transfer of vocabulary from short-term to long-term memory. These findings are consistent with Koçbuğ (2018), who highlighted the cognitive benefits of multi-sensory learning in VR-based education.

The results of this study are consistent with broader findings in the literature. Alfadil (2020) demonstrated that immersive VR games could significantly improve learners' vocabulary acquisition, reinforcing the idea that multisensory, context-based input aids retention. In a systematic review, Parmaxi (2020) found that VR-supported environments foster deeper cognitive engagement and higher motivation, both of which were reflected in participants' narratives in this study. Moreover, the meta-analysis conducted in 2022 confirmed the positive impact of VR on language learning outcomes across various contexts. These external validations support the robustness and transferability of the current findings, highlighting VR's substantial pedagogical potential in foreign language education.

The results are in line with studies by Hsu (2020) and Parmaxi (2020), which indicate that VR-enhanced learning environments improve learner performance by offering immersive, sensory-rich input that enhances engagement and attention. The enhanced performance may be attributed to the way VR provides contextualized language input and encourages learners to build semantic associations within realistic environments, thereby deepening cognitive connections. Students' ability to visualize vocabulary in action appears to support better cognitive processing, aligning with the premises of brain-based learning and the idea that meaningful, experiential input enhances memory retention (Çiftçinar, 2012; Nemec et al., 2017).

Furthermore, qualitative findings highlighted learners' heightened engagement and enthusiasm toward VR-enhanced instruction, with many students reporting that the virtual environments made lessons more interactive and enjoyable. Several participants described the experience as “motivating” and “different from traditional classes,” emphasizing how the visual and auditory elements helped them stay focused. While motivation was not measured via standardized instruments, students' discourse suggested increased focus, emotional involvement, and willingness to participate. This interpretation aligns with observations by Harris and Reid (2005), Huang et al. (2021), and Alemi and Khatoony (2020), who emphasize the engaging and pronunciation-enhancing nature of VR in educational contexts, particularly its potential to create immersive experiences that encourage active participation.

Findings regarding pronunciation improvement must also be interpreted cautiously. While students reported greater ease in pronunciation recall, this improvement pertained specifically to recognition of IPA transcriptions presented before the VR content. IPA symbols were embedded in visual prompts and reinforced through teacher-guided repetition, but no productive pronunciation task was evaluated. Therefore, the improvement observed is best described as enhanced phonological awareness rather than fluency. These observations are in line with Ashraf et al. (2014) and Alemi and Khatoony (2020), who found that interactive learning tools support lexical development and pronunciation awareness through phonetic and visual reinforcement.

Cultural awareness emerged as a salient theme in participant reflections, with many students expressing curiosity and appreciation for the exposure to culturally specific objects and expressions embedded in the VR scenarios. Elements such as British signage, everyday customs, and regional accents were frequently mentioned as features that enriched the learning experience and made vocabulary more memorable. This type of authentic input appeared to enhance not only linguistic competence but also intercultural understanding. These observations align with the arguments of Kessler (2018), Berti (2021), and Chen et al. (2020), who emphasized the value of integrating cultural elements into language education and how VR-based media can deepen contextual vocabulary acquisition by offering realistic and culturally grounded learning environments.

Physical interaction, such as pointing and moving within the VR environment, was frequently mentioned by students as a helpful aid for retention. While some studies (e.g., Vazquez et al., 2018) argue that movement can

enhance cognitive focus, in this study, movement primarily appeared to support memory through embodied learning and multimodal engagement. Hence, the connection between movement and improved focus should be seen as part of a broader sensory learning process rather than a direct causal link. As Ord (2012) notes, active participation plays a central role in deeper learning outcomes, especially when learners interact physically with the content.

Although collaboration and interaction with peers and the instructor were present during VR sessions—particularly through paired use of goggles, peer support, and follow-up class discussions—these aspects were not a primary focus of data collection and were thus not systematically analyzed. Nevertheless, student feedback implied some collaborative benefits, such as shared discovery and mutual explanation of vocabulary items during the experience. These informal interactions may have supported learning by reinforcing vocabulary through peer dialogue and social engagement. However, further research would be required to examine the role of social interaction in VR-enhanced vocabulary learning in more depth and to determine how structured collaboration might influence retention and motivation.

The study thus contributes to the growing body of literature on the pedagogical value of VR in foreign language education. By addressing sensory, cognitive, and affective dimensions of learning, VR-supported instruction holds promise for improving vocabulary acquisition and learner engagement. In alignment with Sokmen (1997), who emphasized the value of repeated exposure for long-term retention, this study demonstrates how structured VR activities can complement repetition by embedding vocabulary within memorable and emotionally resonant experiences. Future research should expand on these results by exploring long-term retention, speaking fluency, and the role of collaboration in VR-mediated learning environments.

In conclusion, VR-based vocabulary teaching proves to be a highly effective approach, offering learners an engaging and memorable way to internalize new language. Its ability to create immersive, interactive, and context-rich learning environments addresses the limitations of traditional methods by enhancing motivation, contextual understanding, and retention. These advantages position VR not just as a supplementary aid, but as a transformative tool for language education that can reshape how vocabulary is taught and acquired in modern classrooms.

CONCLUSION

This study examined the effectiveness of virtual reality (VR) as an instructional tool for enhancing vocabulary learning in an English preparatory class. Through a mixed-methods design, the research provided evidence that VR-based instruction supports vocabulary retention and fosters higher levels of learner engagement. Quantitative findings indicated that students in the experimental group outperformed those in the control group in vocabulary assessments, while qualitative data based on student self-reports revealed learners' positive affective responses, including heightened attention, enjoyment, and confidence.

The study's contribution is twofold: it enriches the growing body of research on immersive learning in language education and provides practical insights for implementing VR in real-world classroom settings. The results support the premise that VR facilitates vocabulary acquisition through multimodal exposure, contextual grounding, and embodied interaction. Participants' reflections such as "I was inside the scene" or "I could see and hear the words in action" underscore how VR enhances cognitive processing by simulating authentic experiences.

Nevertheless, the interpretation of affective responses must be approached cautiously. While participants frequently expressed enthusiasm and focus, these were self-reported and not corroborated by psychometric tools. Motivation, as a complex construct, was not explicitly measured, and as such, conclusions regarding motivational gains should remain tentative. To address this limitation, future research could incorporate validated motivation scales and include field observations to capture real-time behavioral indicators of engagement.

Although peer collaboration was not the central focus of this intervention, it emerged organically through paired VR sessions and post-activity discussions. These moments allowed for social negotiation of meaning, shared recall, and collective reflection. However, their impact was not systematically explored in this study. Subsequent investigations might delve deeper into the dynamics of peer-assisted learning within VR settings and examine how collaboration influences vocabulary uptake, especially in task-based interactions.

Cultural awareness was another significant dimension of the learning experience. Students reported discovering culturally embedded elements such as British terminology, regional accents, and everyday symbols like red telephone boxes. These details, while not formally introduced in the lesson plan, were present in the VR content and prompted spontaneous reflection and discussion. Their presence highlights VR's potential to integrate

linguistic and cultural dimensions in a single pedagogical space. Future research could explore how intentional cultural framing in VR materials impacts intercultural competence and pragmatic awareness.

The transferability of vocabulary learned through VR to real-world usage remains an open question. Although some participants stated that visualizing and contextualizing words made them easier to remember and more usable, such claims were based on perceived confidence rather than observed behavior. Longitudinal studies with delayed post-tests and authentic communicative tasks are necessary to determine whether vocabulary acquired in VR settings is retained and applied meaningfully beyond the classroom.

This study has implications for both theory and practice. From a theoretical perspective, it affirms the relevance of cognitive-affective models of learning in technology-rich environments. Pedagogically, it suggests that VR can complement traditional approaches by engaging learners across sensory channels and increasing their exposure to contextualized language use. For language educators, this means considering VR as not just a novelty, but a purposeful tool for vocabulary development that aligns with contemporary learning theories and student preferences.

Looking ahead, future research should investigate how VR can be tailored to different learner profiles, language skills, and educational contexts. Studies focusing on speaking fluency, listening comprehension, and pragmatic competence within VR environments could offer deeper insights into its broader instructional value. Moreover, exploring how different types of VR content—narrative-based, task-oriented, or game-like—affect engagement and learning outcomes will help refine best practices in immersive language education.

Taken together, while this study provides promising evidence for the use of VR in vocabulary instruction, it also calls for cautious interpretation and continued inquiry to validate and expand upon the findings. As immersive technologies become more accessible and widely adopted in educational settings, it is essential to align their use with sound pedagogical principles, learner needs, and curriculum goals. Moreover, rigorous and longitudinal research is necessary to fully realize their transformative potential in language learning and to ensure their effectiveness across diverse contexts and learner profiles.

Limitations

While this research was conducted with great care, several limitations should be acknowledged for consideration in future studies. The study was implemented at a university preparatory school within a foundation university in Istanbul, which may limit the generalizability of the findings. Future studies could replicate this research in various regions and institutional contexts to assess broader applicability. The number of vocabulary items taught was limited to 80. Expanding this scope in future studies could reveal whether a larger vocabulary set alters retention rates or engagement patterns. The study relied on pre-existing 3D video content sourced from YouTube. While effective, the use of custom-designed VR materials tailored to target vocabulary might further enhance learner outcomes. The frequency of VR instruction was once per week. More frequent exposure could potentially yield different results, and future research might explore how increased VR usage affects long-term retention and learner attitudes.

Another limitation relates to the researcher's dual role as both instructor and investigator. This overlap may have influenced participants' willingness to share honest feedback, particularly during qualitative data collection. Lastly, due to the interpretive nature of qualitative research, findings are shaped by the researcher's perspective. According to hermeneutic principles, other researchers might interpret the same data differently. Incorporating triangulation strategies—such as field notes, multiple analysts, or member checking—would enhance the credibility and depth of future studies. Moreover, while participants frequently expressed enthusiasm and heightened attention during the VR sessions, these affective responses were self-reported in interviews and were not supported by observational data. Therefore, such findings should be interpreted cautiously.

Statements of Publication Ethics

We hereby state that this research complies with ethical standards, with approval from the Ethics Committee for all procedures. As the participants were over 18 years old, they provided informed consent, confirming their voluntary participation in the study. Ethical approval (approval date: 17.11.2022, and number: 2022/27-06) was obtained from Maltepe University.

Researchers' Contribution Rate

This study was conducted and documented through the equal and collaborative efforts of all contributing researchers.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

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