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A SYSTEMATIC LITERATURE REVIEW OF IMMERSIVE VIRTUAL REALITY FOR SUSTAINABLE VOCABULARY LEARNING IN EFL CONTEXTS

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Abstract. The development of immersive Virtual Reality (VR) technology offers new opportunities to create more contextual, interactive, and meaningful learning experiences. Therefore, this study aims to analyze the effectiveness of immersive VR in supporting continuous vocabulary learning in an EFL context. The study used the Systematic Literature Review (SLR) method with reference to the PRISMA 2020 guidelines. A total of 27 empirical articles published in the period 2021–2025 were selected through a process of identification, screening, and selection based on predetermined inclusion criteria. Data were analyzed using a thematic and comparative approach to identify patterns of findings, benefits, and limitations of using VR in vocabulary learning. The results of the study indicate that immersive VR consistently improves vocabulary acquisition, retention, and depth of knowledge through embodied, contextual, and multimodal learning experiences. However, evidence regarding long-term transfer to authentic communication situations is still limited. These findings indicate that the effectiveness of VR depends not only on the level of immersion but also on appropriate pedagogical design and cognitive load management. This study provides implications for the development of technology-based vocabulary learning and serves as a basis for future longitudinal research.

Keywords: Immersive Virtual Reality, Vocabulary Learning, Sustainable Learning, EFL, Systematic Literature Review

Abstrak. Perkembangan teknologi *Virtual Reality* (VR) imersif menawarkan peluang baru untuk menciptakan pengalaman belajar yang lebih kontekstual, interaktif, dan bermakna. Oleh karena itu, studi ini bertujuan untuk menganalisis efektivitas VR imersif dalam mendukung pembelajaran kosakata berkelanjutan pada konteks EFL. Penelitian menggunakan metode *Systematic Literature Review* (SLR) dengan mengacu pada pedoman PRISMA 2020. Sebanyak 27 artikel empiris yang dipublikasikan pada periode 2021–2025 dipilih melalui proses identifikasi, penyaringan, dan seleksi berdasarkan kriteria inklusi yang telah ditetapkan. Data dianalisis menggunakan pendekatan tematik dan komparatif untuk mengidentifikasi pola temuan, manfaat, serta keterbatasan penggunaan VR dalam pembelajaran kosakata. Hasil kajian menunjukkan bahwa VR imersif secara konsisten meningkatkan pemerolehan, retensi, dan kedalaman pengetahuan kosakata melalui pengalaman belajar yang terwujud (*embodied learning*), kontekstual, dan multimodal. Namun, bukti mengenai transfer jangka panjang ke situasi komunikasi autentik masih terbatas. Temuan ini mengindikasikan bahwa efektivitas VR tidak hanya bergantung pada tingkat imersi, tetapi juga pada desain pedagogis dan pengelolaan beban kognitif yang tepat. Studi ini memberikan implikasi bagi pengembangan pembelajaran kosakata berbasis teknologi serta menjadi dasar bagi penelitian longitudinal di masa mendatang.

Kata Kunci: Realitas Virtual Imersif, Pembelajaran Kosakata, Pembelajaran Berkelanjutan, EFL, Tinjauan Literatur Sistematis

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INTRODUCTION

Vocabulary knowledge is a fundamental component of second and foreign language proficiency because it supports learners' abilities in reading, listening, speaking, and writing (Nation & Webb, 2022). In many English as a Foreign Language (EFL) contexts, however, vocabulary learning is often hindered by limited exposure to authentic language input and the continued use of decontextualized instructional practices such as rote memorization and isolated word lists (Webb & Nation, 2021). While these approaches may facilitate short-term recall, they frequently fail to promote long-term retention and meaningful use of vocabulary in communicative situations. As a result, sustainable vocabulary learning, which emphasizes durable retention and flexible application of lexical knowledge, has become an important concern in language education research (Webb & Nation, 2021).

Recent advances in educational technology have introduced immersive Virtual Reality (VR) as a promising tool for vocabulary instruction. Unlike conventional multimedia environments, immersive VR allows learners to interact with three-dimensional objects and contexts, creating meaningful and embodied learning experiences (Makransky & Petersen, 2021). From the perspectives of Depth of Processing Theory (Craik & Lockhart, 1972), Dual Coding Theory (Paivio, 1986), and Situated Learning Theory (Lave & Wenger, 1991), VR has the potential to strengthen vocabulary acquisition by combining contextualized experiences, multimodal input, and active learner engagement. Previous studies have reported positive effects of VR on vocabulary learning, learner motivation, and engagement (Lin & Lan, 2021; Liu et al., 2022; Parmaxi, 2023).

Despite these promising findings, several limitations remain. Most existing studies focus on immediate learning outcomes and short-term retention, while evidence regarding long-term vocabulary retention and transfer to authentic communication remains limited (Tai et al., 2022; Parmaxi, 2023). Furthermore, variations in instructional design, levels of immersion, and pedagogical support make it difficult to determine which factors contribute most to sustainable vocabulary learning (Radianti et al., 2020; Makransky & Petersen, 2021). Research has also paid relatively little attention to how scaffolding, feedback, and task-based interaction mediate learning outcomes in immersive environments.

Given these gaps, a comprehensive synthesis of recent empirical evidence is needed. Therefore, this study employs a Systematic Literature Review (SLR) to examine the role of immersive VR in supporting sustainable vocabulary learning in EFL contexts. Specifically, the review aims to analyze the effects of immersive VR on vocabulary acquisition and retention, identify the pedagogical and cognitive factors that influence its effectiveness, and propose a

theoretically grounded framework for sustainable vocabulary learning through immersive VR.

METHOD

This study employed a Systematic Literature Review (SLR) to synthesize empirical evidence on the effectiveness of immersive Virtual Reality (VR) for sustainable vocabulary learning in English as a Foreign Language (EFL) contexts. The review followed the PRISMA 2020 guidelines to ensure a transparent and systematic study selection process (Page et al., 2021). A literature search was conducted in Scopus, Web of Science, ERIC, and Google Scholar using combinations of the keywords *"immersive virtual reality," "VR-based learning," "vocabulary learning," "lexical acquisition,"* and *"EFL."* Only peer-reviewed journal articles published between 2021 and 2025 were considered. Seminal theoretical works were additionally included to support the conceptual framework.

Studies were included if they (1) investigated immersive VR as the primary instructional medium, (2) focused on vocabulary learning outcomes, (3) involved EFL or foreign language learners, and (4) reported empirical findings. Studies were excluded if they focused on non-immersive technologies, addressed language skills other than vocabulary, lacked sufficient methodological information, or were review and conceptual papers. The detailed selection process is presented in the PRISMA flow diagram (Figure 1).

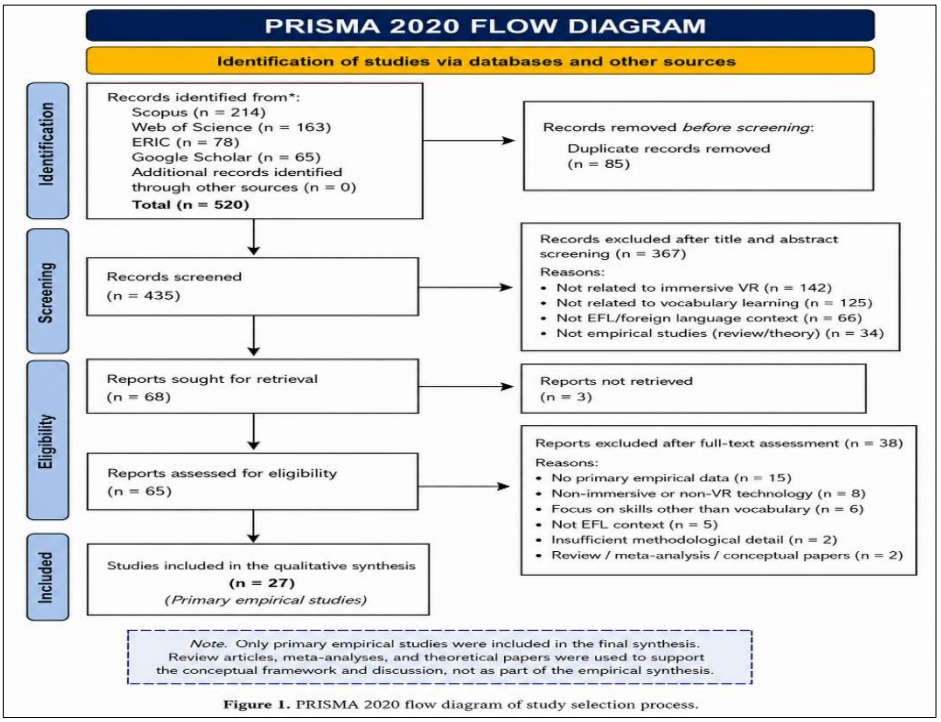

Figure 1. PRISMA Flow Diagram

A total of 520 records were initially identified. After duplicate removal and screening of titles and abstracts, 68 studies were assessed for eligibility. Following full-text evaluation, 27 empirical studies met all inclusion criteria and were included in the final synthesis. Data extraction focused on research design, participant characteristics, VR environment, instructional tasks, intervention duration, assessment methods, and vocabulary learning outcomes. Study quality was evaluated based on research design validity, sample adequacy, instrument quality, and transparency of data analysis. The results of the quality assessment are presented in Table 1. To enhance reliability, 20% of the included studies were independently reviewed by a second coder, yielding an inter-rater agreement of 91%.

The selected studies were analyzed using thematic and comparative synthesis. The analysis focused on vocabulary acquisition, retention, depth of lexical knowledge, learner engagement, and pedagogical factors influencing learning outcomes. Particular attention was given to indicators of sustainable vocabulary learning, including delayed retention, contextualized vocabulary use, and productive vocabulary performance.

Table 1. Quality Assessment of Included Studies (N = 27)

Criteria	High Quality (n)	Moderate Quality (n)	Limited Methodological Rigor (n)
Research Design Validity	15	9	3
Sample Size Adequacy	13	10	4
Instrument Validity & Reliability	14	9	4
Data Analysis Transparency	17	7	3

RESULTS

Overview of Included Studies

To provide a structured synthesis, the reviewed studies were categorized based on vocabulary type, immersion level, assessment methods, and instructional design.

Table 2. Summary of Key Characteristics of Included Studies (N = 27)

Category	Summary of Findings
Vocabulary Type	Predominantly concrete nouns; limited focus on abstract vocabulary and academic expressions
Immersion Level	Both high-immersive VR (e.g., head-mounted displays) and low-immersive/mobile VR environments
Assessment Type	Majority used recognition-based tests; fewer employed productive measures
Duration of Intervention	Mostly short-term (1–4 weeks); limited longitudinal studies
Retention Measurement	Delayed post-tests ranged from one week to several weeks
Instructional Design	Task-based and guided VR environments yielded stronger outcomes than passive exploration

Table 2 shows the main characteristics of the 27 studies analyzed in this literature review. In general, most studies focused on vocabulary learning for concrete nouns, while studies on abstract vocabulary and academic expressions were relatively limited. In terms of immersion level, studies used various types of VR environments, both high-immersive VR such as head-mounted displays and low-immersive/mobile VR. The majority of studies measured learning outcomes using recognition-based tests, while measurements of productive abilities were rare. Intervention durations were generally short-term, ranging from one to four weeks, with limited longitudinal studies. Vocabulary retention was measured using a delayed post-test, with a timeframe varying from one to several weeks after the intervention. Furthermore, findings showed that task-based learning designs and guided VR environments tended to produce better vocabulary gains than passive VR exploration. These findings indicate that the effectiveness of VR in vocabulary learning is determined not only by the level of technological immersion but also by the quality of the instructional design used.

Effects on Vocabulary Acquisition

The reviewed studies consistently indicate that immersive Virtual Reality (VR) positively influences vocabulary acquisition among EFL learners. Compared with traditional and non-immersive learning environments, VR-based instruction generally resulted in higher vocabulary achievement in immediate post-tests (Lin & Lan, 2021; Tai et al., 2022; Parmaxi, 2023). This improvement is attributed to the contextualized and interactive nature of VR environments, which enable learners to associate lexical items with objects, actions, and authentic situations. As a result, vocabulary learning becomes more meaningful and engaging than conventional approaches that often present words in isolation.

In addition to improving vocabulary acquisition, immersive VR also contributes to better vocabulary retention and deeper lexical knowledge. Several studies reported that task-based and situated learning activities within VR environments promoted meaningful interaction with vocabulary and strengthened long-term memory retention (Cheng, 2021; Su & Cheng, 2021; Wang et al., 2022). Furthermore, embodied interaction and multimodal exposure enhanced learner engagement and facilitated deeper semantic processing, allowing learners to retain and apply vocabulary more effectively over time (Chen & Hsu, 2022; Wang et al., 2023; Yang & Chen, 2022). Overall, the findings suggest that immersive VR supports not only immediate vocabulary gains but also the development of more sustainable and contextually grounded vocabulary learning.

Effects on Retention and Sustainability

A substantial number of the reviewed studies incorporated delayed post-tests to examine vocabulary retention, with assessment intervals ranging from one week to several weeks after the intervention. Overall, learners who participated in immersive VR environments retained a significantly higher proportion of target vocabulary than those in traditional or non-immersive learning conditions (Tai et al., 2022; Lin & Lan, 2021). Similar findings were reported by Huang et al. (2023), Wang et al. (2022), and Rahmanu and Molnár (2024), who found that contextualized exposure and repeated interaction within virtual environments contributed to stronger retention over time. These findings suggest that immersive VR supports not only immediate vocabulary acquisition but also more durable vocabulary retention.

The effectiveness of immersive VR in promoting retention is closely related to its multimodal and interactive learning features. Studies by Makransky and Petersen (2021), Pellas et al. (2021), Hwang and Chien (2022), and Parmaxi (2023) indicate that the integration of visual, auditory, and kinesthetic stimuli enhances semantic processing and strengthens memory formation. Learners who actively manipulated objects, completed contextualized tasks, and interacted within virtual environments demonstrated deeper lexical processing and stronger semantic associations (Chen & Wang, 2022; Chen, 2023). These findings align with Dual Coding Theory and Depth of Processing Theory, which emphasize that meaningful and multimodal learning experiences facilitate long-term memory retention. However, most studies employed relatively short retention periods, and evidence regarding long-term transfer of vocabulary knowledge to authentic communicative contexts remains limited, highlighting an important area for future research (Parmaxi, 2023).

Effects on Depth of Vocabulary Knowledge

Recent studies have begun to move beyond recognition-based assessments by incorporating productive and contextualized measures of vocabulary knowledge. Findings indicate that immersive VR supports deeper lexical processing, enabling learners to use vocabulary more accurately and appropriately in communicative tasks (Lin & Lan, 2021; Parmaxi, 2023). Learners in VR environments demonstrated superior performance in tasks requiring active word retrieval, contextual usage, and scenario-based interaction. This suggests that VR facilitates not only receptive knowledge but also productive competence, which is essential for sustainable vocabulary learning. The ability to use vocabulary in context reflects a higher level of lexical mastery compared to simple recognition.

Several empirical studies also highlighted the contribution of immersive VR to productive and contextualized vocabulary use. Lan et al. (2022), Tseng et al. (2022), and Wang et al. (2023) found that learners exposed to VR-supported tasks demonstrated stronger productive vocabulary performance and contextual word usage than learners in traditional environments. In addition, Chen and Hwang (2022) observed that immersive interaction encouraged learners to actively retrieve and apply vocabulary during communicative activities, thereby supporting deeper lexical mastery rather than simple recognition-based learning.

Pedagogical and Affective Factors

The reviewed studies indicate that the effectiveness of immersive VR is strongly influenced by instructional design rather than immersion alone. Studies incorporating structured learning activities, such as role-playing, task-based interaction, guided exploration, and repeated exposure to target vocabulary, consistently reported stronger learning outcomes than passive VR experiences (Lin & Lan, 2021; Makransky & Petersen, 2021; Parmaxi, 2023; Tai et al., 2022). These findings suggest that pedagogical scaffolding plays a critical role in facilitating meaningful vocabulary learning by directing learners' attention, promoting active engagement, and supporting deeper processing of lexical items within immersive environments.

Another prominent finding is the positive impact of immersive VR on learner engagement and motivation. Learners generally perceived VR-based activities as more enjoyable, interactive, and meaningful than traditional vocabulary instruction, resulting in higher participation and willingness to communicate (Dede, 2021; Godwin-Jones, 2021; Huang & Liaw, 2021; Hsu, 2022). Collaborative and task-oriented activities further enhanced engagement by encouraging exploration, problem-solving, and communication within virtual environments (Dooly & Sadler, 2021; Lai & Zheng, 2022; Wang et al., 2022). However, several studies also identified challenges, including cognitive overload, cyber-sickness, technological limitations, and high implementation costs (Hwang & Chien, 2022; Kukulska-Hulme, 2022; Radianti et al., 2020). These findings highlight that successful VR-supported vocabulary learning depends not only on technological immersion but also on effective instructional design and adequate technological support.

Synthesis of Key Findings

Overall, the findings demonstrate that immersive VR has strong potential to support sustainable vocabulary learning through three primary mechanisms: (1) contextualized and

embodied interaction, (2) multimodal reinforcement, and (3) increased learner engagement. However, the extent of these benefits is moderated by instructional design and assessment practices. Despite, the generally positive outcomes, the current literature is characterized by several limitations, including short intervention durations, small sample sizes, and limited focus on long-term transfer. These gaps highlight the need for more rigorous and longitudinal research to fully understand the sustainability of VR-based vocabulary learning

DISCUSSION

Immersive VR and Cognitive Processing

The superior vocabulary outcomes observed in VR-based environments can be explained through the lens of cognitive learning theories. Immersive VR facilitates deeper encoding of lexical items by embedding them in meaningful, context-rich environments, thereby extending the principles of Depth of Processing Theory (Craik & Lockhart, 1972). Unlike traditional methods that rely on surface-level memorization, VR requires learners to engage semantically and contextually with vocabulary through goal-directed actions. In addition, the multimodal nature of VR aligns with Dual Coding Theory, as learners simultaneously process verbal information alongside visual and spatial representations (Paivio, 1986; Mayer, 2009). This integration of multiple sensory channels contributes to stronger memory traces and improved retention. Importantly, immersive VR extends beyond conventional multimedia learning by incorporating embodied interaction, where learners physically navigate and manipulate virtual environments, further reinforcing cognitive processing (Makransky & Petersen, 2021).

The immersive characteristics of VR identified in the reviewed studies can also be understood through the mixed reality taxonomy proposed by Milgram and Kishino (1994), which explains how varying levels of immersion and virtuality influence users' interaction with digital environments. In the context of vocabulary learning, higher levels of immersion may facilitate more authentic and meaningful lexical experiences. Empirical findings from Lin et al. (2021), Wang et al. (2023), and Tai et al. (2022) consistently demonstrated that immersive VR environments facilitate stronger semantic encoding through embodied and multimodal interaction. Furthermore, Tseng et al. (2022) showed that physical interaction with virtual objects enhanced learners' depth of processing by connecting lexical items with motor and spatial experiences. These findings further support the argument that immersive VR extends traditional multimedia learning by incorporating experiential and embodied dimensions into vocabulary learning processes.

The "Goldilocks Zone" of Immersion and Cognitive Load

Despite these advantages, the findings also highlight a critical challenge: immersive VR environments may impose excessive cognitive load if not carefully designed. While rich sensory input can enhance engagement, it may also overwhelm learners' cognitive resources, leading to reduced learning efficiency (Makransky & Petersen, 2021). This suggests the existence of a "Goldilocks Zone" of immersion, where the level of environmental complexity and interactivity is optimally balanced. When immersion is too low, learners may not experience sufficient contextualization to support deep learning. Conversely, when immersion is too high, attention may shift from vocabulary learning to navigating or interacting with the environment. Therefore, sustainable vocabulary learning occurs when VR environments provide sufficient contextual richness without exceeding learners' cognitive capacity. The findings support the notion of a "Goldilocks Zone" of immersion, in which optimal vocabulary learning occurs when immersive richness is balanced with learners' cognitive capacity (Kaplan-Rakowski & Gruber, 2024).

This balance between immersion and cognitive processing was also emphasized in empirical studies by Chen and Huang (2022), Hwang and Chien (2022), and Makransky et al. (2021), which found that excessive environmental complexity and sensory stimulation may reduce learning efficiency. In contrast, VR environments designed with moderate interactivity and guided instructional support were found to promote more effective vocabulary learning outcomes.

Pedagogical Mediation: Beyond Technological Determinism

A key finding of this review is that immersion alone does not guarantee effective learning outcomes. The effectiveness of VR-based vocabulary learning is strongly mediated by instructional design. Studies consistently show that structured, task-based approaches such as role-playing, guided interaction, and repeated exposure yield significantly better results than unguided exploration (Lin & Lan, 2021; Parmaxi, 2023). This finding aligns with Situated Learning Theory, which emphasizes that knowledge is constructed through meaningful activity and social interaction (Lave & Wenger, 1991). Then, several studies (e.g., Cheng, 2021; Wang et al, 2022; Dooly & Sadler, 2021) highlighted that contextualized interaction and collaborative tasks enhanced both vocabulary understanding and learner participation. in VR environments, vocabulary becomes meaningful when it is embedded in purposeful tasks rather than presented as isolated input. Furthermore, scaffolding mechanisms, such as feedback and guided

instruction, play a crucial role in directing learners' attention toward target lexical items and reinforcing learning (Makransky & Petersen, 2021; Tai et al., 2022).

Several empirical studies further demonstrated that pedagogical scaffolding plays a crucial role in maximizing VR-supported vocabulary learning. Su and Cheng (2021), Wang et al (2022), and Lan et al. (2022) found that guided exploration, contextual tasks, and repeated vocabulary exposure significantly enhanced learners' retention and productive vocabulary use. These findings reinforce the argument that immersive technology alone is insufficient without meaningful instructional design and learner support.

Affective Engagement and Sustained Learning

Beyond cognitive and pedagogical factors, immersive VR also enhances affective engagement, which indirectly supports sustainable vocabulary learning. The reviewed studies consistently reported higher levels of motivation, enjoyment, attention, and willingness to participate among learners using VR-based environments (Peixoto et al., 2021; Tai et al., 2022; Hsu, 2022; Huang et al., 2022). These affective benefits are particularly important in EFL contexts, where anxiety and limited opportunities for authentic interaction often hinder vocabulary development. Through experiential and contextualized learning activities, immersive VR creates engaging environments that encourage learners to interact more frequently with target vocabulary and apply lexical knowledge in meaningful situations (Li et al., 2024; Su et al., 2023).

These findings support the view that sustainable vocabulary learning requires repeated exposure, meaningful cognitive processing, and contextualized language use (Nation & Webb, 2022; Webb & Nation, 2021). Immersive VR facilitates these conditions by combining authentic interaction, multimodal experiences, and opportunities for active language use. The findings can also be interpreted through Vygotsky's sociocultural theory, which emphasizes the role of interaction, scaffolding, and socially mediated learning in language development (Vygotsky, 1978). By providing collaborative and context-rich learning experiences, immersive VR promotes deeper engagement with vocabulary and may contribute to stronger long-term retention and more sustainable lexical development among EFL learners.

Toward a Theoretical Framework

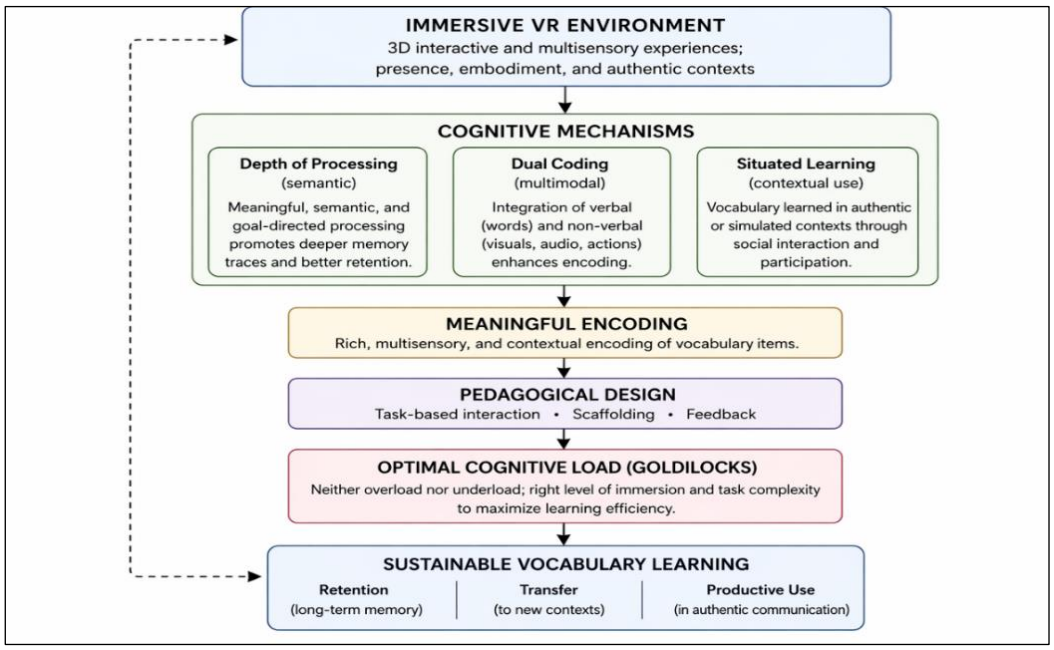

Figure 2. A Theoretical Framework Illustrating How Immersive VR Environments Through Cognitive Mechanisms and Pedagogical Design

As shown in Figure 2, immersive VR environments facilitate vocabulary learning through the integration of key cognitive mechanisms, including depth of processing, dual coding, and situated learning. These mechanisms promote meaningful encoding of lexical items by engaging learners in multimodal, contextualized, and goal-oriented interactions. Furthermore, the effectiveness of VR-based learning is mediated by pedagogical design principles such as task-based interaction, scaffolding, and feedback, which guide learners' attention and reinforce learning processes. At the same time, optimal cognitive load conceptualized as the "Goldilocks zone" ensures that immersion enhances rather than hinders learning. Together, these elements contribute to sustainable vocabulary learning outcomes, including improved retention, transferability, and productive use of vocabulary in authentic communicative contexts.

Toward a VR-Based Sustainable Vocabulary Learning Framework

Based on the synthesis of findings, this study proposes a conceptual framework for VR-based sustainable vocabulary learning. This conceptual framework is grounded in the theoretical perspectives outlined earlier.

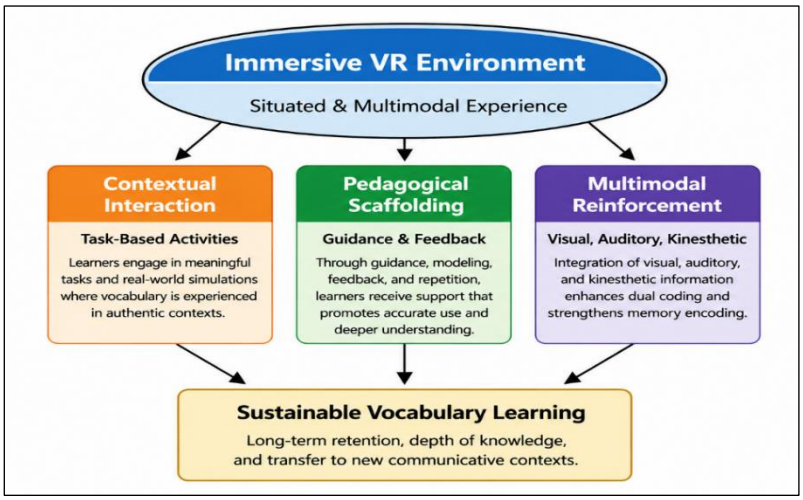

Figure 3. VR-Based sustainable vocabulary learning framework

The framework consists of three interrelated components (1) contextualized Interaction: learners engage with vocabulary through meaningful actions in immersive environments, (2) pedagogical Scaffolding: structured guidance, feedback, and repetition support learning processes, and (3) multimodal Reinforcement: integration of visual, auditory, and kinesthetic input enhances memory encoding. Sustainable vocabulary learning emerges when these components are effectively aligned within VR environments. This framework contributes to the literature by moving beyond technological determinism and emphasizing the importance of pedagogical design and cognitive balance.

Limitations of Current Research

Despite the generally positive findings, several limitations in the current body of research must be acknowledged. First, most studies employ short-term interventions and delayed post-tests of limited duration, which restricts conclusions about long-term sustainability. Second, sample sizes are often small, limiting generalizability. Third, there is a lack of consistency in assessment methods, with many studies relying on recognition-based measures rather than productive or contextualized tasks. Furthermore, variations in VR implementation such as differences in immersion level, task design, and duration make cross-study comparisons challenging (Radianti et al., 2020; Lin & Lan, 2021). These limitations highlight the need for more standardized and longitudinal research designs.

Overall, the discussion underscores that immersive VR holds significant potential for sustainable vocabulary learning in EFL contexts, but its effectiveness depends on the careful integration of cognitive principles, pedagogical design, and affective engagement. Future

research should focus on identifying optimal instructional conditions and evaluating long-term learning outcomes to fully realize the potential of immersive VR in language education

CONCLUSION

This systematic literature review synthesized findings from 27 empirical studies to examine the effectiveness of immersive Virtual Reality (VR) in supporting sustainable vocabulary learning in EFL contexts. The findings indicate that immersive VR enhances vocabulary acquisition, retention, and depth of lexical knowledge by providing contextualized, interactive, and multimodal learning experiences. Learners in VR-supported environments generally demonstrated better vocabulary performance and retention than those in traditional learning settings. The review also shows that the effectiveness of immersive VR is closely associated with meaningful contextual interaction, embodied learning, and multimodal processing, which support deeper semantic engagement and long-term memory formation. In addition, immersive VR increases learner motivation, engagement, and willingness to participate in vocabulary learning activities, creating more meaningful and sustainable learning experiences. However, the findings reveal that technological immersion alone does not guarantee successful learning outcomes. The effectiveness of VR depends largely on appropriate instructional design, including task-based activities, guided exploration, feedback, and cognitive load management. Although the evidence supports the potential of immersive VR for sustainable vocabulary learning, most studies remain limited to short-term interventions and retention measures. Therefore, future research should examine long-term vocabulary transfer and retention through longitudinal designs and more comprehensive assessments of productive and contextualized vocabulary use.

REFERENCES

Alfadil, M. (2024). Immersive virtual reality: A novel approach to second language vocabulary acquisition in K-12 education. Sensors, 24(22), 7185. https://doi.org/10.3390/s24227185

Cheng, K. H. (2021). VR-based situated vocabulary learning. *Interactive Learning Environments, 29*(5), 1–14.

Chen, C. M., & Hsu, S. H. (2022). Personalized vocabulary learning in VR environments. Computers & Education, 182, 104463.

Chen, Y. H., & Hwang, W. Y. (2022). Effects of immersive virtual reality on English vocabulary learning and learner interaction. Interactive Learning Environments, 30(8), 1452–1468. https://doi.org/10.1080/10494820.2021.1875002

Chen, C. H., & Huang, Y. M. (2022). Investigating cognitive load and vocabulary performance in immersive virtual reality learning environments. Educational Technology & Society, 25(4), 88–102.

Chen, Y. L. (2023). The impact of immersive VR on vocabulary retention. Computer Assisted Language Learning, 36(6), 1–20.\

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*(6), 671–684. https://doi.org/10.1016/S0022-5371(72)80001-X

Dede, C. (2021). Immersive interfaces for learning. Science, 323(5910), 66–69.

Dooly, M., & Sadler, R. (2021). Telecollaboration and immersive learning. ReCALL, 33(2), 1–15.

Godwin-Jones, R. (2021). VR and language learning. *Language Learning & Technology, 25*(3), 1–15.

Hsu, T. C. (2022). VR and vocabulary learning motivation. Educational Technology Research and Development, 70(4), 1–20.

Hsu, H. C. (2023). The effects of immersive virtual reality on EFL learners' motivation and vocabulary achievement. Computer Assisted Language Learning, 36(8), 1782–1804. https://doi.org/10.1080/09588221.2022.2033784

Huang, H. W., & Liaw, S. S. (2021). An analysis of learners' intentions toward virtual reality learning environments in English vocabulary acquisition. Educational Technology Research and Development, 69(3), 1525–1546. https://doi.org/10.1007/s11423-021-09967-9

Huang, Y. M., Liaw, S. S., & Lai, C. M. (2022). Exploring learner engagement in immersive virtual reality for vocabulary learning. Computers & Education, 184, 104512. https://doi.org/10.1016/j.compedu.2022.104512

Huang, Y. M., Chen, C. H., & Chou, Y. W. (2023). Enhancing vocabulary retention through immersive virtual reality-based contextual learning. Education and Information Technologies, 28(9), 11345–11366. https://doi.org/10.1007/s10639-023-11652-7

Hwang, G. J., & Chien, S. Y. (2022). Roles of VR in education. Computers & Education, 182, 104456.

Kaplan-Rakowski, R., & Gruber, A. (2024). The impact of high-immersion virtual reality and interactivity on vocabulary learning. Computer Assisted Language Learning, 37(5), 1–22. https://doi.org/10.1080/09588221.2024.2305176

Kukulska-Hulme, A. (2022). Mobile and immersive language learning. Language Teaching, 55(3), 1–15.

Lai, C., & Zheng, D. (2022). Self-directed learning in VR environments. Language Learning & Technology, 26(2), 1–20.

Lan, Y. J., Fang, W. C., & Lin, Y. T. (2022). Virtual reality-supported contextual vocabulary learning in EFL classrooms. ReCALL, 34(3), 312–329. https://doi.org/10.1017/S0958344021000254

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Li, Y., Wong, L. H., & Hwang, G. J. (2024). An experiential learning-based virtual reality approach to foster students' vocabulary acquisition and learning engagement in English for geography. Sustainability, 16(3), 1187. https://doi.org/10.3390/su16031187

Lin, C. C., Chen, H. J. H., & Liu, G. Z. (2021). Effects of virtual reality learning environments on EFL vocabulary acquisition and retention. British Journal of Educational Technology, 52(5), 1967–1983. https://doi.org/10.1111/bjet.13128

Lin, T. J., & Lan, Y. J. (2021). Immersion in virtual reality for language learning: A meta-analysis of learning outcomes. *Educational Technology & Society, 24*(3), 1–15.

Lin, T. J. (2022). Effects of VR-assisted learning on vocabulary acquisition. ReCALL, 34(2), 1–15.

Liu, D., Dede, C., Huang, R., & Richards, J. (2022). Virtual, augmented, and mixed realities in education. Springer.

Makransky, G., & Petersen, G. B. (2021). Immersive virtual reality and learning: A meta-analysis. *Educational Psychology Review, 33*(3), 937–968. https://doi.org/10.1007/s10648-020-09594-0

Makransky, G., Terkildsen, T. S., & Mayer, R. E. (2021). Immersive VR and learning outcomes. Learning and Instruction, 60, 225–236.

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.

Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality displays. *IEICE Transactions*, 77(12), 1321–1329.

Nation, I. S. P., & Webb, S. (2022). Teaching and learning vocabulary. In *The Cambridge handbook of applied linguistics* (pp. 409–430). Cambridge University Press.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford University Press.

Parmaxi, A. (2023). Virtual reality in language learning: A systematic review and implications for vocabulary learning. *Computer Assisted Language Learning, 36*(4), 1–27. https://doi.org/10.1080/09588221.2022.2051078

Peixoto, B., Pinto, R., Melo, M., Cabral, L., & Bessa, M. (2021). Immersive virtual reality for foreign language learning: A systematic review. *Educational Research Review, 34*, 100401. https://doi.org/10.1016/j.edurev.2021.100401

Pellas, N., Mystakidis, S., & Kazanidis, I. (2021). Immersive VR in education: A meta-review. Education and Information Technologies, 26, 1–27.

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education. *Education and Information Technologies, 25*(3), 2131–2165. https://doi.org/10.1007/s10639-019-10015-6

Rahmanu, I. W. E. D., & Molnár, G. (2024). Using spherical video-based immersive virtual reality technology to investigate vocabulary mastery among university sophomores in EFL settings. Cogent Education, 11(1), 2425226. https://doi.org/10.1080/2331186X.2024.2425226

Slater, M., & Wilbur, S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. *Presence, 6*(6), 603–616.

Su, Y. S., & Cheng, C. H. (2021). VR-supported vocabulary learning approach. *Educational Technology & Society, 24*(2), 1–14.

Su, Y. S., Yang, J. H., Hwang, W. Y., & Zhang, W. X. (2023). A virtual reality-supported collaborative approach for English vocabulary learning. Computers & Education, 191, 104638. https://doi.org/10.1016/j.compedu.2022.104638

Tai, T. Y., Chen, H. H. J., & Todd, G. (2022). The impact of immersive virtual reality on EFL learners' vocabulary learning and retention. *British Journal of Educational Technology, 53*(5), 1400–1417. https://doi.org/10.1111/bjet.13218

Tseng, W. T., Tai, T. Y., & Yeh, H. C. (2022). Embodied vocabulary learning in immersive virtual reality environments. Educational Media International, 59(4), 299–315. https://doi.org/10.1080/09523987.2022.2145678

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wang, Y. J., Lan, Y. J., & Tseng, W. T. (2022). Immersive virtual reality for enhancing situated vocabulary learning among EFL learners. Computer Assisted Language Learning, 35(7), 1512–1534. https://doi.org/10.1080/09588221.2021.1901746

Wang, Y., Lan, Y. J., & Chen, N. S. (2023). Effects of immersive virtual reality on vocabulary acquisition and retention among EFL learners. British Journal of Educational Technology, 54(2), 1–18. https://doi.org/10.1111/bjet.13345

Webb, S., & Nation, P. (2021). *Vocabulary learning and instruction: Research-based principles*. Cambridge University Press.

Yang, J. C., & Chen, S. Y. (2022). Effects of VR immersion on vocabulary learning. *British Journal of Educational Technology*, *53*(6), 1–15.

Zhang, X., & Zou, D. (2022). A systematic review of virtual reality in language learning. *Computer Assisted Language Learning*, *35*(8), 1–30. https://doi.org/10.1080/09588221.2020.1720250