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The Impact of Augmented Reality Driven Gamification on Lexical Acquisition and Long Term Vocabulary Retention

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Abstract: Persistence in challenges with acquiring vocabulary and retaining it over time is an issue in learning English as a target language that is further compounded by the lack of learner engagement and context in typical teaching methods. This research examines how Augmented Reality (AR) affects gamified learning experiences and, in turn, vocabulary acquisition and retention among English as a Second Language (ESL) students. A quasi-experimental research approach was used with 60 intermediate students. These students were split into the experimental group (AR-based gamified learning) and the control group (traditional methods). A pre-test, an immediate post-test, and a retention test (administered 3 weeks later) were administered to measure retention. There was a statistically significant improvement in the experimental group relative to the control group. The AR-gamified group showed a 34.6% increase in vocabulary acquisition from the pre-test ($M = 42.3$, $SD = 6.1$) to the post-test ($M = 56.9$, $SD = 5.4$), while the control group showed a comparatively lower increase of 12.8%. After three weeks, the experimental group retained 82.5% of its vocabulary, compared with 61.2% for the control group. The significance of these differences was confirmed by an independent samples t-test ($p < 0.01$). The retention and acquisition results support the idea that AR gamification improves long-term retention and acquisition. With the growing use of technology, pedagogically, more focus should also be placed on improving outcomes in language-learning teaching methods. This study has helped fill a gap in the literature on ESL learning and modern techniques. Wider demographic studies and longer-term studies in this field would also be beneficial.

Key Words: augmented reality (ar), gamification, lexical acquisition, vocabulary retention, english language learning, immersive learning, technology-enhanced education

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Introduction

Acquiring vocabulary has been a significant challenge across all second-language learning, particularly for ESL learners, who tend to struggle more with depth and retention over time. When vocabulary is taught through traditional methods, such as rote memorization, repetition, and practicing out of context, it is likely to lead to only short-term retention. Retention decay is significant here, as new vocabulary is rapidly forgotten, especially when it is taught in a loose, unengaging context (Haoming & Wei, 2024). Traditional methods also tend to ignore the inclusion of multiple input modes and the lack of interactivity, both of which significantly impact vocabulary retention (Belda-Medina & Marrahi-Gomez, 2023). Traditionally, language pedagogy has sought to avoid incorporating technology, which is now seen as a necessity. Of all the technologies, AR has been more widely adopted because it integrates digital information into real-world environments. When combined with a reward-and-challenge system and interactivity, AR is expected to improve vocabulary retention significantly (Ravichandran et al., 2024).

There is also evidence of improved cognitive processing when AR is used, especially at the intersection of linguistic and spatial inputs (Zheng, 2025). Even for young learners, AR interactive applications and storytelling have been shown to improve vocabulary retention (Bibi, 2024). Gamification utilizes game-like mechanics in non-game contexts to promote learner participation and engagement. Involved in language learning, gamification fosters sustained interest, learning improvement, and greater engagement (Mohammed & Jesudas, 2025). When paired with AR, gamification fosters a learning ecosystem in which learners interact with meaningfully contextualized vocabulary, leading to greater acquisition and retention (Hung & Yeh, 2023). Despite these advancements, research continues to demonstrate a gap in long-term vocabulary retention. Most research on AR gamification has focused on time-on-task gains and motivational aspects, leading to a scarcity of empirical evidence (Zhang et al., 2025). Additionally, the evidence leading to reported outcomes has been unclear due to differences in study design, sample, and instructional duration (Binhomran & Altalhab, 2021; Fernandez-Alcocer & Belda-Medina, 2025).

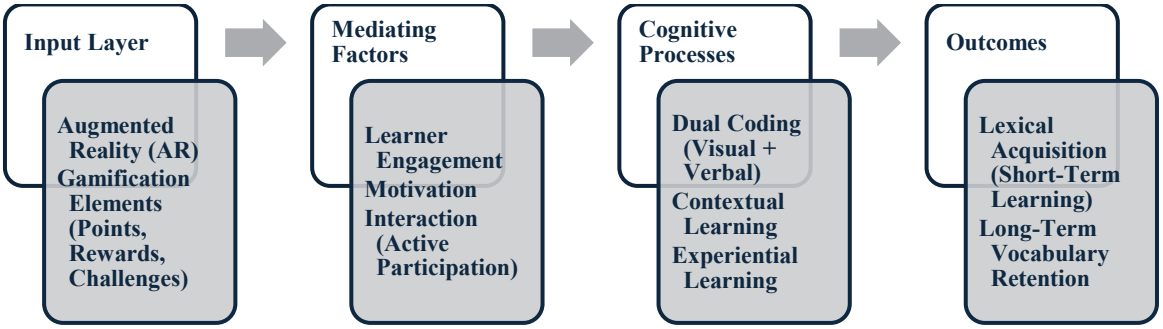

Figure 1: Conceptual Framework of AR-Driven Gamification for Vocabulary Acquisition and Retention

This model (Figure 1) proposes a conceptual framework in which augmented reality (AR) and gamification elements serve as focal inputs that foster learner engagement, motivation, and active participation. These mediating inputs encourage cognitive processing through dual coding, contextual learning, and experiential learning. Consequently, learners show heightened gains in lexical acquisition in the short term and improved vocabulary retention in the long term. This showcases the combined effect of immersive and interactive learning environments.

The implication of this study is to assess the effectiveness of AR gamification in ESL learners' vocabulary and retention. This study is based on two primary research questions dealing with the effectiveness of AR gamification in vocabulary learning. One question is: Does AR-based gamification assist vocabulary acquisition more than traditional teaching methods? The second question aims at long-term vocabulary retention. How long can learners recall and apply the newly acquired lexicon from the AR gamification?

This study attempts to address the longstanding problem of vocabulary retention, which has plagued ESL learning. It seeks to establish a more technologically advanced and engaging gamification model, rather than having learners memorize. The paper provides a detailed empirical study of AR-driven gamification, particularly its impact on immediate vocabulary learning and subsequent retention, offering a more balanced appraisal of its instructional value.

The rest of this paper is structured as follows. In Section II, a review of the literature pertaining to the language learning domain's lexical acquisition, gamification, and augmented reality is provided. Section III is concerned with the methods of the paper, and includes the design, participants, instructions, and analysis. The statistical results on vocabulary acquisition and retention are provided in Section IV. Section

V relates the findings to existing frameworks and literature, as well as the implications for teaching. Section VI features the conclusion, where the main findings alongside the limitations are stated, with a recommendation of potential further research.

Literature Review

How vocabulary is learned in ESL/EFL is determined by both the way the brain processes this new information and the methods the teacher employs. They may learn vocabulary via memorization or may pick it up without intentionally trying to. Vocabulary acquisition improves or worsens depending on the method of its presentation. Teaching vocabulary in a vacuum often results in poor retention. However, teaching vocabulary in context usually results in better comprehension and recall (Khan et al., 2023). Cognitive load is also an important factor. Input that is unstructured or overwhelming may impede retention. Teaching methods that utilize both verbal and visual components contribute to better retention. This supports the dual coding theory that retention is better when words and images are both used. Studies suggest that the retention of vocabulary may be better when some visual elements are provided and students actively participate. (Larchen Costuchen et al., 2021).

The incorporation of game elements into learning makes learning a second language more enjoyable. Elements such as rewards, challenges, and systems of progression make learning more engaging. Studies have shown that students in a gamified learning environment are more motivated and have better vocabulary acquisition that students in learning environments that are not gamified (Jia et al., 2025). Game-based tasks and activities promote retention and reinforce vocabulary acquisition as students repeat activities. Not all gamified learning experiences are effective. When game elements are poorly incorporated into more traditional, non-gamified tasks, students do not make significant learning gains. Learning theory dictates that for gamification to be effective, it must prioritize meaningful engagement over just entertaining students (Budiarti et al., 2025).

Augmented Reality (AR) improves learning through integration of digital information with the environment which allows learners to engage in interactive and contextual experiences. In AR-based learning, vocabulary acquisition was improved as learners could comprehend normally abstract concepts in a more concrete and relatable manner (Wu et al., 2025). AR also supported multimodal learning by integrating visual, auditory, and text inputs which bolstered both engagement and retention (Korosidou, 2024). Moreover, AR bolstered and strengthened spatial cognition which is a significant component of the memory process. Because of these attributes, AR is effective in vocabulary learning where visual and contextual factors are imperative.

With the integration of AR and gamification, an interactive learning atmosphere is created where learners engage with vocabulary through dynamic activities and instant gamification feedback. These approaches are positive contributors to vocabulary acquisition and learner engagement (Salehi, 2025; Muangchan & Yanhua, 2025). There are, however, certain limitations with the preceding research. Many investigations have focused on short-term outcomes while neglecting long-term retention. In addition, variations in AR design, as well as small sample sizes, impact the consistency and generalizability of research findings (Oto-Millera et al., 2025; Soriano-Gonzalez & Abad-Bataller, 2025).

While AR and gamification, in isolation, support vocabulary learning, there is a lack of research into their combined effect on long-term retention, particularly in ESL. This combined effect touches on all

mentioned dimensions in the literature while also leaning into the research a bit more by addressing a lack of sustained vocabulary learning.

Methodology

Research Design

A quasi-experimental research design is employed in this study to assess the effect of AR-driven gamification in learning new lexical items and the retention of vocabulary over a long period. The participants were divided into two groups: the experimental group who received AR-based gamified instruction and the control group who were taught vocabulary using the traditional method. A pre-test–post-test–delayed post-test design was applied to provide evidence for learning gains and retention over a period of time.

Participants

The participants of this study were selected from a higher secondary educational institution. There were 60 intermediate level ESL learners. They were divided into experimental (n = 30) and control (n = 30) groups. The participants were selected based on their previous academic records, and a preliminary vocabulary assessment was conducted to guarantee that the participants' level of achievement were comparable across the groups.

Instructional Intervention

The experimental group was offered an AR-driven gamified learning experience that was intended to facilitate vocabulary growth. The learning tool included 3D object visualization, interactive quizzes, reward-based progress, and immediate feedback. The learners were engaged in several activities such as the association of an object with its word, construction of sentences in context, and challenges which were task based. The duration of the intervention was four weeks with three 45 minutes sessions a week. The vocabulary items taught during the intervention were 100 target lexical items from academic and non-academic areas. The control group, on the other hand, was taught using the traditional method. They were given instructions using a textbook, and then the learner's practiced vocabulary through repetition and written exercises.

Data Collection Instruments

Two vocabulary assessments were created: a pre-test and a post-test. Both assessment types included multiple-choice, matching, and sentence completion items. Additionally, vocabulary retention was assessed via a delayed post-test three weeks after the intervention. To assess learner engagement and motivation specifically in the experimental group, a Likert-scale questionnaire was administered.

Procedure

The study was conducted in five stages. All participants began with a baseline vocabulary knowledge pre-test. Next, an instructional phase followed. In this phase, the experimental group participated in AR-based gamified sessions, while the control group received conventional instruction. After instruction, a post-test was given to assess immediate learning outcomes. This was followed by a three-week retention assessment with no additional vocabulary instruction. Finally, the experimental group answered a questionnaire regarding engagement and learning experience.

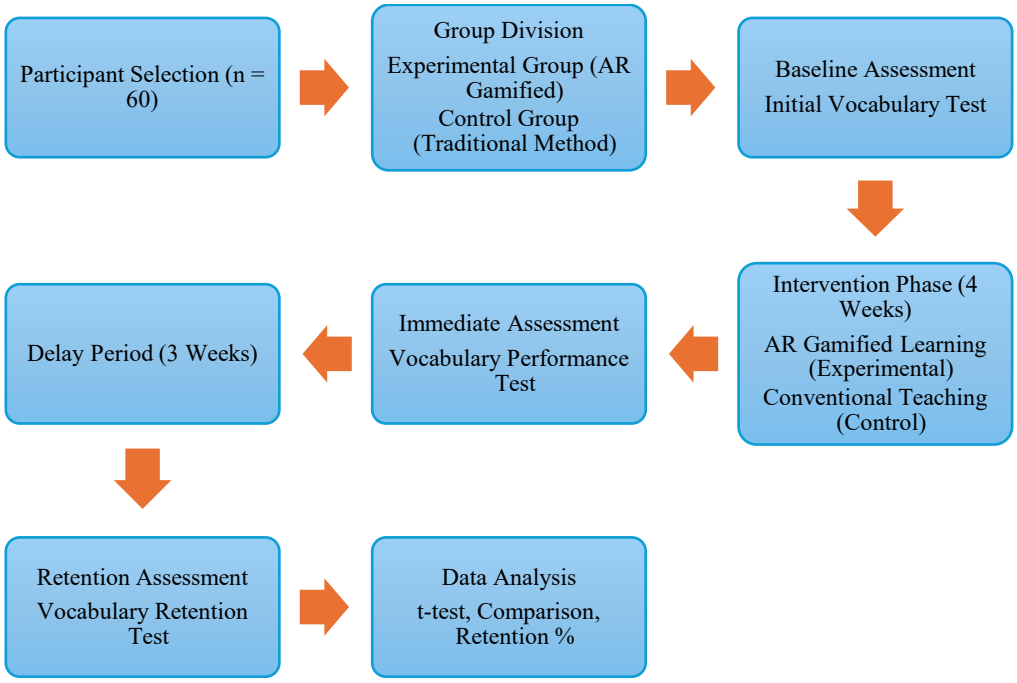

Figure 2: Experimental Workflow of AR-Gamified Vocabulary Learning Study

This figure 2 outlines the experimental process conducted in this study, starting from how participants were selected and split into experimental and control groups, carrying on to the first round of vocabulary assessments done to secure baseline equivalence. During the interventional phase, the experimental group underwent AR-driven gamified learning, while the control group remained with traditional teaching, after which vocabulary assessments were conducted. To measure long-term vocabulary retention, a three-week delay was introduced prior to the retention assessment. The process ends with the application of the t-test and retention comparison to analyze the data statistically.

Data Analysis Techniques

To assess the effectiveness of the intervention, various statistical analyses were conducted. For both group pre-test and post-test scores, a paired sample t-test was used. In contrast, an independent sample t-test was used to compare the experimental and control groups. Delayed post-test scores were used to determine retention. To assess performance and engagement levels, descriptive statistic, and, where appropriate, and were utilized.

Results

The results are shown according to the differences in vocabulary performance before and after the intervention and the retention results after a three-week period.

Vocabulary Acquisition Performance

The results of the first evaluation showed that both groups had similar levels of vocabulary. The experimental group had a mean of 42.3 (SD= 6.1) and the control group had a mean of 41.8 (SD= 5.8). After the intervention, both groups showed a positive change in vocabulary performance. The experimental group had a mean of 56.9 (SD=5.4), which is an improvement of 34.6%. The control group had a mean of 47.1 (SD=6.0), which is an improvement of 12.8%.

Table 1: Vocabulary Performance Before and After Intervention

Group	Initial Mean (SD)	Final Mean (SD)	Improvement (%)
Experimental Group	42.3 (6.1)	56.9 (5.4)	34.6%
Control Group	41.8 (5.8)	47.1 (6.0)	12.8%

Table 1 shows the mean and standard deviation of the two groups before and after the intervention and the percentage of improvements. While it is clear both groups improved, it is obvious the experimental group demonstrated significantly higher improvement than the control group in terms of improving vocabulary.

Retention Outcomes

Vocabulary retention was examined after a period of three weeks. The experimental group had a mean of 47.0 and retained 82.5% of the vocabulary learned. The control group had a mean of 28.8 and retained 61.2%.

Table 2: Vocabulary Retention After Three Weeks

Group	Final Mean Score	Retention Mean	Retention Rate (%)
Experimental Group	56.9	47.0	82.5%
Control Group	47.1	28.8	61.2%

In table 2, the post retention results of both groups are both represented, as are post retention results after 3 weeks, with average scores and retention rates. It is evident that the experimental group had a higher retention of vocabulary than the control group.

4.3 Statistical Significance

Inferential analysis provided evidence for the claims made. For the within group analysis, there was significant improvement for the experimental group ($p < 0.01$), while the control group had a lower significance. For the across group analysis, there was improvement in vocabulary performance after the intervention ($p < 0.01$). There was also a difference in the retention outcomes for both groups ($p < 0.01$).

Table 3: Statistical Analysis Results

Comparison Type	Test Used	p-value	Significance Level
Within Experimental Group	Paired t-test	< 0.01	Significant
Within Control Group	Paired t-test	< 0.05	Moderately Significant
Between Groups (Performance)	Independent t-test	< 0.01	Significant
Between Groups (Retention)	Independent t-test	< 0.01	Significant

In table 3, the results of the inferential statistical analysis are consolidated in order to identify the differences, both within and between groups. The experimental group in particular had a greater positive outcome, as the p values affirmed the degree of statistical significance of retention and their vocabulary performance.

The results are consistent with the differences observed in vocabulary acquisition and retention due to the two instructional methods.

Discussion

Effects of AR-Driven Gamification on Vocabulary Learning

Compared to traditional instruction, AR driven- gamification provided increased vocabulary gains. This is likely due to AR environments being immersive and interactive. Learners are able to engage with vocabulary in contextualized ways. Rather than traditional methods that rely on memorization, AR allows learners to associate words with visual and situational cues, resulting in more cognitive processing and improved recall.

Theoretical Implications

The results support dual coding theory, which states that verbal and visual inputs work in synergy to enhance memory retention. The AR mediated learning environment was multimodal, allowing learners to engrave words in their memory and their meanings. The results also support experiential learning theory since learners interacted with the content to complete tasks and challenges, which fostered retention.

Consistency with Prior Research

The improvement of vocabulary acquisition is in line with prior research reinforcing the effectiveness of AR and gamification in learning. Prior studies had shown increased engagement and motivation in gamification. The majority of the studies addressed short term gains. In contrast, the current research demonstrates that AR driven-gamification aids in long term retention of vocabulary, broadening the scope of literature.

Retention and Unexpected Observations

An important finding is the large discrepancy between retention and immediate learning gains. This means that traditional methodologies may facilitate learning on a cognitive level, but do not provide the necessary support to fix the vocabulary knowledge on a long-term basis. No particular results were entirely unexpected. Individual variations were evident in terms of the impact of technological familiarity and the learning preference of the individual.

Pedagogical Implications

The results affirm the innovation and potential that AR and gamification provide in the English language pedagogy, and the implementation of these methods can lead to vocabulary acquisition that is more engaging, interactive, and contextualized. This approach can lead to a more active involvement of the students, and higher levels of participation, which can result in a transference of learning in the process.

Role of Engagement in Retention

Of the many factors influencing vocabulary retention, engagement appears to hold the most significance. Retention is most affected by the interactive features of AR and the engagement factors of gamification that encourage repeated exposure and active involvement. Briefly, Long-term retention of vocabulary is largely influenced by the active engagement of the learners, as active learners tend to reinforce vocabulary more and result in learning gains.

Conclusion

The purpose of this research was to investigate how gamified AR instruction affected English as a second language (ESL) students' vocabulary acquisition and retention. Compared to learners that received regular instruction without AR and gamification, the study participants that received gamified AR instruction achieved considerably higher retention and vocabulary acquisition. The immersive and interactive nature of AR-rich gamified instruction exemplifies how these constructs can improve cognitive processing and retention. From an educational standpoint, the study demonstrates how gamified AR instruction can improve instruction in ESL settings by improve motivation and retention. Integrating AR and gamification are two practices that can also modernize and engage ESL instruction. There are limitations of this study, including a relatively short duration of instruction, a small sample size. The short duration of instruction may also limit how much the students retain and acquire vocabulary. Future research on this topic should include longer instructional periods within the same age and vocabulary proficiency group as this would improve retention and overall acquisition of the vocabulary. Integrating AR and AI can also add an additional element of personalization and adaptation that would enhance ESL instruction. There may also be other creative avenues added to ESL instruction as a result of these two facilitative technologies.

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