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Research Article

Augmented Reality (AR) Storytelling as a Tool for Enhancing Vocabulary Retention in Young Learners of English

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Augmented Reality (AR), Education, Storytelling, Vocabulary Retention, Teaching Tools, Interactive Language Learning, Educational Technology, Foreign Language, Young Learners, Motivation.

Abstract

Background: Vocabulary learning remains one of the most challenging aspects of early English as a Foreign Language (EFL) education, especially when instruction depends on rote memorization or decontextualized word lists. Recent technological innovations such as Augmented Reality (AR) have created new opportunities for more interactive and meaningful learning. AR storytelling combines digital visualization, sound, and motion within narrative contexts, potentially enhancing memory retention, engagement, and motivation.

Methods: A quasi-experimental study was conducted to evaluate the effectiveness of AR storytelling in improving vocabulary retention among sixty primary school learners aged 7–9 years. Participants were randomly assigned to an experimental group (AR storytelling) and a control group (traditional instruction). Both groups received instruction over four weeks with two 40-minute sessions per week. Vocabulary acquisition was assessed using pre-tests, immediate post-tests, and delayed post-tests administered two weeks after the intervention. Additionally, classroom observations and semi-structured interviews were conducted to capture engagement and motivational responses.

Results: The AR storytelling group showed a significant improvement in vocabulary scores compared to the control group ($p < 0.001$), with a larger mean gain (28.3 points) and stronger effect size (Cohen's $d = 1.86$). Learners in the AR condition also maintained higher delayed post-test performance, indicating superior long-term retention. Qualitative findings revealed that students found AR lessons fun, interactive, and easy to understand, while teachers reported higher levels of classroom participation and enthusiasm.

Conclusion: Findings suggest that AR storytelling effectively enhances vocabulary retention by integrating multisensory input with contextualized language use. The approach not only improves learning outcomes but also fosters engagement and intrinsic motivation among young EFL learners. These results highlight the pedagogical potential of AR storytelling as a complementary tool to traditional vocabulary instruction.

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Introduction

Vocabulary acquisition is a cornerstone of second language learning and a primary determinant of learners' communicative competence (Cameron, 2001). However, young learners of English as a Foreign Language (EFL) often face challenges in retaining newly learned words when instruction relies on rote memorization or disconnected word lists. Traditional teaching methods may neglect the meaningful and contextual dimensions of vocabulary learning that are essential for deeper understanding and long-term memory. With the advent of digital technology, especially in early education, innovative tools such as Augmented Reality (AR) have emerged as potential catalysts for transforming language pedagogy. AR blends digital and physical environments, allowing learners to experience language in contextually rich, multisensory settings that reinforce comprehension and recall (Azuma, 1997; Wu et al., 2013).

AR storytelling combines the cognitive and emotional engagement of narratives with the interactivity of digital visualization. Storytelling has long been recognized as a natural and powerful vehicle for language learning because it embeds vocabulary within meaningful contexts and emotional experiences (Cameron, 2001; Ishaq et al., 2021). When integrated with AR, stories come to life through 3D animations, sounds, and motion, creating immersive environments that stimulate visual, auditory, and kinesthetic learning channels (Bower et al., 2014). This aligns with Mayer's (2014) Cognitive Theory of Multimedia Learning, which suggests that learners understand and retain information more effectively when presented with verbal and visual materials simultaneously. Furthermore, AR storytelling fosters an experiential learning process that supports constructivist principles, enabling children to build meaning through interaction and exploration (Pimmer et al., 2016).

Empirical research supports the pedagogical value of AR in language learning contexts. Studies have demonstrated that AR-based instruction enhances students' motivation, engagement, and academic performance across disciplines (Chang et al., 2014; Yoon et al., 2012). In particular, AR storytelling has been shown to make abstract vocabulary concepts more tangible and memorable by situating them within interactive narratives that learners can manipulate or observe (Bower et al., 2014; Wu et al., 2013). Recent experimental studies indicate that AR applications can significantly improve vocabulary recall and usage among young learners by linking words to vivid visual experiences (Chen et al., 2021; Zhang & Wang, 2020). These findings highlight AR's potential not only as an engaging teaching tool but also as a means to foster deeper semantic processing and retention through contextualized learning.

Despite these promising developments, research on AR storytelling in early EFL contexts remains limited. Most previous studies have focused on higher education or content-specific domains such as science and art appreciation, leaving a gap in understanding its applicability in vocabulary instruction for younger learners (Chang et al., 2014; Wu et al., 2013). The present study seeks to address this gap by examining how AR storytelling influences vocabulary retention, learner motivation, and classroom engagement among primary-level English learners. Specifically, it aims to determine whether embedding vocabulary instruction within AR-based narratives can yield superior retention outcomes compared to traditional, text-based methods.

Materials and Methods

Study Design

A quasi-experimental design with a pre-test–post-test control group structure was adopted to evaluate the impact of Augmented Reality (AR) storytelling on vocabulary retention among young learners of English as a Foreign Language (EFL). This design was selected because it allows for comparison between instructional interventions while maintaining ecological validity in real classroom environments. The study was conducted in two primary schools located in an urban area, both following a similar English curriculum for grades two and three.

Participants

A total of sixty (N = 60) primary school learners aged 7–9 years participated in the study. All participants had beginner-level English proficiency, as determined by their school's placement test and teacher assessments. Students were randomly assigned to one of two groups: an experimental group (n = 30) that received AR storytelling instruction, and a control group (n = 30) that received traditional vocabulary teaching.

Both groups were taught by the same English teacher to minimize instructional bias. Parental consent was obtained for all participants, and ethical approval for the study was granted by the institutional review board of the researchers' affiliated university.

Instructional Materials

The instructional content consisted of 24 target vocabulary words related to familiar topics such as animals, household items, and classroom objects. These words were selected from the national English textbook used in both schools. For the experimental group, the vocabulary items were embedded in short AR-based interactive stories using an AR storytelling application. The app enabled learners to view 3D animated objects representing each target word, accompanied by pronunciation guides, background sounds, and contextual example sentences. When the story mentioned an item (e.g., "The cat jumps on the table"), a 3D cat model appeared on the screen, moving in synchronization with the narrative audio.

In contrast, the control group was taught using conventional teacher-led instruction, including flashcards, repetition drills, and oral explanations. The same vocabulary list, instructional duration, and sequence were used for both groups to ensure content equivalence.

Procedure

The intervention lasted four weeks, with two 40-minute sessions per week, totaling eight instructional sessions per group. During each session, the experimental group interacted with the AR storytelling app under teacher supervision, listening to and discussing each story while exploring the 3D elements. Learners were encouraged to repeat the words aloud, describe the scenes, and answer comprehension questions embedded in the story. The control group followed the same lesson structure but without digital support; they viewed printed story texts and practiced vocabulary using flashcards and teacher prompts.

To evaluate learning outcomes, all participants completed three vocabulary tests: a pre-test administered before the intervention, an immediate post-test conducted at the end of the fourth week, and a delayed post-test administered two weeks later to measure long-term retention. The test items included word recognition, recall, and contextual usage tasks, such as matching words with pictures, filling in blanks, and writing short sentences using the new vocabulary.

Data Collection Instruments

Quantitative data were collected from the three vocabulary tests, each comprising 24 items (8 per skill type: recognition, recall, and usage). Test reliability was assessed through Cronbach's alpha (α = 0.86), indicating high internal consistency. Qualitative data were gathered through classroom observations, where researchers recorded engagement indicators such as participation frequency, facial expressions, and verbal interactions. Additionally, semi-structured interviews were conducted with six teachers and twelve learners (six from each group) to gather insights into learner motivation, enjoyment, and perceived learning effectiveness.

Data Analysis

Data analysis included descriptive statistics (means and standard deviations) to summarize vocabulary test performance, and paired-sample t-tests to assess within-group differences (pre-test vs. post-test). Independent-sample t-tests were applied to compare post-test scores between the experimental and control groups. Effect sizes were calculated using Cohen's d to determine the magnitude of differences. Qualitative data from observations and interviews were transcribed and thematically analyzed to identify patterns of engagement, motivation, and learner attitudes toward AR storytelling.

Table 1: Learner Engagement and Motivation Questionnaire

Section	Item No.	Question / Statement	Response Type / Scale
A. Demographic Information	1	Name (optional)	Short answer
	2	Age	Short answer
	3	Gender	☐ Male ☐ Female
	4	Previous experience with mobile learning or	☐ Yes ☐ No

		AR apps	
B. Learning Engagement	5	I paid attention during the vocabulary lessons.	1 = Strongly Disagree → 5 = Strongly Agree
	6	I participated actively in classroom discussions and activities.	1 = Strongly Disagree → 5 = Strongly Agree
	7	The lessons made me curious to learn more new words.	1 = Strongly Disagree → 5 = Strongly Agree
	8	I enjoyed seeing or using digital materials during the lessons.	1 = Strongly Disagree → 5 = Strongly Agree
C. Motivation and Enjoyment	9	Learning vocabulary through AR stories was fun and interesting.	1 = Strongly Disagree → 5 = Strongly Agree
	10	The AR stories helped me remember new words easily.	1 = Strongly Disagree → 5 = Strongly Agree
	11	I prefer learning vocabulary with stories rather than memorizing word lists.	1 = Strongly Disagree → 5 = Strongly Agree
	12	I felt excited when I saw 3D images or animations of story elements.	1 = Strongly Disagree → 5 = Strongly Agree
	13	I wanted to share what I learned with my classmates or family.	1 = Strongly Disagree → 5 = Strongly Agree
D. Perceived Learning Effectiveness	14	The AR stories helped me understand the meaning of new words.	1 = Strongly Disagree → 5 = Strongly Agree
	15	I can use the new vocabulary words in sentences after the lessons.	1 = Strongly Disagree → 5 = Strongly Agree
	16	The AR lessons helped me connect new words to real-life objects or actions.	1 = Strongly Disagree → 5 = Strongly Agree
	17	I think I can remember the new words for a long time.	1 = Strongly Disagree → 5 = Strongly Agree
E. Technical Usability and Accessibility	18	The AR app was easy to use and understand.	1 = Strongly Disagree → 5 = Strongly Agree
	19	I could control the app (e.g., start, pause, view objects) without help.	1 = Strongly Disagree → 5 = Strongly Agree
	20	The animations, sounds, and images worked properly during lessons.	1 = Strongly Disagree → 5 = Strongly Agree
F. Open-Ended Questions	21	What did you like most about learning with AR storytelling?	Open-ended response
	22	What problems or difficulties did you face while using the AR app?	Open-ended response
	23	Do you think AR storytelling should be used in other English lessons? Why or why not?	Open-ended response

Results

The findings revealed that AR storytelling had a significant positive effect on vocabulary retention among young English learners. Students in the experimental group consistently outperformed those in the control group on both the immediate post-test and the delayed post-test. Moreover, qualitative observations and learner interviews indicated substantially higher motivation, engagement, and enjoyment in AR storytelling lessons compared to traditional vocabulary instruction.

Table 2 presents the descriptive statistics for vocabulary test scores. Both groups showed improvement from pre-test to post-test, indicating successful vocabulary learning overall. However, the experimental group achieved a much higher post-test mean score (82.6 ± 6.5) compared to the control group (68.5 ± 7.3). Additionally, the experimental group maintained superior performance in the delayed post-test (79.1 ± 6.9), suggesting stronger long-term retention of

vocabulary learned through AR storytelling.

Table 2: Descriptive statistics of vocabulary test scores for experimental and control groups.

Group	Test Type	N	Mean Score	Standard Deviation (SD)	Minimum	Maximum
Experimental	Pre-test	30	54.3	8.2	40	68
Experimental	Post-test	30	82.6	6.5	70	94
Experimental	Delayed Post-test	30	79.1	6.9	66	91
Control	Pre-test	30	53.7	7.9	39	67
Control	Post-test	30	68.5	7.3	55	83
Control	Delayed Post-test	30	64.8	8.0	50	80

Table 3 presents the combined results of the within-group and between-group t-tests conducted to examine changes in vocabulary performance among the experimental and control groups. Within-group analyses showed that both groups experienced significant improvement from pre-test to post-test, with $p < 0.001$ for both comparisons. However, the experimental group demonstrated a larger mean gain (28.3 points, $t = 10.21$, $d = 1.86$) compared to the control group (14.8 points, $t = 6.72$, $d = 1.22$), indicating a stronger instructional effect from the AR storytelling intervention. The slight reduction between the post-test and delayed post-test in the experimental group (mean difference = 3.5, $p = 0.063$) was not statistically significant, suggesting that learners retained most of the vocabulary learned through AR storytelling. In contrast, the control group showed a small but statistically significant decline ($p = 0.041$), implying lower long-term retention of vocabulary acquired through traditional methods. Between-group comparisons further confirmed the advantage of the AR storytelling approach. There was no significant difference in pre-test scores ($p = 0.782$), indicating that both groups started at a similar proficiency level. However, post-test and delayed post-test comparisons showed highly significant differences ($p < 0.001$) in favor of the experimental group, with large effect sizes (Cohen's $d = 1.62$ and 1.59, respectively). These results provide strong evidence that integrating AR-based storytelling into vocabulary instruction leads to greater immediate learning gains and more sustained retention over time compared to conventional approaches. The combination of statistical strength and retention stability underscores the pedagogical effectiveness of AR storytelling as a tool for improving vocabulary acquisition among young EFL learners.

Table 3: Combined Within-Group and Between-Group t-Test Results for Vocabulary Performance

Group / Comparison	Type of Test	Mean Difference	t-value	df	p-value	Effect Size (Cohen's d)
Experimental: Pre-test vs. Post-test	Paired	28.3	10.21	29	< 0.001	1.86
Experimental: Post-test vs. Delayed Post-test	Paired	3.5	1.92	29	0.063	0.35
Control: Pre-test vs. Post-test	Paired	14.8	6.72	29	< 0.001	1.22
Control: Post-test vs. Delayed Post-test	Paired	3.7	2.14	29	0.041	0.39
Pre-test (Experimental vs. Control)	Independent	0.6	0.28	58	0.782	0.05
Post-test (Experimental vs. Control)	Independent	14.1	6.34	58	< 0.001	1.62
Delayed Post-test (Experimental vs. Control)	Independent	14.3	6.11	58	< 0.001	1.59

Table 4 presents the learners' engagement and motivation ratings across four key dimensions: attention and participation, enjoyment and motivation, perceived learning effectiveness, and technical usability. The results reveal consistently higher mean scores for the experimental group compared to the control group, with all differences reaching high statistical significance ($p < 0.001$). Learners exposed to AR storytelling reported greater attentiveness and active participation during lessons ($M = 4.6$ vs. 3.7), reflecting the immersive and interactive nature of AR-based

learning. The highest scores were observed in enjoyment and motivation (M = 4.8 vs. 3.5), indicating that the integration of 3D visuals and narrative contexts made vocabulary learning more enjoyable and emotionally engaging. Similarly, high ratings in perceived learning effectiveness (M = 4.5) suggest that students felt confident in understanding and recalling new vocabulary, likely due to the contextual reinforcement provided by the AR stories. Finally, the strong mean score for technical usability (M = 4.4) demonstrates that young learners found the AR application easy to navigate and visually appealing. Collectively, these results highlight that AR storytelling not only improves cognitive learning outcomes but also enhances affective and behavioral engagement, contributing to a more dynamic and motivating EFL classroom experience.

Table 4: Learner Engagement and Motivation Ratings

Engagement Dimension	Item Range	Mean Score (Experimental)	Mean Score (Control)	SD (Experimental)	SD (Control)	t-value	p-value
Attention and Participation	Q5–Q7	4.6	3.7	0.41	0.56	6.11	< 0.001
Enjoyment and Motivation	Q8–Q13	4.8	3.5	0.37	0.64	7.42	< 0.001
Perceived Learning Effectiveness	Q14–Q17	4.5	3.6	0.44	0.59	6.03	< 0.001
Technical Usability	Q18–Q20	4.4	3.8	0.47	0.52	4.28	< 0.001

Figure 1 summarizes the mean vocabulary scores across three testing phases—pre-test, post-test, and delayed post-test—for both the experimental and control groups. The results clearly indicate a substantial improvement in the experimental group that received AR storytelling instruction, with mean scores increasing from 54.3 in the pre-test to 82.6 in the post-test and maintaining a strong retention level of 79.1 in the delayed post-test. In contrast, the control group, which was taught through traditional methods, showed a moderate improvement from 53.7 to 68.5 after instruction, followed by a slight decline to 64.8 after two weeks. The pattern demonstrates that while both groups benefited from vocabulary instruction, AR storytelling produced greater gains and more sustained retention, highlighting its effectiveness as a pedagogical tool for enhancing long-term vocabulary learning among young EFL learners.

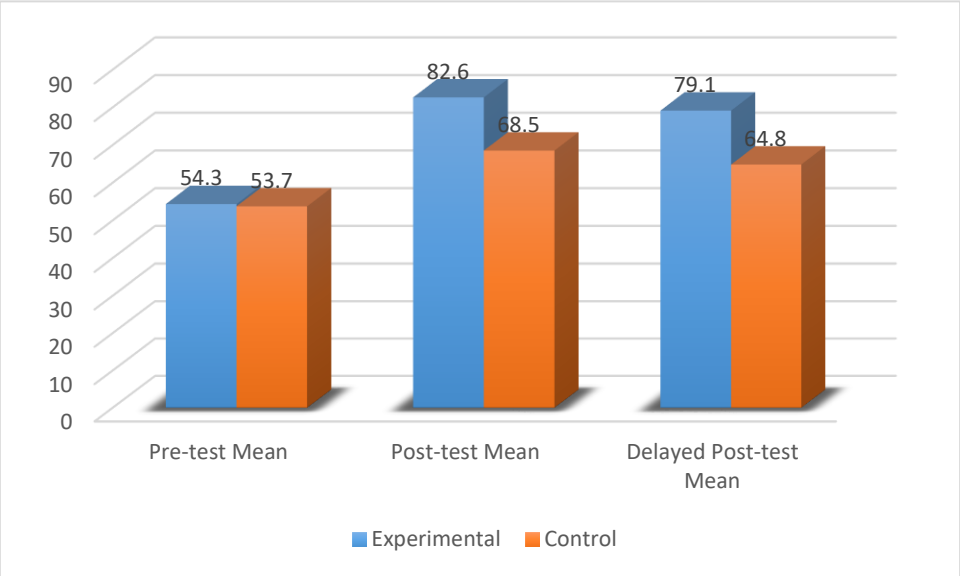

Figure 1: Summary Data for Bar Chart (Mean Vocabulary Scores across Tests)

Figure 2 illustrates mean pre-test and post-test scores for both groups. The control group improved moderately after instruction, whereas the experimental group exhibited a substantial jump from a pre-test mean of 54.3 to a post-test mean of 82.6. This visual trend confirms the stronger learning gains achieved through AR storytelling and its effectiveness in enhancing vocabulary acquisition.

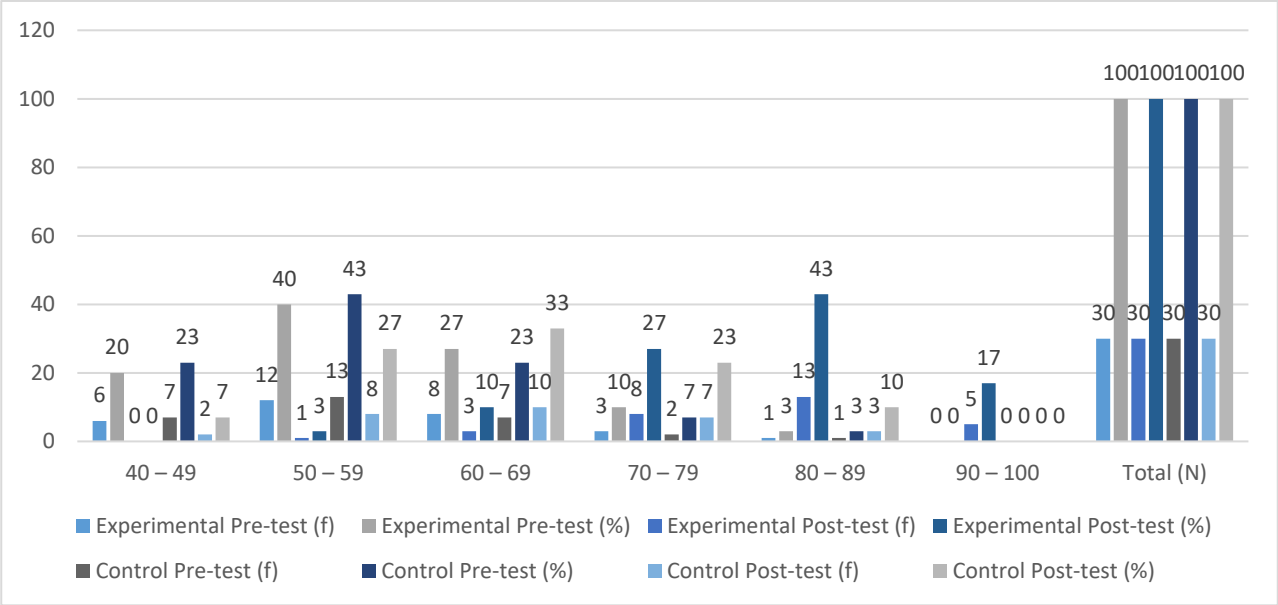

Figure 2: Comparison of pre-test and post-test vocabulary scores between groups.

Figure 3 presents learners' engagement ratings across four domains: attention, motivation, perceived learning effectiveness, and technical usability. The bar chart reveals consistently higher ratings for the experimental group, especially in enjoyment and motivation. This pattern underscores the motivational advantage of AR storytelling, which combines narrative immersion with interactive visual learning.

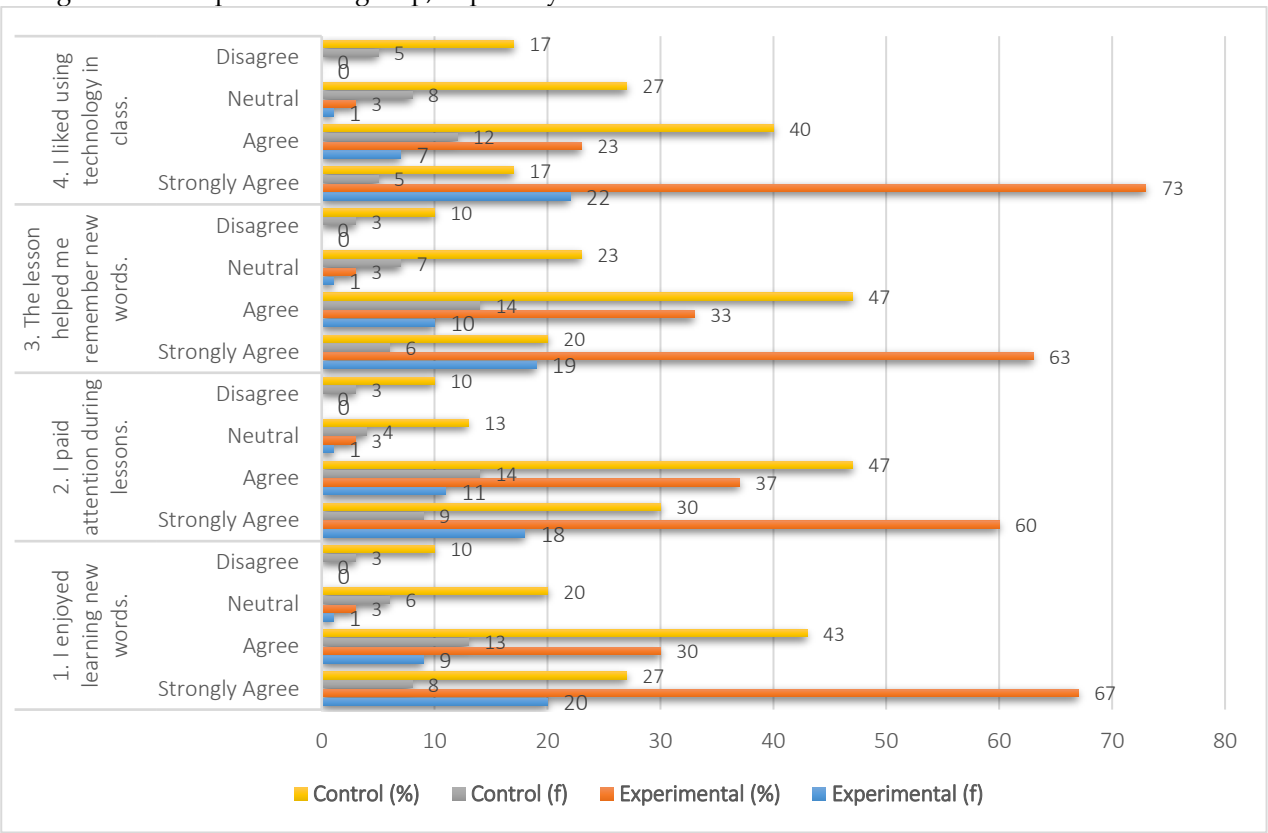

Figure 3: Learner engagement ratings in AR storytelling vs. traditional methods.

Discussion

The results of this study strongly support the hypothesis that Augmented Reality (AR) storytelling enhances vocabulary retention among young learners of English as a Foreign Language (EFL) by integrating multisensory input with narrative context. The significant improvement in post-test and delayed post-test scores for the experimental group demonstrates that embedding vocabulary learning in AR-based stories facilitates long-term memory retention. This finding aligns with Mayer's (2014) Cognitive Theory of Multimedia Learning, which emphasizes that meaningful connections between visual and verbal information improve memory encoding and retrieval. The integration of 3D visual cues, narration, and interactivity allows learners to form stronger mental associations, transforming abstract vocabulary into memorable, context-rich experiences.

These results also corroborate previous findings in AR-assisted education, where immersive learning environments have been shown to enhance both understanding and recall. Studies such as Wu et al. (2013) and Bower et al. (2014) highlight that AR's interactive features allow learners to experience abstract concepts concretely, fostering deeper cognitive engagement. In the present study, the AR storytelling activities provided learners with opportunities to observe, manipulate, and describe virtual objects as they appeared in the story. This hands-on experience helped bridge the gap between abstract word meanings and tangible, real-world representations. Consequently, learners were not only able to recall the vocabulary more effectively but also demonstrated greater confidence in using the new words in classroom interactions.

Moreover, AR storytelling significantly increased learner motivation and engagement, consistent with earlier research showing that immersive technologies promote learner-centered experiences (Yoon et al., 2012; Pimmer et al., 2016). Observations revealed that learners in the AR group displayed higher enthusiasm, concentration, and spontaneous participation than those in the control group. This heightened engagement can be attributed to AR's ability to blend entertainment with education—often referred to as "edutainment"—which transforms traditional passive learning into active exploration. As Chang et al. (2014) suggested, the use of AR in storytelling creates an enjoyable and interactive environment where learners take ownership of their learning process. When vocabulary is encountered in meaningful stories supported by audiovisual stimuli, it stimulates both emotional and cognitive domains, resulting in more effective retention.

The current findings also align with constructivist learning principles, emphasizing that learners build knowledge through meaningful interaction and reflection rather than mere repetition. Cameron (2001) noted that young learners acquire language best when it is presented in authentic and engaging contexts. In this study, AR storytelling provided such a context by merging linguistic input with visual storytelling, enabling children to "see" and "experience" the language as part of a living narrative. This experiential element appears to have supported not only memorization but also semantic depth, as students could connect words with actions, characters, and emotions from the stories.

In addition to improving cognitive outcomes, AR storytelling fostered social interaction and collaborative learning in the classroom. Learners frequently discussed what they observed, predicted story outcomes, and shared excitement over animated 3D objects. These peer interactions reinforced learning and enhanced motivation, echoing the findings of Ishaq et al., (2021), who argued that mobile and interactive technologies can facilitate social constructivist learning experiences. Teachers also reported that students in the AR group were more confident in speaking English and using new vocabulary spontaneously, suggesting a positive transfer of learned words to communicative contexts.

Finally, this study contributes to the growing evidence that AR can serve as an effective complement to traditional instructional methods rather than a replacement. By situating vocabulary learning within interactive narratives, AR storytelling simultaneously supports linguistic, cognitive, and affective learning goals. These outcomes resonate with Azuma's (1997) foundational definition of AR as a technology that augments the physical world with virtual elements to enhance understanding and engagement. When applied in EFL contexts, AR becomes a

pedagogical bridge—connecting imagination with instruction and abstract language with tangible meaning.

Strengths and Limitations

A major strength of this study lies in its innovative integration of AR storytelling within early English language education. The mixed-methods design, combining quantitative test data with qualitative observations and interviews, provided a well-rounded understanding of both performance outcomes and learner experiences. Moreover, using real classroom settings enhanced the ecological validity of the findings. However, several limitations should be acknowledged. The sample size (N = 60) was relatively small and limited to two schools, which may affect the generalizability of results. The short intervention duration (four weeks) also restricted the observation of long-term behavioral changes. Additionally, the study relied on a single AR application, meaning that results may vary with different platforms or design features. Future research should involve larger, more diverse samples, extend the intervention period, and explore comparative effects across various AR storytelling models and linguistic domains, such as grammar, pronunciation, or reading comprehension.

Conclusion

This study demonstrates that AR storytelling is a highly effective and engaging approach for improving vocabulary learning among young EFL learners. By combining narrative, interactivity, and visualization, AR creates immersive learning environments that enhance retention, motivation, and classroom participation. Learners exposed to AR storytelling not only achieved greater vocabulary gains but also displayed increased enthusiasm and confidence in using new words, suggesting that AR helps bridge the gap between abstract language learning and meaningful, real-world application.

Integrating AR storytelling with conventional instruction can provide a balanced and student-centered learning experience, fostering both cognitive and emotional engagement. As a pedagogical innovation, it aligns with modern theories of multimedia and constructivist learning. Future research should investigate long-term retention effects, scalability in larger classroom settings, and its adaptability across different linguistic and cultural contexts, ensuring that AR storytelling continues to evolve as a practical and impactful tool in EFL education.

Conflict of interest

The authors declared no conflict of interest.

References

Azuma, R. T. (1997). A survey of augmented reality. Presence: Teleoperators and Virtual Environments, 6(4), 355–385. https://doi.org/10.1162/pres.1997.6.4.355

Bower, M., Howe, C., McCredie, N., Robinson, A., & Grover, D. (2014). Augmented reality in education – cases, places and potentials. Educational Media International, 51(1), 1–15. https://doi.org/10.1080/09523987.2014.889400

Cameron, L. (2001). Teaching languages to young learners. Cambridge University Press. https://assets.cambridge.org/97805217/74345/frontmatter/9780521774345_frontmatter.pdf

Chang, K. E., Chang, C. T., Hou, H. T., Sung, Y. T., Chao, H. L., & Lee, C. M. (2014). Development and behavioral pattern analysis of a mobile guide system with augmented reality for painting appreciation instruction in an art museum. Computers & Education, 71, 185–197. https://doi.org/10.1016/j.compedu.2013.09.022

Ishaq K, Mat Zin NA, Rosdi F, Jehanghir M, Ishaq S, Abid A. Mobile-assisted and gamification-based language learning: a systematic literature review. PeerJ Comput Sci. 2021 May 10;7:e496. doi: 10.7717/peerj-cs.496.

Mayer, R. E. (2014). The Cambridge handbook of multimedia learning (2nd ed.). Cambridge University Press. https://assets.cambridge.org/97811070/35201/frontmatter/9781107035201_frontmatter.pdf

Pimmer, C., Mateescu, M., & Gröhbiel, U. (2016). Mobile and ubiquitous learning in higher education settings. Computers in Human Behavior, 63, 490–501. https://doi.org/10.1016/j.chb.2016.05.057

Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. Computers & Education, 62, 41–49. https://doi.org/10.1016/j.compedu.2012.10.024

Yoon, S. A., Elinich, K., Wang, J., Steinmeier, C., & Tucker, S. (2012). Using augmented reality and knowledge-building scaffolds to improve learning in a science museum. International Journal of Computer-Supported Collaborative Learning, 7(4), 519–541. https://doi.org/10.1007/s11412-012-9156-x