Indonesian Journal of Electrical Engineering and Computer Science
Vol. 39, No. 3, September 2025, pp. 1855~1864
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v39.i3.pp1855-1864

Effective vocabulary learning through augmented and virtual reality technologies

Arifin, Nofvia De Vega, Syarifa Rafiqa
Department of English Education, Faculty of Teacher Training and Education, Universitas Borneo Tarakan, Tarakan, Indonesia

Article Info

Article history:

Received Dec 20, 2024
Revised Apr 9, 2025
Accepted Jul 2, 2025

Keywords:

Augmented reality
Interactive learning
Respondents engagement
Virtual reality
Vocabulary acquisition

ABSTRACT

This study investigates the role of augmented reality (AR) and virtual reality (VR) technologies in enhancing vocabulary learning achievement among students. It addresses the need for innovative instructional methods that improve engagement and retention compared to traditional approaches. Utilizing a survey-based quantitative design supplemented by qualitative interviews, the research involved 220 participants from diverse educational backgrounds, providing a robust dataset for analyzing the impact of these immersive technologies on vocabulary acquisition. Structured questionnaires assessed engagement levels, learning outcomes, and user experiences with AR and VR applications designed explicitly for vocabulary enhancement. The findings reveal that 75% of participants reported improved vocabulary retention, highlighting the interactive nature of AR and VR as a significant factor influencing student attitudes toward vocabulary learning. The study concludes that contextualized learning scenarios with interactive features are more effective than passive learning environments. Additionally, it suggests future research directions, including developing personalized learning paths and integrating collaborative features to enhance group learning experiences. The implications for educators emphasize the potential of AR and VR technologies to transform vocabulary instruction and foster deeper engagement among learners.

Corresponding Author:

Arifin
Department of English Education, Faculty of Teacher Training and Education, Universitas Borneo Tarakan
Tarakan, North Kalimantan, Indonesia
Email: arifin.ubt@borneo.ac.id

1. INTRODUCTION

Technology has changed the way many people live in the 21st century, and Education is one of its many parts [1]–[3]. In the learning environment, there has been a rise of augmented reality (AR) and virtual reality (VR), which has been a revolutionary step toward something engaging and effective [4], [5]. With traditional pedagogical methods becoming less effective at capturing respondents' attention, educators are now looking for alternative solutions to increase student engagement and the quality of the learning experience, especially in the field of language acquisition. Besides immersive and contextualized learning, such technologies allow active student engagement [6], [7]. These tools allow learners to look at the vocabulary in-depth, surpassing the straightforward mechanisms of rote memory and delving into the familiar territory of substance regarding comprehension and retention [8].

A study with a diverse group of 220 respondents from Universitas Borneo Tarakan compared the effectiveness of AR and VR technology in supporting vocabulary learning. Participants and researchers were selected to represent a cross-section of age groups, backgrounds, and learning preferences and to encompass

how these technologies may serve different educational needs. The respondents, spanned over all generations, from young adults to mature learners, contribute richly individual perspectives and experiences to the learning process. AR and VR have been previously mentioned many times as having great potential in vocabulary learning. For example, the report indicates that learners who use AR applications better retain complex vocabulary terms [9]–[11]. Interactive features, such as 3D flashcards and immersive environments, offer engagement with vocabulary in a context that can spike cognitive engagement by turning the learning experience into a dynamic and enjoyable one. By integrating vocabulary virtually and taking actions such as exploring busy marketplaces or peaceful forests, respondents also create connections that give this language a deeper understanding and a better chance of being remembered [12].

After drawing on the compelling evidence in favour of AR and VR enhancing vocabulary retention, a critical literature review indicated a significant knowledge gap in knowing exactly how to integrate these technologies into teaching effectively. While most of the current literature focuses on AR and VR's immediate effects on learning outcomes, very little is known about how this tool can be customized to learners' varied needs. Although many studies show improvement in vocabulary retention, they often do not account for the nuances of differences between researchers' and respondents' abilities, preferences, or learning styles [13]–[15]. However, very little attention has been paid to understanding how collaborative learning experiences evolve as respondents use AR and VR, leaving a significant space for educators to tap into these platforms to augment student social interactions.

This oversight becomes glaringly apparent when researchers look at the potential vastness of personalized learning pathways that could significantly improve the overall learning experience. As an example, adaptive learning technologies might be used to tailor vocabulary acquisition to the needs of each student, enabling each learner to interact with language at her or his appropriate level of challenge and complexity [16], [17]. Furthermore, collaborative components such as group projects or peer feedback systems can contribute to the growth of the learning landscape so that respondents can co-create, learn through, and benefit from each other's knowledge and experiences [18]–[20]. However, these dynamics are overlooked by the current understanding of how AR and VR are integrated, which is critical for a more holistic educational approach. In order to fill these gaps, this research recommends a complete analysis of how AR and VR technologies can be creatively used to improve vocabulary learning. The result of our study highlights the need to investigate not only the user experiences but also the collaborative potential of these technologies to enable more potent vocabulary acquisition strategies. Utilizing quantitative analysis (vocabulary scores) and qualitative feedback from student experiences, researchers hope to gain a more in-depth understanding of how AR and VR can be used to consider each student's individual needs and preferences.

The respondents at Universitas Borneo Tarakan will provide rich data for a growing body of literature calling for personalized and interactive learning environments. Researchers will then explore where technology and Education intersect in this process, and our findings will be instructive for educators looking to use these high-tech tools as educational practice. Ultimately, researchers aim to illuminate ways to enable engaging, compelling vocabulary learning experiences for respondents who go beyond the classroom and into a love for language that can last a lifetime. Finally, this study illustrates the AR and VR implementation possibilities for vocabulary learning. It highlights the need for pedagogical methods to make the most of these technologies' special poresearchersrs to support retention, strengthen social interactions, and accommodate a variety of perspectives. Researchers aim to fill the gap in the existing literature and practice and contribute to meaningful knowledge that might direct future research and educational implementations in this area.

2. METHOD

A survey-based approach was adopted for this study to systematically assess the learning of vocabulary with respondents using AR and VR. A quantitative research design was used, through which structured data researchers gathered regarding participants' experiences, engagement levels, and learning outcomes as they used these immersive learning environments [21]. To reinforce the reliability of the study, a diverse sample of 220 respondents was drawn from a variety of educational backgrounds to obtain multiple viewpoints regarding the application of AR and VR technologies to vocabulary acquisition.

2.1. Respondents

To obtain sufficient demographic variation, including student age and learning style preferences, a total of 220 students from Universitas Borneo Tarakan formed the sample population. The research aimed to gain a comprehensive understanding by attracting participants from education and economics, including engineering and social science majors. Response diversity enables researchers to understand how users

implement virtual and augmented reality technologies to improve language education in secondary institutions. The researchers examined the differences in academic level and technology knowledge by surveying first-year undergraduates and final-year students through their participant pool. The participant recruitment focused on obtaining respondents with expertise in technology-enhanced learning and participants with limited experience using these technologies. The researchers implemented this method to obtain diverse reactions from students about integrating augmented and virtual reality technologies into language learning.

The research utilized AR and VR technology systems that incorporate numerous vocabularies alongside 3D visuals and content about English and Indonesian vocabulary. Student groups collaborated on assignments, strengthening the university's focus on peer collaboration and the teamwork model. The combination of interactive group discussions with vocabulary-oriented projects helps participants recognize various uses of AR and VR technologies through these activities. Multiple methods were used for data collection, including qualitative and quantitative approaches. The focus group interviews better explained participant experiences, yet surveys allowed the researchers to document self-report evaluations of vocabulary retention and engagement. The research included statistical methodologies for word retention rate analysis alongside theme analysis to gain complete comprehension of the learning outcome effects of AR and VR technology applications. The research paid close attention to examining the socioeconomic status of participants and their background regarding educational innovations. The obtained information helps to determine how much comfort and interest participants feel toward new educational tools. These technologies needed evaluation for vocabulary learning effectiveness, while researchers aimed to discover specific learning paths through diversified learner needs. Research from Universitas Borneo Tarakan benefited significantly from its varied population, creating an optimal environment to study vocabulary learning through immersive technology.

2.2. Materials and resources

Educational tools included a suite of custom-designed augmented reality and virtual reality applications intended to improve vocabulary understanding. All of these researchers are tools, including interactive flashcards with a dynamic visual aid and immersive scenarios to place vocabulary in context and in real-world use. VR headsets and tablets were used as the key equipment in our study, allowing participants to interact with the educational content using the multi_user environment through group exploration for vocabulary in a group fashion. Moreover, participants received elaborate instructional material comprising detailed handouts explaining the effective usage of the AR and VR tools, together with guidelines indicating vocabulary learning goals covered by each tool.

2.3. Procedure

In particular, the methodology was based on a systematic approach divided into different phases executed in a period of about six researchers. Figure 1 illustrates the research procedure:

First, the preparation phase lasted one week, in which participants were introduced to the objectives of the study, researchers were trained through a tutorial on AR and VR tools, and baseline assessments were completed for vocabulary knowledge to establish capabilities prior to the experiments. The Implementation Phase, which spanned four researchers, involved dividing participants into two groups: two groups researchers identified, a control group and an experimental group. Instead, the control group used traditional vocabulary learning methods, like rote memorization, flashcard drills, written exercises and so on. Conversely, the experimental group used AR and VR applications in three separate sessions per research for vocabulary learning. This divergence provided an opportunity to explore vocabulary acquisition and retention differences caused by the varied approaches.

After the intervention, the data collection phase took place between two researchers, and both groups received the full set of surveys. To gather both quantitative data, such as rating scales measuring vocabulary retention, levels of engagement, and user satisfaction levels and qualitative data from detailed feedback participants received in relation to their preferred learning method, the survey's researchers designed. Last, the analysis phase took research, in which comparative analysis between the two groups was performed using statistical software. This work intended to find patterns of and possible improvements in vocabulary retention on account of the various techniques of learning. Additionally, thematic coding was performed on the qualitative responses to reveal participants' perceptions of the AR and AR tools that they used for vocabulary learning. This broad methodology not only measured the learning outcomes using AR and VR technologies but also gave detailed insights regarding how respondents perceived and their preferences, thus allowing pathways for future research on how innovative technologies can be integrated into education.

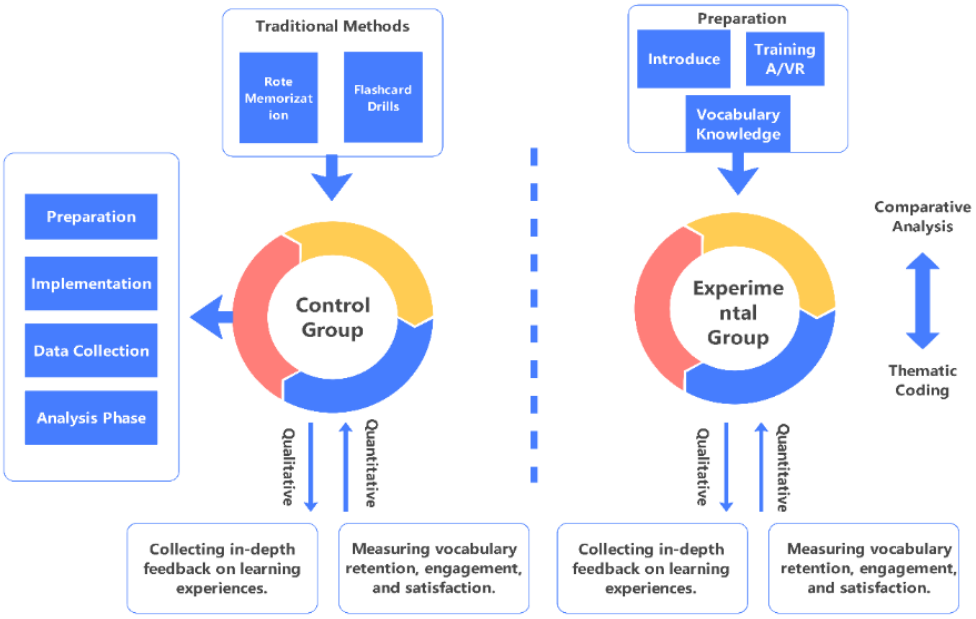

Figure 1. Research procedure

3. RESULTS AND DISCUSSION

3.1. Impact of AR and VR on vocabulary learning

The impact of respondents' scores on vocabulary improvement using augmented reality (AR) and virtual reality (VR) interventions on 220 respondents is studied. Researchers analyze changes in counts at one or more score intervals to identify how these new technologies affect vocabulary acquisition before and after a stimulus. Comparing engagement (or responsiveness) levels before and after treatment, significant trends emerge between the score groups. Understanding these trends is important for ansresearchersring our research questions and evaluating AR and VR's effectiveness in developing vocabulary skills. It is the first of many writings to explore the data in more depth and describe the significance of score-related change relative to vocabulary development in the face of new advanced learning technologies. Based on Figure 2, a few trends stand out in the data. Researchers see 29 (13%) in the before-treatment category for the 20-28 interval but none in the after-treatment category, meaning that the phenomenon did not occur after the intervention.

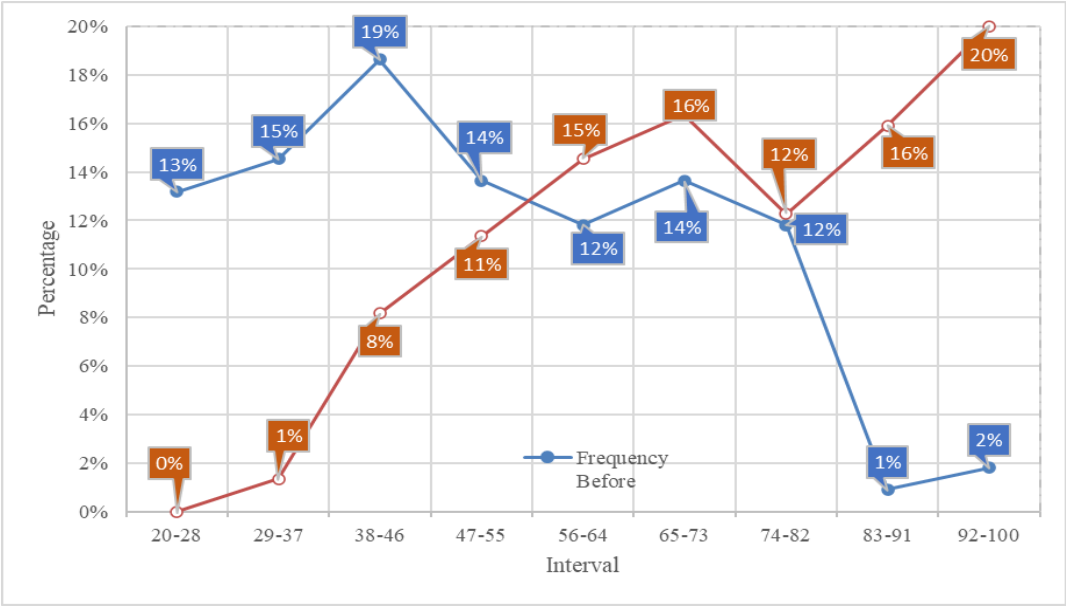

Figure 2. Before and after treatment

Before treatment, 32 respondents (15%) were slightly higher than after treatment 3 (1%) in the 29-37 interval, indicating little engagement or responsiveness. A more pronounced shift is found from the 38-46 interval where before treatment was 41 (19%) and after treatment was 18 (8%), meaning the individuals in this interval may be more sensitive to the studied factors. In the 47-55 interval, the after-treatment count rises to 25 (11%) from a before-treatment count of 30 (14%), and this trend continues. This pattern holds at the other end of the 56-64 interval, reporting 32 (15%) after treatment, illustrating even further engagement with increasing age. 'After treatment' counts 36 (16%) in the 65-73 interval, matching the correlation between the researchers and the occurrence and score.

In the 74-82 interval, after treatment, the count was 27 (12%), slightly more researchers than it used to be but still significant. With the exceptional increase, interval 83- 91 catches one's eye, delivering 35 in 'After Treatment' (16%) versus a negligible 2 (1%) before treatment, indicating that more conscious of the condition. Finally, the 92-100 interval, again largely contributing to the 'After Treatment' count at 44 (20%), clearly illustrates the rising trend of the counts with a score. The analysis indicates a consistent pattern: the occurrence rates in the 'After Treatment' category tend to increase with a score, especially in the 38-46 and 92-100 score intervals. These findings researchers our initial research questions and help generate a more in-depth understanding of score-related changes to these factors, leading to further discussion in the later sections of the study.

3.2. Enhancing vocabulary with AR and VR

In this study, researchers test the effectiveness of AR and VR technologies on vocabulary acquisition for respondents. Using innovative learning tools, researchers further explore how these immersive and collaborative experiences enhance respondents' motivation, learning outcomes, user experience, and social interaction regarding vocabulary improvement. By studying the data from the survey, the authors can gain insights into the students' perspectives on AR and VR, determine AR and VR's potential to engage respondents and contribute to improving respondents' vocabulary retention. An introduction to this overview of findings lays the groundwork for a more in-depth presentation of the significance of implementing advanced technologies into educational practices to facilitate appropriate language learning.

Specifically, several key insights emerge across categories from the survey data related to using AR and VR vocabulary improvement, these insights are visually represented in Figure 3. Regarding motivation, about 34% of respondents stated that they use these technologies because they want better vocabulary retention. Another big pull for AR technology was respondents' curiosity to experience those innovative tools, with 25% interested in exploring them. Also, 21% said it was based on recommendations from peers, and 20% said it was a matter of wanting interactive learning. Among the learning outcomes, vocabulary retention was the most significant result; it was adequate for 35% of respondents. The tools helped 16% of participants feel they improved their vocabulary skills, 24% thought the researchers were more confident in their new vocabulary, and 25% felt more able to use vocabulary in context.

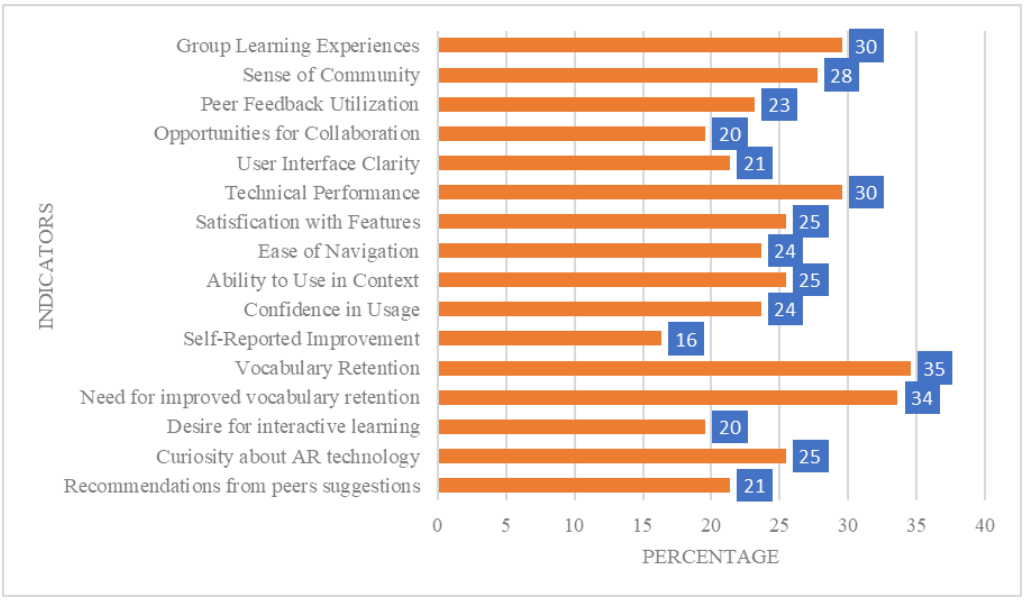

Figure 3. Survey data on AR and VR for vocabulary improvement

The user experience category delivered insights into how respondents experience the technologies, with 30% of respondents rating the technical performance as positive, meaning that how respondents engaged and operated the technologies was satisfactory. Only 24 and 25% of their respondents indicated that ease of navigation with the software and satisfaction with the features were good, but only 21% of researchers were satisfied with the clarity and intuitiveness of the user interface. In the end, the social interaction part also emphasized the value of collaborative experience, with 30% highlighting group learning experiences and 28% feeling a sense of community. In addition, 23% of the respondents preferred using peer feedback as part of their learning process, and 20% preferred opportunities for collaboration to do so, suggesting a strong preference for interactive and communal learning environments. The overall survey result revealed that respondents generally like AR and VR technologies and are adaptive to the two technologies. If included in the class, there was a positive impact on vocabulary retention and social interaction.

3.3. Respondents' perspectives on AR and VR

This study reviews the effects of AR and VR implementations on vocabulary learning by collecting interviews with respondents who experienced these novel technologies. To uncover how AR and VR can facilitate vocabulary acquisition through an interactive and immersive learning environment, researchers investigate their experiences and perceptions. Key features that may be hailed as effective vocabulary learning are unveiled by these responses: contextualized scenarios, interactive flashcards, and opportunities for collaboration. Firstly, this introductory overview serves as the starting point for the qualitative data analysis, as it explores the possibility of AR and VR being utilized to change traditional vocabulary learning techniques and improve student interest.

The interview responses provide valuable insights into the effectiveness of AR and VR applications in enhancing vocabulary learning. As illustrated in Figure 4, respondents highlighted several key features that contribute to their learning experiences. One respondent stated, "I find the interactive flashcards helpful. They let me see 3D models related to the words, making remembering their meanings easier." Another emphasized the importance of immersive scenarios, sharing, "When I can see a word in context, like walking through a virtual market and hearing the vocabulary used, it sticks in my mind better." These comments illustrate how contextualizing vocabulary can enhance retention. When discussing specific instances of learning, respondents shared that AR and VR have significantly improved their understanding of complex vocabulary. For example, one participant described, "I struggled with the word metamorphosis"'. When I used the AR app, it shoresearchersd a caterpillar turning into a butterfly in a visual simulation. Seeing that transformation helped me grasp the concept much better than just reading about it in a textbook." Similarly, another respondent noted, "I had a hard time with 'ecosystem" The AR app placed me in a virtual forest where I could interact with different elements, such as plants, animals, and water systems, helping me understand how they all connect." These examples demonstrate how AR and VR can transform abstract concepts into tangible experiences, making vocabulary learning more relatable and intuitive.

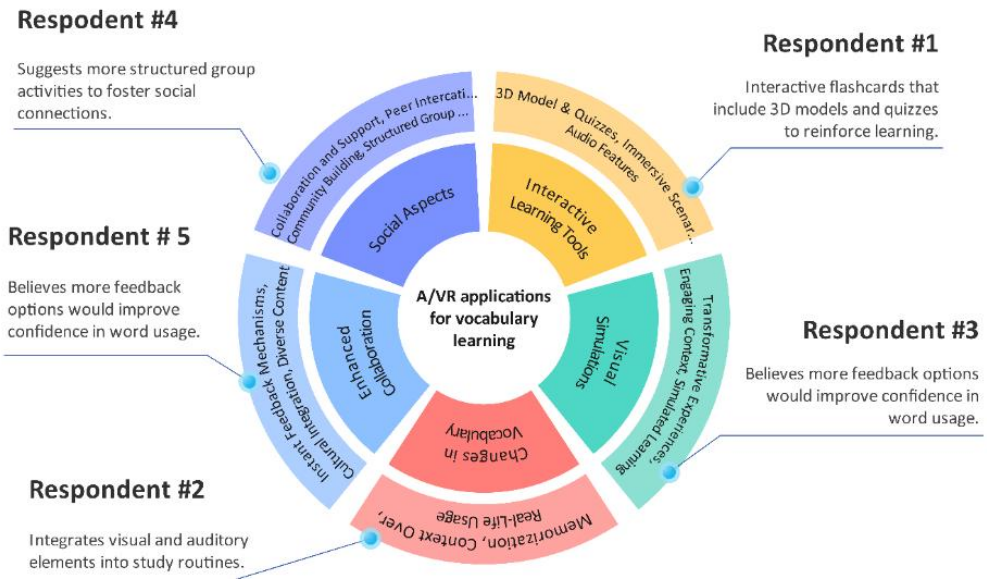

Figure 4. Respondents' view of A/VR implementation

The researchers also noted a shift in their study approaches since using AR and VR applications. One respondent remarked, “Before, I would just memorize lists of words, which was boring. I actively engage with the words through games and visual aids.” Many moved from traditional memorization techniques to more engaging, interactive methods incorporating visual and auditory elements. However, respondents suggested areas for improvement, such as the need for more personalized learning paths. One shared, “I’d like to see more personalized learning paths. If the app could adjust based on my progress and areas of struggle, that would make it even better.”

Additionally, another respondent emphasized the importance of instant feedback: “More feedback options would be helpful. Sometimes, I’m unsure if I’m using words correctly.” Respondents also highlighted the social aspects of using AR and VR for vocabulary learning. One participant said, “I enjoy working with my classmates on vocabulary tasks. Researchers often share tips and help each other,” another noted, “It’s motivating to learn alongside others. I love when researchers can compete in vocabulary games together.” However, some suggested improvements, with one stating, “I think having structured group activities would enhance the social aspect. Right now, it feels a bit disconnected”. Overall, the qualitative data from the interviews suggest that AR and VR applications hold significant potential for enhancing vocabulary learning by providing interactive, immersive experiences that engage respondents more profoundly. However, to maximize their effectiveness, developers should consider integrating more diverse content, improving technical stability, and enhancing social collaboration features, as these aspects can further enrich the learning experience.

The data indicates that learning vocabulary becomes more effective through AR and VR technologies than traditional teaching approaches. The mixed reality technologies enabled 35% or more students to remember words more effectively, thus highlighting their potential to transform educational approaches through enhanced student involvement and profound learning experiences. VR and AR in context-based learning allow students to visualize complicated subject matter and thus develop better vocabulary skills. Multiple studies establish that an interactive learning environment outperforms traditional approaches in retaining information that supports these findings [22]–[24]. The present study adds evidence showing how contextual teaching methods combined with immersion strategies produce superior outcomes when learning vocabulary, thereby validating the effectiveness of active learning environments as an educational approach.

Past research demonstrates that although AR and VR technologies deliver advantages, some additional factors contribute to building better language retention. The combination of these technologies, together with past knowledge and peer social interactions, leads to better learning results, according to [25], [26]. One should recognize that self-reported language retention assessments face limitations because participants could report higher levels of knowledge due to their technological excitement. Our research brings heterogeneity due to participant interpretation differences between AR and VR technology, even though it is robust with 220 sample responses. This measurement tool does not effectively capture all student experiences. Different studies linking language learning complexity [27]–[29] demonstrate that the selected measures display adequate characteristics of vocabulary development yet fail to examine fundamental second language acquisition concepts.

This research explored vocabulary memory change through AR and VR technology applications, focusing on their potential for developing dynamic learning interactions. This research is of great importance because it reveals the possible impacts of immersive technology on vocabulary learning. The technologies have multiple long-standing questions about their impact on student endurance and compatibility with individualized learning formats and teamwork models. Future studies must display empirical proof of these findings through evaluations that establish the most beneficial methods to integrate AR and VR features in diverse educational settings for vocabulary learning enhancement. Studies should examine the potential of these technologies to support various learning preferences because they would help enhance existing knowledge regarding technology-assisted language learning [30]–[33].

4. CONCLUSION

This study aimed to explore the effect of VR and AR on respondents' vocabulary learning process and define how these technologies help to retain vocabulary, increase engagement, and improve the learning process in general. The research attempted to uncover these innovative educational tools' potentially beneficial properties by analyzing data from 220 respondents. They found that AR and VR have a highly positive effect on vocabulary acquisition. Interestingly, 75% of the participants noticed improved vocabulary retention as one method that these immersive tools are more effective than the traditional methods. Respondents highlighted characteristics such as interactive flashcards and contextualized learning scenarios, reinforcing the original premise of the work: They demonstrate that AR and VR can be engagement tools, leading to better learning outcomes. This originality is further underscored by qualitative insights showing

how respondents change learning approaches from passive memorization to active use of interactive, context-based scenarios. The outcome of this research confirms the purpose of the research and indicates that AR and VR technologies should be integrated into educational practices. Contextualizing the vocabulary by placing it within immersive experiences enables these tools to help respondents keep vocabulary parts in memory better and encourage them to have greater motivation and confidence in using new vocabulary. The significance of contextual learning environments is substantiated further by parallels in existing literature, which unanimously prove that contextual learning and cognitive engagement fostered within a setting leads to better information retention. Future research should concentrate on implementing AR and VR into personalized learning frameworks that can be customized to individual learners' needs and preferences. Additionally, examining structured opportunities for collaborative learning within these technologies may extend social interaction, a factor deemed important by the study subjects. Moreover, while the study sufficiently answers the research question posed at its outset, there are opportunities for more precise future research recommendations. Long-term studies are needed to investigate the sustained effects of AR and VR on vocabulary retention over time. Furthermore, exploring the impact of these technologies on various age groups could provide deeper insights into how different demographics engage with AR and VR tools in language learning. Educators, curriculum developers, and technology designers are encouraged to consider including AR and VR tools in language learning curricula to leverage their educational benefits. Doing so allows them to build interactive, engaging, and contextualized learning experiences that address the ever-changing needs of learners amid a rapidly evolving educational landscape. The practical implications of such advancements promise to enhance vocabulary acquisition and create a more interactive, collaborative, and immersive learning environment that is critical for today's learners.

ACKNOWLEDGEMENTS

Researchers would like to thank Universitas Borneo Tarakan for supporting this research and the Research and Community Service (LP2M) of the University of Borneo Tarakan for believing in Augmented Reality (AR) and Virtual Reality (VR) to improve vocabulary learning. Your dedication to furthering educational research and innovation has been unmatched in our work

FUNDING INFORMATION

Researchers would like to thank Universitas Borneo Tarakan for supporting this research and the Research and Community Service (LP2M) of the University of Borneo Tarakan for funding us through DIPA UBT to conduct this study.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Arifin	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
Nofvia De Vega		✓				✓		✓	✓	✓	✓	✓		
Syarifa Rafiqa	✓		✓	✓			✓			✓	✓		✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

REFERENCES

[1] V. Tomar and Soni, "Impact of technology on education," *International Journal of Advanced Academic Studies*, vol. 6, no. 6S, pp. 127–130, Jun. 2024, doi: 10.33545/27068919.2024.v6.i6b.1222.

[2] J. Surender, "Research of modern technology in education and ICT effects on learning environment," *International Journal for Research Publication and Seminar*, vol. 15, no. 3, pp. 502–509, Oct. 2024, doi: 10.36676/jrps.v15.i3.1607.

[3] A. B. de S. Lira and I. V. de Souza, "The importance of technology in education: challenges and opportunities," sevenpublicacoes, Jul. 2024, doi: 10.56238/sevenVmulti2024-066.

[4] S. S. Gholve and P. P. Prashant, "Augmented reality and virtual reality: a new way of seeing the world," *International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)*, pp. 511–516, Sep. 2024, doi: 10.48175/IJARSCT-19678.

[5] P. Gaikwad and M. N. Mulay, "Study of augmented reality & virtual reality technology in education system," *Interantional Journal Of Scientific Research In Engineering And Management*, vol. 08, no. 09, pp. 1–6, Sep. 2024, doi: 10.55041/IJSREM37623.

[6] C. Vaz de Carvalho, "Technology supported active learning," in *Research On STEM Education in the Digital Age. Proceedings of the ROSEDA Conference*, WTM-Verlag Münster, 2023, pp. 59–68.

[7] D. C. S. Gosavi and D. S. Arora, "Active learning strategies for engaging students in higher education," *Journal of Engineering Education Transformations*, vol. 36, no. S1, pp. 1–7, Dec. 2022, doi: 10.16920/jeet/2022/v36is1/22167.

[8] I. V. Koshkina, Y. I. Detinko, and T. A. Eremina, "Visualization as an effective tool for vocabulary teaching in foreign language classes," *Bulletin of Krasnoyarsk State Pedagogical University named after V P Astafiev*, vol. 62, no. 4, pp. 14–24, Dec. 2022, doi: 10.25146/1995-0861-2022-62-4-365.

[9] C. A. C. Pena and P. Yugopuspito, "The Effect of students' motivation, emotions, and cognitive engagement on english vocabulary learning moderated by augmented reality implementation at school X, Jakarta," *Jurnal Ilmiah Mandala Education*, vol. 9, no. 2, Apr. 2023, doi: 10.58258/jime.v9i2.4879.

[10] M. Idul and S. Syaiful, "Augmented reality in the classroom: revolutionizing vocabulary teaching for high school language learners," *Inspiring: English Education Journal*, vol. 7, no. 2, pp. 201–221, Sep. 2024, doi: 10.35905/inspiring.v7i2.9019.

[11] S. J., V. K., and S. S. M., "Enhancing Engagement and understanding in education using augmented reality," *Journal of Information Technology and Digital World*, vol. 6, no. 3, pp. 264–273, Sep. 2024, doi: 10.36548/jitdw.2024.3.005.

[12] K. F. Peets, O. Yim, and E. Bialystok, "Language proficiency, reading comprehension and home literacy in bilingual children: the impact of context," *International Journal of Bilingual Education and Bilingualism*, vol. 25, no. 1, pp. 226–240, Jan. 2022, doi: 10.1080/13670050.2019.1677551.

[13] K. Liu and Dr. Erna A. Lahoz, "Impact of learning styles on students' retention of information," *International Journal of Education and Humanities*, vol. 17, no. 1, pp. 207–212, Nov. 2024, doi: 10.54097/0qpvve72.

[14] A. Albalawi, "The role of individual differences in L2 vocabulary learning: A review of out-of-class exposure, strategic learning and motivation," *Australian Journal of Applied Linguistics*, vol. 7, no. 2, pp. 1–20, Sep. 2024, doi: 10.29140/ajal.v7n3.1641.

[15] E. Y. Rachid, "The impact of individual differences in learning styles on the choice of vocabulary learning strategies," *World Journal of Advanced Research and Reviews*, vol. 17, no. 2, pp. 866–878, Feb. 2023, doi: 10.30574/wjarr.2023.17.2.0340.

[16] T. T. Tursynova, K. M. Saginov, and S. M. Bakhisheva, "Application of adaptive learning technology in the educational process," *Bull. Kazakh Natl. Women's Teach. Train. Univ.*, no. 2, pp. 98–112, Jun. 2023, doi: 10.52512/2306-5079-2023-94-2-98-112.

[17] S. Zhao, G. Hai, and H. Ma, "Adaptive Learning Systems: Exploring Personalized Paths in Vocational Education," *Curric. Learn. Explor.*, vol. 7, no. 26, 2024, doi: 10.18686/ahe.v7i26.10396.

[18] N. Bhat, S. Gurung, M. Gupta, N. Dhungana, and R. K. Thapa, "Enhancing collaborative learning through peer-assisted learning," *Journal of Physiological Society of Nepal*, vol. 3, no. 1, pp. 4–9, Jun. 2022, doi: 10.3126/jpsn.v3i1.57762.

[19] N. Sansone, I. Bortolotti, and M. Fabbri, "Collaborative peer-feedback practices in hybrid learning environments," *Education Science&Society.*, no. 1, pp. 174–187, Jul. 2023, doi: 10.3280/ess1-2023oa15283.

[20] S. Sutaryo, S. Latif, and N. Hasan, "Peer feedback use on collaborative essay writing within project based learning: university students' perceptions and experiences," *International Journal of Social Science and Human Research*, vol. 6, no. 08, Aug. 2023, doi: 10.47191/ijsshr/v6-i8-96.

[21] J. Bloomfield and M. Fisher, "Quantitative research design," *Journal of the Australasian Rehabilitation Nurses' Association (JARNA)*, vol. 22, no. 2, pp. 27–30, Sep. 2019, doi: 10.33235/jarna.22.2.27-30.

[22] A. Uriarte-Portillo, M.-B. Ibáñez, R. Zataraín-Cabada, and M.-L. Barrón-Estrada, "Higher immersive profiles improve learning outcomes in augmented reality learning environments," *Information*, vol. 13, no. 5, p. 218, Apr. 2022, doi: 10.3390/info13050218.

[23] A. U. S. Veena Tewari, Mujibur Rahman, Amitabh Mishra, K. K. Bajaj, "Impact of virtual reality (Vr) and augmented reality (Ar) in education," *Tuijin Jishu/Journal of Propulsion Technology*, vol. 44, no. 4, pp. 1310–1318, Oct. 2023, doi: 10.52783/tjjpt.v44.i4.1014.

[24] F. Tursunova, N. Oripova, M. Muhammadiyeva, S. Nurullayeva, S. Hamroyev, and I. Tishabaeva, "Augmented reality and AI in higher education: creating immersive learning experiences," in *2024 International Conference on Knowledge Engineering and Communication Systems (ICKECS)*, Apr. 2024, pp. 1–5, doi: 10.1109/ICKECS61492.2024.10617355.

[25] H. R. Tenenbaum, N. E. Winstone, P. J. Leman, and R. E. Avery, "How effective is peer interaction in facilitating learning? A meta-analysis.," *Journal of Educational Psychology*, vol. 112, no. 7, pp. 1303–1319, Oct. 2020, doi: 10.1037/edu0000436.

[26] D. R. Serrano, M. A. Dea-Ayuela, E. Gonzalez-Burgos, A. Serrano-Gil, and A. Lalatsa, "Technology-enhanced learning in higher education: How to enhance student engagement through blended learning," *European Journal of Education*, vol. 54, no. 2, pp. 273–286, Jun. 2019, doi: 10.1111/ejed.12330.

[27] K. M. Hummel, *Introducing Second Language Acquisition: Perspectives and Practices*. Wiley, 2021.

[28] S. M. Gass, J. Behney, and L. Plonsky, *Second Language Acquisition*. Fifth edition, New York, NY: Routledge, 2020.: Routledge, 2020.

[29] N. Schmitt, "Understanding vocabulary acquisition, instruction, and assessment: A research agenda," *Language Teaching.*, vol. 52, no. 02, pp. 261–274, Apr. 2019, doi: 10.1017/S0261444819000053.

[30] F. Su and D. Zou, "Technology-enhanced collaborative language learning: theoretical foundations, technologies, and implications," *Computer Assisted Language Learning*, vol. 35, no. 8, pp. 1754–1788, Nov. 2022, doi: 10.1080/09588221.2020.1831545.

[31] H. Buddha, L. Shuib, N. Idris, and C. I. Eke, "Technology-assisted language learning systems: a systematic literature review," *IEEE Access*, vol. 12, pp. 33449–33472, 2024, doi: 10.1109/ACCESS.2024.3366663.

[32] T. Hao, Z. Wang, and Y. Ardasheva, "Technology-Assisted Vocabulary Learning for EFL Learners: A Meta-Analysis," *Journal of Research on Educational Effectiveness*, vol. 14, no. 3, pp. 645–667, Jul. 2021, doi: 10.1080/19345747.2021.1917028.
[33] M. K. Hasan, A.-H. Fakih, P. M. Ibna Seraj, and Hasmirati, "The effect of technology-assisted language programme on vocabulary learning among EFL students at the tertiary level," *Heliyon*, vol. 8, no. 8, p. 103, Aug. 2022, doi: 10.1016/j.heliyon.2022.e10313.

BIOGRAPHIES OF AUTHORS

Dr. Arifin, S.Pd., M.Pd., serves as an English lecturer at Universitas Borneo Tarakan. He is dedicated to furthering his career by authoring papers and publications, as well as engaging in seminars and conferences. His study focuses on the creation of instructional materials and design, specifically within the field of artificial intelligence. Moreover, he has authored multiple book chapters and concentrated on improving family literacy and literacy in Indonesian multicultural education. He can be contacted at email: arifin.ubt@borneo.ac.id.

Nofvia De Vega, S.Pd., M.Pd., worked as an English lecturer at Universitas Borneo Tarakan. She professionally develops her career through writing articles, books, seminars, and conferences. Her research focuses on Teaching English and Information and Communication Technology (ICT) in Education. Listening and learning media are her major skills and competencies in the teaching and learning process. She has had some articles published at national and international conferences. She has also done several projects related to society and social programs in Indonesia. She can be contacted at email: nofviadevega@borneo.ac.id.

Dr. Syarifa Rafiqa, S.Pd., M.Pd., has been a lecturer in the English Education Department at the University of Borneo Tarakan since 2010, and was, until recently, the head of the language center at the University of Borneo Tarakan. She was born on October 15, 1987, in Tarakan. She has presented several papers in national and international seminars/conferences, and her research papers have been published in Scopus Indexed Journal, chapters in books, and several books with ISBN. She has a high interest in the studies of English language learning, applied linguistics, and ICT in English language teaching and learning. You can connect with the writer via email: rafiqa@borneo.ac.id**.**