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Utilizing Augmented Reality Technology in English Vocabulary

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ABSTRACT

This study explores the potential of augmented reality (AR) technology in enhancing English vocabulary learning among EFL students at Muhammadiyah University of Enrekang. The study identifies key issues such as the lack of engagement and retention in vocabulary learning using traditional methods. A qualitative research approach was employed, involving 15 students and utilizing AR tools such as Google Expeditions, AR Flashcards, and Merge Cube to facilitate vocabulary learning. Data were collected through semi-structured interviews and classroom observations. The findings reveal that AR technology significantly enhances students' engagement, motivation, and vocabulary retention by providing interactive, multimodal learning experiences that place vocabulary in real-world contexts. However, several challenges were identified, including technical limitations such as device compatibility, internet connectivity issues, and the insufficient access to AR-capable devices. Additionally, concerns regarding the feasibility of scaling AR in resource-constrained settings, where students may lack access to adequate technological infrastructure, were raised. Furthermore, there is a critical need for comprehensive teacher training to effectively implement AR in the classroom. To address these challenges, the study recommends an integrated approach that combines AR technology with traditional teaching methods, alongside significant investment in technological infrastructure, development of affordable AR tools, and continuous professional development for teachers. This study contributes to the growing body of literature on the use of AR in language education and offers practical insights for overcoming the challenges of accessibility and scalability, ultimately improving the integration of AR in EFL classrooms, particularly in resource-limited contexts.

***Keywords**: Augmented Reality, Vocabulary Learning, Student Engagement, EFL Education*

INTRODUCTION

The rapid advancement of technology has transformed education, including the way languages are learned. English, as a global language, requires innovative strategies to enhance learners' vocabulary acquisition, which is fundamental for developing language proficiency. However, many English as a Foreign Language (EFL) learners face significant challenges in mastering vocabulary due to traditional teaching methods that often rely on rote memorization and lack engagement (Nation, 2001). The disconnect between conventional teaching strategies and the needs of digital-native learners underscores the necessity for technology-enhanced learning tools to address these challenges effectively.

Augmented Reality (AR) technology, which overlays digital content onto the physical world, has emerged as a promising tool in language

education. AR creates an interactive and immersive learning environment, providing learners with contextualized and engaging experiences (Billinghurst & Duenser, 2012). Augmented Reality (AR) has emerged as a powerful tool in education, enhancing engagement and providing contextualized learning experiences. Bower et al. (2014) emphasize that AR applications in classrooms create interactive environments that support active learning, fostering deeper engagement with the content. In the context of vocabulary learning, AR can enhance retention and comprehension by presenting words in visually enriched, real-world contexts. For instance, learners can interact with 3D objects and animations that represent vocabulary items, making abstract concepts more tangible and memorable (Lin & Chen, 2017).

Recent studies have expanded on the potential of AR in EFL education. For instance, Chen et al. (2020) examined the role of AR in enhancing vocabulary learning and found that it significantly increased student engagement and retention compared to traditional methods. Similarly, Wu et al. (2013) highlighted how AR can transform passive learning into interactive experiences, leading to deeper cognitive engagement. However, the integration of AR technology in EFL vocabulary learning is still in its nascent stage, particularly in Indonesia.

Dunleavy et al. (2009) discuss the affordances and limitations of immersive AR simulations for teaching, highlighting how they can transform the learning experience, though challenges such as technological limitations and the need for specialized training remain. Many educational institutions face barriers such as limited technological infrastructure, lack of teacher training, skepticism regarding the efficacy of AR-based learning tools, and insufficient access to AR-capable devices. These barriers are particularly pronounced in resource-constrained regions like Indonesia, where schools may lack basic infrastructure such as stable internet connections or the financial resources to invest in AR-capable devices and tools. Moreover, teachers may not have the necessary training to effectively integrate AR into their teaching practices, further exacerbating the challenges in adopting AR technology in the classroom.

The adoption of AR in EFL learning is particularly crucial in Indonesia, where English proficiency remains a key concern for students aspiring to compete in the global workforce. Despite ongoing efforts to modernize English language instruction, many classrooms still rely on outdated teaching approaches that fail to fully engage learners. Traditional vocabulary instruction often lacks context, making it difficult for students to internalize word meanings and apply them in real-world communication. Sahin & Yilmaz (2020) found that AR technology positively influenced middle school students' achievements and attitudes towards learning, suggesting that AR’s interactive nature fosters better engagement and deeper learning. AR

technology has the potential to bridge this gap by offering interactive learning experiences that align with contemporary pedagogical principles, such as contextual learning and experiential education. By allowing students to visualize vocabulary in authentic situations, AR can enhance comprehension and make language learning more meaningful.

Furthermore, the role of AR in improving motivation and reducing anxiety in language learning should not be overlooked. Many EFL learners experience language anxiety, particularly when faced with unfamiliar vocabulary or communication tasks (Horwitz et al., 1986). AR-based learning environments provide a low-stress setting where learners can interact with digital objects at their own pace, reducing fear of making mistakes. Gamified AR applications, for instance, incorporate elements such as rewards, challenges, and interactive storytelling, which can make vocabulary learning more engaging and enjoyable. Wu, J. G., et al. (2025) discuss how digital gaming and AR/VR technologies are being integrated into language learning, with studies showing significant improvements in student engagement and vocabulary retention. This aligns with self-determination theory (Deci & Ryan, 1985), which suggests that learners are more likely to persist in language learning when they feel intrinsically motivated and in control of their learning process.

Given these promising advantages, there is a need for empirical research to assess the feasibility and effectiveness of AR technology in EFL vocabulary instruction, particularly in the Indonesian context. Jiang et al. (2025) highlight the growing role of both virtual reality (VR) and augmented reality (AR) in K-12 STEM learning, noting how these technologies create engaging, immersive environments that support deep learning experiences. While existing studies have demonstrated positive outcomes in technologically advanced regions, there remains a lack of research on how AR can be successfully implemented in environments with limited resources.

Addressing this gap, the present study seeks to investigate the impact of AR-enhanced vocabulary instruction on student engagement and retention while also identifying challenges that may arise in its implementation. The findings of this research will contribute valuable insights for educators, policymakers, and instructional designers seeking to optimize technology integration in language education.

These challenges necessitate empirical studies to explore the feasibility, effectiveness, and pedagogical implications of utilizing AR in vocabulary instruction. While much of the existing literature on AR in education has focused on developed countries with more robust technological infrastructure, there is a clear gap in research on AR applications in resource-limited settings like Indonesia. This study aims to fill this gap by examining the integration of AR into EFL education in Indonesia, offering insights into both the

benefits and the challenges faced in such contexts.

The primary objective of this study is to examine the effectiveness of AR technology in enhancing English vocabulary learning among EFL students. Specifically, the research aims to evaluate the impact of AR-based vocabulary instruction on learners' vocabulary retention and engagement compared to traditional methods. Additionally, this study seeks to identify potential challenges and strategies for implementing AR in the classroom. By addressing these objectives, the research contributes to the growing body of literature on technology-enhanced language learning and offers practical insights for educators and policymakers.

The theoretical framework for this study is rooted in dual coding theory, which posits that information is better retained when presented in both visual and verbal formats (Paivio, 1986). AR technology aligns with this theory by integrating multimodal inputs—visual, auditory, and kinesthetic—into the learning process. Moreover, constructivist learning theory emphasizes the importance of active and experiential learning, both of which are facilitated by AR's interactive features (Vygotsky, 1978). Previous studies have demonstrated the potential of AR to enhance language learning outcomes by increasing motivation, engagement, and contextual understanding (Azuma, 1997; Chen et al., 2020).

The findings of this research are expected to have significant implications for both theory and practice. Theoretically, the study contributes to the understanding of AR's role in vocabulary learning within EFL contexts, providing a basis for further exploration of technology-enhanced learning. Practically, the research aims to provide actionable recommendations for integrating AR into English language instruction, addressing common challenges and optimizing its educational impact. Ultimately, this study aspires to bridge the gap between technological advancements and educational practices, fostering a more effective and engaging learning environment for EFL learners, particularly in regions with limited technological resources.

METHODS

This study employed a qualitative research design to explore the potential of augmented reality (AR) technology in enhancing English vocabulary learning among EFL students. The research aimed to gain an in-depth understanding of how AR-based tools influence vocabulary retention, engagement, and motivation. Data were collected through semi-structured interviews and observations, focusing on students' and lecturers' experiences with AR technology in a classroom setting. The qualitative approach was chosen to capture rich, detailed insights into participants' perceptions and the contextual factors affecting AR implementation.

The study involved 15 students from the English Education Department at Muhammadiyah University of Enrekang, selected through purposive sampling to ensure a diverse representation of learning styles and technological familiarity. However, it is important to note that the selection of a single university may limit the generalizability of the findings to a broader population. The experiences and challenges identified in this study may be specific to the institutional context of Muhammadiyah University of Enrekang and may not be representative of other regions or educational settings. Future research should consider a more diverse sample of institutions to increase the external validity of the findings.

The participants engaged with AR applications designed to teach English vocabulary through interactive 3D models and real-world contextualization. Device requirements and compatibility with AR tools were an essential consideration for this study. AR applications such as Google Expeditions, AR Flashcards, and Merge Cube were used to facilitate vocabulary learning. The devices used in the study included smartphones and tablets compatible with these AR tools. However, it is important to mention that device compatibility can be a critical factor for the practical implementation of AR in EFL classrooms. Not all students had access to high-end smartphones or tablets that fully support the necessary AR applications, leading to some limitations in the learning experience. The study also observed that internet connectivity issues in certain areas of the university could affect the smooth functioning of AR-based applications. These technical limitations, including device and internet compatibility, should be considered when planning future AR-based interventions.

Observations were conducted during AR-integrated learning sessions to record students' engagement, participation, and challenges. Semi-structured interviews with both students and instructors provided additional perspectives on the effectiveness and practicality of AR technology in vocabulary instruction.

Thematic analysis was employed to analyze the qualitative data. The analysis process involved several stages to ensure transparency and rigor. First, all interview and observation data were transcribed verbatim, and initial coding was performed by categorizing data into broad themes related to vocabulary retention, engagement, and challenges. These initial codes were reviewed for consistency and grouped into overarching themes through an iterative process. The themes were refined by revisiting the data, ensuring that they were grounded in participants' actual experiences. Finally, the themes were organized into a coherent narrative that highlighted key findings, including the impact of AR on students' vocabulary retention and their perceptions of AR's effectiveness in the classroom.

Ethical considerations, including informed consent and confidentiality, were

prioritized throughout the research process. Participants were informed about the study's purpose, their voluntary participation, and their right to withdraw at any time without consequence. Data were anonymized and securely stored to protect participants' privacy.

The qualitative approach allowed for a nuanced exploration of AR's impact, offering practical insights for improving its integration into language learning contexts. The process of thematic analysis was a crucial step in deriving clear insights from the data and ensuring that the findings were both valid and meaningful. This approach enhances the transparency of the research by providing a systematic, step-by-step explanation of how the themes were derived and interpreted.

FINDINGS

This study revealed several significant findings regarding the utilization of augmented reality (AR) technology in English vocabulary learning among EFL students. The findings are organized into key themes derived from the data collected through semi-structured interviews and classroom observations. The themes include increased engagement and motivation, improved vocabulary retention, and the challenges faced during the integration of AR technology.

Increased Engagement and Motivation

One of the most prominent findings was the heightened engagement and motivation among students when using AR technology. Students expressed excitement about the interactive features of AR, which transformed vocabulary learning from a monotonous activity into an enjoyable experience. For instance, during an observation session, a student exclaimed, "It feels like I'm playing a game, but I'm also learning at the same time." This sentiment was echoed during interviews, with another participant stating, "I usually find vocabulary lessons boring, but using AR made it fun and easy to understand."

Lecturers also observed increased participation from students who typically remained passive in traditional classroom settings. One instructor remarked, "I noticed that even the quiet students were eager to interact with the AR tools. It was like they forgot about their anxiety and just focused on the activity." The gamified elements of AR applications, such as earning points for correct answers and completing challenges, were particularly effective in sustaining students' interest throughout the learning sessions.

Improved Vocabulary Retention

The data also indicated that AR technology significantly enhanced vocabulary retention. Students reported that the combination of visual, auditory, and kinesthetic elements in AR made it easier to remember new words. One participant shared, "Seeing the 3D model and hearing the pronunciation helped me connect the word to its meaning more effectively. I don't forget it as quickly as before."

During classroom activities, students were asked to recall vocabulary learned through AR in a follow-up session. Most students demonstrated an ability to remember the words and their meanings with greater accuracy compared to those taught using traditional methods. A teacher noted, “The students could describe the words they learned through AR without hesitation, and they even used them correctly in sentences during group discussions.”

Challenges in AR Integration

Despite its benefits, the integration of AR technology was not without challenges. Technical issues such as limited access to devices, unstable internet connections, and occasional software glitches hindered the smooth implementation of AR-based learning. During an interview, a student mentioned, “Sometimes, the app didn’t work properly, or it took too long to load. It was frustrating because I wanted to keep learning.” Another student added, “Not everyone had a smartphone that could support the AR app, so we had to share devices, which slowed things down.”

Lecturers also faced challenges in adapting to AR technology, particularly those who were less tech-savvy. One instructor admitted, “It took me a while to figure out how to use the AR app effectively in the classroom. I had to watch tutorials and practice a lot before I felt confident teaching with it.” Furthermore, the need for additional training and resources to fully integrate AR into the curriculum was highlighted as a significant barrier.

Student Perspectives on AR Technology

Interviews revealed that students appreciated the contextualized learning environment provided by AR. A participant stated, “Seeing the words in a real-world setting, like a virtual store or park, made it easier to understand how to use them in real conversations.” Another student explained, “It felt like I was actually experiencing the words, not just memorizing them.”

However, some students expressed concerns about over-reliance on technology. One participant shared, “AR is great, but I think it’s also important to learn how to use words without the app, especially during exams or when we don’t have access to technology.” Students were concerned that while AR enhances learning, they might become too dependent on it, which could pose challenges in traditional or low-tech environments such as exams or areas without adequate technology access.

Overall, the findings demonstrate that AR technology has the potential to revolutionize vocabulary learning by increasing engagement, enhancing retention, and providing meaningful contexts for language use. However, addressing the technical and logistical challenges is crucial to ensure its effective implementation. These findings underscore the importance of integrating AR into a comprehensive teaching strategy that balances technological innovation with traditional learning approaches. The inclusion of student feedback and ongoing

teacher training will be essential in maximizing the benefits of AR technology in language education.

DISCUSSION

The findings of this study reveal valuable insights into the potential of augmented reality (AR) technology as an innovative tool for enhancing English vocabulary learning among EFL students. This discussion explores the implications of the findings, connects them to existing literature, and provides practical recommendations for integrating AR technology effectively into language education.

AR Technology as a Catalyst for Engagement and Motivation

The heightened engagement and motivation observed among students align with prior research emphasizing AR's ability to transform passive learning into an interactive and immersive experience (Billinghurst & Duenser, 2012; Wu et al., 2013). The interactive elements of AR, such as gamification and 3D modeling, provide a dynamic learning environment that appeals to digital-native learners, who often struggle with traditional, text-heavy approaches (Lin & Chen, 2017). This increased engagement fosters a positive attitude toward vocabulary learning, making students more receptive to language acquisition.

Comparing these findings to those in previous studies, such as Chen et al. (2020), who also found that AR promotes engagement in EFL classrooms, our study extends this understanding by exploring how the interaction between technology and students' individual characteristics, such as their prior tech proficiency, further enhances the learning experience. Our results support the idea that AR's effectiveness increases with students' comfort and familiarity with technology, as those with higher tech proficiency showed more significant improvements in vocabulary retention and engagement.

These findings highlight the importance of leveraging AR's unique features to create an enjoyable learning experience. By addressing the motivational gap that often hinders vocabulary learning, AR has the potential to reduce learner fatigue and sustain interest in language learning over the long term. However, while AR can enhance engagement, it should be complemented by other teaching strategies to ensure that students develop a well-rounded understanding of vocabulary usage beyond the technological interface.

Improved Vocabulary Retention Through Multimodal Learning

The study confirms the effectiveness of AR in enhancing vocabulary retention through its multimodal approach, which combines visual, auditory, and kinesthetic elements. This finding supports Paivio's (1986) dual coding theory, which posits that information presented in multiple modalities is more likely to be retained. Students reported that the ability to see 3D models, hear pronunciations, and interact with

words in a contextualized setting helped them better understand and remember vocabulary.

This insight underscores the importance of integrating multimodal learning experiences into language instruction. AR provides a platform for contextualized learning, where students can connect vocabulary to real-world applications, thereby improving both retention and practical usage. However, it is important for educators to ensure that students are encouraged to practice vocabulary in various contexts, both within and outside the AR environment, to reinforce learning.

Addressing Challenges in AR Integration

While AR technology offers numerous benefits, the challenges identified in this study highlight the need for careful planning and resource allocation to ensure successful implementation. Technical issues such as device limitations, software glitches, and internet connectivity problems echo concerns raised in previous research (Santos et al., 2016). These obstacles can hinder the learning process and may frustrate both students and lecturers, reducing the overall effectiveness of AR-based instruction.

To overcome these challenges, schools and institutions should invest in robust technological infrastructure and provide lecturers with comprehensive training on using AR tools. Institutional support is key in addressing these technical issues, including providing the necessary devices, improving internet connectivity, and offering technical support to ensure AR applications function smoothly. Additionally, AR developers should focus on creating user-friendly applications that are compatible with a range of devices, especially low-cost smartphones and tablets, to ensure accessibility for all students.

Balancing Technology and Traditional Methods

While students appreciated the contextualized and interactive learning environment provided by AR, some expressed concerns about over-reliance on technology. This finding aligns with Harmer's (2010) caution against relying solely on technology in language teaching. While AR can enhance vocabulary learning, it is essential to balance its use with traditional methods to ensure that students can apply their knowledge in various contexts, including those where technology is unavailable.

Educators should aim to integrate AR into a broader pedagogical framework that includes traditional techniques such as flashcards, group discussions, and writing exercises. This balanced approach ensures that students develop a comprehensive understanding of vocabulary and the skills to use it effectively in different settings. Furthermore, policy changes at the institutional level should encourage the adoption of a hybrid teaching model that uses technology in combination with established methods to achieve the best possible outcomes.

CONCLUSIONS

This study concludes that augmented reality (AR) technology has significant potential

to enhance English vocabulary learning among EFL students. By offering an interactive and multimodal learning experience, AR increases student engagement, motivation, and retention of vocabulary. However, challenges such as technical limitations, device accessibility, and the need for teacher training underscore the importance of strategic and sustainable implementation, especially in low-resource settings. To maximize AR's benefits, educators should adopt a balanced approach that integrates AR with traditional methods. In resource-constrained environments, it is essential to focus on cost-effective solutions, such as smartphone-based AR applications, shared devices, and community access centers. Training programs should be designed to be accessible and affordable, offering offline video tutorials or peer-to-peer learning as alternatives in areas with limited internet connectivity. Additionally, mobile phone partnerships and BYOD (Bring Your Own Device) programs can help students access AR learning tools through affordable smartphones.

Further, AR developers should design user-friendly applications that cater to a wide range of device capabilities, including low-cost smartphones and offline modes. Optimizing AR for lower-end devices and exploring paper-based or cardboard AR solutions can make the technology more accessible in classrooms with limited resources. Institutions should also invest in affordable technological infrastructure, such as subsidized smartphones, and work alongside AR developers to create scalable solutions that meet the needs of diverse educational environments. Research should explore how AR can be integrated into not just vocabulary learning but also other language skills such as speaking, listening, and writing. Long-term studies on the impact of AR and how to achieve sustainable integration in low-tech classrooms will be crucial in informing future practices.

By addressing these challenges through teacher training, resource allocation, and the development of cost-effective AR tools, AR can become a transformative tool in advancing English language education. A systemic approach involving educators, institutions, and policy makers is needed to harness the full potential of AR technology, ensuring that it is accessible to students in resource-limited settings. This study calls for the integration of innovative, affordable AR solutions that ensure accessibility and engagement for all learners, regardless of socio-economic background.

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