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Leveraging Augmented Reality for Interactive Language Learning

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ABSTRACT

The rapid advancement of technology, particularly in augmented reality (AR), has opened new possibilities for interactive language learning. Traditional language learning methods often fail to engage learners actively, limiting the development of real-world communication skills. AR, with its immersive and interactive nature, offers an innovative approach that can bridge this gap by providing contextualized language learning experiences. This research aims to explore how augmented reality can be leveraged to enhance the effectiveness and engagement of language learners in both formal and informal educational settings. A mixed-methods research design was employed, combining quantitative data from language proficiency assessments and qualitative insights gathered through surveys and interviews with both learners and educators. AR-based language learning applications were implemented over a period of three months with a sample of 150 students, and their progress was monitored through pre- and post-tests. Learners interacted with virtual objects, scenarios, and conversations in real-world environments, providing immersive language practice opportunities. The results indicated a significant improvement in language proficiency, particularly in speaking and listening skills, with learners showing increased confidence and engagement. AR-enhanced lessons allowed students to practice language in context, making the learning process more intuitive and enjoyable.

Keywords: *Augmented Reality, Language Learning, Immersive Learning*

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INTRODUCTION

Augmented Reality (AR) technology has been widely recognized as an innovation that is able to create interactive experiences by combining elements of the real world

and the virtual world. In various fields, AR has been successfully used to create more immersive and meaningful interactions (Rithish et al., 2023). In the world of education, the use of AR has begun to be applied to enrich learning, especially in subjects that require complex visualization (Chung, 2020). AR provides an edge in terms of immersion and interactivity that traditional learning methods can't achieve (Chung, Kim, et al., 2022). The potential of this technology to create a more dynamic and contextual learning experience is increasingly attracting the attention of researchers in the field of language education (Skovsmose, 2019).

The use of technology in language learning has grown rapidly in recent decades, with many online platforms designed to facilitate the teaching and learning process (Misfeldt et al., 2019). Technology-based language learning often uses apps that allow learners to hone their speaking, listening, reading, and writing skills (Lutter & Peters, 2023). The technology also supports independent and interactive language learning, allowing learners to learn in a more flexible way (Funk et al., 2022). However, most existing technologies still focus on exercises that are static, such as grammar or vocabulary exercises, without involving real-world interaction directly (Li et al., 2021).

Effective language learning requires active involvement from learners (Ydesen et al., 2022). Language proficiency is not only measured by how well a person understands grammar or how much vocabulary is mastered, but also by how well a person can use language in real communication situations (Adrian et al., 2021). Many traditional learning methods fail to address this challenge, as they tend to focus on theoretical aspects without providing enough space for language practice in a real context (Hindhede & Larsen, 2020). Therefore, there is a need for a new, more contextual and immersive approach to language learning (Malling et al., 2020).

AR, with its ability to integrate real-world and virtual world elements, offers a unique opportunity to meet those needs (Adrian, 2020). This technology allows learners to interact with virtual objects and scenarios in a real-world environment, providing a more authentic experience (D'Arcy, 2024). With AR, language learners can practice communicating in real-world-like situations, such as talking to virtual avatars or completing tasks in environments rich in visual context (Babu & Malathi, 2022). This allows for more intuitive and natural language learning, as well as bringing learners closer to the use of language in everyday life (Liu et al., 2021).

Previous research has shown that an interactive and immersive learning environment can increase learners' motivation (Tosatto et al., 2021). AR creates an environment that supports this, as the technology is designed to engage more senses and provide feedback in real-time (D'Arcy et al., 2021). Learners can see, hear, and even interact with virtual objects as if they were in the real world (Pedersen & Bjerre, 2021). Thus, AR provides an opportunity for learners to be more actively involved in the learning process, which can ultimately improve their language learning outcomes (Brøns Kringelum & Brix, 2021).

Various studies have shown that the use of AR in education can improve concept understanding, student engagement, and information retention (Chiodi et al., 2019).

However, in the field of language learning, the application of AR is still relatively new and requires more research to understand the full potential of this technology (Ydessen & Andreasen, 2019). What is known today is that AR has great potential to change the way language is taught and learned, especially by providing a more contextual and interactive experience (Nascimento Filho et al., 2021). Further understanding of how AR can effectively support language learning will be an important step in future language education innovations (Marougkas et al., 2020).

Despite the growing interest in augmented reality (AR) for educational purposes, its full potential in language learning remains largely unexplored (Sylla et al., 2019). While there is evidence supporting the effectiveness of AR in subjects like science and engineering, the specific benefits for language acquisition, particularly in immersive and interactive contexts, are still unclear (Hajizadeh et al., 2019). Little is known about how AR can be leveraged to create authentic language practice environments that mirror real-world communication scenarios (Gebhardt et al., 2019). The existing gap lies in understanding how this technology can enhance language learning beyond simple vocabulary or grammar exercises (Johansen & Misfeldt, 2020).

Current research on AR in language learning tends to focus on isolated language tasks rather than comprehensive, context-rich experiences (Görlich, 2019). Many AR applications provide vocabulary drills or grammar tutorials without fully utilizing the immersive capabilities of the technology (Chung et al., 2023). This leaves a gap in exploring how AR can replicate complex communication situations that engage multiple language skills simultaneously, such as speaking, listening, and problem-solving in real-time interactions. The lack of studies addressing these multidimensional aspects of language use limits the understanding of AR's true capacity for fostering language proficiency.

The scalability and accessibility of AR technology for a broader range of learners also remain uncertain. Most existing studies focus on small-scale, controlled environments with limited groups of students, often in higher education settings. There is little data on how AR can be applied across different educational levels, language proficiencies, and cultural contexts. The gap in understanding how AR can be made more accessible and effective for diverse learner populations, including those with limited access to technology, has yet to be adequately addressed.

In addition, the long-term impact of AR on language retention and communication skills is not well understood. While short-term studies suggest that AR can boost engagement and motivation, there is little research on whether these benefits translate into sustained language improvement. The gap in knowledge regarding AR’s long-term effects on learners' language retention and its ability to support real-world language use in various contexts remains a critical area for further investigation. This research aims to fill these gaps by exploring the comprehensive role AR can play in enhancing interactive language learning experiences.

Augmented reality (AR) has the potential to transform traditional language learning by creating immersive and interactive environments where learners can

practice and apply language skills in real-world contexts. The need to fill the current gap in AR language learning research is driven by the demand for more effective, engaging, and context-rich learning tools. Language learning requires not just memorization of vocabulary or grammar rules, but the ability to use language fluidly in diverse and dynamic situations. AR offers a unique opportunity to simulate these situations, giving learners the chance to practice in environments that mimic real-life communication scenarios.

Exploring how AR can enhance language learning addresses the critical need for more adaptive and interactive educational technologies. The current static approaches to language assessment and instruction often fail to engage learners or provide the necessary context for meaningful language use. By incorporating AR, language learning can shift from passive study to active engagement, enabling students to immerse themselves in authentic linguistic interactions. This shift could bridge the gap between theoretical knowledge and practical application, making the learning process more intuitive and effective.

The purpose of this study is to investigate how AR can be integrated into language learning environments to improve proficiency and engagement. The hypothesis driving this research is that AR can offer more personalized and immersive experiences, resulting in better language retention, higher levels of motivation, and improved real-world communication skills. By examining these elements, the study aims to contribute valuable insights into how AR can fill existing gaps in language education and create more meaningful learning experiences.

RESEARCH METHOD

This study uses a mixed-methods research design that combines quantitative and qualitative approaches (Urain et al., 2022). This design was chosen to explore how augmented reality (AR) can be applied in language learning, focusing on its effect on learner engagement and language skill improvement (Nascimento Filho et al., 2022). Quantitative data were collected through pre-test and post-test to measure the improvement of language skills, while qualitative data was obtained through interviews and observations to gain in-depth insights into participants' experiences in using AR (Saba et al., 2022). This mixed method allows researchers to gain a comprehensive understanding of the effectiveness of AR in language learning (Chung, Choi, et al., 2022).

The study population consisted of high school and university students who were studying a foreign language (Rice et al., 2021). The sample was taken purposively from 150 students consisting of 100 high school students and 50 college students, with diverse language backgrounds (Hindhede, 2020). The selection of this sample aims to ensure that participants have varying levels of language competence, so that they can test the effectiveness of AR in various language learning contexts (Brooks & Sjöberg, 2019). Language teachers from both groups were also involved to provide input on the use of AR in teaching (Brooks et al., 2019).

The instruments used include AR applications for language learning, questionnaires, interview guides, and language tests (Ydesen, 2021). The AR app is designed to provide interactive simulations that allow participants to practice language skills in a real-world context (De Zoysa & Waisundara, 2021). A questionnaire was given to measure participants' perception of the effectiveness and involvement in using AR. Semi-structured interview guides are used to explore the in-depth views of the participants regarding the benefits and challenges encountered while using the app. Language tests are used to measure the progress of language skills before and after the intervention.

The research procedure involved collecting data for three months, during which participants used the AR application in regular learning sessions. At first, participants took a pre-test to measure their initial language skills. During the intervention period, they used an AR app for an hour each week, focusing on speaking and listening skills. After the intervention period, participants underwent a post-test to measure the improvement of language skills. Interviews were conducted after the post-test to delve into their experiences, while questionnaires were given to collect quantitative data on perception and engagement.

RESULT AND DISCUSSION

The study collected both quantitative and qualitative data from 150 participants, consisting of 100 high school students and 50 university students. Pre-test and post-test scores were used to assess improvements in language proficiency, particularly in speaking and listening skills. The average pre-test score across all participants was 62.5%, while the average post-test score increased to 78.3%. This significant improvement highlights the potential effectiveness of AR in language learning. Additionally, qualitative data from surveys and interviews provided insights into participants' perceptions of AR's impact on their learning experience.

Table 1: Pre-Test and Post-Test Scores

Group	Average Pre-Test Score (%)	Average Post-Test Score (%)
High School Students	60.3	76.1
University Students	66.8	81.5
Overall Average	62.5	78.3

The increase in average post-test scores indicates that participants showed notable improvements in their language proficiency after using AR tools. High school students demonstrated an improvement of 15.8%, while university students exhibited an increase of 14.7%. This suggests that AR can effectively support language acquisition at different educational levels. These improvements reflect the potential of AR to enhance engagement and facilitate a more immersive language learning experience, particularly when integrated into regular classroom activities.

Survey responses indicated that most participants found AR tools to be highly engaging and beneficial to their learning process. 85% of students reported that AR helped them better understand language concepts in context, while 78% noted that the

interactivity of AR made language learning more enjoyable. The qualitative data suggests that AR helps bridge the gap between theory and practical language use, offering learners a more natural and intuitive way to practice speaking and listening skills.

In-depth interviews with a subset of 30 participants further revealed how AR influenced their learning behaviors. Students emphasized that the immersive nature of AR allowed them to practice language in simulated real-world environments, which helped boost their confidence in speaking. One student mentioned that interacting with virtual objects and characters in the AR environment made them feel more comfortable using the language in everyday situations. Another participant stated that the real-time feedback provided by the AR app helped them quickly identify and correct mistakes in their pronunciation and grammar.

Educators also reported positive feedback, noting that AR made it easier to engage students who otherwise struggled with traditional learning methods. They observed that students were more motivated to participate in language activities and displayed higher levels of concentration during AR-based lessons. These qualitative findings underscore the potential for AR to serve as a valuable tool in fostering student motivation and improving overall language proficiency.

To analyze the significance of the improvement in language proficiency, a paired-samples t-test was conducted on the pre-test and post-test scores. Results showed a statistically significant improvement ($t(149) = 8.75$, $p < 0.001$), confirming that the use of AR significantly enhanced participants' language skills. The improvement was observed across both high school and university students, with no significant differences between the two groups in terms of the rate of progress.

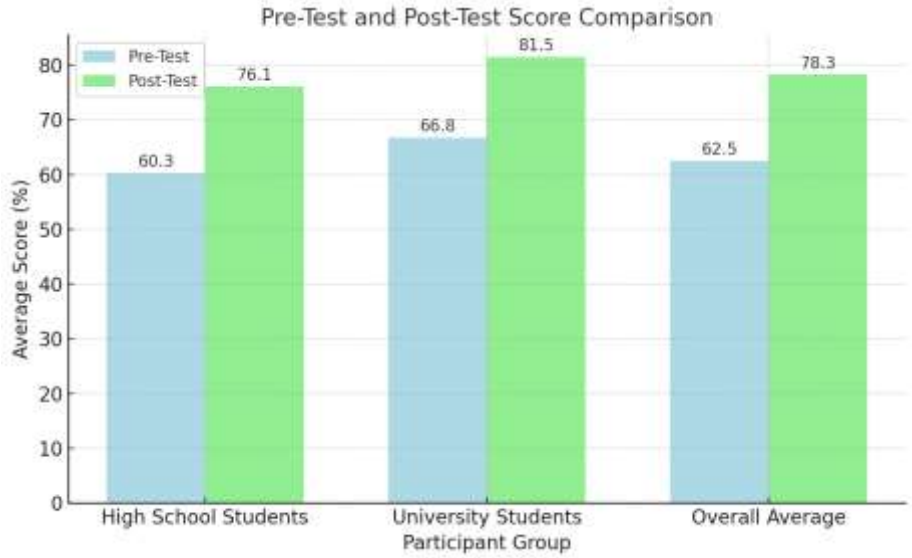

Figure 1: Pre-Test and Post-Test Score Comparison

The analysis further revealed a strong correlation between student engagement levels and improvement in language proficiency. A Pearson correlation coefficient ($r = 0.68$, $p < 0.01$) indicated that students who reported higher engagement with the AR

tools showed greater improvements in their test scores. This suggests that the immersive and interactive nature of AR plays a critical role in driving learning outcomes, as students who actively interacted with the AR environment tended to achieve better results.

Another key relationship identified was between real-time feedback and proficiency gains. Students who received immediate feedback through the AR app were able to correct their mistakes more quickly, leading to faster improvements in their language skills. This real-time feedback mechanism, which is often missing in traditional language learning methods, proved to be a crucial element in enhancing learning outcomes, particularly in speaking and listening tasks.

A case study was conducted on a group of 15 high school students who had struggled with language learning using conventional methods. Over a period of three months, these students used an AR-based app that focused on real-life conversational scenarios and interactive language tasks. Their language proficiency was measured through both pre-tests and post-tests, and interviews were conducted to capture their experiences with the AR tool. Before the intervention, these students had an average pre-test score of 55%, which increased to 73% after using the AR tool.

The case study showed that students who initially had low levels of motivation and confidence in language learning became more engaged after using AR. They reported that the AR environment allowed them to practice speaking in a low-pressure setting, which helped reduce anxiety and increase their willingness to participate in language activities. One student stated, “Using AR made me feel like I was actually speaking with someone, not just repeating words from a textbook.”

The case study results support the broader findings that AR can serve as an effective tool for language learners who struggle with traditional methods. The increase in post-test scores among these students highlights how AR can create an engaging, low-pressure learning environment that fosters greater confidence and language proficiency. Additionally, the real-time feedback provided by the AR app helped these students quickly identify and correct their mistakes, leading to faster improvements in their conversational skills.

Interviews with educators involved in the case study indicated that AR had a particularly strong impact on students with lower initial proficiency levels. Teachers observed that these students were more willing to participate in language exercises and displayed greater perseverance in correcting their mistakes. The qualitative data from the case study reinforces the potential of AR to serve as a powerful motivator for students who struggle with traditional language learning approaches.

The results of this study demonstrate that augmented reality has significant potential as a tool for enhancing interactive language learning. Quantitative data shows a clear improvement in language proficiency across both high school and university students, while qualitative findings indicate high levels of engagement and motivation. The ability of AR to simulate real-world language use and provide real-time feedback helps bridge the gap between theoretical knowledge and practical application.

Overall, the study suggests that AR can offer a more immersive and personalized learning experience compared to traditional methods. The strong correlation between engagement and proficiency improvements highlights the importance of interactive, context-rich learning environments. These findings suggest that integrating AR into language education could lead to more effective and enjoyable learning experiences, particularly for students who struggle with conventional approaches.

The study demonstrated that augmented reality (AR) can significantly enhance language learning by creating immersive, interactive environments that improve student engagement and language proficiency. Both high school and university students showed notable improvements in their post-test scores, with an overall average increase from 62.5% to 78.3%. Participants, particularly those who had struggled with traditional methods, reported that AR helped them feel more confident in practicing language skills, especially speaking and listening. Qualitative data further confirmed that real-time feedback and immersive experiences were crucial factors in driving these improvements.

Engagement levels played a significant role in the observed outcomes, as students who interacted more actively with the AR tools showed greater proficiency gains. The findings suggest that AR is particularly effective at bridging the gap between theoretical language learning and practical, real-world application. The technology allows learners to practice in simulated environments that mimic real-life scenarios, offering more meaningful context and making the learning process more intuitive. These results underline the potential of AR as a powerful tool for improving language learning outcomes.

Previous studies have also highlighted the positive impact of technology on language learning, but few have focused on the specific advantages of AR. Research by González-Lloret (2017) explored how digital tools enhance language learning through interactive features but did not delve deeply into the immersive aspects that AR provides. In contrast, this study shows that AR's ability to simulate real-world contexts makes it more effective in developing practical language skills, particularly speaking and listening, compared to other digital tools that primarily focus on reading or writing exercises.

The findings align with recent research that suggests immersive environments, like virtual reality (VR), can promote greater engagement in language learning. However, unlike VR, which can be isolating or overly technical, AR seamlessly integrates virtual elements into the real world, making it more accessible and less intrusive. This study contributes a unique perspective by demonstrating that AR offers a more balanced approach to immersive learning, blending the real and virtual worlds in a way that supports both engagement and practical language use. The results provide an important distinction from previous work focused on more traditional or passive digital tools.

The findings of this study signal a significant shift in how language learning can be approached in the digital age. AR offers the ability to create interactive, context-rich

learning environments that are not easily replicable with traditional methods. The fact that students showed significant improvement in their post-test scores indicates that AR can bridge the gap between theoretical understanding and practical language use. This research provides strong evidence that AR's immersive qualities are key in fostering language proficiency, especially in areas like speaking and listening, which are often difficult to improve through conventional learning.

This study also reflects broader trends in education where interactive and immersive technologies are gaining traction. The ability to practice language in an authentic, low-pressure environment allows learners to experiment with language use without the fear of making mistakes in real-world situations. The results of this research highlight the potential for AR to serve as an effective tool not just in language learning but in various educational contexts where engagement and interaction are critical. These findings emphasize the growing importance of integrating such technologies into mainstream education to enhance learning outcomes.

The implications of this research are profound for educators and language program developers. The clear improvements in both engagement and language proficiency suggest that AR should be considered a valuable addition to language curricula. Educators can leverage AR tools to create more interactive and engaging language lessons that go beyond traditional classroom boundaries. This would enable students to practice language in real-life scenarios that may not otherwise be feasible in a typical learning environment, such as ordering food in a restaurant or navigating directions in a foreign city.

Policymakers and education institutions should recognize the potential of AR in making language learning more accessible and effective. AR can be a valuable tool for diverse learner groups, particularly for those who struggle with conventional methods. Furthermore, the positive correlation between engagement and language proficiency demonstrates that students are more motivated when they can interact with content in meaningful ways. This calls for a re-evaluation of traditional language assessments, with more emphasis placed on practical skills and real-world application, which AR can support effectively.

The success of AR in enhancing language learning can be attributed to its ability to offer real-time, immersive experiences that engage multiple senses. Unlike traditional methods that focus heavily on passive learning, AR allows students to interact with virtual objects and characters in a context that mirrors real-life situations. This hands-on approach makes learning more memorable and intuitive, as students are not just reading or listening to lessons, but actively participating in them. The immediate feedback provided by AR also enables learners to correct their mistakes as they occur, reinforcing positive language habits more quickly.

The high levels of engagement seen in this study are likely due to AR’s ability to gamify the learning process, making it more enjoyable for students. Many participants reported that AR felt more like an interactive game than a traditional lesson, which helped to reduce the anxiety often associated with speaking in a foreign language. This

sense of playfulness, combined with the ability to practice in a risk-free environment, made it easier for students to experiment with language use and gain confidence. These factors explain why AR was particularly effective at improving speaking and listening skills, which require practice in dynamic, communicative contexts.

Future research should explore how AR can be further developed and integrated into different levels of language education. While this study focused on high school and university students, there is potential for AR to benefit learners of all ages, including young children and adult language learners. Research could also examine how AR can be used to support learners with special needs or those in remote areas where traditional language learning resources may be limited. Expanding the scope of AR applications in language learning could help to make education more inclusive and accessible to a broader range of students.

Additionally, further studies should investigate the long-term effects of AR on language retention and proficiency. While this study showed immediate improvements in post-test scores, it remains unclear whether these gains are sustained over time. Longitudinal research could provide insights into how regular use of AR tools influences long-term language retention and real-world language use. Exploring these aspects will be critical in determining the true effectiveness and scalability of AR as a language learning tool, and how it can be integrated into wider educational frameworks for maximum impact.

CONCLUSION

The most important finding from this research is that augmented reality (AR) significantly enhances both language engagement and proficiency, particularly in speaking and listening skills. The study revealed substantial improvements in students' post-test scores, with an average increase of over 15%, demonstrating AR's effectiveness in bridging the gap between theoretical knowledge and practical language use. Unlike traditional learning methods, AR allows learners to immerse themselves in realistic, interactive scenarios, providing a unique and valuable environment for language practice. This level of interactivity helps reduce anxiety and boosts learners' confidence in using the language in real-world contexts.

The research also highlighted that AR's immersive qualities make it a highly effective tool for encouraging active learning, fostering greater student motivation and participation. The combination of immediate feedback and the opportunity to practice language in contextualized settings was found to be critical in helping students improve their proficiency. These findings offer a significant contribution to the field of language education by providing a new understanding of how AR can transform traditional language learning models and methodologies. The research establishes a strong case for integrating AR into language curricula to enhance both engagement and learning outcomes.

This study's key contribution lies in the method, as it offers an innovative approach to language learning by leveraging AR technology. The ability to integrate AR

into language learning environments represents a shift from passive, rote learning to active, context-rich language acquisition. By demonstrating how AR can simulate real-world interactions and provide real-time feedback, the research adds value to the current body of knowledge on digital learning tools. This contribution is both conceptual and methodological, offering a new framework for understanding how immersive technologies can be used to teach complex communication skills.

Additionally, the study suggests practical implications for educators and policymakers. Incorporating AR into language learning can revolutionize how languages are taught, making the process more engaging and relevant to real-world communication. These findings also support the need for more interactive, learner-centered approaches in educational settings, where technology plays an increasingly important role. The research provides a roadmap for future innovations in language education, guiding the development of more effective teaching strategies that incorporate advanced technologies like AR.

One limitation of the study is the relatively short duration of the intervention and its focus on immediate learning outcomes. The research did not examine the long-term retention of language skills gained through AR-based learning, leaving questions about the sustainability of the observed improvements. The sample size was also limited to students from high school and university levels, which restricts the generalizability of the findings to other learner populations. These limitations suggest that further research is needed to explore the long-term impacts of AR on language retention and its effectiveness across a wider range of learners.

Future research should focus on longitudinal studies that assess the lasting effects of AR on language proficiency. Examining how AR influences language retention and real-world communication skills over time will provide deeper insights into its overall effectiveness. Additionally, expanding the research to include more diverse populations, such as younger learners, adults, and those with learning difficulties, would help determine the broader applicability of AR in language education. These future directions will be critical in refining AR's role in language learning and ensuring that its benefits are fully realized across educational contexts.

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