Evaluating the lasting impact of immersive VR simulations in enhancing language learning results

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Abstract

This study aims to investigate the sustained impact of immersive virtual reality (VR) simulations on language learning outcomes by comparing an experimental VR-based instructional approach with a traditional teacher-led method utilizing videos and presentations. Conducted at the International Information Technologies University (IITU) in Almaty, Kazakhstan, the research involved two groups of first-year General English pre-intermediate students: an experimental group (n = 15) engaged in VR activities and a control group (n = 14) receiving conventional instruction. A mixed-methods design was employed to comprehensively evaluate the effects of VR integration. Quantitative data were collected through pre- and post-tests measuring language proficiency gains in vocabulary, grammar, and speaking skills, enabling objective comparison between groups. Complementing this, qualitative data from questionnaires and semi-structured interviews provided insights into learners' motivation, engagement, and subjective experiences with the VR environment. The findings demonstrate that students in the VR group achieved significantly greater improvements in language retention and conversational fluency compared to their peers in the traditional classroom. Moreover, qualitative feedback revealed enhanced learner motivation and confidence, attributed to the immersive and interactive nature of VR simulations. These results underscore the potential of immersive VR to not only improve measurable language outcomes but also positively influence learner attitudes and engagement, suggesting a sustainable educational benefit. The study highlights the importance of integrating immersive technologies thoughtfully within language curricula to maximize their pedagogical impact.

Keywords

immersive VR, language learning, educational technology, English, student motivation

1. Introduction

In recent years, immersive Virtual Reality (VR) has gained increasing attention as an innovative educational technology, particularly in the field of language learning. Traditional language instruction often faces challenges in providing authentic, engaging conversational practice and sustaining learner motivation. VR's immersive and interactive capabilities offer promising solutions by simulating realistic communicative environments that foster active language use and reduce anxiety. Empirical studies have demonstrated VR's potential to enhance various language skills, including vocabulary acquisition, grammar, speaking fluency, and listening comprehension, while also positively influencing learners' motivation and confidence. Despite growing interest, much of the existing research has focused on short-term effects or isolated skill improvements, leaving a gap in understanding the sustained impact of VR integration on comprehensive language learning outcomes over time. Furthermore, few studies have employed mixed-methods designs that combine objective proficiency measures with qualitative insights into learner experiences, which are critical for evaluating VR's pedagogical effectiveness holistically. This study addresses these gaps by investigating the lasting effects of immersive VR simulations on language acquisition among first-

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year General English students at the International Information Technologies University (IITU) in Kazakhstan. By comparing an experimental VR-based instructional approach with traditional teacher-led methods, and employing both quantitative and qualitative data, the research provides a comprehensive evaluation of VR's impact on language proficiency, learner motivation, and engagement.

The novelty of this research lies in its integrated mixed-methods approach applied within a real educational context, offering robust evidence of VR's potential to produce sustainable improvements in language retention and conversational fluency. Moreover, it highlights practical considerations for thoughtfully embedding immersive technologies into language curricula to maximize their long-term pedagogical benefits.

2. Literature review

The contemporary educational environment is undergoing a significant transformation under the influence of digital technologies, with virtual reality playing a particularly notable role. Research shows that immersive environments have the potential to enhance the efficacy of learning, particularly in the domain of foreign language acquisition. According to a number of authors, the use of VR has been demonstrated to facilitate deeper student engagement, promote the development of motivation and support the acquisition of language skills in a context that emulates real-life communication [1,2].

A systematic meta-analysis [3] confirmed that integrating VR into foreign language teaching has a significant impact on both cognitive (vocabulary, grammar, and speaking skills) and affective (motivation, engagement) parameters. Furthermore, the integration of VR technology into educational settings has been shown to tanscend the constraints imposed by conventional classroom environments, thereby facilitating a multifaced, sensory-rich learning experience [4].

An important aspect of the successful use of VR in language teaching is situational and contextually relevant interaction. A study by Xie et al. involving 106 students showed a direct correlation between the level of immersion and final performance, especially in the speaking and listening components [5]. Similarly, Wu and Hung note that the use of situational learning in VR promotes fluency, improves pronunciation, and promotes stronger learning through engagement in authentic situations [6].

According to a study [1], immersive technologies enhance learners' cognitive activity by providing the opportunity to actively engage with the content. This assertion is corroborated by the findings of Legault et al. [4], which highlights the increase in language fluency through the utilization of VR simulations. Participants in these classes exhibited heightened levels of confidence in their oral communication skills and demonstrated improvements in subsequent assessments. One of the key benefits of VR technology is its ability to reduce anxiety in language learners. For example, in an experiment by Huang and Lee, it was found that learners who studied in a highly immersive environment demonstrated significantly lower levels of communication anxiety and greater confidence in language use compared to participants who studied via Zoom [7].

The motivational aspect is also considered a key factor for success. A study by Bonner and Reinders [8] found that students working with VR were more likely to report a sense of engagement and interest in the learning process, compared to those who studied in a traditional model. Similar results are presented in [9], where VR tools were considered as a way to personalize learning and increase emotional attachment to the material being studied. In this context, research on other digital tools is also relevant. For example, the integration of the Akelius application as a blended learning tool supports methodological effectiveness and highlights the need for carefully designed instructional approaches [10]. Similarly, it has been demonstrated that digital technologies possess strong motivational potential, enhancing student engagement in learning English for Specific Purposes (ESP) [11].

However, the integration of VR into the educational process requires a meticulously designed methodology. The mere presence of the technology does not guarantee a positive effect; it is critical

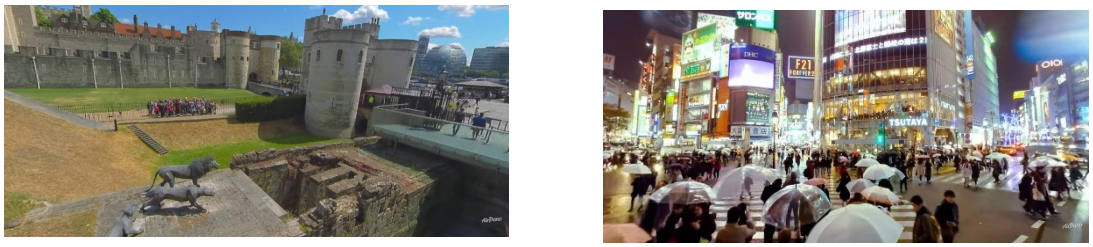
to develop didactically appropriate scenarios adapted to the level of students [2]. The literature also raises the issue of the so-called "novelty effect", according to which students may demonstrate a high level of motivation not so much due to the effectiveness of the technology, but because of its novelty. It is emphasized that this effect can have both positive and negative consequences: on the one hand, it increases engagement, on the other, it can distract attention and overload cognitive resources [6]. This is especially relevant for students without previous experience of interacting with VR, which requires a preparatory stage of implementing the technology.

In general, the conducted research allows us to state that immersive VR technologies hold considerable potential as a pedagogical tool in the context of foreign language instruction. Concurrently, it is imperative to incorporate such solutions into the overarching educational strategy, taking into account the age, cognitive and linguistic characteristics of students.

3. Research methodology and procedure

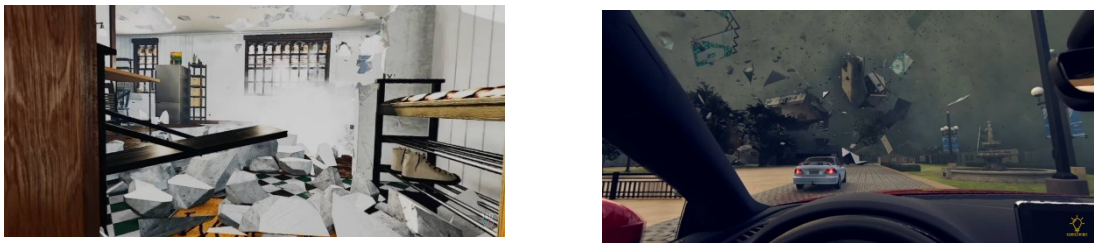
This study employed a mixed-methods quasi-experimental framework to investigate the sustained effects of immersive Virtual Reality (VR) on language learning in pre-intermediate English students. Twenty-nine participants (24 males, 5 females; ages 17-20) were voluntarily selected from ongoing General English classes, ensuring appropriate proficiency and motivation. They were assigned to an experimental group (n = 15) using Meta Quest 3 VR headsets and a control group (n = 14) receiving traditional classroom instruction. Over four weeks and 38 instructional hours, both groups completed pre- and post-tests assessing speaking, grammar, and vocabulary to measure learning outcomes.

Grammar and vocabulary tests were carefully designed by language teachers and reviewed by supervising educators to ensure alignment with language acquisition theories and curriculum standards appropriate for the pre-intermediate level. These tests included 15 multiple-choice and 5 open-ended questions. Speaking assessments consisted of three questions modeled after Part 1 of the IELTS speaking test, adapted for pre-intermediate learners, focusing on given topics, and opinion expressions. These speaking tasks underwent the same rigorous review to confirm pedagogical validity and relevance. Before the intervention, all assessments were pilot tested on a group of 15 students with similar proficiency. This pilot phase enabled the research team to evaluate the clarity, difficulty, reliability, and practical feasibility of the tests, leading to refinements that enhanced validity and measurement accuracy.



a) b)

Figure 1: (a) London; (b) Tokyo



a) b)

Figure 2: (a) simulations of earthquakes; (b) simulations of tornado

The experimental group engaged with four thematic VR modules "Traveling," "Going Places," "Natural Disasters," and "The World Around Us" which used 360-degree videos from YouTube and aiplano.com. The "Traveling" module offered virtual tours of cities like London and Tokyo, guided by a narrator introducing key sights and cultural insights. In "Natural Disasters," students experienced immersive tornado and earthquake scenarios where they listened to and viewed crucial survival instructions, including essential dos and don'ts. VR interaction involved head movements and point-and-click actions using controllers that mimicked mouse functions, providing an immersive but easy-to-navigate experience. Each session started with contextual introductions, followed by VR exploration. Students then joined guided group discussions to reflect on their experiences and practice English conversational skills inspired by the VR content. The control group accessed the same themes through traditional methods including YouTube videos and teacher-led presentations supplemented by group discussions. Instruction time and collaborative activities matched those in the experimental group, with VR immersion as the only variable for comparison. After the intervention, learner engagement and motivation were assessed through an online questionnaire via Google Forms. Additionally, semi-structured interviews lasting about 8-10 minutes were conducted virtually with students from both groups. These interviews were audio-recorded with informed consent and guided by a protocol exploring students' perceptions of VR usability, learning effectiveness, challenges, and suggestions for improvement.

4. Results

4.1. Data analysis

The quantitative data were analyzed using SPSS 25, employing descriptive statistics and independent samples t-tests to compare pre- and post-test speaking and writing scores between groups (Table 1, 2). Questionnaire responses on engagement and motivation were also summarized. Qualitative interview data were thematically analyzed to capture students' experiences with immersive VR. This combined analysis rigorously evaluated the lasting impact of VR simulations on enhancing language learning outcomes, highlighting both performance improvements and learner perceptions of VR's educational value.

Table 1
Descriptive Statistics (writing)

Writing	Group	N	Mean	Standard Deviation	Standard Error
Pre_test	Experimental	15	73.0	4.5	1.16
Post_test	Experimental	15	75.0	4.2	1.08
Pre_test	Control	14	74.0	3.8	1.02
Post_test	Control	14	75.5	3.9	1.04

Table 2
Descriptive Statistics (speaking)

Speaking	Group	N	Mean	Standard Deviation	Standard Error
Pre_test	Experimental	15	74.0	5.0	1.29
Post_test	Experimental	15	82.0	4.7	1.21
Pre_test	Control	14	77.0	4.3	1.15
Post_test	Control	14	79.0	4.1	1.10

4.2. Students' attitudes towards usability of VR glasses

After the completion of the four-week experimental period, a comprehensive questionnaire was administered to evaluate students' perceptions regarding the lasting impact of immersive VR simulations on their language learning outcomes. The results offer valuable insights into how VR technology influences sustained engagement, motivation, and skill development in language education. The results are shown in Table 3.

Table 3
The Questionnaire Results

Categories	Number of Items (N)	Mean	Standard Deviation (SD)	Std. Error Mean	Min	Max
VR helped me remember new words better	15	4.07	0.73	0.19	3	5
Using VR increased my confidence in speaking English	15	4.00	0.67	0.17	3	5
I improved my speaking skills using VR	15	4.20	0.63	0.16	3	5
VR reduced my fear of making mistakes	15	3.73	0.85	0.22	2	5
It improved my pronunciation and listening skills	15	4.07	0.70	0.18	3	5
I was motivated to study more with VR	15	4.20	0.63	0.16	3	5
The VR learning experience was more enjoyable than traditional learning	15	4.40	0.50	0.13	4	5

4.3. Students' interview insights on VR glasses in language learning

At the end of the research, we interviewed 15 students from the experimental group to gather qualitative feedback on their experiences with immersive VR in language learning. The interviews focused on VR's effects on motivation, engagement, speaking, listening, and confidence. These insights complemented the quantitative data, providing a comprehensive evaluation of the lasting impact of immersive VR simulations in enhancing language learning outcomes (Table 4).

Table 4
Findings of the Interview

Theme	Positive Insights	Negative Insights
Engagement & Interest	"VR made learning exciting and immersive"; "More enjoyable and motivating than traditional videos"	"The VR headset became uncomfortable after some time"; "I wanted other students to be in the simulation too, so we could stroll the streets together"
Comprehension & Retention	"Visuals helped me understand and remember vocabulary better"; "I remember safety steps clearly after experiencing them in VR"	"I got distracted by the environment …"; "Too much happening at once made it hard to focus"; "I wished to speak directly in simulations with an AI guide"; "to have meetings with native speakers within VR for conversation practice"

Speaking & Interaction	"Partner discussions helped me use new phrases confidently"; "I wish we could interact more with peers and native speakers"; "VR helped me speak more confidently without fear of mistakes"	"Discussion time was too short and felt rushed"
Listening Comprehension	"I could understand conversations better because I saw what was happening"	
Vocabulary Acquisition	"The visuals helped me connect words to situations"	
Anxiety & Comfort	"VR helped me feel less nervous speaking in front of others"	"I felt a bit dizzy during the VR sessions"; "The headset was heavy and uncomfortable after long use"
Technical & Accessibility Issues	"VR made the lessons feel real"; "Discussing with my partner after VR videos helped me use new phrases"; "I wish we could talk to native speakers in VR"	"Sometimes the video froze, which was frustrating"; "Bad quality of the video"

5. Discussion

5.1. Analysis of the efficacy of immersive VR in language learning

The analysis of the quantitative data using SPSS 25 revealed that both the experimental and control groups showed slight improvements in writing scores from pre-test to post-test, with the experimental group increasing from a mean of 73.0 (SD = 4.5) to 75.0 (SD = 4.2), and the control group from 74.0 (SD = 3.8) to 75.5 (SD = 3.9). The differences between groups at both testing points were minimal, suggesting that the integration of VR technology did not produce a statistically significant advantage in writing performance over traditional instruction within the sample size. Conversely, speaking scores indicated a more notable increase in the experimental group, which rose from a mean of 74.0 (SD = 5.0) at pre-test to 82.0 (SD = 4.7) post-test, compared to the control group's increase from 77.0 (SD = 4.3) to 79.0 (SD = 4.1). Such data indicates that the experimental group not only improved more significantly in speaking skills compared to the control group, but also suggests that VR may play a critical role in developing learners' speaking confidence and competency.

5.2. Students' attitudes towards usability of VR glasses

The analysis of the questionnaire results regarding students' attitudes toward the usability of VR glasses in language learning reveals a strong, positive response to immersive VR technology across several key educational outcomes. The feedback from the 15 participants in the experimental group highlights both the practical and affective benefits of integrating VR into language instruction. Foremost, the data shows that VR significantly enhanced students' speaking skills, with a mean score of 4.20 out of 5 for the statement "I improved my speaking skills using VR." This high average signifies that the majority of students perceived tangible progress in their oral proficiency, likely attributable to the realistic and immersive contexts provided by VR simulations, which encourage active verbal participation and spontaneous use of the target language. Confidence in speaking English also marked a notable improvement, earning a mean score of 4.00. This suggests that the VR environment, by simulating real-life conversational scenarios, can help alleviate common student anxieties about speaking, offering a low-stakes space to practice and make mistakes without judgment. The acquisition and retention of new vocabulary was another area where students felt VR offered substantial assistance, with a mean score of 4.07. This aligns with research indicating that multimodal and contextual learning, as enabled by VR, supports deeper memory encoding and recall of new terms and phrases. In addition, students reported similarly positive effects – mean score 4.07 – for improvements in pronunciation and listening skills, suggesting that immersive auditory exposure

and the opportunity to hear native-like input can benefit receptive and productive language abilities. While the mean score for reducing fear of making mistakes was slightly lower at 3.73, it still indicates a general trend toward greater comfort and risk-taking in speaking, a critical component of communicative language development. Further, the high score for motivation (4.20) shows that students found VR to be a compelling reason to engage more deeply and persistently with their studies. Most strikingly, the enjoyment of the learning experience, reflected in a mean score of 4.40, underscores VR's potential to transform language education into a more engaging and satisfying endeavor. This increased enjoyment may underpin the observed gains in motivation and skill development, as positive affect is closely tied to sustained engagement and academic achievement.

Collectively, these results confirm that immersive VR is not only effective in developing key language skills but also excels at fostering confidence, motivation, and enjoyment – core drivers of successful long-term language acquisition. These findings affirm the value of VR in modern language classrooms and suggest that broader adoption could yield significant educational benefits.

5.3. Analysis of students interview insights on VR glasses in language learning

The qualitative insights gathered from interviews with 15 students in the experimental group provide a rich context that complements the quantitative data on immersive VR in language learning, aligning with previous research emphasizing VR's positive impact on learner engagement and motivation. Many students expressed that VR made learning exciting and immersive, describing it as more enjoyable and motivating than traditional videos, which supports findings that VR's interactive nature captivates learners and fosters a stimulating educational environment [1-3]. Participants also reported significant benefits in comprehension and retention, noting that visuals helped them understand and remember vocabulary more effectively. One student's comment, "I remember safety steps clearly after experiencing them in VR," highlights the effectiveness of experiential learning, consistent with studies showing VR's role in enhancing long-term memory through multisensory engagement [3]. Challenges reported by students included occasional distractibility within the VR environment and difficulties maintaining focus due to the abundance of stimuli, echoing concerns raised in prior research about cognitive load in immersive settings [6]. In terms of speaking and interaction, students appreciated partner discussions that helped build their confidence in using new phrases and felt that VR supported more confident speaking without fear of mistakes. However, many expressed a desire for longer interaction times with peers and native speakers, noting that discussion periods often felt too short and rushed, indicating a need for more extensive social engagement opportunities within VR learning settings. Listening comprehension was also reported to improve through the use of contextualized visuals, which aided understanding of conversations. Some students experienced discomfort from the headset's weight and occasional dizziness during extended sessions. Additionally, technical issues such as video freezing occasionally disrupted the learning experience. These factors highlight the importance of addressing ergonomic and technical challenges to fully optimize the educational effectiveness of immersive VR technology. Overall, the findings suggest that while immersive VR significantly enhances engagement and skill development in language learning, careful attention to device comfort, interaction design, and system reliability is essential to maximize its benefits.

6. Conclusion

The findings from our study demonstrate that the incorporation of immersive virtual reality (VR) technologies into English language instruction leads to substantial enhancements in students' speaking skills and motivation. Although writing performance did not show statistically significant differences between the experimental and control groups, those engaged with VR exhibited more pronounced improvements in oral communication. This suggests that VR's immersive environments uniquely support the development of speaking skills, reduce anxiety, and refine the reception of audiovisual information, positively impacting the affective domain of learners. Qualitative data from questionnaires and interviews further reinforce that students perceive VR as a more engaging and

enjoyable method of language learning compared to traditional approaches. The immersive simulations contributed to improved vocabulary retention, listening comprehension, and pronunciation, while also increasing overall engagement throughout the learning process. However, the study also identified several challenges related to technical and ergonomic factors. Students occasionally experienced cognitive overload due to the dense stimuli in the VR environment, as well as physical discomfort from extended headset use and interruptions caused by technical glitches such as video freezing.

Moreover, participants expressed a clear desire for more interactive VR experiences. Current simulations were primarily passive, limiting engagement to observation and limited control. Students wished for collaborative learning opportunities within VR, such as navigating virtual environments together and interacting with AI-driven characters, which would more closely mimic authentic social and communicative interactions. These insights highlight the potential for future VR applications to incorporate richer interactivity and social components, enhancing their pedagogical effectiveness. To realize the full benefits of VR in language education, it is essential to invest in the development of tailored 360-degree content that aligns closely with curricular needs and supports vocabulary acquisition. Equally important is the advancement of VR platforms that facilitate multiplayer experiences and conversational exchanges with virtual interlocutors, fostering a more immersive and socially authentic learning environment. Educators and institutions must also prioritize methodological rigor by adapting VR content to students' proficiency levels and providing comprehensive technical and pedagogical training for instructors to integrate VR smoothly into their teaching.

Addressing ergonomic concerns and technical reliability will be critical for sustained engagement, requiring improvements in hardware comfort and stable software performance. Finally, ongoing research should explore the long-term impact of interactive VR on a broader range of language skills and the role of social interaction within immersive settings. Through these concerted efforts, VR can evolve beyond a novel tool to become an indispensable component of innovative, effective, and learner-centered language education.

Declaration on Generative AI

During the preparation of this work, the authors used Grammarly AI in order to grammar and spelling check. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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