Learning Foreign Language Vocabulary Through Task-Based Virtual Reality Immersion

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Abstract. In the rapidly evolving landscape of language learning pedagogy, Virtual Reality (VR) has emerged as a potent tool for enhancing the educational experience beyond traditional platforms like Duolingo. This study explores the efficacy of task-based language learning (TBL) in immersive VR. We conducted an experiment with 27 participants, teaching them 20 Spanish vocabulary words through a VR-enabled cooking task in Spanish, across three distinct learning conditions: fully immersive VR, traditional non-VR, and mixed modality. The inclusion of VR did not affect the overall gains; however, analysis of post-experiment feedback taken three weeks later showed that VR markedly enhanced engagement and appeal value for participants in the mixed modality, highlighting VR's potential to enrich the language learning experience. These results suggest the promise of immersive TBL pedagogy in VR in making language learning more engaging and effective. Further, the success of the mixed condition indicates future explorations should factor in when to capitalize on VR and when traditional methods are sufficient.

Keywords: Virtual Reality · Immersion · Task Based Language Learning

1 Introduction

Learning a new language requires dedication and patience, usually over multiple years, and a means of learning like a tutor, a class, or a digital learning tool. The latter is one of the most accessible — for example, in 2022 alone over 500 million people around the world accessed Duolingo [2]. Duolingo and similar apps have grown in popularity due to the ease of access and low cost (Duolingo is free with ads). These apps also focus on short lessons while encouraging users to engage daily, emphasizing that learners may proceed through the courses at a pace that fits their lives.

However, despite the success of these apps, how language learning applications best balance engagement and learning gains is an open problem. For example, a side effect of Duolingo's ease of use and accessibility is that many users

do not end up making much progress learning the language: an informal study highlighted a striking statistic: only 0.01% of users studying Spanish actually complete the course [10].

One potential solution is to refocus language learning around task or game completion, with language learning being a byproduct of task completion — this idea, "task-based language learning" focuses on the intersection of immersive environments and language learning. One popular task-based learning paradigm [3] focuses on kitchen settings [18]. In this work, we combine task-based language learning in a kitchen environment with the immersive nature of Virtual Reality (VR) [4,6].

While other works have examined education or language learning in VR [1,12,18], there is a surprising dearth of research that examines task-based learning with VR. Our study aims to bridge this gap by introducing participants to a fully immersive virtual environment where they are tasked with cooking fajitas, a Mexican-American dish. 27 participants participated in the learning task in either a VR, mixed modality, or traditional (non-VR) condition. We found that while there were no statistically significant differences in learning outcomes, an analysis of participant survey data showed VR learners were more engaged with the learning task and were generally more interested in returning to the task.

The contributions of our paper are summarized as follows:

- A novel methodology that integrates VR-assisted language learning (VRALL) with Task-based Learning (TBL).
- Qualitative feedback from a post-task survey followed by a post-experiment survey administered three weeks later.
- Design and development of a flexible application framework capable of incorporating multiple languages beyond Spanish, thereby broadening the scope for user language selection, laying the groundwork for future research and application enhancements.

2 Related Works

Language Learning in VR Immersion has been proven to be the most effective way to learn a second language [7,8]. People can experience much higher language learning results when brought into an environment surrounded by the target language, with a need to engage in it. Similarly, when removed from the environment, many of the learners will see a decrease in their language skills [16,17]. Interactivity has also been found to have a positive impact on learning [16,21].

Language learning has been explored in Augmented Reality (AR) and VR as well. Studies have shown that VR can provide a more immersive and enjoyable method of learning than traditional language learning applications [5] regardless of preferred learning style [15]. AR language learning has also been shown to increase vocabulary, reading, speaking, and writing skills [1,14]. VR can also improve motivation in learners [9]. These applications have often involved interactions where participants can grab objects and be told the word for the object

in the target language [5]. Another VR language learning task is a search-and-find task, where participants are given instructions in the target language and tasked with finding the object in the environment [5]. In the realm of VR, one of the most significant benefits is the provision of immediate feedback to users regarding linguistic information. This is particularly relevant in the context of language acquisition and vocabulary development. The research conducted by Miller and Gildea [11] sheds light on the process through which children assimilate new words, primarily through interactive methods such as conversations and writing. They assert that an ideal learning scenario, especially when encountering unfamiliar words in text, involves the availability of an automated system capable of elucidating the meaning of these words within their specific sentential context. This system functions similarly to how one might inquire about the meaning of a new word used in a live conversation [19]. This approach underscores the transformative potential of VR in enhancing language comprehension and acquisition.

Task-Based Language Learning Task-based learning (TBL) has been a widely recognized instructive approach in language education. It emphasizes practical tasks as the primary means of learning language skills, promoting communication and problem-solving in real-life situations. TBL has shown success in fostering speaking, listening, and comprehension skills by engaging learners in meaningful activities within the target language [3,20].

3 Methods

3.1 Participants

Participants were recruited by word of mouth primarily on campus at Coloardo State University (CSU). A participant was considered eligible for this study if they were 18 years of age or older, were comfortable with wearing a head mounted display (HMD), had correctable-to-normal vision, and had very little prior Spanish knowledge, which could be determined with a pre-test (if a participant scored higher than 50% on the pre-test they were disqualified from participating). In total, 27 eligible participants were recruited, leaving 9 participants to be compared for each given condition. This study was approved by the IRB board at Colorado State University.

VR Setup The three-dimensional (3D) VR kitchen environment was constructed with Unity and OpenXR. For hardware, due to its standalone and non-tethering nature, we used a Meta Quest 2, and ported the software physically onto the Quest.

Users were placed into an isolated room with just researchers, where they had the freedom to walk around, rather than rely purely on the teleportation or in game movements of the application.

Fig. 1. Two moments captured from participant videos during the VR kitchen task. On the left, a participant is shown washing an onion under virtual water, illustrating the immersive detail of the task environment. On the right, another participant prepares to cut a freshly cleaned pepper, highlighting the application of learned vocabulary and procedures. These images showcase the practical application of language skills in an immersive VR setting.

The Quest 2 had screen recording built in, including audio. While out of scope for this work, these recordings allowed for re-watching of participants videos and conducting analyses of the user experience.

3.2 Language Lesson Conditions

Participants were randomly assigned to one of three conditions: fully real-world, mixed modality, and fully virtual.

Real-World In the fully real-world segment, we concentrated on traditional learning methods, using Quizlet for the introduction and repetitive reinforcement of vocabulary to make the learning process straightforward. Participants then watched a recorded silent video demonstrating the steps of cooking fish fajitas, with the same steps from the VR environment. For each step in the video, the Spanish sentence was shown on the screen and then the corresponding action was shown, then the sentence and action were shown again, repeating three times before moving on the the next step in the recipe, to reinforce the vocabulary. For example, "corte el pescado" would display followed by a video of someone cutting a fish. This approach was crafted as an easy-to-follow baseline to compare with the results from VR learning. Designed to be as simple as possible, we ensured the vocabulary was drilled into participants by showing them the words multiple times before performing the related action in the demonstration. Our objective was to determine if a more immersive VR environment could achieve or approach the learning effectiveness of this baseline, which, while easy to learn from, lacked engagement and might not support long-term retention.

Mixed Modality In the mixed modality segment, participants began their Spanish vocabulary learning with flash cards utilizing Quizlet in a real-world setting, aiming for a swift and familiar lesson format. This approach leveraged Quizlet's interactive platform to quickly introduce vocabulary, setting the stage for its application in a virtual context. Following the flash card lesson, participants transitioned to the VR environment, specifically to a kitchen setting, to prepare fish fajitas using the vocabulary learned from the flash cards. This phase tested the effectiveness of combining traditional learning with immersive VR tasks in reinforcing language skills. As in the fully virtual segment (described below), participants were oriented to VR controls before starting, ensuring readiness for the immersive task. During the VR cooking task, participants were encouraged to verbalize their thought process, blending learned vocabulary with in-the-moment reasoning. This mixed modality approach aimed to assess how initial real-world learning impacts subsequent application in a virtual setting, focusing on participant engagement and the practical use of newly acquired language skills.

Fully Virtual In the fully immersive virtual environment, participants engaged exclusively within the VR space, starting with a Spanish vocabulary lesson through the Librarium app. Following this, they were tasked with applying their newly acquired language skills in a VR kitchen setting designed to simulate a real-world cooking scenario. This segment aimed to evaluate the effectiveness of VR in facilitating language comprehension and application, with a focus on participant engagement during the task. Before loading into VR, participants were shown the controls in the real world, and allowed to ask any questions. Once the participants were comfortable with the setting, they were then given the headset. Participants were loaded into the kitchen application in front of a virtual knife and five lemon objects, with which they could see how the controls functioned. After they were comfortable, they were brought into the kitchen and given 10 minutes to complete a recipe of fish fajitas, where they were given no hints, and the recipe was completely in Spanish. We designed the task to be challenging in order to test participants' ability to assimilate new vocabulary through the use of physical representations and their active application within the task context. As the participants conducted the study they were instructed to think aloud, and they would often say the word in Spanish, followed by what they thought it meant in English, and try and infer their way through the recipe.

3.3 Procedures

The study comprised of six main steps: a pre-test, an initial vocabulary lesson, an applied language learning task, a distraction activity, a post-test, and finally an engagement survey.

Pre-test: Participants completed a pre-test to assess their baseline Spanish vocabulary knowledge. This test consisted of the 20 vocabulary words that would

be taught in our Spanish lesson, and was in the form of fill in the blank. The participants were given a word in Spanish, and asked to translate the word into English. A score greater than 10 was deemed too high to continue in the experiment, and we omitted any participants who achieved this.

Vocabulary Lesson After the pre-test, participants were given a flashcard vocabulary lesson for the 20 terms focused on in this experiment. This lesson took place either on the Quizlet (real, mixed) or Librarium (VR) platforms, depending on the participant's condition as described in 3.2.

Language Task: After the lesson, participants completed a language task to assess their ability to apply the learned vocabulary. Two-thirds of participants (mixed, VR) were placed in a VR kitchen environment where they were presented with a recipe in Spanish and tasked with completing it. The remaining participants (real) watched a video of the same cooking task being performed in real life (detailed in 3.2). This setup allowed for a comparison between VR and real-world learning experiences.

Distraction Activity: To allow time between the participants learning the material and taking a test, we constructed distraction activities lasting seven minutes. Participants selected one of two VR games to play: competing in a leader-board of Beat Saber Demo, giving all participants the same song and difficulty, or entering into NFL Pro Era 2, where they could experience VR football. Participants were given a brief introduction to the games, before their seven minutes were started.

Post-Test: A post-test was administered after the distraction activity to assess the learning gains achieved by participants in each condition. The post-test was the same format and vocabulary as the pre-test; however, the word sequence was randomized for each participant.

Engagement Survey: The final step in our procedure was providing participants a post-experiment survey three weeks after participating in the experiment. The survey consisted of a subset of questions from the short-form user engagement scale [13] on the participants' perceived engagement in their lesson and learning task (detailed in 3.4).

3.4 Data Analysis

In this study, we assess the effectiveness of VR in language learning by analyzing both the participants' engagement and their learning gains. Our method combines subjective evaluations of the learning experience with objective measures of vocabulary acquisition. This approach enables us to explore the dual impact of VR on language learning, assessing not only educational outcomes but also learner engagement and satisfaction.

Survey Analysis In assessing the participants' preference for learning environments, our survey analysis focused on their experiences in virtual reality versus traditional settings. Three weeks after completing the lesson and tests, participants took a post-study survey which elicited feedback on four factors: focused attention, perceived usability (negative affect), aesthetic appeal, and endurability [13]. This survey includes multiple questions for each factor to get accurate responses. Responses were on a 5-point Likert scale, and responses for the same topic were averaged together. Through this process, we aimed to gauge levels of enjoyment and immersion, providing insights into the overall appeal of VR as a learning medium.

Learning Analysis To accurately assess the learning gains across the three distinct groups, we employed an ANOVA (Analysis of Variance) to examine the differences in performance outcomes. We define the learning gain of the participant as their pre-test score, subtracted from their post-test score. This statistical analysis enabled us to identify any significant variances in learning achievements among the groups. Moreover, we closely analyzed the mean and median scores of each group to obtain a comprehensive understanding of their overall performance and central tendencies.

4 Results

	Full VR	**Mixed**	**Real**
Average Pre-Test Score	2.67 ± 2.69	3.78 ± 3.60	3.44 ± 3.13
Average Post-Test Score	12.67 ± 3.90	16.22 ± 5.36	17.78 ± 3.53
Average Learning Gain	10.00 ± 3.67	12.44 ± 4.25	14.33 ± 3.54
Median Learning Gain	13	14	16

Table 1. Comparative Analysis of Learning Outcomes Across Conditions. This table presents a summary of the mean, standard deviation, and median learning gains (post-test score - pre-test score), alongside the mean and standard deviation for pre-test and post-test scores. The data is segmented by condition — Full VR, Mixed Modality, and Real World — highlighting the diverse impact of each learning environment on participant performance and gains.

To accurately measure the participants' learning gains, defined as the difference between their post-test and pre-test scores, we conducted a thorough analysis of their performance before and after exposure to various learning conditions. The real-world scenario, serving as a baseline, exhibited the highest learning gains with an average increase of 14.33 ± 3.54 on a 20-point scale. The mixed modality closely followed with a gain of 12.44 ± 4.25, as detailed in Table 1, indicating its substantial effectiveness. Conversely, the fully immersive VR group experienced a noticeable decrease in performance with a gain of

10.00 ± 3.67, highlighting potential limitations of excessive immersion without adequate structured learning opportunities. In comparing the learning environments, the immersive Librarium app led participants to encounter vocabulary less frequently than the Quizlet platform, where words could be reviewed multiple times within the same duration. Nevertheless, the tangible interaction with vocabulary in VR suggested a unique potential for enhancing learning, albeit at a more gradual pace.

The diverse range of scores in the real-world group, with no two participants achieving the same result, stood in contrast to the more uniform achievements in the mixed modality. An ANOVA test found no significant difference between groups ($p = .07$, $\alpha = .05$). Thus, in this study we saw no differences in learning gains between conditions. Such statistical evidence bolsters the argument for the balanced integration of VR in educational contexts, especially when aiming for outcomes comparable to real-world learning experiences.

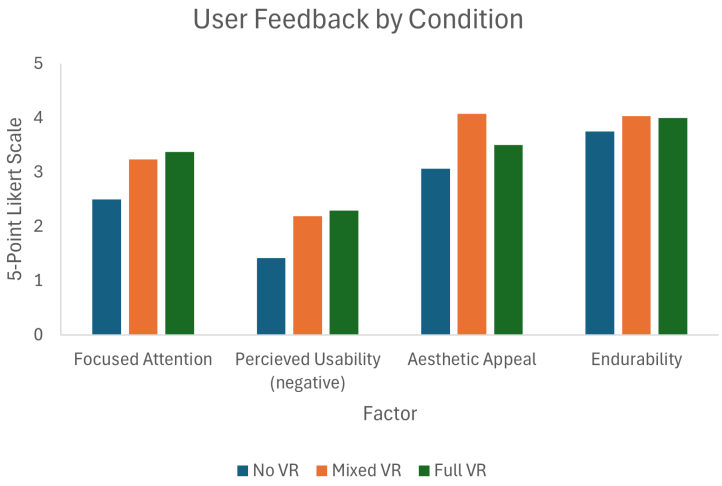

Fig. 2. Average participant ratings by condition: The full VR condition was rated highest for focused attention and perceived usability, whereas the mixed modality scored highest for aesthetic appeal and endurability. A detailed statistical analysis is provided in the subsequent section.

Figure 2 shows the post-task survey results. The full VR condition had the highest reports for focused attention and perceived usability (negative) while the mixed modality condition had the highest scores for aesthetic appeal and endurability. The fully real condition were consistently rated lowest across topic. These findings underscore the advantages that a VR setting can bring to the language learning experience, providing an overall more enjoyable user experience to language learners.

5 Discussion and Future Work

Full immersion, traveling to a place and only speaking/hearing the language being learned, is widely regarded as the best way to learn; however, it is simply not practical for most people. Our experiment supports the idea that VR may provide an alternative path to immersion, and highlights how common immersive tasks like cooking can be used in VR to support language learning.

The results from the fully immersive VR experience highlighted issues with a wholly VR approach: this condition was the most difficult to develop, and was also the one that had the most negative perceived usability by participants. Our takeaway is that the pursuit of full virtual immersion may overshadow the structured learning opportunities, in some cases — the mixed condition was successful because it capitalized on both VR and traditional approaches to language learning. This investigation underscores the feasibility and value of incorporating VR into language learning, revealing that a gradual integration of virtual elements with conventional teaching methods enhanced the educational experience, in this case.

Future studies should aim to refine VR learning environments, explore diverse subject areas, and further investigate the optimal balance between virtual and real-world components. Ultimately, our work lays the groundwork for more immersive, engaging, and effective learning experiences, harnessing the power of virtual reality to enrich educational outcomes.

6 Conclusion

In this study, we have developed and examined a novel method for conducting task-based language learning experiments within virtual reality environments. Our research involved 27 participants in an exploration of how different modalities impact language acquisition across three distinct conditions: fully immersive VR, a hybrid model combining real-world lessons with VR tasks, and a traditional (e.g., not in VR) video that served as a benchmark. Our findings highlight the unique benefits and challenges associated with each learning condition. While the real-world scenario, designed to facilitate easy learning, confirmed its effectiveness as a baseline, the mixed modality approach emerged as a particularly promising model. This blend of traditional and VR learning not only demonstrated substantial learning gains comparable to the real-world condition but also offered insights into optimizing VR's educational potential.

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