Thematic Analysis of Foreign Language Learning in a Virtual Environment

Mariah Bradford, Ethan Seefried, Nikhil Krishnaswamy and Nathaniel Blanchard

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Mariah BRADFORD[a,1], Ethan SEEFRIED[a], Nikhil KRISHNASWAMY[a], and Nathaniel BLANCHARD[a]
[a] *Colorado State University*
ORCiD ID: Mariah Bradford https://orcid.org/0009-0009-2162-3307

Abstract. Virtual reality provides a novel landscape for learners to experience active, hands-on education. In the context of language acquisition, it provides opportunities to apply attained vocabulary, engaging the user with their new knowledge. In this work, we focus on the users' experience of an application we developed and tested. We ran user studies and collected feedback via a think-aloud method. We then conducted a thematic analysis over the results. Our analysis revealed five key themes, each with two relevant categories. The themes we identified include experience (feedback and aesthetics), mechanics (actions and bugs), resources (equipment and lesson), likes/dislikes, and other feedback (narration and off-topic comments). We then quantify the occurrence of each label, allowing us to easily identify the strengths and weaknesses of our application. The most common label was narration, showcasing the engagement of users with the task. Our analysis also revealed that the participants often felt unprepared for the task, highlighting the need for more connection between the initial lesson and the given task. This analysis provides a process of attaining user feedback and categorizing that feedback to identify routes for improved user experience.

Keywords. virtual reality, education, user experience

1. Introduction

In recent years, virtual reality (VR) has blossomed into a new modality of experience for users. This is particularly interesting for learning applications, as it presents a new tool to engage and teach learners. One area where VR can be applied is in foreign language acquisition. Conventional language learning applications like Duolingo, while accessible, often struggle with user engagement and retention [1]. VR offers a promising alternative through immersive, task-based experiences.

Prior studies [2,3] have demonstrated the potential of task-based learning in VR. Task-based learning is enhanced in VR settings because of its ability to provide unique experiences despite a lack of resources or access to task-oriented settings. Previous work has shown the value of immersive technology in education, especially in the learner's experience [4–6]. Theoretical frameworks have also explored the learning process in extended reality, highlighting the importance of user presence [7,8]. Language learning is well-suited for virtual reality because of its immersive and engaging nature [9,10]. In previous work [11], we proposed a novel method — using a virtual kitchen environment

[1] Corresponding Author: Mariah Bradford, mbrad@rams.colostate.edu

for cooking tasks to facilitate Spanish vocabulary acquisition. This approach leverages VR's immersive nature to enhance engagement and learning efficacy. Here, we explore the app from users' perspectives to get specific feedback on our app and lesson design.

Our chosen method of retrieving feedback from users is the think-aloud method [12]. This approach elicits user feedback in real time while using the application, which allows researchers to discover a rich set of reactions which may be forgotten or undervalued in a post-interview. We combine this method with a thematic analysis to identify the common topics that arise from users. Thematic analysis is an approach to explore qualitative data in a systematic way, providing a high-level overview of diverse responses [13]. We use this combination to identify key areas of insight for future improvements within our app and encourage others to apply this method in pursuit of improving their own work as well.

2. Methodology

We recruited and consented 27 participants, dividing them randomly into three groups: a group who used the app in a fully virtual reality (VR) setting, a multi-modal group (combining VR and real-world elements), and a fully real-world group. All participants underwent a pre-test of 20 vocabulary words to assess their prior Spanish knowledge. Those with extensive familiarity (achieved 50% or greater on the pre-test) were excluded to maintain the learning challenge. Additionally, prior to the task, participants were introduced to VR technology — those unfamiliar with VR were taught how to use the Meta Quest 2, including its controls and navigation. For the VR components, we utilized Unity software to develop a custom virtual kitchen environment and deployed this simulation on Meta Quest 2 headsets. We allowed participants to freely move around in the study room. This setup was chosen to maximize the immersive experience and facilitate naturalistic interaction with the virtual environment. An example of the Unity learning environment can be seen in Figure 1.

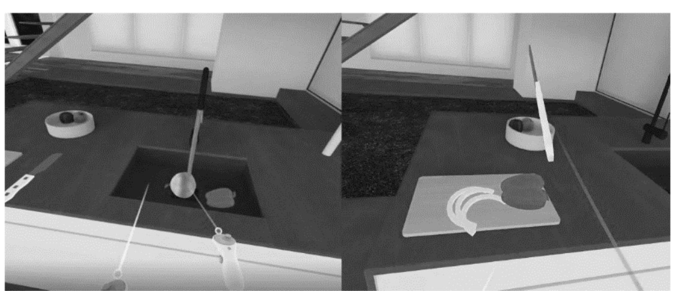

Figure 1. Example images of the Unity cooking environment.

Each group received tailored instruction in Spanish vocabulary relevant to the cooking task, using different modalities: the VR group used 'Librarium', a VR-based flashcard application, while the multi-modal and real-world groups used 'Quizlet'. After completing the vocabulary lesson, the VR and multi-modal groups were tasked with preparing fajitas in the virtual kitchen by following a recipe provided only in Spanish. This recipe used the previously taught vocabulary words. Meanwhile, the real-world group observed a video demonstration of the same task, with the same recipe displayed on-screen. Throughout these sessions, we asked all participants to verbalize any thoughts and opinions they had using the think-aloud method, which was recorded for subsequent thematic analysis. Note that, while all participants were asked to 'think-aloud' for consistency, we only analyze the VR and multi-modal Unity recordings since this work focuses on feedback on our application. Participants then went through a short distraction activity, where they played a game through the VR headset. Finally, participants took a post-test to explore learning gains. For details on the quantitative learning results, see [11]. The overall experimental process can be seen in Figure 2.

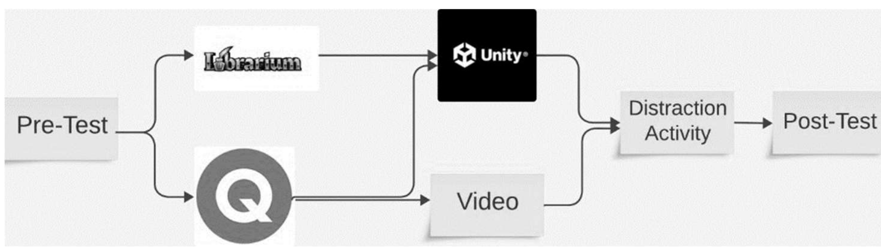

Figure 2. Flow chart of the experiment.

2.1. Thematic Analysis

To conduct our thematic analysis, we first reviewed all the feedback from the think-aloud recordings. We manually segmented and transcribed all 18 VR recordings. We had a total of 551 utterances. We then gave descriptive semantic labels to each utterance. This allowed us to get an initial overview of our data. We then reviewed those labels and identified common themes between them. We identified five themes, each with two categories:

- Experience (Feedback/Aesthetics)
- Mechanics (Actions/Bugs)
- Resources (Equipment/Lesson)
- Likes/Dislikes
- Other (Narration/Off-Topic)

Here, *feedback* refers to the response users get from actions, such as an onion changing color when it cooks. *Aesthetics* refers to the appearance of the app. *Actions* refers to the way users interact with items. *Bugs* refers to unintentional application behavior. *Equipment* refers to the VR headset and controls. *Lesson* refers to learning support, such as the need for hints or translations. *Likes/dislikes* refers to user opinions. *Narration* refers to users describing their own actions. *Off-topic* refers to comments not relevant to the task. We annotated each utterance with these labels. Finally, we quantified the occurrences of each label by percentages, shown in Table 1.

3. Results and Discussion

In this work, we investigated our think-aloud data with a novel thematic analysis composed of five key themes, each comprising two categories: experience, mechanics, resources, likes/dislikes, and other feedback. These codes provide a high-level analysis of the feedback we got from participants. As seen in Table 1, the most frequent comments involved narration (38.73%), where participants described their actions in detail, underscoring the immersive nature of the VR environment. The next most common label was lesson resources, appearing in 16.36% of utterances. Notably, participants expressed that the initial lesson resources were insufficient for task completion, highlighting a gap in vocabulary retention and application. The feedback around lesson resources suggests the need for enhanced instructional design, possibly by integrating interactive hints or comprehensive translations within the VR experience. Furthermore, feedback mechanisms within the VR environment proved to be a critical issue, appearing in 11.45% of utterances. Participants often struggled with certain tasks, like washing vegetables, where the lack of clear feedback left them unsure if they had successfully completed the step. This issue was exacerbated by technical bugs, such as ingredients getting stuck in virtual appliances, which disrupted the learning flow and caused frustration among users. Such interaction feedback is crucial for reinforcing language learning through task completion and needs significant improvement. By eliciting this feedback from users, we can easily identify issues which hinder the learning process and can be resolved before deployment.

Table 1. Frequency of each label across the 551 utterances in the dataset.

Theme	Category	Example	Percent
Experience	Feedback	“Oh, it’s browning!”	11.45
	Aesthetics	“Is this an onion?”	7.64
Mechanics	Actions	“How do I cut this?”	6.00
	Bugs	“The onions got stuck”	10.00
Resources	Equipment	“How do I turn around?”	4.18
	Lesson	“There are some words I don’t remember”	16.36
Likes/Dislikes	Likes	“I really love the fish”	2.18
	Dislikes	“I don’t like the onions”	0.55
Other	Narration	“I need an onion”	38.73
	Off-Topic	“It should be fine”	2.91

This work emphasizes the need for user input on learning environments in VR. Our study underscores the viability of VR for language learning, with participants showing a clear preference for the immersive VR environment over traditional methods [11]. Our results show strong engagement with the app, with think-aloud comments signaling focus on the task at hand. Our analysis also highlights crucial areas for improvement, including lesson depth and interaction feedback, which are essential for developing effective VR-based language learning applications. By identifying these needs and issues before deployment, we can refine the educational experience for learners. Specifically, the initial lesson will be re-designericd, and hints/translations should be provided during the task. Moreover, the visual and audio feedback from actions will be further developed to clearly signal a successful action. Think-aloud is a strong tool for eliciting real-time user feedback while users are still engaged with VR and provides moment-to-moment insights from users that directly link to specific user experiences. Toward the end of an improved language learning modality, we will apply this feedback to ensure a positive experience with sufficient resources for learners to succeed.

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