UNIVERSIDADE FEDERAL DE JUIZ DE FORA
FACULDADE DE LETRAS
PROGRAMA DE PÓS-GRADUAÇÃO EM LINGUÍSTICA

Ana Maria Vieira Monteiro

Virtual reality as a tool for foreign language vocabulary learning

Juiz de Fora
2021

Ana Maria Vieira Monteiro

Virtual reality as a tool for foreign language vocabulary learning

Tese apresentada ao Programa de Pós-Graduação em Linguística da Universidade Federal de Juiz de Fora como requisito parcial à obtenção do título de Doutora em Linguística. Área de concentração: Linguística Aplicada

Orientadora: Prof.ª Dr.ª Patrícia Nora de Souza Ribeiro

Coorientador: Prof. Dr. Thies Pfeiffer

Juiz de Fora

2021

Ficha catalográfica elaborada através do programa de geração
automática da Biblioteca Universitária da UFJF, com
os dados fornecidos pelo(a) autor(a)

Vieira Monteiro, Ana Maria.
Virtual reality as a tool for foreign language vocabulary learning / Ana Maria Vieira Monteiro. -- 2021.
171 f.

Orientadora: Patrícia Nora de Souza Ribeiro
Coorientador: Thies Pfeiffer
Tese (doutorado) - Universidade Federal de Juiz de Fora, Faculdade de Letras. Programa de Pós-Graduação em Linguística, 2021.

1. Virtual Reality. 2. Immersion. 3. Foreign Language Vocabulary Learning. 4. Affect. 5. Flow. I. Nora de Souza Ribeiro, Patrícia , orient. II. Pfeiffer, Thies, coorient. III. Título.

FEDERAL UNIVERSITY OF JUIZ DE FORA
RESEARCH AND GRADUATE PROGRAMS OFFICE

Ana Maria Vieira Monteiro

Virtual reality as a tool for foreign language vocabulary learning

Thesis submitted to the
Graduate Program in Linguistics
of the Federal University
of Juiz de Fora as a partial
requirement for obtaining
a Doctorate's degree in Linguistics.
Concentration area: Linguistics

Approved on 29 of november of 2021.

EXAMINING BOARD

Professor / Dr. Patrícia Nora de Souza Ribeiro – Academic Advisor
Federal University of Juiz de Fora

Professor / Dr. Thies Pfeiffer
University of Applied Sciences Emden/Leer

Professor / Dr. Marta Cristina da Silva
Federal University of Juiz de Fora

Professor/ Dr. Rogério de Souza Sérgio Ferreira
Federal University of Juiz de Fora

Professor/ Dr. Reinildes Dias
Federal University of Minas Gerais

Professor/ Dr. Sandra Regina Buttros Gattolin de Paula
Federal University of São Carlos

Juiz de Fora, 29/11/2021.

Documento assinado eletronicamente por **Patricia Nora de Souza Ribeiro**, **Professor(a)**, em 29/11/2021, às 15:40, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Marta Cristina da Silva**, **Professor(a)**, em 01/12/2021, às 15:34, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Rogerio de Souza Sergio Ferreira**, **Professor(a)**, em 01/12/2021, às 15:51, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Reinildes Dias**, **Usuário Externo**, em 01/12/2021, às 16:14, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Sandra Regina Buttros Gattolin de Paula**, **Usuário Externo**, em 01/12/2021, às 18:48, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Tiago Timponi Torrent**, **Coordenador(a)**, em 01/12/2021, às 19:00, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Ana Maria Vieira Monteiro**, **Professor(a)**, em 02/12/2021, às 08:10, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

A autenticidade deste documento pode ser conferida no Portal do SEI-Ufjf (www2.ufjf.br/SEI) através do ícone Conferência de Documentos, informando o código verificador **0574740** e o código CRC **82376C6E**.

ACKNOWLEDGMENTS

I Thank Dr. Nora for her guidance and restless support to this research. Even through difficult times her supervision kept me on the right track to remain hopeful. I thank Dr. Pfeiffer for welcoming me to Germany, at Bielefeld University, and the collaboration initiative between UFJF and the University of Applied Sciences Emden/Leer.

I also thank Christiane Freese, from the Skills Lab at Fachhochschule Bielefeld and the undergraduate and graduate students from the mentioned institutions who participate directly at the making and testing of the immersive virtual learning environments described in this thesis: Anila Dawar, Felix Dyck, Jennifer Bitschene, Michael Gröning, Morten Biermann, Muhammad Katri, Teena Chikaral, and Tim Heptner. An especial thank you to Carolin Hainke and Leonard Meyer, from the University of Applied Sciences Emden/Leer, for over a year of dedication to improving the Virtual Reality learning environment. These acknowledgements would not be complete without the mention of gratitude to all the students who accepted to participate in the experiments described in this thesis.

This work was funded by Federal University of Juiz de Fora and the National Council for Scientific and Technological Development (CNPq).

A student is sitting in front of a color video monitor connected to stereo headphones and a tiny microphone; at her fingerprints are a computer keyboard and mouse. Out of sight is a powerful computer CPU [...]. Using the mouse, the student points at a little square on the screen, clicks, and the screen fills with the sights and sound of Madrid. A voice asks her (in Spanish) if she is ready to continue; speaking into the microphone, she answers, 'Si.' [...] The screen now shows the street in front of Javier's apartment. She rings the doorbell with a mouse-click and Javier appears on the screen. [...] The student begins to ask questions. At times Javier seems reluctant to talk and she must rephrase her questions to get him to respond. (UNDERWOOD, 1989, p. 80 apud CHAPELLE, 2001, p. 14).

ABSTRACT

The purpose of this research was to investigate the potential of virtual reality (VR) technology for foreign language vocabulary learning, based on the motivational theories of affect (SCHUMMAN, 1997) and flow (CSIKSZENTMIHALYI, 1990). From the theoretical framework a model was developed to guide the making and analysis of VR language learning scenarios. This model was applied to analyze the collected data from three virtual environments implemented for this research: a mobile VR tour, an immersive VR healthcare training program, and its desktop version. The first environment, a mobile VR tour at the Frida Kahlo Museum, in Mexico, was conducted with 18 students from English courses at Faculdade de Letras (UFJF). The second experiment, a comparative one, had a sample of 14 students from undergraduate healthcare courses at UFJF. These experiments also considered the proficiency levels of its participants in relation to their quantitative and qualitative results. The results of both experiments support the evidence that VR, both in its mobile modality and immersive one contributes to the learning of foreign language vocabulary. As for the comparative study, it was seen that immersive VR had a learning significance advantage over the desktop environment, except for the participants categorized with an elementary level of fluency, in the immediate post-test. In the late post-test, after 21 days, the results suggested that both the desktop and the immersive VR learning environments had the same rate of retained learned words, except for the intermediate group which scored better among participants from the experimental group. Thus, immersive VR showed to be more relevant for this level in a long-term recall of FL vocabulary. Concerning the qualitative data, this thesis focused on the influence of affect in the way participants learned from the VR environments. Both experiments retrieved data from the categories of motivation contained in the model, with an emphasis on novelty and pleasantness. The exception was the category of flow, which could only be hypothetically verified in Experiment two. A fourth environment, in which improvements on immersive techniques were made and the variable flow would be verified, is described in this thesis at its methodological level, since its testing could not be implemented due to the COVID-19 pandemic.

Keywords: Virtual Reality. Immersion. Foreign Language Vocabulary Learning. Affect. Flow.

RESUMO

O objetivo desta pesquisa foi investigar o potencial da tecnologia de realidade virtual (RV) para a aprendizagem de vocabulário de língua estrangeira, com base nas teorias motivacionais de afeto (SCHUMMAN, 1997) e *flow* (CSIKSZENTMIHALYI, 1990). Do referencial teórico um modelo foi desenvolvido para orientar a construção e análise de cenários de aprendizagem de língua em RV. Esse modelo foi aplicado para analisar os dados coletados de três ambientes virtuais implementados para esta pesquisa: um tour em RV móvel, um programa de RV imersiva para treinamento em cuidados em saúde e a versão deste em aplicativo desktop. O primeiro experimento, um tour de RV móvel no Museu Frida Kahlo, no México, foi realizado com 18 alunos de cursos de Inglês da Faculdade de Letras (UFJF). O segundo experimento, de caráter comparativo, teve uma amostra de 14 alunos dos cursos de graduação da área da saúde da UFJF. Esses experimentos também consideraram os níveis de proficiência de seus participantes em relação aos seus resultados quantitativos e qualitativos. Os resultados de ambos os experimentos corroboram as evidências de que a RV, tanto na modalidade móvel quanto imersiva, contribui para a aprendizagem do vocabulário de uma língua estrangeira. No estudo comparativo, verificou-se que a RV imersiva teve uma vantagem de aprendizagem sobre o ambiente desktop, exceto para os participantes categorizados com nível elementar de fluência, no pós-teste imediato. No pós-teste tardio, após 21 dias, os resultados sugeriram que tanto o ambiente desktop quanto o ambiente imersivo de aprendizagem em RV apresentaram a mesma taxa de aprendizagem de palavras, exceto para o grupo intermediário que obteve melhor pontuação entre os participantes do grupo experimental. Assim, a RV imersiva mostrou-se mais relevante para esse nível em uma recordação de longo prazo do vocabulário de língua estrangeira. No que diz respeito aos dados qualitativos, esta tese tem como foco a influência do afeto na forma como os participantes aprenderam com os ambientes de RV. Ambos os experimentos recuperaram dados das categorias de motivação contidas no modelo, com ênfase nas categorias novidade e prazer. A exceção foi a categoria *flow*, que só pôde ser hipoteticamente verificada no Experimento dois. Um quarto ambiente virtual, no qual melhorias nas técnicas imersivas foram feitas e a variável *flow* seria verificada, é descrito nesta

tese em seu nível metodológico, uma vez que sua testagem não pôde ser implementada devido à pandemia de COVID-19.

Palavras-chave: Realidade Virtual. Imersão. Aprendizagem de vocabulário em Língua Estrangeira. Afeto. *Flow*.

ILUSTRATIONS LIST

LIST OF TABLES

LIST OF ACRONYMS

AL	Applied linguistics
AMTB	Attitude/Motivation Test Battery
AR	Augmented reality
CASLA	Computer-Assisted Second Language Acquisition
DR	Dispositional representations
ESP	English for specific purposes
HD	High definition
HDM	Head Mounted Display
FL	Foreign language
FLL	Foreign language learning
L1	First language
L2	Second language
SLA	Second language acquisition
SLL	Second language learning
VR	Virtual reality

TABLE OF CONTENTS

1 INTRODUCTION

Computer technologies have always been seen as potential tailored-made systems for learner's pace and needs. This view is also a consequence of applied linguistics' intimate relationship with language problems in the real world[1]. Already in the 1980s, developers envisioned a system capable of reproducing realities of everyday language use that could be observed and learned implicitly. With subsequent technological advances, applied linguistics (AL) researchers hoped to combine artificial intelligence, computational linguistics, and voice recognition into multimodal interactive programs (CHAPELLE, 2001).

Around the same time, with the rise of the personal computer and with Computer-Assisted Second Language Acquisition (CASLA) becoming a field, some linguists saw within computer science a kind of toolset for the reproduction of natural language behaviors. It is also during the first years of CASLA that concordancers were created, programs which list occurrences of given words or phrases with their frequency and contextual use. It became increasingly the case that hypermedia systems were designed to adapt themselves to the needs of an individual user and provide feedback on a one-to-one basis. Such phenomena might be due not only to the notion that conventional methods fail by the uniformity of their didactic schemes but also because of the possibility of instant communication between the learner and the real world of the target language on the internet, which started its popularity in the 1990s.

Until the early 2000s, evaluative studies of the effects of hypermedia on second language acquisition were based on the use of glosses (annotations in the form of links whose function is to provide meaning to unknown words) and online dictionaries. These resources relied not only on text, but also on audio and image files that were presented as means of vocabulary representation. In other words, when it comes to the internet, multimodality, which was not new, becomes hypermedia. What became new, perhaps, was the perspective with which it could be

[1] Since the beginning of AL as an institutionalized discipline, in the 1980s, there has been an interest focused on knowledge of a language in its relation to decision-making processes (SIMPSON, 2011). Even with new emerging relationships between language and other disciplines, such as Psychoanalysis, Cognitive Sciences and Information and Communication Technologies (KLEIMAN; CAVALCANTI, 2007), AL draws most of its attention to language pedagogy, teaching and acquisition (KAPLAN, 2010).

deployed since hypermedia resources can match different learners' individual preferences.

Although much of what has been studied concerning desktop applications have been transferred into the rationale behind mobile applications, the latter has made a new level of interactivity possible. Mobile learning is a paradigm under which a personal digital assistant guides the learner. Even though mobile applications had been reported on SLL (second language learning) research since the early 2000s (CHINNERY, 2006), it was not until smartphones had replaced their predecessors, around the year 2010, that this research topic had left its marginal position in the AL's agenda, possibly due to the technology available at the time, which limited the multimedia features of cellphones. Since then, studies in mobile-assisted language learning (MALL) have targeted a varied use of the resources of these devices for vocabulary learning, among them, SMS (short message service), emails, online games, and video caption.

Still through smartphones, research in the SLL field began experimenting with augmented and virtual realities, mainly in the vocabulary domain. Although augmented reality (AR) represented a step forward towards a more contextualized SLL, a significant change in immersive learning came about with the advent of virtual reality devices, in commercial scale, around the year 2014.

The term virtual reality (hereafter referred to as VR) has gained increasingly academic attention in recent years, and a possible reason for that might be its spread-out applications across different sectors of life. This was made possible, hypothetically, because the technology that enables it, hardware and software, has taken a non-exclusive approach to neither a system nor a niche. Although, to date, the game industry has been taking the lead on the development of VR, many other markets have shown interest in it, education included.

After following the development of VR technology within second language learning, over the past years, this thesis unfolds its interest both in mobile VR and immersive VR. The former means that a cellphone application can offer a basic level of immersion to its user by splitting the screen into identical images, one per eye, which will be seen through lenses contained in a visor/headset. The latter makes use of proper immersion techniques, which include 3D images, simulation of touch through controllers, and freedom of movement in the virtual environment despite the limitations of the physical space. Taking that into consideration, this thesis aimed to

experiment with VR as a tool for vocabulary learning considering its potential for enhancing learners' motivation in the activity. Besides, the audio-visual and tactile stimuli in VR have been related to positive results both in knowledge tests and in the motivation of learners to study a given content (HUANG; RAUCH; LIAW, 2010). Nonetheless, all few studies in second language vocabulary learning in VR are focused on the cognitive aspect of the experience. Motivation is rather mentioned as a consequence of the VR experience alongside learning, instead of being considered a condition for it, an idea that has had a considerable attention in AL. Thus, it could be the case that prior to immersion, one must consider learner's willingness to be immersed in the first place.

Perhaps the prominent feature of VR is its potential to transport one's senses to a sort of parallel world. This sense of presence, however, is not only a consequence of the technology but also a psychological feature, dependent on the affective content of the environment (BAÑOS et al., 2004). And the theory that unites affect, motivation and second language learning has been proposed by Schumann (1997), in his work entitled *The Neurobiology of Affect in Language*. According to this approach, emotions[2] underlie cognition from its very beginning, which means, at the moment of signal perception. The consequences of the aspects that support his claim are discussed in second language classroom practices and methodologies throughout his work.

The terminology for affect includes a vast list of psychological and biological definitions. Schumann (1997) has united these two features into his four categories of appraisals[3], supposedly deliberated by the learners' brain when faced with the task of acquiring a second language. Consequently, the way information gets to its recipient, as well as how it is interpreted according to learners' history and self-image, makes affect intrinsically linked to motivation - according to Schumann (1999), they can even be considered synonyms. This means that a simulation in VR of a real-life communication in the targeted language would be relevant not only because of a higher sense of presence in the activity, but because of the way learners feel when presented to a task in this type of environment.

---

[2] Here, considered to be of biological origin, generated by organic reactions to what is experienced at the time (WALLON, 1968).

[3] Schumann has derived his studies of affect partially from the *appraisals theory*, a framework for studies in the field of psychology and communication.

Considering the novelty of VR technology in the realm of AL, and the lack of attention to affective components of the immersive learning experience, the questions that have been guiding this research are:

1) Does VR contribute for short and long-term learning and recall of English vocabulary as a foreign language (FL)?

2) Which learning environment, desktop or VR, is the most efficient for FL vocabulary learning?

3) Comparatively, which student benefits the most from VR for FL vocabulary learning – elementary, pre-intermediate or intermediate?

4) How does affect influence English vocabulary learning in VR?

To obtain plausible answers from a little investigated field, it was needed to experiment with VR for foreign language vocabulary learning, meaning the making of such virtual environments and then do the testing, including a comparative one. It is also worth mentioning that there have not been studies in the field among public Brazilian schools and universities.

This thesis is structured as the following. Chapter two provides a general view on VR technology since it is a new area of knowledge for applied linguistics. Thus, it presents the existent works in the area, a literature review whose purpose was to gather research on VR for second language vocabulary. Besides their results, it was also important to see what theories supported those experiments and findings.

Chapter three delved into the concept of affect, from a broader definition to its application in SLL. Before this thesis, theories on multimedia learning were at the core of the research that sought to answer the question whether virtual reality could be more effective than other media. As it became clear over time, some characteristics of this medium in its current state of the art, if compared to the media under scrutiny of multimedia learning theories, seemed to demand a new set of theoretical tools to be properly addressed. Those are, essentially, its novelty in the marketplace and the enhanced sense of presence it has as an effect on its users. Thus, looking at motivational theories gave the research the chance to originally explore this approach to VR technology for SLL. In this chapter, a trajectory of such theories is provided.

Chapter four is concerned about flow, another construct that has been linked to sense of presence in a way that was not mediated by technology, as its author, Csikszentmihalyi (1990) put it. Nonetheless, it is argued here that VR has the

potential to induce flow, a state of mind in which fully immersion is achieved, and based on that motivation and learning can be enhanced. Drawing from this theory for SLL the work by Egbert (2003) is discussed. This chapter ends with the proposal of a model for guiding the making of VR FLL environments and the data analysis of the experiments conducted for this thesis.

Chapter five is dedicated to the methodology used in the experiments, both on mobile and immersive VR. It also details their quantitative and qualitative results, limitations, and partial conclusions. The methodology includes making a second version of the immersive VR scenario, which implemented improvements suggested by the previous experiments but was not tested due to the restrains on research imposed by the COVID-19 pandemic. Both immersive environments as well as the desktop one, developed for the comparative purpose, were made in collaboration with the Cluster of Excellence Cognitive Interaction Technology, Bielefeld University, the Nursing Faculty at Fachhochschule Bielefeld, and the University of Applied Sciences Emden/Leer, German institutions. This part of the research was made possible by a sandwich Ph.D. scholarship granted by CNPq (National Council for Scientific and Technological Development).

Chapter six presents the conclusions drawn from the results achieved by the research and experimental data of this thesis.

2 VIRTUAL REALITY

The popularization of the personal computer and the internet, particularly hypermedia, made researchers start focusing on the advantages of these resources for SLL. Moreover, in the last decade, different ways of inserting hypermedia in the study of vocabulary teaching and learning, other than desktop, have proliferated on mobile interfaces, such as in augmented[4] and virtual reality applications.

To discuss these changes, the VR terminology and technology will be presented, since their understanding seems essential for the reading of both the literature review and the methodology sections. Therefore, although virtual reality is vast in its history, devices, and techniques, the scope of this section was limited to include only the necessary information for this work.

After this introduction to the theme, the VR technology will be placed into the realm of AL, by bringing and discussing the data from the still early experiments using VR gear for second language vocabulary learning. This chapter will be concluded by pointing out a research agenda for further investigation on the topic of VR and vocabulary learning in SLL, namely, the role of motivation in the design of immersive experiences, which has not been explored in the field yet.

Virtual reality is the current metaphor of the ultimate simulation, in which the body is *teleported* to different worlds, aided by the capacity of the brain to suspend disbelief. In VR, this capacity is possible through immersion techniques that allow one's taking for real what is only on the screen, as the gesture of reaching out, in Figure 1, suggests.

By naming an experience VR, it is possible to refer at least to a visualization in 360 degrees of digital content displayed, e.g., inside a visor, called *virtual reality headset* or *HMD* (Head Mounted Display). Such a device fits on the head of its users in a way to block or minimize the interference with the surrounding environment. The image seen on the screen is split into two to create or simulate stereopsis, i.e., the phenomenon of binocular vision in which the brain receives information from two

[4] Augmented reality (AR) uses a smartphone or tablet camera to integrate computer-generated images into the real environment. In a typical example within SLL applications, objects in the real environment are tagged with symbols that are captured by the camera of the device to trigger the images and sounds the user receives on the screen, which may be the spelling of the object in the target language, its pronunciation, or any other relevant annotation. AR applications, therefore, do not block the user's view of what happens outside the device.

identical images, each one seen by an eye from a different angle, and combines them into one tridimensional image, the world as we see it. Stereopsis makes possible the assessment of information regarding depth[5], which is assimilated by the brain when an action is planned or in motion. For what it matters the most for VR applications, this biological aspect induced by technology puts the focus of narratives into the user's action, while 2D images keeps the viewer as a spectator only.

Figure 1 - Exhibition of the short movie *Cooped Up*[6]

Source: Monteiro (2016, p. 66).

Experiments with computer graphics and VR gear date back to 1968. The occasion was the first head-mounted display, invented by Ivan Sutherland. Nonetheless, it was only around the year 2012 that VR headsets connected to computers became a commercially viable enterprise, because the hardware and software components[7] made the experience of immersion a more pleasant one (MONTEIRO, 2016). Motion tracking, using cameras and sensors in VR gear, was also made possible in a more compact way[8].

[5] Even though stereopsis only works in the closes vicinity of the body, up to five to seven meters.

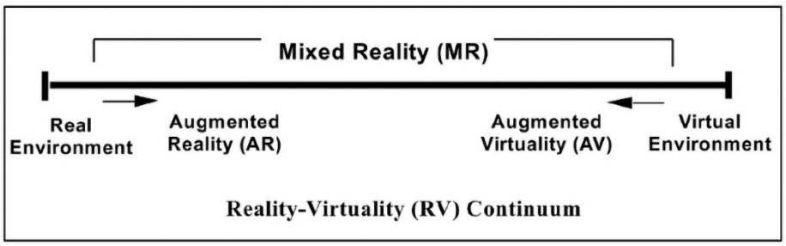
[6] Author's installation placed at the *II Seminário de Pesquisas em Artes, Cultura e Linguagens* at UFJF, 2015.

[7] The components include resolution of the screen of at least full HD (1920 x 1080 pixels), low latency (motion-to-photon delay) and field of view (FOV) closer to non-mediated perception (110° horizontally and 70° vertically).

[8] Motion tracking had been available in other forms, such as in the CAVE (Cave Automatic Virtual Environment) system.

The scale known as *Reality–Virtuality Continuum* (MILGRAM; KISHINO, 1994), depicted below as Figure 2, illustrates how one can place image technologies in regard to the degree of influence of the outside world (real environment) on the virtual environment. In this scale, the concept of immersive virtual reality is the closest to the farthest right since its devices and techniques are meant to make the user of such a system to act as if they were actually in the virtual world. In order to acquire such a *sense of presence*, a full *immersion* would be necessary. Thus, here immersion means the techniques that enable the user of a system to feel an illusion of non-mediation between them and the virtual world (LOMBARD; DITTON, 1997). Or, simply put, immersion is what is needed, on the technological side, for sense of presence to occur in humans within a VR set up.

Figure 2 - Reality–Virtuality Continuum



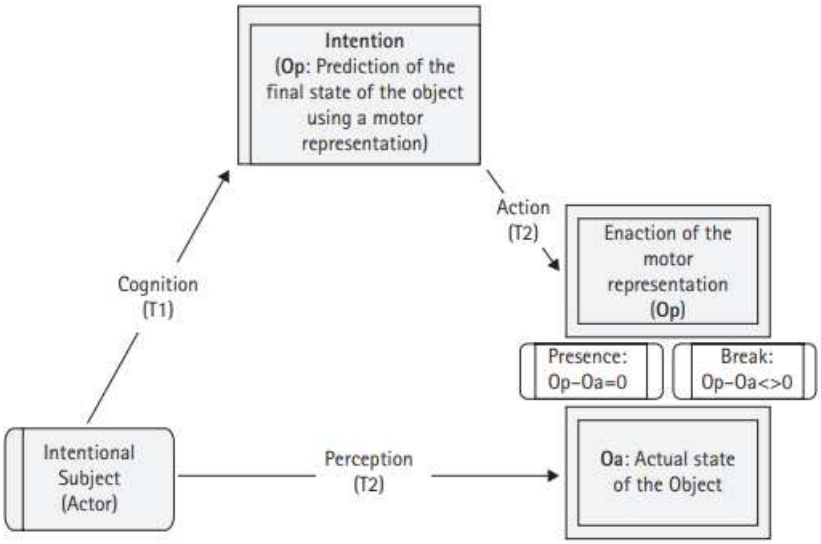
Source: Milgram and Kishino (1994, p. 1321).

Sense of presence has its own academic interest concerning other fields such as experimental Psychology. What is perhaps most important here is to retain from this concept a useful scheme on what is required for the sense of presence to occur in virtual environments so that immersion can group its techniques accordingly. Towards this direction, the work by Riva and Waterworth (2013) presents a model (Figure 3) to explain how maximum presence is achieved, by a conscious creature[9]. It begins with an intentional subject or actor, with an intention, a prediction of the final state of a given object or him/herself, using a motor representation. According to this scheme, presence occurs as long as the enaction of the motor representation is equal to the actual state of the object (RIVA; WATERWORTH, 2013). Anything less than that means there was a break in the subjective feeling of being present. Towards an application of this model in media, there must be a design that is as

[9] In this paper, the authors present a variation in degrees of presence as consciousness states, following Darwin's theory of evolution.

interactive and as intuitive as possible, which means that the user of such a system can replicate much of what they do in the real world in the virtual one, knowing intuitively how.

Figure 3 - Simulative forward model



Source: Riva and Waterworth (2013, p. 214).

Taking the model as a starting point to define characteristics of VR which would provide a user with as-much-possible presence in it, technically speaking, my definition of VR would consider at least the following: a) a three-dimensional computer-generated environment – neither still photography nor video; b) multi-sensory experience – one needs to be able to perceive the virtual environment using the sense organs just as they do in the real one[10]; c) a system that allows real-time feedback from its user's interaction with it. This means that no perceivable delay should be experienced between an action from the user and a reaction from the system.

The design characteristics of a virtual world are in connection to other three standards which should be present in a VR environment: navigation, selection, and manipulation. A three-dimensional space means exactly the possibility to navigate and interfere in the virtual environment, just as one could do in a real one, instead of

[10] Ultimately, this would mean to include, in the VR experience, the senses of taste and smell. A few experiments have been published about it, but for more realistic current scenarios, vision, hearing, and touch are good enough to induce the sense of presence given the fact that most experiences are short in time and task-oriented.

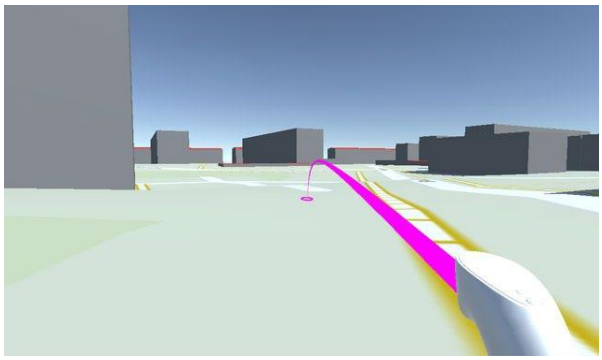
only contemplating it as a fourth wall, which would be the case of photography and film, even though there are levels of interactivity on them in VR, as it will be discussed here later on.

When a virtual world allows navigation, it means that its user can alter their position in it, which can be done either by their avatar, a representation of their body as a third-person digital form; or point-of-view, first-perspective camera (Figure 4). Navigation can serve the purposes of exploration, i.e., with no specific goal or build knowledge of the space; search, to find something or somewhere; and maneuvering, e.g., to perform a task, to avoid obstacles. Some common techniques that enable navigation in VR, which are recurrent in the data presented further on in this work, are the mapping of the physical movement into the virtual world, which uses head trackers (sensors), and teleportation, meaning a sudden change of one's location in space. The latter is usually applied when the user cannot walk to the target point due to limitation of their physical space. After clicking on the target on the floor, represented on Figure 5 by the circle at the end of the light ray, the user finds themselves there, as if they had jumped.

Figure 4 - Head tracking in the Oculus Rift Development Kit. Below, the illustration is the Oculus' headset (on the left) and the scene it is displaying (on the right)

Source: LaValle et al. (2014, p. 187).

Figure 5 - Standard VR point and click teleportation



Source: Berger and Bill (2019, p. 4).

In the commercial state-of-the-art VR devices, navigation is directed affected by head tracking. In a typical set up, the VR headsets should allow its user six degrees of freedom (6 DoF)[11] to experiment the virtual environment. This means the representation on the screen of the body moving right and left; up and down; forward and backward; combined with rotation along three perpendicular axes, known, in computer graphics, as X, Y and Z, as depicted on Figure 4. Here, the user's movement in any direction depicted by the arrows is represented accordingly in the image he sees. When the body positions are not tracked in the virtual world, the user of the system can feel a break in presence, which can be the case of the so-called *mobile VR*. In this case, the spectator is surrounded by images, but their body presence – its tracking, does not affect the scene in any way. Another concern about mobile VR is that its head tracking is done by the built-in accelerometer of the cellphones, whose lag[12] can cause headaches and motion sickness in many users.

In mobile VR, a cellphone screen is also split into two identical images (one per eye), so stereopsis can simulate tridimensional vision (see Figure 6). The cellphone is inserted into a headset which contains a pair of lenses whose function is to make the users' eyes focus the images even though they are displayed very closely. It also makes the field of view larger than what would have been possible with the smartphone screen. The screen appears, for the brain, at about two meters distance, which makes the accommodation of the eyes relaxed. The headset also holds the cellphone still and block the exterior view. An example of a simple and low-

[11] For comparison, a typical mouse has two degrees of freedom since it can only go up and down, right and left.
[12] In this case, a noticeable delay by the viewer between its movements (input) and the correspondent image seen on the screen (output).

cost headset is the Google Cardboard (Figure 7). This device started to be sold in 2014, although Google itself also published a DIY (do it yourself) tutorial on how to make one. In fact, there are only three materials involved in the making of such a headset: cardboard, plastic lenses, a magnet, and an elastic band. In this type of device, the user can access a link simply by looking at it for a few seconds or by sliding the magnet placed in the side of the headset, which interferes with the screen as if it had been touched. More about the technicalities of mobile VR will be seen in the methodology section. Since the Google Cardboard launch, other mobile HMDs made to the market as more affordable options for VR applications. They are made from either cardboard or plastic and come from various manufactures.

Figure 6 - One frame of a scene in Mobile VR

Source: Monteiro and Ribeiro (2020, p. 1325).

Figure 7 - Example of how Google Cardboard is used with a smartphone

Source: Peltekova and Stefanova, 2016.

In this way, the term *virtual reality* names a wider spectrum of visual and narrative experiences, from the simplest 360-degree-photo on a cellphone, viewed through a cardboard headset, to sophisticated computer graphics accessible through VR gear, which includes built-in full HD screens in the headsets, motion tracking and hand controllers, as exemplified per Figure 8. Here, after selecting an icon, the viewer sees more information about the scene in the forms of text and picture. Regardless of the device, the narrative can be a compelling one serving different purposes, such as entertainment, education, training, and contemplation, although, in practice, these purposes are often mixed.

Figure 8 – HCT Vive headset, controllers, and lighthouses (sensors) being used by researchers at ESA's mission control centre in Darmstadt, Germany

Source: ESA (The European Space Agency)[13].

The other two components of the VR experience are selection and manipulation of objects. They are intrinsically related since it is not possible to manipulate an object in the virtual environment before selecting it, even if this selection is not apparent, i.e., it does not cause any change in the image seen. However, for a more fluid interaction between user and system, selection feedback, for instance, in the form of object highlighting or tactile vibration, is considered important to indicate to the user they will be able to manipulate that object if they wish to. Thus, manipulation consists of change in some parameter or state of an object previously selected (TORI; HOUNSELL, 2019). Although a device, usually a

[13] The full term of the creative commons license can be retrieved from <http://www.esa.int/ESA_ Multimedia/Terms_and_Conditions>. Accessed on 10 dec. 2020.

controller, is necessary, manipulation in VR can be done by direct interaction, as per simulating hand grabbing.

A less technological feature to be discussed here is, perhaps, equally important for mediated sense of presence. Some immersive techniques, in this sense, are first-person perspective of the narrative; realistic responses from the virtual environment from changes made by the user in it, and conversational interactions with virtual agents. Despite this, 360° videos, computer animations, and photos in mobile VR have also been called immersive narratives, requiring much less responsiveness from or interference in the system.

In general, VR narratives could be divided into two main purposes. One sees narratives as means to demonstrate immersion techniques (MONTEIRO, 2016). It could be said, immersion as a means to its end. Such VR productions could be compared to the era known as Early Cinema (1890 - 1905), when the movies were a presentation of the technology rather than its narratives, an idea later on represented by the concept of Cinema of Attractions (GUNNING, 1990).

On the other side of VR storytelling, it could be grouped those productions which have immersion as a tool, a means to an end. In the field of psychology, for example, VR has been used as a controlled resource in the treatment of phobias (RIVA, 2009), psychoses (RUS-CALAFELL et al., 2018), eating disorders (CLUS et al., 2018) and anxiety (CARL et al., 2019), among other conditions, with favorable results to clinical practice.

Another type of psychological impact of VR narratives has been often referred to as to induce *empathy* (YEE et al., 2008), which can be described as the ability of people to understand each other through the sharing of affective-cognitive responses linked to specific situations (SAMPAIO; CAMINO; ROAZZI, 2009). A possible consequence of this effect, in its social dimension, was described by Herrera et al. (2018), in a study where participants who were exposed to VR, as a means of information about people living on the streets, signed a petition supporting the construction of popular housing in a significantly higher number than those in the control group.

In the pedagogical domain, VR narratives have been called an innovative way to present content, especially in the field of hard sciences, where some concepts gain a new perspective when they can be perceived in 3D and 360 degrees, as in demonstrations of structures in atomic levels (CURCIO; DIPACE; NORLUND, 2016).

In addition to this trend, which focuses on demonstrations and problem-solving, simulations of fieldtrips to historical sites are also found, where the user receives information in the form of text and/or audio while contemplating the virtual environment. In sum, one could say that VR learning modules are a justified enterprise when they “implement contexts and relationships not possible to achieve in a traditional learning setting” (Yee et al., 2015, p. 106).

When it comes to the field of SLL, some experiments have been conducted in line with various methodologies as researchers are only beginning to discover VR as a learning tool, without enough experimental research data and supporting theories to either refute or encourage the use of VR in language courses and methodologies. As it was tried to be shown on the next section, researchers are only beginning to discover VR as a learning tool. Even so, there have been commercial applications[14] for language teaching in immersive scenarios such as the ones described above. Thus, the problem, as seen in Moreno and Mayer (2001), can be that new technology does not necessarily address learning differently. Besides, there is always the risk of taking immersion to a level illustrated ironically by Stevick (1996, p. 43) towards affect in SLL: “Before us nothing was. And after us nothing else need ever be. […] If we can only – if we will only manage our teaching so as to take leaner affect into account, then dead materials will come to life, and the lead-headed students will produce golden achievements”.

In classroom scenarios, the VR gear that has been used is mostly the mobile VR. This sort of arrangement seems to be the case, at least in part, because it is low-cost and simple to set up. Up to date, some of the most expressive immersive VR headsets in the market vary from 399 to 799 US dollars[15] and their functioning depend on powerful CPUs[16]. Thus, in addition to research on the possible positive effects of VR in the field of education, one has to think about how realistically accessible technology will be in the educational context, especially in classrooms (PELTEKOVA; STEFANOVA, 2016).

---

[14] The applications from where the comment was based can be seen on: <https://www.mondly.com/vr-for-daydream>; and <https://www.oculus.com/experiences/gear-vr/1129567930394285/?locale= en_US>. Accessed on 29 jul. 2019.

[15] As last consulted in July 2019.

[16] The requirements vary according to the VR headset, but generally, computer items such as the processor, graphics card and memory should be the closest to the high-end versions in the market.

Therefore, the Google Cardboard and similar HDMs had been used to view, for example, the Google Expeditions application, whose purpose is to simulate field trips for groups of students guided by their teacher. This application, developed in 2015 and discontinued in 2021, had over 500 experiences (tours) available for free download, along with text-based scripts for the guide of the virtual experience, usually done by 360-degree photos. Parmaxi, Stylianou, and Zaphiris (2017) reported a study using Google Cardboard and Expedition in an English classroom, and according to them, students were more motivated and at ease with the oral task of describing a place they *had just been at*, using VR, then they would be having to speak about an imaginary experience.

2.1 RESEARCH ON VIRTUAL REALITY IN SECOND LANGUAGE VOCABULARY LEARNING

This section intended to have a larger sum of studies on VR in the broader field of second language other than vocabulary learning. Nonetheless, research retrieved, initially, only a few publications. They also revealed to have in common the prerogative that, unlike other forms of digital content, the technical attributes of VR allow the creation of experiences remarkably close to those in real contexts. This feature is seen as an advantage for the VR learner because of the so-often impossibility of actually being immersed in a language-speaking community (GUPTA, 2016) and for enabling learning in less artificial contexts, such as traditional role-plays (PARMAXI; STYLIANOU; ZAPHIRIS, 2017; IBHAR; MAY; YUNUS, 2018).

The mobile and immersive VR applications designed specifically for SLL have been following the path of contextual vocabulary based on simulations of a real-life scenario. This usually means, for the narrative, the elaboration of tasks where vocabulary is put in action through the manipulation of objects, in the virtual world, which a set of pre-defined target-words represent. Besides, each object can display relevant multimedia annotation, such as its name and pronunciation. Figure 9 shows an example of this type of information display, a screenshot taken from my experiment with immersive VR, described in the Methodology section.

Figure 9 - View of the application, in first-person perspective, for teaching English words in the context of nursing

Source: The author (2019).

For the literature review under this topic, comparative studies have been searched both on quantitative and qualitive aspects, since they are a starting point to stablish the characteristics of the VR medium, during the learning experience, that differentiate it from other digital media, such as paper and a desktop computer. The scope of the review considered the publications from 2014 - when mobile VR has gained a commercial enterprise, making it accessible to teachers and researcher alike, to 2019. As for the database of this search, the following online journals have been used, continuing the review of the literature in these same journals, made by Lin and Lan (2015) on language learning in a virtual environment*:* *Language Learning & Technology*, *CALICO Journal*, *Computer Assisted Language Learning*, and *ReCALL*. Google Scholar and two digital libraries, IEEE Xplore and ACM Digital Library, internationally recognized for their publications and conferences on virtual and augmented realities, have been also used. All searches contained the relevant keywords to select the studies which evaluated second (or foreign) vocabulary learning in VR.

In mobile VR, the literature review on this topic retrieved only one study, within the scope of English for specific purposes (ESP), showing statistically significant quantitative results in vocabulary tests in favour of 360-degree VR videos in comparison to TV-screen-video instruction (MADINI; ALSHAIKHI, 2017).

Research on immersive VR, on the other hand, has shown more studies, although it remains a niche. In the cognitive path, Legault et al. (2019) and Cho

(2018) found that participants in the VR experimental groups[17] had better results in vocabulary tests applied immediately after exposure to the learning environments. Also, among these participants, less-successful second language learners within the experiment had a significant higher score in the test, if compared to the results of successful learners, for whom the media did not significantly alter their learning performance (LEGAULT et al., 2019).

On the counter-side of evidence, in Vazquez et al. (2018) and Gupta (2016), the results of immediate post-exposure vocabulary tests, within their experimental groups, did not show evidence that VR could be more effective than the other media (desktop and flashcards, respectively) contemplated in each study. However, in these studies, long-term vocabulary tests were also applied seven days after the exposure, showing that participants from the VR groups had better retention rates than those who were on the control groups. Both studies also mentioned that the immediately-after-exposure results of the experimental groups may be influenced by the fact that the VR media was unfamiliar to participants as a vocabulary learning tool, meaning that it could have been distracting and/or difficult to use. “Given the positive effect on retention, this work suggests that with additional exposure and conditioning to the effect of ‘novelty’, kinesthetic language learning in virtual reality can positively impact language education” (VAZQUEZ et al., 2018, p. 276).

Through the theoretical point of view, the cognitive scrutiny in these studies have been backed up with a few theories. Legault et al. (2019) and Vazquez et al. (2018) had in common the embodied cognition framework to raise their hypothesis and explain their results. Vazquez et al. (2018) cited works on embodiment effect on memory for vocabulary acquisition, whilst Legault et al. (2019) point out to the validation of their findings to the embodied cognition hypothesis (BARSALOU, 2008), according to which, “learning in contexts involving a high degree of perceptual and sensorimotor integration is more effectively” (Legault et al., 2019, p. 21). Another possible interpretation of the results of the study, mentioned on the discussion section, is that most of the items whose words were in the vocabulary tests referred to kitchen tools, i.e., are objects that can be manipulated. Thus, according to Legault

[17] The control condition in Legault et al.’s study (2019) was the exposure to explicit vocabulary teaching - L1 (first language, Chinese) to L2 (second language, English), using the screen of a desktop computer to display simultaneously the English word and it’s corresponding Chinese word in audio. In Cho’s work (2018), the control condition was the desktop version of the VR application, i.e., visualized without the HDM.

et al. (2019), the task of learning these words in VR could lead to them having greater embodied representations in the brain, based on Martin et al.'s work. As for Cho (2018), the author's references lied on several studies on the correlation between spatial presence for memory improvement and, in another segment, fostering motivation.

In the qualitative aspects of the studies, motivation and/or learner satisfaction were rated higher in their VR learning environments (LEGAULT et al., 2019; CHO, 2018; GUPTA, 2016) than in the control groups. Yet, none of these studies investigated further the role of motivation as a variable in positive relation to learning or had motivational theories linked to the designs of their virtual environments.

As this literature review suggests, the results on the effectiveness of VR, when compared to other forms of digital content for learning, may be due less to the media and more to individual differences and methodologies. Moreover, the findings of these studies were not built on top of previous ones. In a way, they have all been pioneers of the new technology exploration in the field of second language vocabulary learning.

Still, except for Cho (2018), the studies brought up in this review were focused on the relation between immersive techniques and cognition, and on how learning and memory would be affected by them. The affective aspect of motivation remained as a sub-product of the results, i.e., a finding without mentioned practical consequences. Besides, motivation has not been correlated to learning in none of the studies, even though there is a consolidated research branch in AL in this topic (LÓPEZ; AGUILAR, 2013), as the next section will present.

As a possible conclusion one could draw from the data gathered above, there have not been studies focusing on motivation as a result of immersion techniques, even though the topic seems promising, not only to engage students with an activity but also to increase learning performance. Moreover, motivational theories could also be explored at the design level of the experiment, bearing in mind that sense of presence is not only enabled by immersive techniques, but also dependent on affective components of the hypermedia experience (BAÑOS et al., 2004).

In the work by Schöne, Wessels and Gruber (2019), it is shown that VR experiences become part of a network of autobiographical memories, while images from video, in non-immersive media, remain in the category of isolated episodic events, prone to weaker memorization. Also, according to this study, the emotions

elicited by autobiographical events have greater informative value and are potentially more relevant for the choice of adaptive behaviors, when compared to the emotions generated by the visualization of narratives external to the subject, through traditional screens. The study by Parong and Mayer (2018) showed that motivation to learn is significantly higher in VR, and several studies have shown that learning in immersive VR environments can increase the obtained knowledge and acquired skills while additionally leading to higher engagement and motivation in the learner (CONCANNON; ESMAIL; ROBERTS, 2019).

Towards this approach is the concept of *affect*, since the term accommodates not only motivation but others that follow in importance to achieve learning, such as attention and memory (DALGALARRONDO**,** 2019). The following chapter presents Schumann's theory of affect (1997) as a useful framework for the designing and evaluation of VR content for SLL.

3 AFFECT IN SECOND LANGUAGE LEARNING

It has been recognized that affect is an inseparable set of variables from cognition[18], not only in the field of psychology (VYGOTSKY, 2003; PIAGET, 1977) but also in neuroscience (DAMÁSIO, 1996, 2000). As a background concept throughout this research, whenever *affect* has been evoked, it means, bottom-line, a shift from the focus of attention through excitation of senses (mainly visual and auditory) and/or the eliciting of emotions, whose origin is biological, generated by organic reactions to what is experienced at the time (WALLON, 1968).

Within this definition, it is possible to incorporate all terms related to affect that have been mentioned in the literature about it, such as emotion, feeling, temper, attitude, mood, and motivation, just to name a few. In other words, it has not been a consensus among scientists of the two fields mentioned above about what, exactly, affect refers to. Also understood in this working definition, then, is the notion that the body proper plays a key role in learning, a claim that has been profusely being made in all fields that reject Cartesian dualism[19]. More importantly, each of those terms associated to affect has had a place in AL studies concerning SLL, even though, traditionally, research has separated variables between the ones associated with cognitive functioning, i.e., general intelligence, language aptitude, memory, and the ability to analyze and evaluate; and affectivity, i.e., empathy, language attitudes, language anxiety, and motivation (RICHARDS; SCHMIDT, 2010).

As it was pointed out in the previous section, in the studies about VR as a tool for FL vocabulary learning, motivation, an affective aspect of learning, remains seen as a product of the experience rather than part of it from the beginning, meaning, from the learner's brain signal perception. Important work in SLL, however, has highlighted the relevance of motivation for SL learners, as it will be discussed in the next section. Research in AL, concerning this, has prioritized investigation on

[18] Cognition is seen here as an umbrella-term for the information processing by the brain involving perception, attention, and memory (STERNBERG, 2015).
[19] Such a dualism refers to René Descartes' view of mind, a metaphysical phenomenon, existing independently from the body (matter).

learner's individual preferences (ARAGÃO, 2011), while sociolinguistics has filed the gap where a focus on a social and historical process of SLL has been considered[20].

From here, a general view will be presented of why motivation became an important variable to consider in SLL studies and how the CALL field has incorporated motivational theories in its research, though models of information processing.

3.1 MOTIVATION AS KEY TO SECOND LANGUAGE LEARNING

In a compilation of studies on affect in language learning, Arnold (1999) suggests that managing negative emotions in the second language classroom seems key to learner's motivation. That does not mean only the avoidance of circumstances in which such emotions, e.g., anxiety, would appear, but also carefulness for pleasant situations in the learning process. Pleasure, in this sense, can come from fostering intrinsic motivation, meaning the teacher's ability to lead the learner to mobilize their interests and resources towards their own goal. In other words, the learning experience becomes rewarding in itself (ARNOLD, 1999). An extrinsic motivation, on the other hand, is the desire to be rewarded in consequence of the learning experience outcome, e.g., through grades, prizes, etc., or to escape punishment.

Major works in the field had the role of motivation highlighted among the individual's aspects influencing SLL, such as Krashen's affective filter hypothesis (1991), according to which, low motivation, self-confidence, and anxiety can lift a filter through which the linguistical input *is hard to pass*. The journey of the input in the learner's brain, for Krashen, follows a computational view of brain information processing, i.e., L2 input would pass through neurons of concatenated modules, areas in the brain, from the sensorial organs to apprehension by consciousness and possible memory retention and recovery. When exposed to an L2 passed infancy[21],

---

[20] An example of the type of analysis based on theoretical frameworks within sociolinguistics, when it comes to FLL, can be found in Monteiro and Salgado (2018), on the teaching of Portuguese and Spanish at a borderland in Brazil.

[21] Referred in Krashen's model as learning, a conscious process, which is different from acquisition, an unconscious one, most notoriously highlighted by Universal Grammar (UG) theorists, to whom language learning in infants is due to innate processes that could explain the effortless acquisition of language even in poor exposure to syntax rules. Even critics of UG theory, such as linguist Everett (2012) acknowledge research evidence that there is a limited optimal period, of about four years after birth, for the acquisition of grammar and phonology by natural communicative interaction with others.

Krashen's model predicts that learners constantly monitor their errors and correlates the L2 to the L1.

Arnold (1999), Krashen (1991) and many others agree that Gardner's motivational theory has been a cornerstone for motivation studies in SLL, and it was developed based on his social-educational model, the first one published in 1979[22]. In sum, Gardner's work predicts success in SLL based on individual's cognitive (intelligence and language aptitude) and motivational variables. In the latter, there are factors such as the learner's interest and/or affection for the target-language community and how useful the language is as a means towards a goal. Motivation, also according to his model, is responsible for, among other things, attention to classroom content and the practicing of the learned content in informal contexts (e.g., outside the classroom).

Perhaps Garner's major contribution was to balance the importance between affective and cognitive variables in SLL since his and Lambert's seminal paper on the topic, *Motivational Variables in Second Language Acquisition* (1959). In fact, these variables could be considered independent from each other in terms of how successful a learner is. For example, a student can have a high ability in learning languages but little interest in pursuing it beyond academic demand. On the other hand, a motivated student lacking ability would be in advantage in a long-term commitment to learning, especially in communicative situations. Also distinguishable in Garner's model (2010) is the role of the environment (social *milieu*) which would not only influence motivation; for instance, triggering anxiety to a point the learning activity is no longer pleasant, but also the cognitive development of the learner since an early stage in life, an idea that makes a claim against biological determinism of the term *ability*[23].

Gardner (2010) accesses[24] motivation through learner's effort, desire, and attitudes towards the second language. These attitudes refer to affective reactions to class material, the teacher, and any other factor playing a role in SLL. Still within the model, although multifaceted, motivation is defined as "the aggregate of these three

---

[22] The late version of Gardner's model was published in 2010, which is the reference used here to describe it.

[23] It is relevant to note that what Gardner thought of ability would be then approached by Howard Gardner (1994) under his theory of multiple intelligences, according to which linguistic intelligence assumes one of the categories.

[24] Based on his model, Gardner measures motivation through a set of questions in the Attitude/Motivation Test Battery (AMTB).

variables as either one alone does not yield a complete index of motivation" (GARDNER, 2010, p. 23). In defense of that view, the author also differentiates what is purely a reason to learn a second language and what one could see as the profile of a motivated learner: "If one is motivated, he/she has reasons (motives) for engaging in the relevant activities, persists in the activities, attends to the tasks, shows desire to achieve the goal, enjoys the activities, etc" (GARDNER, 2010, p. 10).

Motivational studies blossomed in SLL in the 1990's, mostly deriving from, or criticizing, Gardner's early work. In this sense, contributors to the theme of motivation within SLL unfolded what is understood by motivation, such as in Dörnyei and Otto (1998), to whom learner's goals vary over time, and so does motivation. Other than the variables associated to motivation, considered by Gardner (2010), there have been proposed that willingness to communicate (MACINTYRE; CHAROS, 1996), the learning and the social environment (WILLIAMS; BURDEN, 1997), and the learner's ideal self (DÖRNYEI, 2005; DÖRNYEI; USHIODA, 2009) play important roles in how successful an individual will be at their task of knowing an L2. In an evaluation of the models that followed his work, Gardner (2010) sees them as either focusing on affective aspects, such as his own model; on the cognitive side of motivation, such as Dörnyei and Otto (1998), or combining both, as did Krashen (1991).

Like Gardner, Schumann (1997) focused on the affective reactions of individuals learning a second language. His approach to the theme, however, was not only social. Schumann borrowed premises of neurobiology to formulate a model which equals affect to motivation. Schumann's model is speculative, due to the lack of direct experimental evidence[25]. According to this model, it is possible that a tri-partite system, constituted by the amygdala, the orbitofrontal cortex, and the body proper, is involved in a neural mechanism responsible for stimulus appraisal, i.e., classification of stimuli based on the emotional memory of previous experiences.

To support his theory, Schumann (1997) cites the works of neuroscientists' case studies of individuals with certain damaged regions in the brain, showing that orbitofrontal cortex damaged patients demonstrate difficulties in making appropriate appraisals concerning goal/need relevance, copying ability, and self and social image. Also, using electrodes implanted in the amygdala of monkeys, Rolls (1995, apud SCHUMANN, 1997) reported that these neurons would fire in the presence of

[25] Since the only way to possibly suggest which structures are involved in each information process is through brain damaged humans and animals.

pleasant stimuli and when novel items were introduced into the environmental space. Table 1 summarizes the three brain structures according to their characteristics and functions. Throughout his work, appraisals can be understood as the value assessment the brain makes of stimuli. Still according to his book, supported by Eldeman's work (1992 apud SCHUMANN, 1997), the brain stores a value system of external signals in order to assess them based on survival needs, social integration enhancement and the history of individual preferences built on the expansion of one's interaction with the world. In this way, typically, people approach what is appraised as positive and avoid what is evaluated as negatively. For what it is worth here, approaching to (motivation) and avoidance of any SLL situation will impact learning directly.

Table 1 - Location and the main function of neural structures likely to be responsible for the appraisal of stimuli

Structure	Location	Main function
The amygdala	Temporal lobes	To access value based on inherited homeostats and sociostats. Although it is the hippocampus that is known to record the context in which a stimulus occurs, it is the amygdala that is responsible for assigning an emotional significance to an experience and for keeping its emotional memory.
The orbitofrontal cortex	Prefrontal area of the brain	To retain the organism's preferences and aversions.
The body proper	Peripherical nervous system	Together with the amygdala and the orbitofrontal cortex, it generates stimulus appraisals in the form of bodily states that produce positive or negative feelings about agents, objects, and events in the environment, thus contributing to decision making.

Source: Schumann (1997)

In this way, Schumann argues that stimuli in the way of events, agents, and objects generate mental images in the early sensory cortices, such as sight and sound. In these cortices, they become thoughts by the action of dispositional representations (DRs), which are dormant patterns[26] of neuronal firing activity[27]. Mostly, as the author continues, “they are latent memories of all our innate and acquired knowledge” (SCHUMANN, 1997, p. 53). Also, DRs in the orbitofrontal cortex store knowledge of emotional responses paired with certain situations/ experiences. Besides, these DRs sign to the peripherical nervous system bodily states that constitute emotional reactions to the perceived stimulus. Then, the brain interprets that as a feeling which becomes associated with the stimulus, i.e., an image or a sound, for example. In the chemical level,

> When the stimulus appraisal has been made, neurotransmitter systems in the brainstem and the basal forebrain release chemical messengers such as dopamine, norepinephrine, and acetylcholine into various parts of the cortex that regulate perception, attention, memory, and cognitive and motor investigatory-exploratory action toward the stimulus. [In this way], characteristics of the stimuli may be learned. Negatively appraised stimuli are recognized so that they can be dealt with to the extent necessary, recognized in the future and avoided if possible. (SCHUMANN, 1997, p. 53-54).

Besides justifying the appraisals system by looking at the cellular level, based on the work of Leventhal and Scherer (1987, apud SCHUMANN, 1997) Schumann argues that all humans build their unique set of preferences and aversions throughout life, and that the events marked as preferable fall into the categories of novelty, pleasantness, goal or need enhancement, compatibility of one’s coping mechanisms and supportive of one’s self and social image. As the person continues to grow, new repertoires of preferences are formed based on the broader environment, i.e., outside home/family parameters, hometown customs, the culture of the country, etc. Thus, motivation is forever-changing as long as the individual continues to desire new goals and have different experiences. In a nutshell, still

---

[26] A similar claim can be found in Koda’s definition of learning, which can help us to understand the expression *dormant patterns* used by Schumann. As she explains under the term *mappings*: “Learning is achieved primarily through communicative experience of mapping between corresponding elements. The more frequently particular patterns of mappings are experienced, the stronger the linkages holding them together. Under this view, reading skills are seen as an outcome of cumulative experience of symbol-to-sound, as well as symbol-to-morpheme, mappings” (KODA, 2011, p. 303).

[27] Neuronal firing refers to the communication between neurons, which takes place in form of electrical impulses and neurotransmitters.

according to Schumann (1997, p. 35), these repertoires can be simply called affect, which is a term for what "guides cognition in learning and problem solving in areas for which we do not have innate mechanisms".

Using the neurobiology and psychology of these mechanisms for stimuli appraisals, Schumann intended to explain different levels of proficiency in second language acquisition. The language learning situation, either in the target language environment or in the classroom, is the context where appraisals take place, always encoding its corresponding emotional response. The types of appraisals deliberated by the brain are shown in Table 2, based on the work of Scherer (1984, apud SCHUMANN, 1997) and Gehm and Scherer (idem) which is one from many possible schemes presented by Schumann (1997), but it is the one he examined more deeply throughout his book. He also examined diary studies and autobiographies of second language learners and suggested that positive appraisals enhance language learning, while negative appraisals inhibit second language learning. Here, it is important to mention that not everything unpleasant, during second language acquisition, receives a negative appraisal's typical response. As Schumann explains using a study case, an immigrant's language flaws perceived by others can either inhibit the learner towards speaking the language or give them the cues to improve their knowledge continuously, especially if what is at stake is a long-term goal whose importance surpasses the negative feelings after social disapproval[28].

Table 2 - Qualities accessed by the appraisal's mechanisms

Novelty appraisal	Assesses whether internal or external stimulation contains unexpected or familiar patterns.
Pleasantness	Determines whether an agent, an action or an object is appealing and thus fosters approach or whether it is unappealing and promotes avoidance.
Goal/need evaluation	Assesses the degree to which the stimulus event is conducive to satisfying the individual's ability to cope with the event.

[28] In a similar claim, another study (LÓPEZ; AGUILAR), showed that even negative emotions in a L2 classroom, such as fear, worry, and sadness, could be perceived by learners under a positive light in cultures where self-determinism is valued, meaning they served as *red flags* for areas that needed improvement or even to build resilience against.

Norm/self-compatibility check	Accesses a) the compatibility of the event with social or cultural norms, or with the expectations of significant others, and b) the compatibility of the event with the individual's self-concept or ideal self.

Source: Schumann (1999).

In fact, in Schumann's work, pleasantness appears in many ways. The following are some extracts from the autobiographies he analyzed as examples of the appraisal system in real conditions of SLL: "Feeling a kind of tickle in my ear at the pleasure of understanding" (KAPLAN, 1993, p. 55-56, describing her process of learning French in Switzerland, apud SCHUMMAN, 1997, p. 117); "I don't like the way they laugh. I don't care for their 'ugly' jokes, or their five-hundred-pound canary jokes, or their pickle jokes, or their elephant jokes either. And most of all, I hate having to pretend" (HOFFMAN, 1989, p.118-119, from the book *Lost in Translation*, the story of how a Polish girl who immigrated to Canada and later became a professor of English Literature, despite her initial sense of loss of identity, apud SCHUMMAN, 1997, p. 129-130); "I was more tense that I have ever been in my life or ever want to be again […] The professor called me an idiot and an imbecile? […] I, who had been a professor in charge of my own classes for twenty-five years" (WATSON, 1995, p. 39, describing his feeling during French classes in Paris, at his quest to improve his speaking skills, apud SCHUMMAN, 1997, p.146).

Those were concise examples of what can be found in several other SLL experiences throughout time and places. It is perhaps even easy to relate to them at some level in our own experience as SL learners or evoke from memory what we have liked or disliked during those experience(s). Schumann states that learning experiences have a psychological impact which reflects on bodily reactions. For example, "shame experiences generate cortisol in the body, which interferes with cognition" (SCHUMANN, 1997, p. 155). In fact, by reading how Schumann proposed a system of appraisals, one is also taken to consider that this system backs up the idea of the boundness between emotion and cognition. Schumann even states that "emotion underlies most, if not all cognition, and […] variable success in second language acquisition (SLA) is emotionally driven" (SCHUMANN, 1997, p. 15). In the last chapter of his book, this becomes clearly structured on the basis that emotions help constraining information that is relevant to solve a problem them. The same

could be said about the way positive and negative appraisals affect the SL processing.

Another appraisal that demands a more careful analysis is *novelty*. According to Schumann (1997), although motivation questionnaires and diary studies usually highlight the dimensions mentioned above, the novelty appraisal did not appear in them. The topic was also generally absent in the autobiographies of second language learners.

On the other hand, although Schumann's body of work has not been associated with hypermedia tools yet, one way in which novelty in SLL studies has been addressed is by technological means on which people deliver or receive content, such as in novel ways to use a smartphone in the classroom. Computer technologies have always been seen as potential tailored-made systems for learner's pace and needs. The importance of this type of appraisal, for the study that will follow in this thesis, relies on novelty being a scale. At one end, there is the totally unexpected, which can be frightening. At the other end, there are the learning experiences that sound and seem remarkably familiar, which could lead to demotivation. In this sense, technology plays an important role, yet not fully understood, in delivering content that can manage to find a mid-way between innovation and the maintenance of learner's confidence in their capacity to cope with tasks. Similarly, the fact that a learning tool presents itself as something new, as in the case of VR, does not necessarily trigger a good appraisal, depending on how the learner perceives novelty as being something inherently worth-trying or predominantly frightening.

It is not so often that researchers have the possibility to test a breakthrough technology in the classroom. By that, it is meant a device that even outside the teaching context it had never been used or seen by the learner. Perhaps, a parallel situation would have been for those who first manipulated a desktop computer at the school laboratory. As Chapelle (2001) describes, there was a sense of urgency by SL teachers in trying computers as support for the classes already in the late 1980's. Learning evaluation with the new technological tool soon followed, but in this portrait, it was not mentioned the impact of the novelty of the computer itself, whether it caused students to deviate from the lesson content to simply explore the machine or if even it scared some learners. Stockwell and Reinders (2019) question to what extent has pedagogy also evolved to be adequate to the media and in what

circumstances technology is not effective. As one example of the later, teachers may assume that just because learners may be tech savvy in their personal use of the smartphone, that alone does not mean that the learner will be able to make full use of language learning resources at their own time, either because they lack the knowledge of how to use it or because it is simply not a priority for the use of their free time (STOCKWELL; REINDERS, 2019).

The first mention about the effects of novelty in VR for SLL can be found in Vázquez et al. (2018)[29], when the authors discuss a possible distraction and hindering that the technology may have caused in the participants during the experiment, impacting its results. Recently, the novelty effect of VR has been investigated in terms of motivation and learning (HUANG, 2020) in the field of hard science. In this study, the author sought to answer if the increase on learning and motivation that other studies on VR had reported were partly an effect of sensory novelty and whether such positive results on the use of technology would be sustainable overtime, i.e., after novelty ceases to play its possible role as a variable. Based on the quantitative and qualitative data gathered from tests and questionnaires, for what is relevant for this thesis, Huang concluded that, in a highly immersive condition, novelty is a factor for motivation, and it is not likely that familiarity with the technology significantly decrease the novelty effect. This means that sensory novelty may resist to the desensitization effect, which means that the psychological effect of a situation, that is repeated several times, tends to cease. On the other hand, novelty did not predict a learning increase when causally related to a novel quality of VR, i.e., enhancement in sense of presence.

Schumann's theory of affect in SLL has remained to be tested as a predictor of learning based on the claims he made on his book. His model (the system of appraisals) has been formulated as a proposal of how motivation works for every aspect of life, one of these aspects being SLL. In this realm, Schumann focused on the classroom situations, with no mention to technology as a mediator.

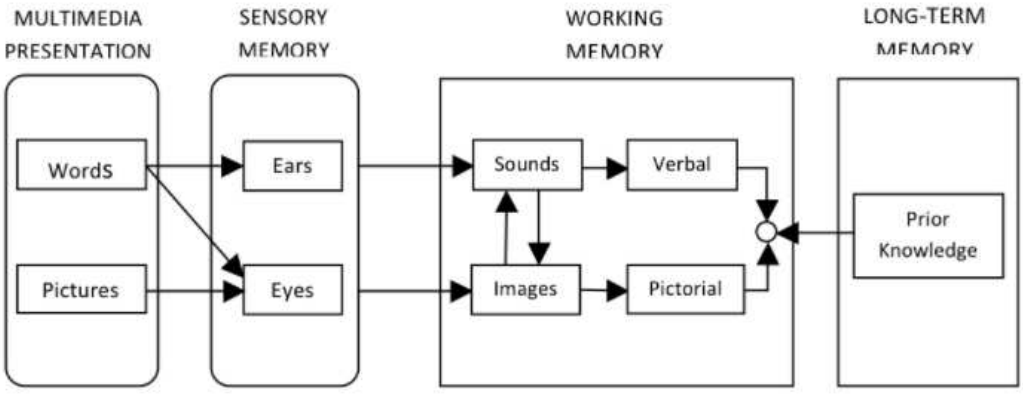
[29] This study was described in the literature review section.

3.1.1 Motivation in Multi/hypermedia learning environments

Traditionally, cognitive models have been used by AL researchers when it comes to investigate how people learn a second language with the aid of the computer/mobile devices. Amongst a few models and theories of information processing, Mayer's (2001) Cognitive Theory of Multimedia Learning is, perhaps, the most often cited in hypermedia studies in SLL. There has been an extensive literature on research in applied linguistics based on such models. Nonetheless, the scope of this thesis remained limited to exposing the models of information processing, analyzing them under the scrutiny of motivation as bounded to cognition.

Although Mayer's theory is an outcome of methods to facilitate the understanding of scientific explanations, it was outlined widely enough so it can be applied to any field of knowledge, in terms of presentation of didactic material. The core of the theory states that "people learn more deeply from words and pictures than from words alone" (p. 47), and it is based on the following assumptions: a) humans process information via two separate channels, auditory and visual; b) there is limited capacity in each channel, and the process of incoming information actively creates mental representations; and c) learning is an active process of filtering, selecting, organizing, and integrating information. The more this information is related to prior knowledge, the greater the chances are for learning to occur successfully. The model is illustrated as in Figure 10.

Figure 10 - Visual Representation of the Cognitive Theory of Multimedia Learning



Source: Mayer (2001).

Based on how the human mind works, Mayer's theory (2001) also presents guidelines for the design of instructional media, since simply adding pictures to words does not guarantee a more effective way of learning. There are 12 design principles in his work, from which I highlight the following, stating that people learn more effectively when 1) a multimedia lesson is presented in user-paced segments rather than as a continuous unit; 2) learners know what to expect to be learned from the lesson, and/or when knowledge is pre-activated; 3) words are presented in conversational (informal) style rather than in formal style; 4) narration is spoken in a friendly human voice rather than a computer generated voice.

In the context of vocabulary learning, Souza (2004), based on Mayer's theory, conjectured that diversified input, in the way of texts, audio files, images, and narration contribute to correct inference of target-words in SLL reading tasks. Besides, the informational redundancy highlighted these words and made the establishment of many connections and relations possible between the different types of information, promoting their retention in memory.

Saito (2015) investigated the short and long-term effects of a hypermedia environment for vocabulary learning in a SL course (English). The virtual reading environment, with a multimodal glossary, was designed according to the Cognitive Theory of Multimedia Learning (MAYER, 2001). Saito's quantitative results between the control and experimental groups suggested that the latter, exposed to the hypermedia text, learned faster and retained more words than the control group, who had read the same text and its annotations on printing.

Following the same principles, in a study based on Mayer's model and Hede's (2002), Procópio (2016) compared students from different levels of proficiency in English as a second language, where she sought to identify the impacts of a multimodal glossary, concluding that, despite both levels, elementary and intermediate, benefited from the multimedia vocabulary learning environment, the elementary one showed more significant numbers in the vocabulary test results. In her analysis, Procópio (2016) suggested this difference could be due to the fact that intermediate learners have a greater prior knowledge *database* from where to draw other linguistic cues which can contribute to right guesses and inferences to new words.

Despite being one of the few models used to understand vocabulary learning in a multimedia environment, presenting significant advances in the area, Mayer's

model is quite simple and limited for having excluded learners' individual characteristics, such as attention, motivation, learning styles, among others, which directly influence the processing of information.

Integrating motivation into information processing appears in Hede's (2002) model for SLL. The relevance of this approach lies in the fact that since information technology has been increasingly integrated into foreign language teaching, multimedia remains the most viable alternative to both classrooms and L2 on-site immersion.

Besides, SLVL include activities where target-words require inference from the learner, who, for that purpose, can translate the word, understand it in context (text, sound or image) or find synonyms for it in the target language. The possibilities of accessing one's knowledge of a word include its lexical category (whether the word is a noun, verb, adjective, etc.), pronunciation, spelling, collocation (i.e., two or more words that are grouped together as the result of usage by native speakers), formal and information variations, and morphology[30]. Thus, multimedia can exploit both linguistic and extralinguistic resources in an integrated way, enhancing the knowledge of a "rich vocabulary[31]" (SCARAMUCCI, 1995).

The different types of word knowledge are likely to be learned gradually, incrementally and in a relational manner, since one type of knowledge increases awareness of another (SCHMITT, 2007). It could also be the case that these types of knowledge are learned in consequence of learner's need and use, which makes the case vocabulary learning applications in mobile devices, for example. Mobile learning is a paradigm under which a personal digital assistant guides the learner. That is to say, not only multimodal content can be explored at individual paces and according to individual preferences but is also readily available everywhere and typically in *small chunks*, designed to fit in the learner's schedule (KENNING, 2007).

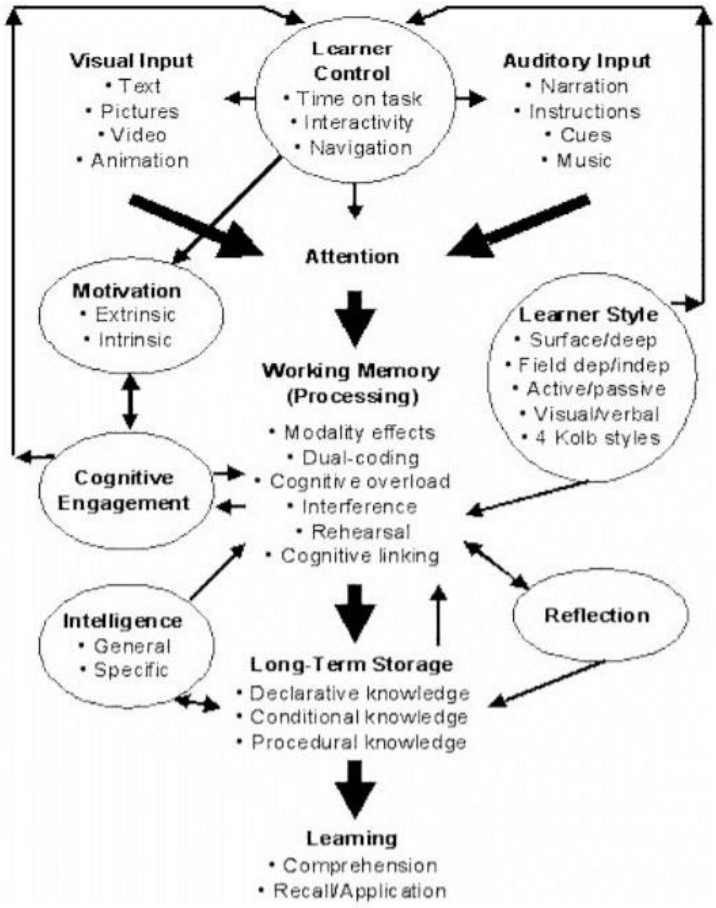
Unlike Mayer's model (2001), Hede includes in his some concepts such as motivation, interactivity, and internet navigation. Motivation appears as subdivided into intrinsic and extrinsic, the latter being related to the design of the teaching tool itself. Extrinsic motivation, therefore, would lead to access (to the classroom, material) but only appealing and challenging content would be decisive for the

[30] For a deeper analysis of types of word knowledge, see Milton and Fitzpatrick, 2014.
[31] Scarammucci's model (1995), based on Richards' (1976), considers vocabulary competence as being divided into levels of lexical, semantic, morphological, syntactic, textual, and prior and world knowledge.

cognitive engagement of the learner and their constancy in the activity, which are seen as consequences of intrinsic motivation.

Hede (2002) has thought of a model (Figure 11) which could serve as a guideline for multimedia course material design, containing 12 variables involved in learning plus its subdivisions. By taking motivation as one of them, Hede approaches his model to the theme of affectivity in SLL without, however, going deeper into how, exactly, multimedia content can be appealing and/or challenging to foster intrinsic motivation or even if there must be a balance between these two characteristics. For example, one could think what the limit of challenges is before *interesting* becomes *difficult and demotivating*. A brief attempt in this direction was made later by Hede and Hede (2002), where the authors put that the motivation is maintained while one can explore the virtual learning environment, as in games.

Figure 11 - The integrated model of multimedia effects on learning



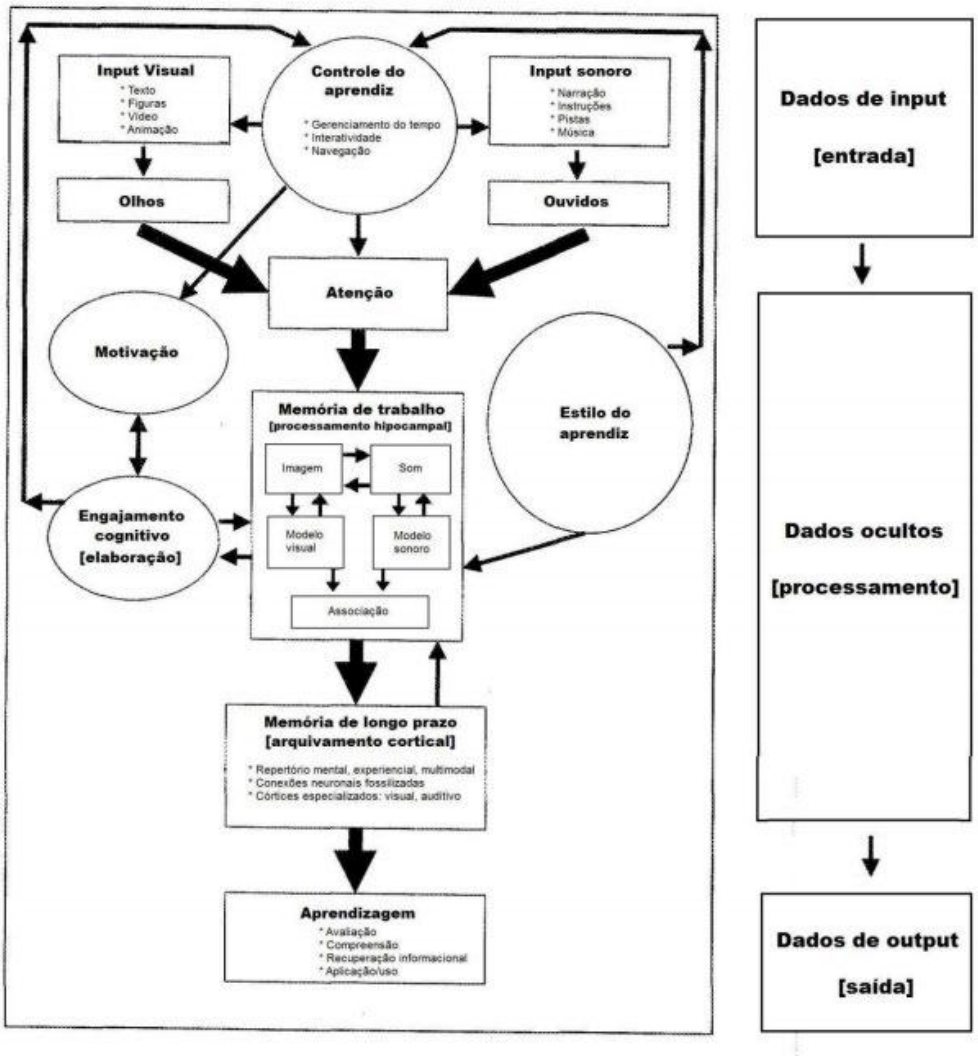
Source: Hede (2002, p. 2)

Moreover, perhaps the main setback of Hede's model is that it gathers many constructs, not always defined in his work, making it difficult to use in analysis of learning applications in general, especially because some of them are individual's characteristics such as learning style. At most, the model could serve as a set of arguments from where to draw evaluative measures since Hede (2002) was attentive to the inconsistency of evaluative results of multimedia learning. The interaction between the multimedia content and each of the elements of the model is, for the author, decisive for the greater or lesser degree of learning success. What can also be taken from Hede's work is that the question whether multimedia teaching is better or not than analogical methods should not consider the effectiveness of a particular tool, but under what circumstances and to whom this tool would be needed.

Reformulating Hede's model, Saito (2015) established relations between long-term memory, at the core of the integrated model of multimedia effects on learning, depicted above, and the connectionist principle of learning by association[32]. Figure 12 depicts the proposed information processing model in Saito's work. In his representation, Saito considered three levels of processing, in consonance with the connectionist model. Thus, the first being the input (*Dados de input*) that feeds the brain with information, the second, the information processing itself (*Dados ocultos*), and the third, the product of the processing (*Dados de output*), in this case, learning. For each level, on the right of the illustration, there are corresponding phenomena and actions, on the right, happening within and with the learner.

[32] This view is an opposition to the modular concept of information processing, as per Krashen's model (1991). The connectionist model sees the neural network as a web, i.e., an interconnected system where the stimuli recruit nodes within this web. An association, thus, would be such a recruitment of experiences/knowledge related to a new event.

Figure 12 – Integrated Connectionist Model of Hypermedia Processing



Source: Saito (2015, p. 53)

The connectionist paradigm emerged in the 1980s aiming to explain brain functioning and information processing. According to this approach, input to the brain does not get compartmentalized in modules, but rather mobilizes neural networks which have been fired (see footnote 28) for similar information in the past. Such a premise has been used in research to explain information processing in SL vocabulary learning through a hypermedia environment (SAITO, 2015; PROCÓPIO, 2016). In this way, one lexical item would be related to another in a structure of interconnected networks. However, despite considering learning a product of past and present experiences combined, the model proposed by Saito (2015) has not explained motivation under the light of connectionism or even further than it has Hede's (2002). It is also a hypothesis, under the connectionism paradigm, that

repetition plays a significant role in learning. In this sense, Saito's work has advanced the studies in the area by emphasizing the importance of target-words repetition in hypermedia learning environments for SLL. This idea had had a history in psychology of memory, as in Baddeley's work (1990, apud NATION, 2008, p. 48), to whom "each successful retrieval of the form or meaning strengthens the link between the two. It is thus very important that the learners not only see the form and meaning together initially, but have plenty of spaced repeated opportunities to make retravels".

3.1.2 Motivation in virtual reality learning environments

To date, Moreno and Mayer (2001) have been the ones who investigated the question whether immersion by media, i.e., with VR, would change any premise in Mayer's model (2001). To do so, they created a learning environment to be accessed either by an HMD (experimental group) or a desktop (control group). Even though the state of the art of the VR apparatus used in their comparative study was quite different from the current ones, it provided a higher degree of immersion than the desktop application, a conclusion reached by a qualitative questionnaire applied to the participants of both groups.

As for the findings of this study, although the motivation to learn was rated higher in the experimental group, the lesson displayed in VR did not affect the quantitative results for learning. According to the authors of the study, this confirmed the idea that

> the same factors that improve student understanding in one medium […] improve student understanding in another medium (such as immersive VREs[33]). Despite the temptation to take a technology-centered approach to learning, it is necessary to search for empirically-based principles for the design of VREs. As long as instructional methods promote appropriate cognitive processing, then media does not seem to matter. (MORENO; MAYER, 2001; p. 3).

While this conclusion might be true, regardless of what information processing model one takes into consideration, the problem on how to think of motivation at the core design of media products for learning is still unanswered. Therefore, a different

[33] Virtual reality environments.

way to look at it was on studies which addressed the issue in other fields of knowledge.

Years later, a study by Parong and Mayer (2018), mentioned in section 2.1, revisited the topic on the application of these principles in immersive media. The study did not find advantages in the use of immersive VR in terms of immediate effects in learning (in this case, a science topic), in comparison to the use of another medium (a slideshow on a desktop computer). Students exposed to the latter had better post-test scores than had those exposed to the VR lesson. However, when the researchers divided participants between the same VR lesson in a continuous pace and one with segmented units, the participants in the segmented VR lesson showed better test results.

Still, according to the analysis contained in Parong and Mayer's study (2018), while the desktop slideshow was designed according to the cognitive principles of multimedia learning (MAYER, 2001), the authors stated that the same could not be done for the VR lesson to the same extent, due to the VR experience. For them, that means that a VR environment offers extraneous information (e.g., surrounding animations) which can be distracting and not offer the right connections between what is being seen and the learning goal. Besides, the study did not make a further comparison between a non-segmented desktop lesson and a VR segmented lesson.

In the same study, Parong and Mayer validated their hypothesis, according to which motivation would be rated higher in the VR lesson than in the desktop one. Thus, one can ask why motivation alone, which foster engagement in the activity and a pleasant sensation, described in the referred study as happiness, is not enough to increase learning. The beginning of such a possible answer can be found on the same study, when the authors conjectured that attention is not favored by a medium that is too exciting. "For example, one participant wrote, 'I was somewhat distracted by the excitement of experiencing a new technology. Because of that, I wasn't able to completely focus on the lesson'" (PARONG; MAYER, 2018, p. 8).

As mentioned in chapter 2, there have not been studies on the design of immersive VR focused on motivation, let alone models of information processing towards this goal. In the latest and systematic literature review under this thesis topic, Palmeira et al. (2020) gathered quantitative studies on the use of immersive VR for SLL, focusing on vocabulary learning. According to their criteria, the review retrieved nine studies, some of which (VÁZQUEZ et al., 2018; LEGAULT et al., 2019) were

described in my own review depicted in section 3.1. Nonetheless, regarding motivation, the data analysis in Palmeira et al. (2020) also concluded that such a variable is presented as a result of the experience rather than part of the design of the experience trying deliberately to motivate its participants.

4 FLOW THEORY

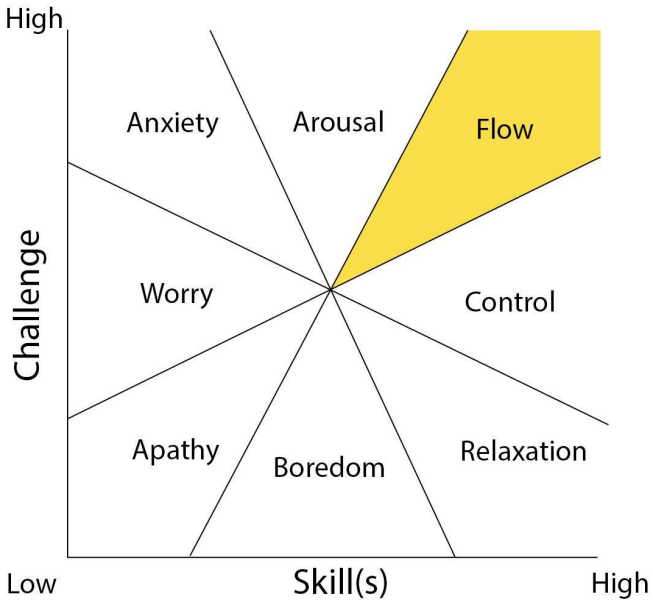
One way to include motivation at the core of the design of VR learning systems would be focusing on sense of presence as novel, pleasant and meaningful experience for the individual, which is based on Schumann's work presented on section 3.1. Another layer to sense of presence, not always achieved, but a possible candidate as a variable for motivation and learning, is a state of consciousness called *flow*.

The concept of flow comes from research on happiness. Its creator, Mihaly Csikszentmihalyi, dedicated his life work to find out what happy people would describe as a moment of happiness and find a pattern in all those descriptions. His discovery was that, essentially, happiness had to do with non-ordinary moments in life when people are transported to a different reality, an ecstasy.

During these experiences of ecstasy, there is no gap for other thoughts to interrupt the mind in its activity. It is, as if, the body is no longer in there. Csikszentmihalyi observed that people experiencing total involvement in what they are doing do not feel hunger or even self-consciousness. Instead of calling this happiness, Csikszentmihalyi (1990) called it the flow experience, and began thousands of interviews around the world, with all sorts of peoples and occupations, to arrive at the conditions which describe flow: complete involvement; a sense of ecstasy (as described above); knowing what needs to be done; knowing that the activity is doable; and a sense of serenity; loosing track of time.

Still according to Csikszentmihalyi's theory, a flow state is somewhat similar to the idea of intrinsic motivation discussed here previously since it also refers to the result of experiences that are gratifying on itself. However, an essential difference in the flow theory is that to experience flow, one needs to be doing something they are really capable of and even excel at it, becoming something effortless for the doer, who enters an ecstatic state. Figure 13 situates flow as the peak of high challenge and high skills in relation to other variables surrounding these two axes and the state of flow.

Figure 13 – The representation of the state of flow



Source: The author, based on Csikszentmihalyi (1990).

It is important to note that the concept of flow does not say anything about either learning or memory, which would also be of interest for any researcher seeking to apply this concept to their objects in education/training. This question has been addressed as an assumption by Csikszentmihalyi (1990) since he concluded that a flow state could increase learner's ability to really engage in experiencing the knowledge. Such a hypothesis was validated later (CRAIG et al., 2004).

4.1 FLOW IN SECOND LANGUAGE LEARNING

A seminal work in the topic of flow in SLL was done by Egbert (2003), who proposed that the theory of flow could form a more consolidated research agenda, including how the experience of flow motivates students. However, as he pointed out, Krashen had already thought of flow, in a way, when the author emphasized a quality of input being so interesting and relevant that the receiver of it focus on it, and not on the fact the message in in a FL (KRASHEN, 1991). A parenthesis must be opened here to point that flow may have been linked to sense of presence much earlier than with the advent of technology, still in the realm of applied linguistics, also within Krashen and Terrel's work.

Krashen and Terrel (1995) proposed *The Natural Approach*, whose hypothesis is that understanding messages encoded in a SL is the core of its learning process. From this point of view, much weight is given to the learner's experience with the living language, specially at the elementary level, instead of teaching being focused on imitation of form and phoneme. Thus, the goal of teaching a SL should be in the spontaneously communicative act, after the learner had been exposed to enough comprehensible language input. The more authentic this exposure is, the better is the occasion for the SL output to emerge, and therefore, immersion in the context where that language is spoken, naturally, seems relevant to this thinking.

In *Principles and Practices in Second Language Acquisition*, Krashen (2009) advocates for an immersive teaching setting which is planned according to the needs and interests of the learner, not necessarily inside a classroom. In this sense, it is reasonable to associate immersion to the extent of how much affected a learner would be in a given communicative situation. The more the teaching setting supports interests and needs of the student, the bigger would be their sense of presence in the activity, leading to the flow state described above as a total involvement in the situation, in this case, the communicative occasion encoded in a SL.

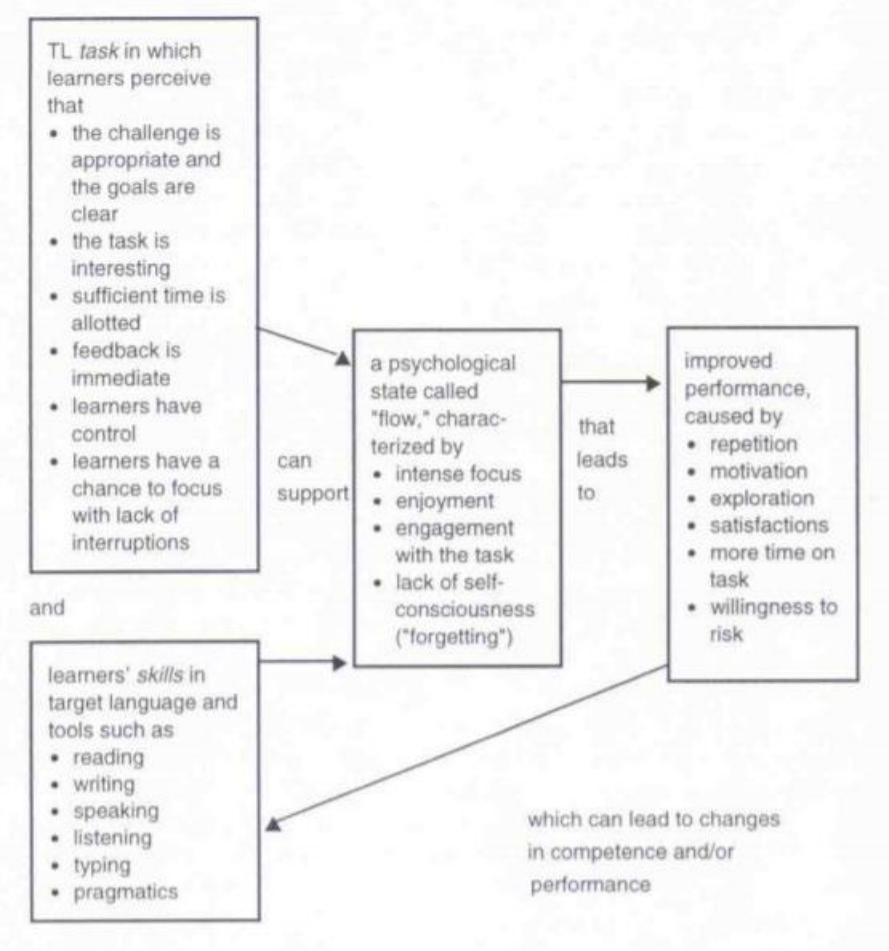
Egbert (2003) was the first to explicitly think of flow in SLL. He first organized a few, basic factors that are common to the relation between any learning situation and the experience of flow. Central to this thinking is the psychological state of the learner, during their task. This state can be affected by their characteristics as individuals (e.g., personality, learning style) and their skill levels, which is particularly important to this equation because of the flow theory. In Csikszentmihalyi's (1990) description of flow, if a person's skills set matches what is required for a given task, the bigger the chances are for the person to experience flow during the execution of the task. More importantly, the state of flow here is implicit within the individual psychological state, since it is impossible to tell, for sure, if it will happen. Thus, it is plausible that a learner improves their skills without experiencing flow, although it may not be as at easy and pleasant as for those who experience it.

Grounded on this and looking at how flow and SLL had been reported in the literature mentioned earlier, Egbert (2003) developed a model (Figure 14) in which the task assigned to the learner takes on a central role. i.e., it is carefully thought of as to elicit a flow experience. In this model, flow is also characterized into four

categories which can be used as parameters to indicate if, indeed, the learner experienced it, e.g., as in a questionnaire.

Before analyzing the model below, it is important to say that in his work, although he delved into the flow theory and its relation to SLL, Egbert did not explain each one of the variables mentioned in the scopes of task, causes of improved performance and learner's skills in target language and tools. In this way, it is only possible to conjecture what he meant by those, for example, *satisfactions*, and it is not possible to comprehend what it is meant by typing as a skill/tool, for instance, as different from writing.

Figure 14 – Model of the relationship between flow and SLL



Source: Egbert (2003, p. 554).

In the variable improved performance Egbert points out motivation, which can be questionable. First, if one thinks of motivation as an ignitor of any activity, it makes sense that it could be in any level of the cycle, but especially in the beginning, when

the activity is proposed. This conclusion can be drawn even by looking at the model which represents a cycle. i.e., the possibly enhanced skills and competence will increase a chance of another flow experience happening in the future since their skills will match those required for the challenge involved in SLL, motivating the learner to participate in it.

Secondly, motivation seems to be a holistic variable, a driving force that emerges based on how the individual responded to the same category of stimuli in past experiences, as proposed by Schumann (1997) when he compares motivation to patterns of appraisals/affect. Schumann makes this point clear after analyzing first language acquisition by the same arguments of the system of appraisals:

> Motivation to learn a second language is studied separately from pragmatic decision making in one's native language, but both may result from how we appraise agents and events in terms of our sense of novelty, familiarity, and pleasantness and in terms of our goals, coping ability, and self and social image. (SCHUMANN, 1997, p. 237).

Egbert assumed that the experience of flow itself could be motivating to SL students, even though he has not tested this hypothesis. Since Egbert's work, there has not been renewed interest in a flow model for SLL, taking into consideration new classroom technologies and self-taught courses and computer applications. Nonetheless, in his paper, Egbert (2003) explores the flow experience mediated by computers to discover the properties unique to this medium that could foster such an experience. According to his literature review on the topic, Egbert mentions that a computer can provide a nonjudgmental learning environment, instant feedback and a less distractive environment since everything happens in a small space, the screen. Perhaps due to the fact that Egbert wrote in a time where smartphones were not as popular as today, and AR/VR technologies virtually did not exist with a viable use, it could be said that a small screen facilitated focus. However, a diachronic evaluation of this statement requires one to think just as the opposite. Small screens were empowered with the internet, which changed drastically the way people use computers and cellphones. It cannot be said, without reasonable doubt, that learners of a given application will not be distracted by all the other possibilities that a smartphone offers. Instant messaging, social media updates, a new video uploaded on a subscribed YouTube channel, among others, can be examples of the

distractions that tend to constantly notify themselves to the user. In the same manner, it can also be the case that VR users will not pay attention to the content of the lesson more than they will want to explore the scene or the sense of presence itself. Thus, what is being argued here is a critical review of how attention needs to be thought of less in terms of the medium and more in terms of how the content itself could foster it[34].

On the other hand, it can also be said that Egbert's model has much in common to what is claimed by Schumann as a model for motivation and learning. Even though the latter did not work with the concept of flow, such state is surrounded by many variables in Egbert's model that find echoes in Schumann's work. Table 3 makes a correlation among them[35].

[34] On the concept of flow applied to studies on learning mediated by computers, in their systematic review, Santos et al. (2018) showed that the state of flow has several positive impacts on students' performance, such as "learning increase, more in-depth reflective process, students' satisfaction, exploratory behavior, sense of cognitive presence and so on. […] These benefits could be potentially considered in the design of different educational systems […]" (SANTOS et al., 2018, p. 51).

[35] Schumann (1997) did a similar thing in his work, asynchronously analyzing motivational questionnaires, such as Gardner's AMTB, and SL learners' diaries and autobiographies, based on his system of appraisals.

Table 3 – Correlation among flow variables in Egbert (2003) and Schumann's system of appraisals (1997,1999)

<table>
<tr><td rowspan="2">System of appraisals Schumann (1997,1999)</td><td colspan="3">Flow and SLL - Egbert (2003)</td></tr>
<tr><td>Pre-task</td><td>during the task</td><td>After the task – improved performance caused by</td></tr>
<tr><td>Pleasantness</td><td>The task is interesting</td><td rowspan="3">Flow itself (intense focus, enjoyment, engagement with the task, and lack of self-consciousness</td><td>Satisfaction</td></tr>
<tr><td>Goal/need evaluation</td><td>The challenge is appropriate and the goals are clear</td><td>More time on task;
Exploration;
Repetition</td></tr>
<tr><td>Norm/self-compatibility check</td><td>Learners skills in target language (reading, writing, speaking, listening, and pragmatics);
Feedback is immediate</td><td>Willingness to risk
Learners skills in target language (reading, writing, speaking, listening, and pragmatics)[36];</td></tr>
</table>

Source: The author (2021).

The variables described on the left of table 3 are those found in Schumann's work, except for *novelty*, since it is not a category in Egbert's model. Thus, the following are considered: pleasantness, goal/need evaluation, and norm/self-compatibility check.

Pleasantness can be an object that is appealing, a task can fulfil this requirement in terms of the content itself, the qualities of the material and/or the methodology applied.

Goal/need evaluation: according to Schumann (1997, 1999), this appraisal assesses the degree to which the stimulus event, the task, favors the learner's ability

[36] This set is repeated here as a consequence of Egbert's model which foresees that in order to be benefited by the flow experience, prior knowledge that favors the execution of the task must be already part of learner's repertoire. The same type of knowledge, however, is also improved by the flow experience.

to cope with it. In this way, the teacher (or the methodology) can think of how appropriate, according to the students' level of proficiency in the class, the task is. And for the learner to appraise that correctly, it is important that the goals are clear and set before the task is in motion. This fosters not only a correct evaluation from the learner about their abilities to complete it, but also allows learners to be in control of their own pace and needs. This would imply that the teacher must be flexible enough in class to deal with different appraisals. Although individual attention is not always practical in the context of the classroom, it is a differential in terms of students' engagement with the activities.

Norm/self-compatibility check, also called "coping potential" (SCHUMANN, 1997, p. 104): this appraisal accesses both the compatibility of the task with social or cultural norms, or with the expectations of significant others (it could be, in this case, of the teacher), and the compatibility of the task with the individual's self-concept or ideal self. Also, according to Schumann, pride and shame, which are often part of the SL learners' journey, would be accounted for within this appraisal. For this to be checked, teachers or content developers for applications, for example, must be aware of learners' skills in the target language at a given proficiency stage in order to propose something that will likely match their self-concept in terms of what they are capable to do. This, added to the goal setting explained earlier, can also put the learner in the position of imagining themselves at the next stage. And for that, immediate feedback is important before another task is proposed.

In the column on the left, Egbert lists the outcome of the flow experience which were chosen for being related to the column on the right, Schumann's categories. In this way, satisfaction is directly related to pleasantness; more time on task, exploration, and repetition are actions that come from the appraisal goal and need evaluation; and willingness to risk is accessed by a self-compatibility check.

Egbert's and Schumann's models were taken here as the basis of a framework to possibly guide the studies on teaching SLL in a VR setting. Although Egbert's model has its flaws regarding motivation, as I tried to point out, it brings flow into the scene in SLL, which would not invalidate Schumann's theory.

In this scheme, flow is at the center of any teaching experience, even though, all the variables surrounding it are not its predictors, i.e, it is impossible to say for sure if this state of consciousness will be achieved by the learner. Egbert (2003) had pointed out a similar observation in his model. It is also fair to say that, although

Schumann did not discuss flow in his work, it could be that motivated learners might experience it occasionally, as it is possible to suppose from a passage of a learning diary he analyzed, when an American student describes her feeling towards the French class: “Frichot, the teacher, calls on me. I feel as if I’m on stage, the lights go down and the desks disappear. The spot is on me. I’m poised as I speak my lines from the play we’re reading” (KAPLAN, 1993, p. 53-54, apud SCHUMMAN, 1997, p. 116).

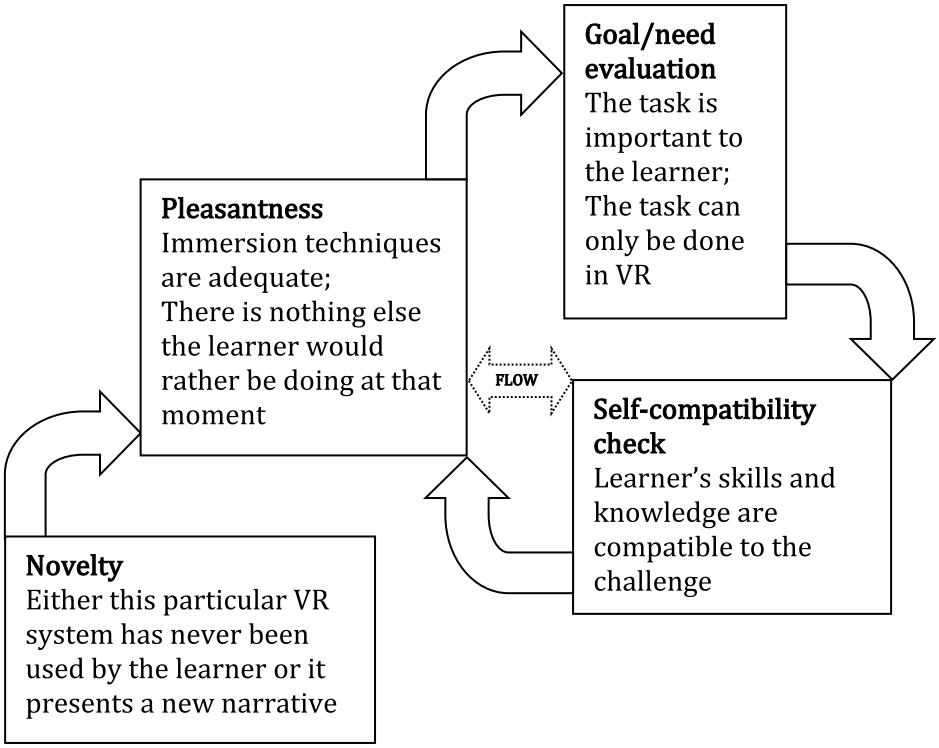
4.2 A PROPOSAL FOR CATEGORIES OF ANALYSIS ON MOTIVATION IN A SLL VR ENVIRONMENT

Lacking in all the theories and parameters presented in this thesis, according to which motivation has been studied in LA, is a SLL motivational-based model for a VR learning environment which could serve the purpose of orienting the teaching of foreign languages. Adding to this perception is the fact that the goal of immersion is to provide users with an enhanced sense of presence, which, in turn, can also be acquired via non-technological means, as mentioned in section 2.1. One instance highlighted here, of how this could happen, is within the state of flow.

As it has been argued so far, the characteristic of VR that mostly differentiate this medium to the others is immersion in its technical components and, at least circumstantially, in its novelty.

In this section, an effort was made to select the relevant categories of appraisal defined by Schumann (1997), adding flow (CSIKSZENTMIHALYI, 1990; EGBERT, 2003) to the equation, focusing on the characteristics of the VR medium which can support such categories. This proposed model is intended to guide the analysis of the data from the experiments conducted for this thesis and described on chapter 5. The rationale toward this model (figure 15) is described below.

Figure 15 – Proposal for a SLL VR model based on motivation



Source: The author (2021).

Flow cannot be achieved without sense of presence, but sense of presence is not a guarantee of flow. Yet, learning can be an outcome that does not necessarily on neither of them. Moreover, flow is not a prerequisite to motivation, although it may facilitate it (EGBERT, 2003).

However, when sense of presence can be enhanced by VR, which in turn can lead to a state of flow, there is a chance for learning to happen, or even be facilitated, that is worth investigating in the analysis of VR SLL applications. Additionally, the flow variable in the model above has appeared only possibly[37] linked to pleasantness and self-compatibility check for these are related to flow as it has been seen do far in this chapter.

In this thesis, it is assumed that a VR SLL environment has the potential to be perceived as something pleasant/nice, meaning that the individual would rate positively the experience as something they liked trying. Pleasantness, in VR, has two inherent elements, one being sensorial, derived from the immersion techniques, meaning that the user of the system will be comfortable using it. The other is found in

[37] Graphically, this possibility is represented with a dotted line surrounding the state of flow.

the narrative itself. In fact, research done in the field of medicine (SHARAR et al., 2016) has demonstrated that immersive VR can work as a pain relief technique as the result of the subject's perception of fun and positive emotions. Thus, the narrative played a significant role. In the SLL domain, though, what has been seen is the weight being put on intrinsic motivation that sense of presence may have, as it was argued in section 2.1. But as it might be the case, pleasantness may be achieved even further when the content is carefully planned towards this goal. In this sense, and according to the flow theory (CSIKSZENTMIHALYI, 1990), to be in complete involvement with a situation is also part of what one calls *happiness*, i.e., in that moment, there is nothing else as important. Interesting to note, however, is that one can experience pleasantness/flow even though the content of what is being experienced is amusing or serene[38].

The self-compatibility check variable, in the model, could not be stated without adding the term *skills* (SCHUMANN, 1997; EGBERT, 2003) to the one of *knowledge.* The latter, as in Csikszentmihalyi (1990), means that the doer of a task knows, for a fact, how to do it and it can be even an expert. Skills mean that the learner is, at least, theoretically ready for the task, and might as well succeed at it even without a certification of stablished knowledge. In the context of exposure to VR, this variable can also refer to how the learner sees themselves capable of managing the apparatuses required by an immersive setup, especially when this exposure happens before the eyes of an audience, e.g., as in a classroom or in an experiment.

Concerning the variables not linked to flow, novelty, has not been linked to flow in any of the theories used here, but it is an appraisal category within the motivational model proposed by Schumann (1997). Moreover, novelty can be seen not only in the content being presented, but also in terms of the technology itself (the device). The category of goal or need evaluation takes into consideration how important it is, for the learner, the task being proposed by the teacher/the learning system, as specified by Schumann, but also as in an instrumental language course. Yet, this category considers the relevance of VR for that given experience, i.e., at that moment, the learner could only experience that type of SLL narrative in a simulative artificial environment. This has been true in other fields of knowledge, such as medicine and aviation, where access to practice can be expensive and even

[38] Here, it is possible to think of a musician experiencing flow while composing in the same way as surgeon operating in a life-threatening condition.

impractical at the first learning stages. In SLL, one can think of situations where the learner is transported to a communicative common type of interaction in a country where the target language is spoken. In fact, this would be an enhanced form of the role-play, a methodology with a long history in SLL, where the learner usually imagines being at a communicative situation with a classroom partner.

Next, the model will ground the analysis of the results of SLL applications developed for two types of VR environment, mobile and immersive, described in the methodology section.

5 METHODOLOGY

This section describes two experiments set up to answer the research questions of this thesis: 1) Does VR contribute for short and long-term learning and recall of English vocabulary as a FL?; 2) Which learning environment, desktop or VR, is the most efficient for FL vocabulary learning?; 3) Comparatively, which student benefits the most from VR for FL vocabulary learning – elementary, pre-intermediate or intermediate?; 4) How does affect influence English vocabulary learning in VR?

During the trajectory of this research, it became necessary to improve the experiments to answer these questions in a satisfactory way. The first experiment was designed for a regular classroom course and made use of mobile VR as it was, at the time, the only technology available within the resources of this researcher. By the time the first data was available, the research project was accepted at the Cluster of Excellence Cognitive Interaction Technology (CITEC), from Bielefeld University, Germany, under the supervision of Prof. Dr. Thies Pfeiffer. This invitation was for two semesters as a guest researcher at Bielefeld University, the first one approaching VR theoretically and practically, and the second one dedicated exclusively to the development of VR projects. By the end of the first semester, this researcher was awarded with a sandwich Ph.D. scholarship granted by CNPq (National Council for Scientific and Technological Development), which financed the research project.

At CITEC, in collaboration with the Nursing Faculty at Fachhochschule Bielefeld, and later the University of Applied Sciences Emden/Leer, this researcher had access to the state of the art VR technology to improve the SL vocabulary learning environment. Thus, the environment created there and applied to an experiment at the Federal University of Juiz de Fora, differ greatly from the technology and narrative points of view, although the first experiment served as a basis from where the methodological procedures could be improved.

A third experiment was implemented at the technical and methodological levels only, this time in collaboration with the researchers at the University of Applied Sciences Emden/Leer. Due to the COVID-19 pandemic declared on March 11th, 2020, by the World Health Organization (WHO), the application of the experiment became unviable due to safety measure social distancing which obliged schools and universities to remain closed for an undetermined period. Nonetheless, this third environment remain relevant in the analysis section since the modifications

implemented there serve as a basis from which it is discussed theoretical and practical subsidies for teachers and researchers interested in the application of VR for FL vocabulary learning.

5.1 EXPERIMENT ONE: A TRIP TO THE FRIDA KAHLO MUSEUM

This experiment had a quantitative perspective according to which vocabulary tests were applied prior and after the exposure to the virtual environment to measure learning. It also sought to investigate the participants' affective responses to FL vocabulary learning in VR using a qualitative questionnaire.

This first part of the methodology section is structured as follows: section 5.1.1 presents the participants of the experiment, while sections 5.1.2 to 5.1.4 the procedures and tools adopted. Section 5.1.5 analyses the results of the vocabulary tests and section 5.1.6, the results of the qualitative questionnaire. Lastly, in section 5.1.7, some observations about participants' comments and reactions regarding the exposure to the virtual environment are shared.

5.1.1 Participants of the experiment

According to the studies by Hulstijn, Hollander and Greidanus (1996), Chun (2001), Souza and Braga (2007), and Yun (2011), students of higher language proficiency levels do not make much use of hypermedia resources since they are typically able to make intratextual inferences to the unknown vocabulary. Therefore, the sample chosen for this study was nine students of English II, from Faculdade de Letras at the Federal University of Juiz de Fora (UFJF) and nine students of a private English course taught by this researcher. In either case, the students' levels of proficiency varied from elementary to intermediate.

The three categories (elementary, pre-intermediate and intermediate) within which the 18 students were identified are based on the results of the proficiency test (see Annex A) *Solutions Placement Test* (EDWARDS, 2007). Table 4 shows the proficiency levels distributed among the sample of this study. Most students were from an intermediate level and none of them had had access to VR as a medium to language learning. The median of the participants' ages was equal to 28.

Table 4 – Level of proficiency and number of participants of the study

Elementary	6
Pre-Intermediate	5
Intermediate	7

Source: The author (2021).

5.1.2 Methodological tools, purposes, and procedures

Table 5 presents the methodological tools, purposes, and procedures of the experiment, as well as what was expected from them. This research was approved by the Ethics Committee of Universidade Federal de Juiz de Fora[39].

[39] Research Ethics Committee's constituted opinion (Parecer consubstanciado do Comitê de Ética em Pesquisa) number: 2.773.372.

Table 5 - Methodological tools, purposes, and procedures

1) Recruitment of participants for the experiment.	To invite the English learners to the study, explain its phases and goals, to distribute the term of free and clarified consent - *Termo de Consentimento Livre e Esclarecido* (Appendix A).	Visits to the classrooms of the targeted English learners for the study.
2) Application of the proficiency test.	To evaluate the participants' levels of English proficiency (Annex A).	Applied on the day of the experiment, without participant's consultation of any kind of material.
3) Application of the vocabulary pre-test.	To identify participants' familiarity with the lexical items displayed as glosses in the virtual reality learning environment (Appendix B).	Applied on the day of the experiment, without participant's consultation of any kind of material.
4) Vocabulary lesson in the virtual reality learning environment.	To display the target-words among the extracts of text provided in the environment, together with their pronunciations and corresponding images.	Students were introduced to the mobile VR technology and the purpose of the lesson. A tour within the Frida Kahlo Museum served as the context for the teaching and learning of the target words.
5) Vocabulary post-test	To quantitatively measure the learning of targeted words immediately after participants' exposure to the learning environment and guided tour.	Applied on the day of the experiment, after the vocabulary lesson, without participant's consultation of any kind of material.
6) Qualitative questionnaire.	To measure participants' enjoyment, management of the devices, and navigation in the virtual environment, as well as their opinions about the experience (Appendix D).	Applied on the day of the experiment, after the vocabulary lesson.
7) Field diary.	To register author's observations about students' comments and reactions during the study.	Kept with the research at all times of the experiment. Notes were made inside the classrooms.

Source: The author (2021).

5.1.3 Vocabulary pre-test

Following the questionnaire, participants took a vocabulary test (see Appendix B), based on adaptations and translation of the *Vocabulary Knowledge Scale* (PARIBAKHT; WESCHE, 1997). These adaptations were first made by Souza (2004) of Scarammuci's (1995) vocabulary scale and evaluates the knowledge of specific lexical items in three categories (columns), and answers can vary from total novelty of the item to a confident definition of it, as in: "I have never seen this word before", "I have seen this word before and I think it means[40]…", and "I know this word. I know its meaning. The meaning is…". To be considered as lexical knowledge, also based on Souza (2004), the participants' answers should give correct definitions to the words using translations and English synonyms in the categories "I have seen this word before and I think it means…", and "I know this word. I know its meaning. The meaning is…". Adding to the forms of correct representation of linguistic knowledge, this experiment included answers using drawings. This change in modes of representation was due to the perception that a multimodal learning experience could be benefited from a multimodal test as well, potentially enhancing other forms of knowledge, such as the visual, that are not always valued in academic life, which traditionally tests students in verbal language.

The vocabulary pre-test had 16 English words, presented as a random word list. Those were: *self-portrait, bedridden, cast, courtyard, disease, struggle, strength, velvet, affairs, easel, foetuses, miscarriage, nips, sketch, ups and downs,* and *whole*. These appeared as glosses in the texts of the VR environment, as well as orally during my guidance of the scenes of the tour. In this way, each word had an average of 5 repetitions. This strategy used as a referral the methodology applied by Saito (2015), based on Nation's (2008) minimum number of repetitive exposures needed for a new word to be learned, in the context of second language acquisition.

The main criteria for choosing such vocabulary were that they should be a) keywords referring to the topic[41]; b) potentially unknown vocabulary, considering the

[40] In the actual test used for the experiment, participants had access to the categories' translations into Portuguese.
[41] In that way, inferences could be made based on the remaining of the text where that word was inserted.

participants' proficiency levels[42]; and c) words that were possible to be represented by the images used in the VR environment, including the adjective *whole*, which was emphasized in a picture by Kahlo where she compared herself *whole* and *broken*.

The pre-test was applied to the participants to provide a true measure of their learning since some of the words could have already been part of their vocabulary knowledge. For all the three proficiency levels, the pre-test confirmed the assumption, based on the criteria explained above, that the words chosen as target-words were mostly unknown, especially for the elementary and the pre-intermediate groups. The results of this test were analyzed in comparison to the ones from the vocabulary post-test, discussed in more detail in section 5.1.5.

5.1.4 The making of the virtual reality learning environment

The gadgets that make up the VR experience come in a variety of arrangements, technologies, and prices on the market, as presented in chapter 2. For this study, due to a budget restriction, the option available matched the simplest that VR can get, meaning the view of 360° images displayed on the screen of a smartphone attached to a headset made according to the standards of the Google Cardboard, as showed in section 2.1., Figure 7.

As it has also been discussed in chapter 2, mobile VR device do not deliver a completely immersive experience since they lack tracking of the user's position in 6 degrees of freedom. However, sense of presence is a psychological feature, less caused by technology than by the individual's willingness to suspend disbelief, as it was possible to state by observing the reactions of the participants from the study. Besides, although stereoscopic photography creates a more predictable narrative, such an environment allows the student to explore it at their own pace, following the principle of segmentation proposed by Mayer (2001), according to which people learn best when multimedia lessons are presented in user-driven segments.

As for the narrative mechanism, the Google Expeditions application (see section 2.1) was used. The choice of the environment was made according to the tours available on Google Expeditions at the time and it took into account the

[42] In addition, none of them were found on the TOEIC (Test of English for International Communication) Service list (BROWNE, C; CULLIGAN, B. 2016), which lists the 1254 highest-frequency English words.

following criteria: the tour should a) be in English, b) make use of visual and auditory resources, following Mayer's (2001) multimedia principle, c) have informative text, and d) the theme of the tour should be potentially appealing and emotional to foster learners' engagement in the activity and learning (VYGOTSKY, 2001).

Among the themes available in the application at the time, a biography was likely to fulfil such requirements, especially considering its potential to generate empathy. Thus, the only possible VR tour among the options available on Google Expeditions, considering the above criteria, was called **Life and Art of Frida Kahlo**. The tour contained scenes from the premises at Frida Kahlo's museum in Mexico City, as well as extracts of text. In total, the original tour had 18 scenes, which would be unpractical to use due to the time spent in the activity and the number of potentially unknown words in the text. Consequently, it was used only some text, edited to be shorter, and four scenes from this tour on another free application, Google Poly, designed to create 3D objects and scenes for VR and AR devices. In that way, the Expeditions VR tour became customizable to attend the study limitations since the four 360° scenes were also found on Google Earth, street view mode, which included images of the museum interior. All it took, for the scenes to be located, was the address of the museum.

The tour created with the adapted text from Expeditions had the target-words (see section 5.1.3) highlighted in the form of capital letters, and none of them had translations or definitions of any sort in the environment, although they appeared in the context of what was being seen on the screen. The first mentions to the words, by the teacher, were followed by their synonyms in English and/or questions directed to the participants to check their comprehension. Besides, some of the questions elicited answers based on their previous experience and world knowledge since knowing a lexical item does not occur only at the linguistic level, but it also happens extralinguistically (PROCÓPIO; SOUZA, 2016). i.e., based on cues that can be available in the context of the vocabulary use.

5.1.5 The guiding of the tour

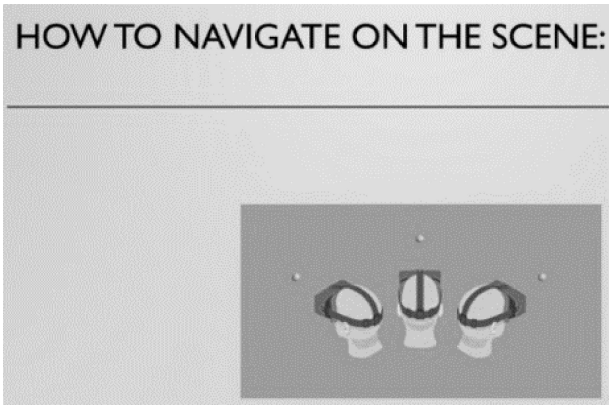
The teaching approach used in the tour made use of implicit and explicit strategies. The first takes place in context and contributes to lifelong learning, providing more learner's autonomy through lexical inference (LAUFER; HILL, 2000).

The second, explicit teaching, facilitates learning by the control of exposure and vocabulary repetition (SCARAMUCCI, 1995).

The tour (see the lesson plan in Appendix C) begins in the patio of the museum, the courtyard of Frida Kahlo's house, and goes to a room where her dresses and pictures were displayed, followed by a garden scene, and Frida's and Rodrigo Rivera's painting studio. The tour had been published and was available to public view on Google Poly since the study took place until Google Expeditions was removed from Google services in June 2021.

To access the tour, there were eleven Google Cardboard headsets, smartphones[43], and earphones[44] for individual use. The configuration of the tour and the safety instructions were presented to the participants at the beginning of section one of the tour, in the form of a slide show. Figure 16 shows how it was possible to navigate on the scenes. Because the image was recorded in 360°, the viewer's gaze finds an image in any direction their head turns. The white dots in front of the headsets represents the gaze of the viewer.

Figure 16 – Image recorded in 360°



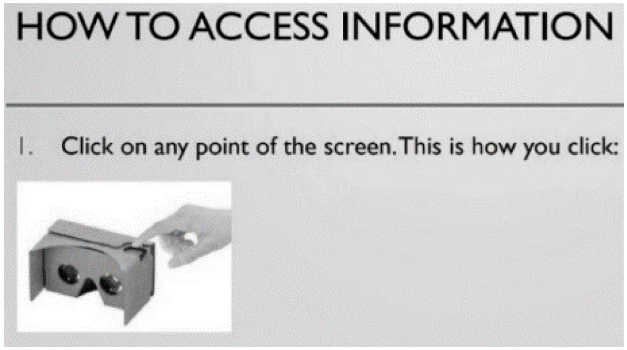
Source: Monteiro and Ribeiro (2020, p. 1323).

The possibilities given to the students, in terms of navigation, were 360° gazing of the environment and access to links to text plus image and audio files (the narration of the same text, recorded with a human voice). Besides, there was a link to the main menu where the links to all the scenes were. To click on links, participants needed to press a button on top of the headset without taking the device from their

[43] A Motorola G4 Plus. At the time of the study, this model had the minimum requirements for VR content to be displayed: gyroscope and accelerometer sensors.
[44] From various models. The participant could also use his/her own.

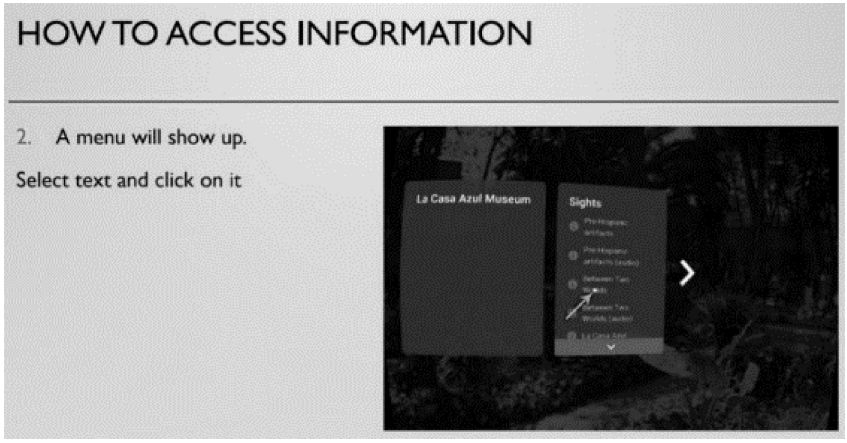
faces, as illustrated in Figure 17. Figure 18 shows a screenshot of the virtual tour where a menu appears by the click of the user anywhere on the screen, making it possible to change between scenes. In the scene, an arrow directed the viewer's gaze to the corresponding text/audio icon, which needed to be clicked again for the text to appear or the audio to play, as in Figure 19. Figure 20 shows how the environment looked like on the screen of the smartphone, as well as an example of how the target-words appeared in the text, together with a related image. After clicking on a text icon, the viewer saw one target word displayed in context. An image followed the text (here, Frida's first self-portrait). The lenses inside the Google Cardboard converge the two images into one, giving it the illusion of three-dimensional space.

Figure 17 **-** Button on top of the Google Cardboard



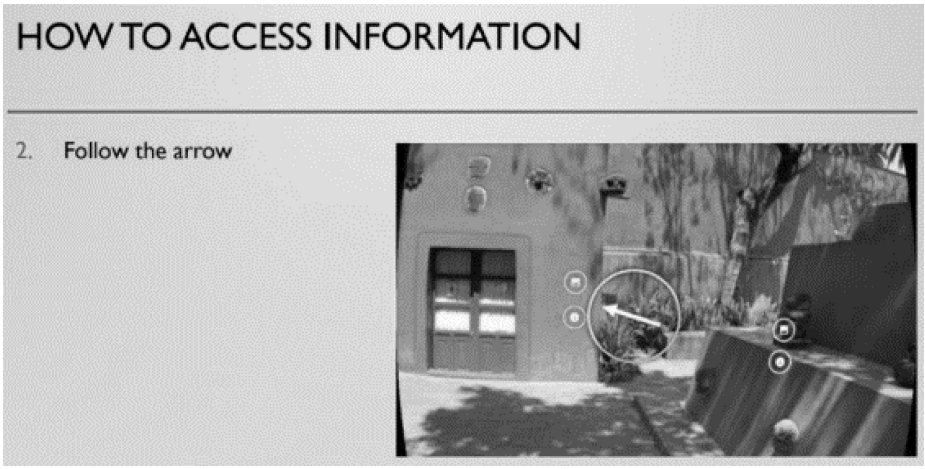
Source: Monteiro and Ribeiro (2020, p. 1324).

Figure 18 - Menu to navigate through the scenes



Source: Monteiro and Ribeiro (2020, p. 1324).

Figure 19 - Arrow that directs the viewer's gaze to the corresponding text/audio icon



Source: Monteiro and Ribeiro (2020, p. 1324).

Figure 20 - One frame of the scene about Frida's dresses.

Source: Monteiro and Ribeiro (2020, p. 1325).

5.1.6 Results of the vocabulary tests

After the virtual tour, a vocabulary post-test (identical to the pre-vocabulary test) was applied to the participants, who were not allowed to make consultations of any kind. As in the pre-test, the participants could give definitions to the words using translations, English synonyms, and representations in the form of a drawing.

The analysis of the tests excluded known words from the vocabulary pre-test, i.e., words that the participants already knew before the experience. Therefore, the numbers in Table 6, referred to the column *post-test*, are learned words, i.e., words that the participants correctly translated, provided English synonyms for or represented by drawings that were found in columns B and C of the test (*I have seen this word before and I think it means…*, and *I know this word. I know its meaning. The meaning is…*, respectively). These results were organized by the participants' three proficiency levels.

The metric used for the two experiments described in this chapter is represented by a formula of percentage change, as follows:

$$\text{Percentage Change} = 100\frac{\Delta}{f(x,y)}, \quad (1)$$

where $\Delta = x - y$ is the learning difference in percentage points between the final, x, and initial, y, values of the average knowledges obtained before and after the experiment respectively. Also, $f(x,y) = \frac{|x|+|y|}{2}$ is considered because it allows to perform comparisons when initial values are equal to zero, which occurred in the experiment reported in section 5.2.6. Note that $|.|$ denotes the absolute value operator.

Table 6 – Results from the vocabulary tests

Proficiency levels	Pre-test (%)	Post-test (%)	Percentage change (%)
Elementary	5	54	166.10
Pre-intermediate	7.5	42	139.39
Intermediate	32	71	75.73

Source: The author (2021).

The difference between the final value and the initial value, x-y, is the learning difference, with the final value meaning the number of words, obtained by the post-test, the participant knew after the virtual tour, minus the number of words they knew

prior to it (as the result of the pre-test). These numbers were calculated using percentage.

For the elementary level, 5% out of the total of 16 words tested represented less than one word (0.8) in average for each participant[45]. For the intermediate level, 7.5% out of the total of 16 words tested prior to the experiment represented a little more than one word (1.2) in average for each participant. Lastly, in the intermediate level, in average, each participant knew 5.12 words prior to the experiment.

Therefore, when looking at Table 6, the results provided a partial answer to the questions of this research, *does VR contribute for short and long-term learning and recall of English vocabulary as a FL?* and *comparatively, which student benefits the most from VR for FL vocabulary learning – elementary, pre-intermediate or intermediate?* As it will be explained in section 5.1.8, concerning the limitations of the experiment, it was not possible to conduct a test intended to verify a long-term recall of the target-words. Nonetheless, the results of the post-test indicate that there was a learning gain for every level, even though, as also expected, the elementary level benefited the most since the lack of a vast lexical knowledge can be a barrier for the inference of new words based on context. Thus, the use of hypermedia resources such as images and narration provide extralinguistic clues, facilitating the correct guesses and inferences of new vocabulary. On the contrary, the participants from the other level groups, pre-intermediate and intermediate, did not depend as much on the same clues provided by VR, specially the intermediate. As linguistic knowledge increases with the proficiency in the target-language, the hypermedia resources seem to be less relevant. Although learning occurs, as seen by the learning gain percentages, it is not as expressive as in the elementary group. These quantitative results are consistent with the ones from a previous experiment (PROCÓPIO, 2016), described on section 3.1.1, adding the evidence that the same can be valid for virtual reality environments.

These results also increase the data available for mobile VR and FL/SL vocabulary learning. As section 2.1 showed, by the time the literature review of this thesis was conducted, only one study (MADINI; ALSHAIKHI, 2017) was available which reached the conclusion that 360-degree VR videos were more effective to teach vocabulary in an English for specific purposes lesson than other media (TV-

[45] This and the other calculations of this paragraph were made by the rule of three.

screen-video instruction). Based on what this section has been discussing so far, it can be the case that mobile customized lessons offer an option that contrast with the notion provided by Mayer and Parong (2018), discussed in section 3.1.2, according to which a VR learning environment offers an extraneous amount of visual information, therefore being impossible to apply the multimedia principles in a way that information is redundant but not distracting, i.e, by offering more than the connections between what is being seen and the learning goal. Although this can be true for ready-made VR scenarios, as it was the case in Parang and Mayer's experiment, what this experiment showed to be possible was exactly the customization of mobile VR to segment a lesson and direct the participants' attention to target-words and their explanation.

5.1.7 Qualitative results: answers from the questionnaire

Four questions evaluating affect (see Appendix D) were addressed in terms of what the 18 participants thought of the environment; if they felt immersed in it, what features of the environment, among pre-selected options, they thought was the most favorable to learning, and if they felt any discomfort during the experience.

For the first and open-ended question, "what did you think of the experience?", Table 7 shows the adjectives they used[46] in their answers to give qualities to the experience, as well as the numbers of reoccurrences of the same adjective, presented according to the fluency levels.

Table 7 - Adjectives used by the participants to answer the first question of the qualitative questionnaire, "what did you think of the experience?"

Appraisal	Elementary	Pre-intermediate	Intermediate
Interesting (interessante, muito interessante)	4	2	5
Different (diferente, difrenciada)	2	1	1

[46] In most cases, one participant gave more than one appraisal to the experience.

Enjoyable/Cool (super legal, gostei muito da experiência, bem legal)	1	1	2
Surprising (surpreendente)	2	0	0
Great idea/great way to learn (ótima ideia, ótimo jeito de aprender)	0	2	0
Creative (criativa)	1	0	0
Rich/Enriching (rica)	1	0	1
Dynamic (dinâmica)	1	0	0
Effective (efetiva, eficaz)	1	0	0
Productive (produtivo)	1	0	0
New (nova)	0	1	0
Challenging (desafiadora)	0	1	0
Valuable (valiosa)	0	1	0
Didatic	0	1	0
Very good (muito bom)	0	1	0
Beneficial (proveitoso)	0	0	1
Attracting (atrativa)	0	0	1

Helpful (ajuda a aprender)	0	0	1
Valid (válida)	0	0	1
Motivating (motivante)	0	0	1
Innovative (inovadora)	0	0	1

Source: The author (2021).

Also considered in Table 7 were the adjectives used in question six of the questionnaire, which addressed the comments, criticisms, and/or suggestions participants would like to give to the researcher regarding the experience they just had. Four participants did not answer this second question. These comments were as follows. The English text presented in all answers on the questionnaire is a direct translation from Portuguese, made by this author: Participant 1: *I thought it was very cool and productive. I hope to have more experiences of this kind*[47]. Participant 2: *Less text, in the case of English beginners; less time, in the case of English beginners; try to apply this virtual environment to the teaching of English in an intermittent way; Always seek important stories such as Frida's, because this helps in the association between words and context*[48]. Participant 3: *Very interesting this experience. It makes the learning more effective, even though the theme is not of my interest*[49]. Participant 4: *Number 5 was chosen in questions 4 and 5 exclusively because I have not used the listening resource, but I do think the experience is valid*[50]. Participant 5: *I thought the experience interesting, but I think the target-words*

[47] Free translation of: "Achei super legal a experiência e produtivo. Espero ter mais experiências do tipo".
[48] Free translation of: "Menos texto, no caso de iniciantes de inglês; menos tempo, idem; tentar aplicar esse ambiente virtual para o ensino de inglês de forma intermitente; buscar sempre histórias importantes como a da Frida, pois isso ajuda na associação de palavras e contexto".
[49] Free translation of: "Muito interessante esta experiência. Torna o aprendizado mais efetivo, mesmo que o tema não seja do meu interesse".
[50] Questions 4 and 5 of the questionnaire asked what, from the virtual environment, contributed the most and what the participant liked the most, respectively. Free translation of: "O número 5 (cinco) foi escolhido no questionário 4 e 5 única e exclusivamente por não ter utilizado o processo de audição ainda, mas que acho válida a experiência".

could be more common, i.e., could be words used in daily life[51]. Participant 6: *I thought it was very cool, both the environment and the easy-to-understand texts, and the movements we made. It was a great idea for teaching new words, but you have to improve a little more the equipment used*[52]. Participant 7: *I thought the experiment very valid for those who wish to learn a foreign language*[53]. Participant 8: *I believe the sharing of the equipment has made it difficult a little the apprehension of the knowledge (visual/textual) and if we could see the content before or after the experience we could learn more*[54]. Participant 9: *I liked the experience very much*[55]. Participant 10: *The equipment presented technical problems, switching off the screen frequently*[56]. Participant 11: *I thought the experience very interesting because I believe that using many senses during the learning makes easy memorizing unknown information. The narration, together with the virtual tour makes the experience very rich*[57]. Participant 12: *I thought it was valid and interesting. For sure a motivating and different way for language learning*[58]. Participant 13: *I thought the activity very beneficial from the learning and fixation of vocabulary point of view. However, I get the feeling that the same activity could be done with visual resources, without virtual reality and without loss of efficiency. Even so, the experience is interesting and can be attractive to those who are learning. If I were to choose a language classroom, I would like to have the resource as something extra, not as an*

---

[51] Free translation of: “Achei a experiência interessante, mas acho que as palavras trabalhadas poderiam ser mais usuais, ou seja, poderia trabalhar palavras usadas no cotidiano”.

[52] Free translation of: “Achei muito legal, tanto o ambiente quanto os textos fáceis de entender e os movimentos que fizemos. Foi uma ótima ideia de ensinar novas palavras, mas tem que aperfeiçoar mais um pouco o equipamento usado”.

[53] Free translation of: “Achei o experimento muito valioso para quem deseja aprender uma língua estrangeira”.

[54] Free translation of: “Acredito que o compartilhamento dos materiais tenha dificultado um pouco a apreensão do conhecimento (visual/textual) e se pudéssemos ver o conteúdo antes ou depois da experiência poderíamos aprender mais”.

[55] Free translation of: “Gostei muito da experiência”.

[56] Free translation of: “O equipamento apresentou problemas técnicos, apagando a tela com frequência”.

[57] Free translation of: “Achei o experimento muito valioso para quem deseja aprender uma língua estrangeira”.

[58] Free translation of: “Achei válido e interessante. Com Certeza uma forma motivante e diferente para o aprendizado de idiomas”.

entire class in virtual reality[59]. Participant 14: *There could be, in English, a definition of the highlighted words*[60].

Table 8 shows the answers which sought to classify the relevance of the components from the VR experience by asking “What most contributed to your vocabulary learning”? This question was a multiple-choice one, where participants were asked to rate from 1 (for what they thought contributed the most) to 5 (for what they thought contribute the least). One participant did not answer this question. the number of times each option received the highest appraisals, according to the fluency levels.

Table 8 - Elements of the VR tour which received the highest appreciation

What most contributed to your vocabulary learning?	Elementary	Pre-intermediate	intermediate
The narration of the teacher/guide	3	1	0
The recorded narration referred to the texts	0	1	1
The virtual environment	3	2	6
The theme	0	0	0

Source: The author (2021).

The question: “Did you experience any physical or psychological discomfort during the experience?” was made to verify possible sources of discomfort mentioned by the participants, since cybersickness. i.e., various symptoms of discomfort on VR, mainly motion sickness, are frequently reported in VR experiences and it can also interfere on sense of presence (WEECH; KENNY; BARNETT-COWAN, 2019). The

[59] Free translation of: “Achei a atividade bastante proveitosa do ponto de vista do aprendizado e fixação do vocabulário. Entretanto, fico com a sensação de que a mesma poderia ter sido realizada com recursos audiovisuais, sem a realidade virtual, sem perda de eficácia. Ainda assim, a experiência é interessante e pode ser atrativa para quem está aprendendo. Se eu fosse escolher uma aula de línguas, gostaria de ter o recurso como algo extra, mas não lima aula inteira na realidade virtual”.

[60] Free translation of: “Poderia haver, em inglês, uma definição das palavras destacadas”.

results are shown also by levels of fluency in Table 9. Three participants answered they did not have any discomfort among the participants of the elementary level. The participant in the elementary group who answered this explained that her discomfort was caused by the sad passages about Frida's life. One participant from the intermediate level did not answer this question. Two participants, in this same group, answered they did not have any discomfort.

Table 9 - Sources of discomfort and the number of times they were mentioned

Did you experience any physical or psychological discomfort during the experience?	Elementary	Pre-intermediate	Intermediate
Dizziness	1	3	3
Headache	1	1	0
Itchiness/pain in the eyes	1	1	1
Nausea	1	0	1
The unpleasant smell of the cardboard	0	1	0
Psychological	1	0	0

Source: The author (2021).

Although most of the participants (13) reported physical discomfort during the experience, none of them abandoned it. In case of any discomfort, exiting the experiment was recommended by this researcher (the guide) before the tour started. Also, interesting to note, physical discomfort, such as nausea and headache/eye soreness, was reported only on day 1 of the experience. Some students said they had gotten *used to* the device and no longer felt the symptoms of the first contact with it.

Lastly, another open-ended question enquired the participants whether they felt immersed in the virtual environment, together with a justification for their answer. The following are the translations of these answers. One group, the one of

participants from this researcher's private English course, did not have access to this question in the questionnaire, as it was added later. Participant 1[61]: "Yes, I felt totally immersed in the environment because the virtual environment brought me some knowledge very close to reality"; Participant 2: "In some aspects as when in contact with the images and some texts that I could visualize, [they] helped me. However, in some moments I could not follow[62]"; Participant 3: "Yes, the images were very realistic and the moving in 360 degrees allow more immersion[63]"; Participant 4: "I super felt immersed, it looked like I was at the very La Casa Azul. And now I want to know it for real[64]"; Participant 5: "Yes, the device allowed us to emerge in the museum and made it look like as if we were really there[65]". Participant 6: "A little, not entirely. Because the part where the nose stays [in the device] it disturbed [me] a little because the smell of the cardboard is a little disturbing. The cellphone did not stay fixed [in the device], thus there are times the vision gets blurry, and the audio did not work[66]"; Participant 7: "Yes, because virtual reality has this capability and everything was conducted in a way to offer the best experience possible[67]"; Participant 8: "Yes, the headset gives us a sensation that we are really in that place[68]"; Participant 9: "Yes, the images and the texts are way much more realistic than in a projector, for example. Besides, the audio in the earphones is better[69]".

The answers from the qualitative questionnaire depicted began to answer the questions 3 and 4 of this research, namely, *does affect influence English vocabulary*

---

[61] Free translation of: "Sim, me senti totalmente imersa ao ambiente, porque o ambiente virtual me trouxe um conhecimento muito próximo da realidade".
[62] Free translation of: "Em alguns aspectos como o contato com as imagens e alguns textos que consegui visualizar me ajudaram. Porém, em alguns momentos não consegui acompanhar.
[63] Free translation of: "Sim, as imagens eram bastante realistas e a movimentação em 360 graus permite maior imersão".
[64] Free translation of: "Super me senti imersa, parecia que eu estava na própria La Casa Azul. E agora quero conhece-la de verdade".
[65] Free translation of: "Sim, o aparelho nos permitiu emergir no museu e fez parecer como se realmente estivéssemos lá".
[66] Free translation of: "Um pouco, não totalmente. Porque na parte onde fica o nariz incomoda um pouco, pois o cheiro de papelão incomoda um pouco. O celular não fica totalmente fixo, então tem hora que embaça a visão e o áudio não funcionou".
[67] Free translation of: "Sim, pois a realidade virtual tem essa capacidade e foi tudo conduzido para proporcionar a melhor experiência possível".
[68] Free translation of: "Sim, o óculos dá uma sensação de que realmente estamos naquele local".
[69] Free translation of: "Sim. As imagens e os textos são bem mais realistas do que num projetor, por exemplo. Além disso, o áudio nos fones de ouvido é melhor".

learning in VR? What components in the VR learning environment can contribute to foreign vocabulary learning?

To answer the first question, the model of figure 15, described on section 4.2 of this thesis, is used. Nonetheless, due to the limitations of this first experiment, as described in the next section, there will be no mention given to flow in the analysis since this aspect emerged in the second experiment, when immersion techniques were more appropriately addressed and the narrative was focused on participants' interests.

Beginning by analyzing to what extent each category of the model was fulfilled by the participants' experience and perception, *novelty* will be described first. On the first day of the experiment, to all the three groups, it was asked by this researcher if any participant had access to a VR device before. A previous experience was described by three participants. Thus, the VR medium was majorly new to them. The novel characteristic was also mentioned in the set of appraisals showed by Table 7. It would be reasonable to group the following adjectives under the novelty perception: different (4 mentions), surprising (2 mentions), creative (1 mention), new (1 mention), and innovative (1 mention). Also, worth mentioning it is the fact that five out of nine mentions were given by the participants in the elementary group, followed by two mentions from participants in the pre-intermediate group and two mentions from participants in the intermediate group. This analysis corroborates the previous section, where the quantitative data was studied, towards the conclusion that the elementary level of fluency benefits the most from the virtual environment, not only because of the contextual clues it provides, but also because motivation, at least in early stages of the learning process can be dependent on novelty, as Schumann (1997) preconized.

The second category of the model to be reviewed according to the data of the experiment is *pleasantness*. In this category, as mentioned in the model, two characteristics are particularly important: immersion techniques must be adequate, i.e., favoring sense of presence at most, and the experience must be perceived as the most pleasant situation among any other one available at that time. The latter will be discussed in the analysis of the second experiment since this characteristic is rather important to the theory of flow discussed in the previous chapter (CSIKSZENTMIHALYI, 1990). Instead, what can be discussed in this first experiment is subjective perception of pleasantness.

Beginning by the former characteristic, in the section dedicated to the limitations of the study below, one can see that the technological aspects of this experiment had flaws regarding the possibility to offer a highly immersive experience due to the type of the device this research had available at the time. The aspects of mobile VR, which interfere in the degree of sense of presence experience were described in section 2. However, apart from all the conditions that were lacking in this first experiment to favor immersion, as the answers to the last question described above showed, most of the participants (eight out of nine responders) felt present (immersed) in the virtual environment. Although this number may not be enough to allow generalizations, it gives a slightly different perspective to the relation between immersion, i.e., the techniques in VR that potentialize sense of presence, and sense of presence itself, which can be a subjective feature based on motivation, for example. Until now, research as depicted in chapter 2 has focused on immersive VR as a tool for SLL since this technology can reduce cybersickness and provide a more interactive experience to learners. Still, much less attention has been given in how enough sense of presence can be provided by mobile VR, so the learners see an advantage in using this resource. As showed by the literature review, only two studies were retrieved towards this thinking (PELTEKOVA; STEFANOVA, 2016; MADINI; ALSHAIKHI, 2017). Thus, it could be the case that, especially in the conditions where mobile VR is novel, the way the narrative is conduced into segmented stages, and attention to the relevance between imagery and text, sense of presence can be produced in a way that motivation and, consequently, learning, are enhanced.

The second characteristic of category pleasantness discussed in this section, will draw its analysis from Table 7, where some adjectives were displayed in terms of what the participants thought of the experience. The following are the adjectives grouped by what can be considered part of the pleasantness category, according to the definition of the term pleasant by the Cambridge Dictionary[70]: Interesting (11 mentions); Enjoyable/cool (4 mentions); Great idea/great way to learn (2 mentions); Dynamic (1 mention); Very good (1 mention); Attracting (1 mention). When these opinions are divided between the levels of fluency, the results are: elementary (6 mentions); pre-intermediate (6 mentions); intermediate (8 mentions). Thus here, the

[70] Disponível em: https://dictionary.cambridge.org/. Acesso em: 8 ago. 2020.

trend is inverted when it is compared with the one within the category novelty. In this case, the higher the level of fluency is, the more pleasant sense of presence may be in the virtual reality environment. A plausible explanation for such a result could be that understanding the language better gives room to enjoyment of immersion techniques. That is, the exploration of the novel resources can be done without prejudice in following the lesson. Indeed, this aspect can be associated with one of the participant's opinion (Participant 6, elementary) about feeling immersed: "*In some moments I could not follow*", and an opinion about the experience, in general, also given by a participant from the elementary level (Participant 1): "*I thought it was very cool and productive. I hope to have more experiences of this kind*". These initial thoughts about the data gathered in the first experience can also reflect Parong and Mayer's study (2018) in terms of what the authors considered a downside of VR as a tool for learning, i.e., overwhelming stimuli, as mentioned in section 5.1.6.

The next category evaluated by the model in figure 15 is *goal/need evaluation*. This category measures subjectively if the task is important to the learner and evaluates if it can be done only in VR. A positively answer to the latter is an indication of the increased relevance of the task. Although it was only in Experiment 2 that the virtual environment was planned towards a target audience of students, being considered an ESP lesson, in this first experiment one could say that the task was important to the learners merely for teaching vocabulary since they were at an English course. About the evaluation on the relevance of the VR medium for the task, considering that the goal of the lesson was to simulate a trip to the Frida Kahlo's Museum in Mexico, it is also reasonable to think that VR would be the most appropriate medium to fulfill such a simulation. As for the previous categories, the adjectives of Table 7 are now grouped according to their meaning related to what could be perceived as related to goals and needs: Rich/Enriching (2 mentions); Effective (1 mention); Productive (1 mention); Valuable (1 mention); Didatic (1 mention); Beneficial (1 mention); Helpful (1 mention); Valid (1 mention). By analyzing these opinions according to levels of fluency, the results are: elementary (3 mentions); pre-intermediate (2 mentions); and intermediate (4 mentions).

Based on the inconsistency of these results and the small sample, it may not be possible to consider, at this time, that the perceiving of how usefulness the vocabulary lesson is, towards specific goals or needs, increases with the level of fluency. Nonetheless, as a thinking exercise, it is possible to conjecture that the

scope of vocabulary knowledge within the intermediate group surpassed the need for a pragmatic vocabulary set, therefore finding usefulness in a lesson that broaden the linguistic knowledge beyond common words. This temporary conclusion could be supported by Participant 5's comment, from the elementary level: *I thought the experience interesting, but I think the target-words could be more common, i.e., could be words used in daily life.*

The previous studies on VR for vocabulary learning, brought here in the literature section, have not explored levels of fluency in their data analysis, which leave this research without a basis for comparison. On the other hand, it suggests that this criterion should be investigated further to understand how the VR tools could be better addressed in terms of its users.

Closing the group of categories in the model proposed, there is the *self-compatibility check*, meaning, learners access if their skills and knowledge are compatible to the challenge. Here, motivation, according to Schumann (1997), observes the degree with which the task is challenging enough to excite but not frighten. In this regard, the levels of fluency play an important role, one could assume, since the lack of enough linguistic knowledge can interfere on the progress of the learning during the lesson and thus demotivate. According to Table 7, only one adjective can be related to this category: Challenging (1 mention, pre-intermediate). Thus, to add to this analysis, the answers it could be the case that the lesson was organized in a way that even lower levels of fluency did not rate difficulty as a main issue, or the other appraisals categories were more relevant for motivation. In any case, it is worthy highlighting the following comments from the ones previously described as answers to the question *What did you think of the experiment?* which could help clarifying how participants perceived their skills and knowledge in relation to the task: Participant 2: *Less text, in the case of English beginners; less time, in the case of English beginners; try to apply this virtual environment to the teaching of English in an intermittent way; Always seek important stories such as Frida's, because this helps in the association between words and context*; Participant 8: *I believe the sharing of the equipment has made it difficult a little the apprehension of the knowledge (visual/textual) and if we could see the content before or after the experience we could learn more*. Participant 14: *There could be, in English, a definition of the highlighted words.*

Participants 2 and 8 were rated as elementary. This last comment was made by a participant from the elementary and pre-intermediate levels, respectively, and indicate that the degree of difficulty was seen as a barrier, while participant 14, from the intermediate level, asked for an increased difficulty, since translations were not as needed to him. Even though we could reach such conclusions, none of these participants consider the activity demotivating.

5.1.8 Limitations of the experiment

Initially, this experiment had counted with 25 participants, seven of which belonging to the course English III from Faculdade de Letras at the Federal University of Juiz de Fora (UFJF). This researcher was allowed, by the professor in charge of the class, to take two days of the student's schedule of the subject English III to conduct the experiment. However, the application of the tour in this classroom took longer than expected on day one due to technical issues. Therefore, on this day it could be done just part one of the tour, which had seven target-words.

On the second day of the schedule, only two students from the first day were present, the rest of the class was composed by students who had not had access to the experiment yet. Since it would not be fair to dismiss this group from the activity (after all, the researcher was using their English class time), the part one of the study was applied to them, while the other group, which had taken the experiment on day one, did the proficiency level test. After the other students completed the first part of the tour, the proficiency test was also given to them. Because of this inconsistency, the data from these seven students were eliminated from the exposure of results and further analysis.

A similar problem happened in classroom English II, from the same facility. Between the first and the second days dedicated to the experiment, there were 11 students who did not complete all the steps of the procedures described in section 5.1.2. Therefore, their data was also excluded from the results and analysis of the experiment.

Regarding the use of mobile VR in the classrooms mentioned, the issues to overcome were unstable and slow internet connection, difficulties in keeping the device functioning during the entire time of the tour, and sometimes, due probably to the most basic configuration of the smartphones and/or the Wi-Fi connection

provided by the university, the images of the tour were not displayed properly, i.e., they would remain static or take long to render, causing a delay between the head movement and the change of the image angle on the screen. In addition, some participants reported having no access to the audio files, although all earphones had been testing and were working properly before the sections. There were also occasional problems with the sound, due to misconfiguration of the audio settings within the application. At times, at the university classrooms, two participants had to share one headset while one of their phones had to be reset.

Novelty can also highlight the many constraints in applying the technology in all the three classrooms used for this experiment. Students did not know intuitively what to do (most of them had never seen a VR headset and its application firsthand). Some participants spent much time trying to configure the device and the application properly so the smartphone would be centered in the headset. Every time there was a technical issue, participants would get frustrated and lose track of what was being seen/heard during the tour. In short, since this topic will be discussed in the analysis further on, novelty can enhance motivation to engage in the activity, but how this is sustained throughout the activity or in extra-classroom situations it is another issue to be proper explored. Another aspect worth paying attention to is the attention shift participants had while exploring the virtual environment and trying to follow the questions proposed by the teacher during the tour.

Although it would not be possible to have the participants standing during the experience, due to the limited space of the classroom, the chairs and desks seemed to limit the participants' moves to explore the VR scenes fully.

Methodologically, this experiment lacked the opportunity to retest the participants for long-term memory of the target-words. That was due to the approval of the research project as part of the sandwich PhD program between UFJF and Bielefeld University, as explained in the beginning of this chapter. This meant that the trip to Germany had to be arranged just after the conclusion of the experiment the way it was presented here.

However, the opportunity of the sandwich program gave this researcher new perspective and resources for making a new VR SLL environment which would potentially improve all the aspects seen as limitations in the first experiment, especially the components of the VR experience itself, since immersive technology and expertise in it would be available as resources to this project.

5.1.9 Partial considerations

Low-cost devices such as the Google Cardboard, together with applications such as Google Expeditions and Google Poly can provide customizable narratives to a point, i.e., within the limitations inherent to their applications, as explained in section 5.1.4, to promote oral discussions in the target language and vocabulary teaching in context. Despite the challenges faced during the execution of the experiment, mobile VR vocabulary lessons have great potential to enhance students' learning upon motivation expressed in four categories: novelty, pleasantness, goal/need evaluation, and self-compatibility check. It is also worth highlighting that all the participants learned new vocabulary. Some of them (12%) had 100% achievement in learning all the 17 target-words.

Nonetheless, the results of the evaluation questionnaire and the classroom observations suggested the need for a refined theme for the virtual tour to contemplate students' needs for a more pragmatic content (as mentioned by students from elementary level and pre-intermediate level, a vocabulary that contemplates real-life-type situation) and a different choice of a VR device so physical discomfort ceases to be an issue. These results were, then, taken into consideration when planning for a second VR environment for the teaching of English vocabulary in context. Therefore, the following issues were addressed.

Research (WEECH; KENNY; BARNETT-COWAN, 2019) suggest that above reported symptoms of cybersickness, such as dizziness, headache, and nausea could be resolved in great measure using immersive VR devices, as chapter 2 also explained. Thus, another problem that would be solved with immersive VR is that, in this way, the screen would not be moved or switched off, and, because all the settings of the virtual environment are done in the computer, there would probably be less problems with audio files playing correctly. In terms of narrative, it seemed that, especially for beginners in FLL, the theme should be directed to the learning of everyday words. A VR lesson should have a purpose that is immediately identified as something valuable and unique to the possibilities of immersion, i.e., the same content would not have the same effect in other media; The VR lesson should add to an existent curriculum instead of being a task out of context. Finally, the attention shifts between the virtual and physical environments could be avoided if the guide

(the teacher) was part of the virtual scenes. This could be done by inserting the guiding as audio files to an animated character.

The second experiment was attentive to these issues and, methodologically, also changed in the way the data was obtained. Thus, the following section presents a comparative study that sought to answer the same research questions and test the long-term memory of the target-words.

5.2 EXPERIMENT TWO: VOCABULARY LEARNING IN IMMERSIVE VR

The creation and application of the virtual environments described below were an outcome of a reflexive process of the first experiment and a semester of VR studies at CITEC/ Bielefeld University, which resulted in a project for a comparative study between the desktop and the immersive VR conditions, as well as a long-term test of the target-words in English taught in them. The learning goal of these environments fall into the category of ESP and it was designed to make use of navigation, selection, and interaction, i.e., the affordances of VR, as explained in section 2. The project had the collaboration of seven students, and it was supervised by this researcher.

The narrative was provided by the Nursing Faculty at Fachhochschule Bielefeld since they were partners at CITEC and manifested the need for a VR simulation in wound care procedures for their undergraduate students. After the end of the second semester of the sandwich PhD program, the environments were tested at Federal University of Juiz de Fora, Faculdade de Letras.

The methodology described below follows the structure of Experiment one. Thus, section 5.2.1 presents the participants of the experiment, while between sections 5.2.2 to 5.2.4 the procedures and tools adopted are addressed, the vocabulary tests are detailed, and the making of the learning environment is described. Section 5.2.5 contains how the guiding of the tour was structured with the virtual agent. Section 5.2.6 analyses the results of the vocabulary tests and section 5.2.7, the results of the qualitative questionnaire. In section 5.2.8 the limitations of the experiment are shared. Lastly, 5.2.8 presents the partial considerations of Experiment two.

5.2.1 Participants of the experiment

This experiment followed the rationale of the first one regarding the criteria of the participants in terms of their fluency level (see section 5.1.1). The final sample of the experiment was composed by two groups, control and experiment, with seven students each. The students were recruited, by institutional email[71] and posters around the university (see Appendix E), from three undergraduate courses at UFJF that were related to the caring of hospitalized patients: Medicine, Nursing, and Physiotherapy. This researcher prepared and taught a five-week (once a week class) free English healthcare lessons for the undergraduates enrolled in the experiment. Their participation also gave them a certificate issued by Faculdade de Letras. At the end of each class, one methodological step of the experiment was conducted (see section 5.2.2), until they could experience the learning setup in a desktop or VR condition at week five. In total, 81 students subscribed on the registration day, but only 21 attended to all the days of the experiment. However, a balanced number of participants in each level was required for comparison between the results of the two groups, thus the final number of 14 was reached by considering the minimum number of each level in the two groups and removing the exceeding ones by their lower score in the vocabulary post-test. Table 10 shows the proficiency levels distributed among the sample of this experiment. The median of the participants' ages in the control group was equal to 21, and, in the experimental group, 20. Table 11 shows the courses where the participants came from.

Table 10 - Number and level of proficiency of the participants in each group of the experiment

Control group (desktop)		Experimental group (VR)	
Elementary	1	Elementary	1
Pre-intermediate	3	Pre-intermediate	3

[71] The coordinators of these courses were crucial to this task since they gently agreed to send this researcher's recruitment email to their students' mailing list.

Intermediate	3	Intermediate	3

Source: The author (2021).

Table 11 – Representation of undergraduate courses in the sample of the experiment

Control group (desktop)		Experimental group (VR)	
Nursing	0	Nursing	3
Physiotherapy	5	Physiotherapy	2
Medicine	2	Medicine	3

Source: The author (2021).

5.2.2 Methodological tools, purposes, and procedures

Table 12 presents the methodological tools and procedures of the experiment, as well as what was expected from them.

Table 12 - Methodological tools, purposes, and procedures

1) Recruitment of participants for the experiment.	To have students from Medicine, Nursing, and Physiotherapy as participants of the experiment.	Emails to the coordination of the targeted undergraduate courses from UFJF were sent to be forwarded to their students; posters were fixated at the respective faculties, university cafeterias, and at the university restaurant. The participation in the experiment involved the enrollment at a five-week English course for healthcare professionals.
2) Registration for the course.	To gather contact information from participants.	Registration was done personally at Faculdade de Letras and online by email and WhatsApp.
3) First week of the course.	To explain to the students the goals of the course and the experiment; to provide	This researcher and the teacher at the course explained that the experiment was part of a PhD

	participants with basic vocabulary for personal information, introductions, and the names of their future professions; explained simple present form; to distribute the term of free and clarified consent - *Termo de Assentimento Livre e Esclarecido* (Appendix F) and retrieved the documents with their signature.	ongoing project aiming at comparing two different methodologies for the teaching of English vocabulary for a specific purpose, i.e., healthcare. Doubts and concerns were given a chance to be clarified. Example of practiced sentences for their introduction using simple present: - Good morning, my name is Clara, and I am a nurse. At the end of the class, the term of free and clarified consent was handed in. After a few minutes dedicated to its reading, the signed documents were retrieved by the teacher.
4) Second week of the course.	To show students what virtual reality is (the device used in the experiment); to give them a vocabulary list and verbs to be used in class in the context of patient care; to explain simple past form, so they could form sentences used in the healthcare context. To give them the proficiency test (EDWARDS, 2007).	Students were introduced to a slideshow containing images of the HTV Vive kit and how it is used. Following that, a vocabulary list was handed in containing names in English of body parts and symptoms. An explanation of verbs in the infinitive and past tense forms was followed. A role-play activity was requested. Example of practiced sentences: - Patient: I fell, and I twisted my ancle. - Doctor: I have to exam it. Could I? The proficiency test was applied at the end of the class.
5) Third week of the course.	Based on the same vocabulary from the previous week, to explain future tense and how to request movements from a patient. To stimulate practice of the content given up to that point.	Example of practiced sentences: - Physiotherapist: I'm going to assist you. Can you bend you knee? Students practiced another role-play based on a fictitious patient file. As homework, students, divided in groups, provided a complete dialogue, from the moment they met the patient to saying goodbye, imagining a multidisciplinary group.
6) Fourth week of the course.	To make students perform their homework dialogue; to divide the participants into the control and	A role-play methodology was chosen for the performance of the dialogues. The two groups of the

	experiment groups.	experiment (control and experimental) were defined by a sortition.
7) Fifth week of the course.	To apply the pre and post vocabulary tests and the qualitative questionnaire. The vocabulary pre-test (Appendix G) identified participants' familiarity with the lexical items displayed as glosses in both virtual learning environments. The goal of the post-test was to quantitatively measure the learning of the targeted words. The qualitative questionnaire (see Appendix I) was applied to measure participants' enjoyment, immersion, discomfort, and the correlation between affect (positive appraisals of the environment) and learning.	The pre-test was the first activity of the class. Both desktop and VR scenes displayed the same target-words, highlighted as the speeches of the virtual assistant. The vocabulary post-test (see Appendix H) was then applied immediately after the participant's exposure to the environment they were designated to by the sortition. The qualitative questionnaire followed.
8) Last phase of the comparative experiment.	To measure how many words could still be remembered and, most importantly, if the environment in which they were learned mattered for this recall; delivery of the certificates.	After three weeks: application of the late vocabulary post-test (see Appendix J). The certificates were printed out and given to the students on the same day.

Source: The author (2021).

5.2.3 Vocabulary tests

The pre-test included distracting words among the targeted ones to prevent participants to be primed with the words that were going to be tested later. Like the first experiment, the three vocabulary tests (pre-test, post-test, and late post-test) were based on adaptations made by Souza (2004) of Scarammuci's (1995) vocabulary scale. In this adapted scale, which evaluates the knowledge of specific lexical items in three categories (columns), answers can vary from total novelty of the item to a confident definition of it, as in: "I have never seen this word before", "I have seen this word before and I think it means…", and "I know this word. I know its meaning. The meaning is…".

In the pre-test, the participants could give definitions to the words using translations, English synonyms, and representations in the form of drawings.

Therefore, whenever there was an image of the object, the participant should write its name or names in English. Whenever the word in English was provided, the participant could write its translation or draw a picture which represented it.

The vocabulary pre-test had 15 objects/states: *wheelchair, gloves, towel, crutch, mask, tweezers, kidney tray, syringe, cotton ball, wiper, patient file, dressing, pain, wound,* and *joint*. Among those, eight were represented by images, and the other seven, by English words. Nine objects were the actual representation of the target words.

The pre-test was applied to the participants to provide a more accurate measure of their learning since some of the words could have already been part of their vocabulary knowledge. The results of this test were analyzed in comparison to the ones from the vocabulary post-test, and the latter was the basis for the long-term vocabulary post-test, applied three weeks after the exposure to the learning virtual environments.

The vocabulary post-test contained only the nine target words, being five of them represented by images. The target words and objects were *wiper*, *gloves*, *towel*, *dressing*, *wound*, *kidney tray*, *cotton ball*, *tweezers*, and *mask*. The images were screenshots taken from the virtual learning environment and corresponded to both the desktop and the virtual reality objects. However, the printing quality of the tests made the recognition of the object sometimes difficult[72], reason why the long-term vocabulary post-test had only the words of the same objects.

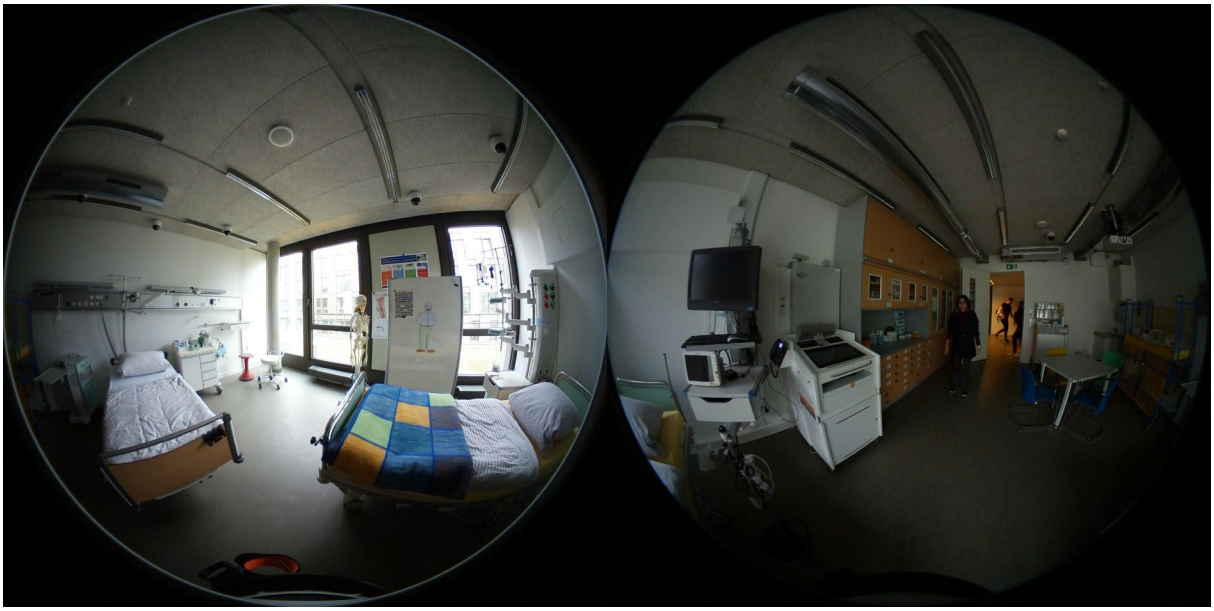
The target words appeared as glosses in the desktop and VR environments as the participant clicked, in the case of the desktop condition, or grabbed the object, in the VR condition. In VR the glosses were labels placed above the objects. The first time they were mentioned was during the narration of the virtual nurse, the guiding of the experience. This narration served to the purpose of teaching the participant the steps of wound care, as section 5.2.5 will detail. It was composed of short audio files, each one containing a task and the mention of a target word that was necessary to the completion of that same task. If the participant clicked or grabbed the wrong object, nothing would happen. If they chose the correct one, the action could be performed, and the narration continued.

[72] When a participant manifested doubt about an object in the picture, the applicant provided its translation in Portuguese.

5.2.4 The making of the virtual reality learning environment

As explained in section 5.2, the narrative was provided by the school of Nursing (Fachhochschule), at Bielefeld University, in attendance to a demand from teachers and students of having a focused training in wound care. In fact, at the faculty building there are two real-file hospital rooms, as part of the Skills Lab of the course, where students practice with *dummies* (realistic dools as patients), as depicted in Figure 21. For the purpose of this project, besides the procedure itself, the goal was for the students to practice a conversation in English based on the protocol students have to observe when treating a patient at a German hospital. Thus, a professor of the Nursing course and one of her students, volunteered in performing a demonstration of the wound care procedure, from beginning to end, which was recorded with a 360 camera and served as a basis for the dialogue in the virtual learning environment.

Figure 21 – One of the rooms at Skills Lab, modeled for the virtual learning environments

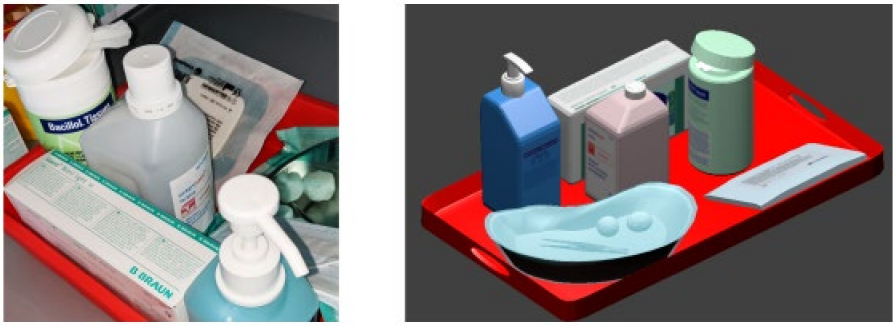


Source: The author (2019).

Pictures of objects were also taken as reference for the modeling of 3D objects needed in the virtual simulation (see Figure 22). The models were made

using the free software Blender[73]. For the objects that needed labels, as well as other objects of the room, the Adobe Photoshop software was used for the making of textures. In this case, meaning the images that mimicked the surface of something when the application of a plain color was not enough for the intended degree of realism. Because the use of textures slows down computation, they were used only when the team judged necessary for better recognition of the objects.

Figure 22 –Skills Lab medical supplies for training (on the left) and the same objects modeled for the virtual learning environments (on the right)

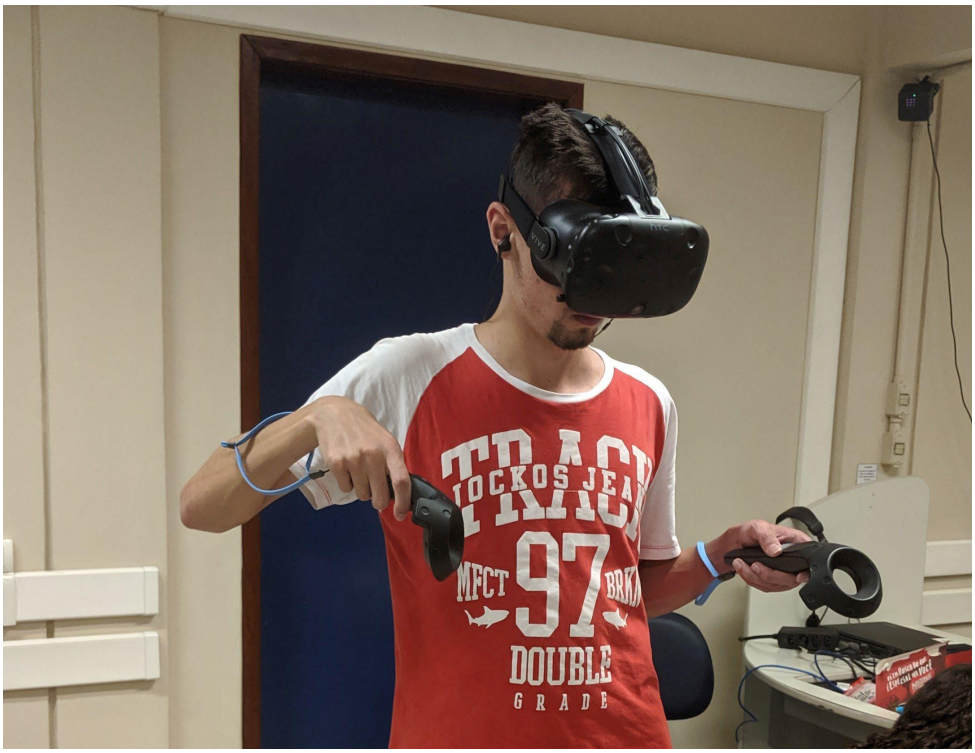


Source: The author (2019).

In terms of the VR device, a substantial change was made in Experiment two in relation to Experiment one. At the time, sate-of-the-art immersive VR headsets were available for the research and the option chosen was the HTC Vive (Figure 23). For the device to function properly, as well as for the platform where the narrative was built, computers with powerful CPU[74]s were also available.

[73] Available on <https://www.blender.org/download/>. Accessed on 6 Jun. 2021.
[74] Central processing unit. As explained in chapter 2, immersive VR devices have computational demands that surpass the capacities of an ordinary computer, i.e., one that would be likely to find outside a computer laboratory.

Figure 23 – HTC Vive headset and controllers used by a participant from Experiment two



Source: The author (2019).

Thus, tracking of the user's position in 6 degrees of freedom was possible, allowing navigation, selection, and manipulation of the objects in the scene, the essential attributes of immersive VR as explained in section 2. As it was said in the then, another essential feature of immersive VR lies on a computer-generated scene, i.e., instead of 360° videos and photos, the environment is composed by 3D objects. This feature can be challenging to comply with, taking into consideration that besides software knowledge it is required a computer processor that is fast enough to allow the satisfactory functioning of the software. Moreover, in the current state-of-the-art, the 3D objects must be exported to a game engine, i.e., another software that will host the objects so they can become a narrative. In a game engine, such as the free Unity 3D[75], it is possible to program these objects to have functions as well. For instance, once an object is grabbed and touch another object, something else happens in the scene, e.g., the narration is played to give a commend or a dialogue box appears.

[75] Available on <https://unity3d.com/get-unity/download>. Accessed on 6 Jun. 2021. Download and use of the software are free for individuals and companies that do not make over one hundred thousand dollars from projects executed on Unity.

Although game engines are currently the most powerful tool to create virtual reality narratives, knowledge about programming language is required, which would demand SLL teachers and AL researchers to go beyond their usual set of skills. At the end of the winter semester at Bielefeld University, this researcher had the opportunity to expand such skills since the final assignment given to the class was to build a game using Blender, for the making of 3D objects, and the software (game engine) Unity, to create the game narrative. Even though the assignment was completed, it became clear that such expertise would be unpractical if applied in the context of SLL research, where VR learning environments are still at the experimental level. The time-cost for learning all the skills required is high, and in research this time is not always available, especially if there is no collaboration between applied linguists and computer scientists, as it was the case of this research.

On that account, another option, Amazon Sumerian[76] (hereafter AS), was discussed for the making of the narrative, an application that would demand less programing knowledge and could be accessed from computers connected to VR headsets[77] and smartphones alike in conjunction with Google cardboard or similar ones. For the students who were involved in the project and familiar with Unity 3D, AS presented a simpler interface in comparison, yet with similar tools. This application is part of Amazon Web Services (AWS), a business branch from Amazon, which offers cloud computational and storage services. AS is designed for the development of VR and AR applications, and this type of service differs from game engines mostly because it is offered directly from any compatible browser[78] (at the time, the latest versions of Chrome or Firefox), i.e., it is not a program that is installed in the computer and can be accessed anywhere by a hyperlink and a minimum setup of devices. Since no installation is needed, updates are immediately available for all users. Amazon Sumerian was also less demanding of powerful hardware.

---

[76] Available on <https://aws.amazon.com/pt/sumerian/>. Accessed on 6 Jun. 2021.

[77] AS supports the main VR headsets in the market today, including the now open-sourced Google Cardboard. The HTC Vive headset and controllers were chosen for this project, for its higher quality.

[78] This technology was made possible with the advent of the WebVR 1.0 API (application program interface), released in 2016., to build and host applications that can be accessed anywhere. The development of WebVR, now continued as WebXR, is, therefore, especially relevant for research on education and teaching since experiments in VR had required expertise in the computer science domain. Moreover, they were also dependent on state-of-the-art hardware, which could have been limiting aspects to researchers and teachers.

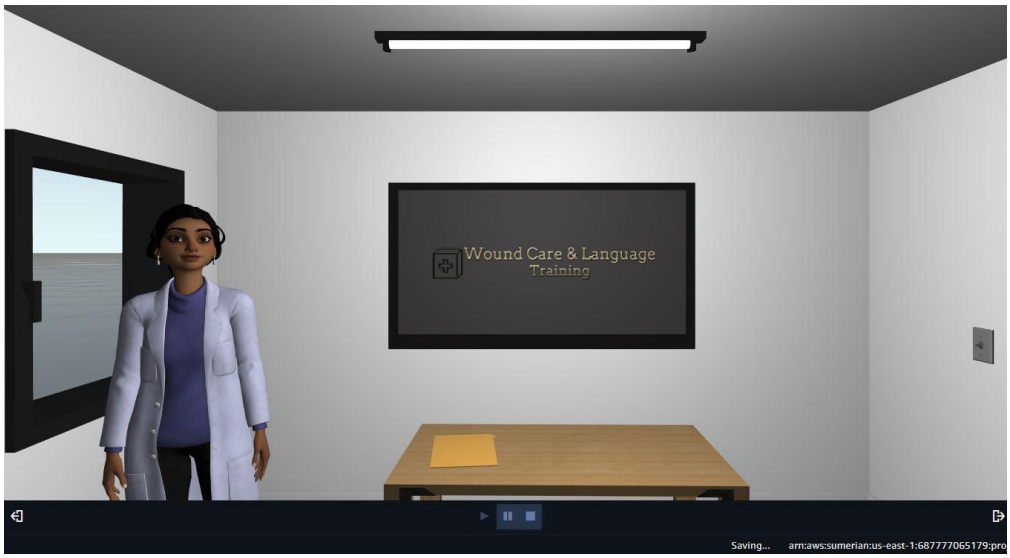
At the time of the making of the environment for Experiment two, AS was free during 12 months for all users who developed a scene of less than 50 MB with no more than 100 views a month, or for academics in an unlimited one-year trial, For the experiment, the second option was chosen and used an institutional email account for the website registration. Multiple emails could be registered under the same project access, whose permissions were administrated by this researcher, the root-user. At the time of the making of the environments, the US-North Virginia server was used, among other servers in different regions of the globe, since it was the only one that allowed access to all services from AWS.

AS has a free library with everyday objects for building scenes without having to make assets (3D objects), but it also allows the user to import them, with their materials (plain colors and textures) and animations, from other programs such as Blender. AS also features the so-called *hosts*, human-like ready-made characters (or avatars) that can guide the user through the experience via speech recognition and text input. For commercial applications, hosts are often used as chatbots, i.e., artificial agents that lead a conversation towards solving a problem or conducting a sale.

The host feature was also seen as an advantage in using AS for this experiment, since one of its goals was the virtual environment to have a guide in it. Figure 24 shows a screenshot of the first scene of the learning environment with its host, *Maya*, here customized to resemble a nurse, who guided the participants in their tasks during the wound care procedure. These avatars come with a set of gestures, mimics, and idle behavior[79] by default. By adding a text file containing a speech, hosts say the text moving their mouth accordingly and making body gestures, enabling a fast way of implementing a naturalistic conversation.

[79] In this case, a behavior that mimics how humans appear when they are waiting for something to happen. When the character is idling, it blinks the eyes, does breathing movements and moves the body a little bit.

Figure 24 – Maya, the virtual assistant of the experiment.



Source: The author (2019).

However, one drawback of using hosts is their limited customization, e.g., their posture cannot be changed. Therefore, an avatar created in a software called MakeHuman[80] was used for the patient, as Figure 25 shows. The rigging of the character, i.e., the making of a structure which simulates a human skeleton, was made in Mixamo[81]. The idle behavior and face animation was hand-made in the modelling software Blender and then imported and used within Sumerian.

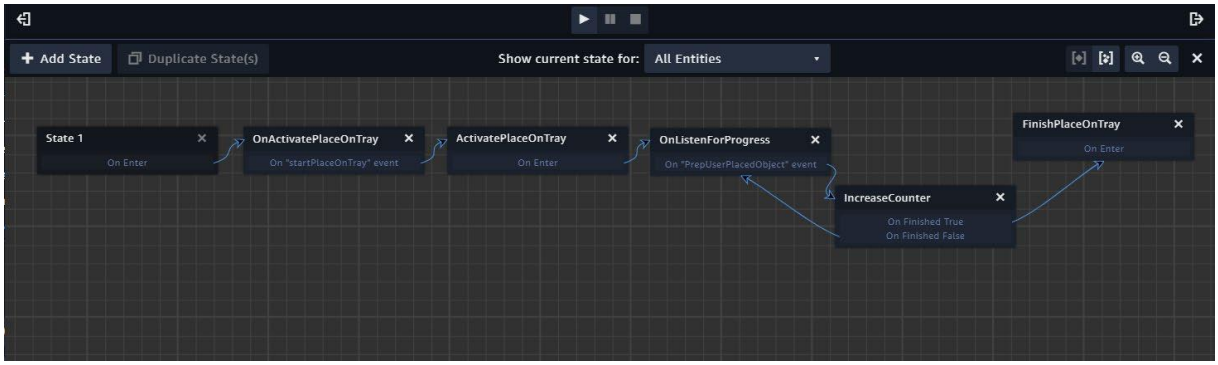
Figure 25 – 3D character playing the patient

Source: The author (2019).

[80] Available on <http://www.makehumancommunity.org/>. Accessed on 12 Dec. 2020.
[81] Available on <http://www.mixamo.com>. Accessed on 12 Dec. 2020.

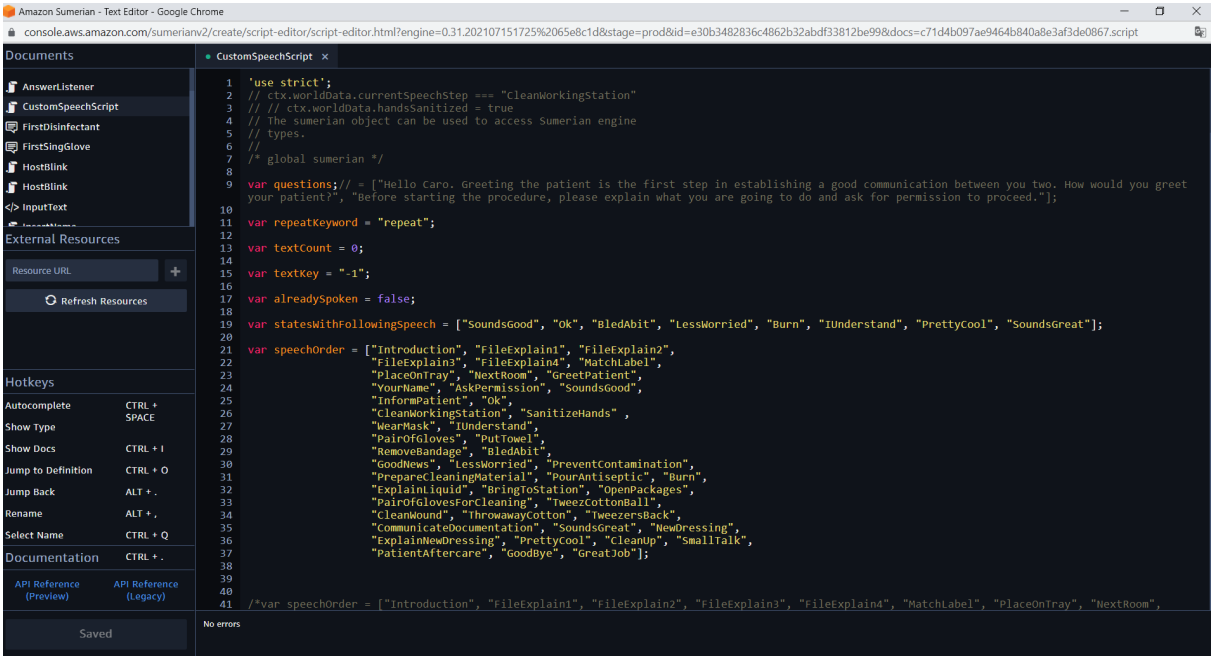
To begin developing the narrative within AS, programming knowledge is not needed, since it uses visual representation – state machines, in a node editing system (see Figure 26). A lot of implementations of users' actions in the VR environment, in AS, can be done by using state machines. They provide access to functionalities such as manipulating the transformation of objects, i.e., their position in the scene, rotation, and scale at a given time of the narrative. State machines also register interactions between objects and emit messages to which event listeners can react. Event listeners are states invoked when some other state is completed. For example, an event listener could wait for the learner to grab, with the VR controllers or the mouse (desktop condition), a surgical mask so a tag with the name *mask* can appear on the screen. Nonetheless, as the goals of the project became more specific, knowledge of JavaScript was beneficial and therefore applied in a series of scripts (lines of coding) for interactions that the state machines could not offer (see Figure 27). These interactions were mainly for the dialogue feature of the narrative, between learner and the virtual guide Maya.

Figure 26 – Example of nodes in a state machine used for the scene



Source: The author (2019).

Figure 27 – Screenshot of the first lines of a JavaScript file used in the scene for enabling the dialogue feature



Source: The author (2019).

5.2.5 The guiding of the tour

Following Experiment one, the teaching approach used in Experiment two made use of implicit and explicit strategies, with the major change being that the guiding was solely done by the virtual agent Maya. The script of the guiding was divided into two sections. In the first part, Maya introduces herself in a waiting room and explains the task and the patient's brief medical condition to the learner. A patient file is exhibited and Maya says she will be in the next room. When the next scene plays, the learner finds themselves in a patient ward, being greeted by him. From that point on, Maya intervenes giving instructions the learner about each step of the wound care procedure, as per the simulation recording mentioned in section 5.2.4. The goal of the task is for the learner to know the vocabulary of the objects and products used in wound care besides practicing the procedure itself.

The two groups, control and experimental, were exposed to a desktop version of the simulation and the VR one, respectively. In both cases, the guiding of the procedure was the same, varying the way the objects were visualized and selected. The participants exposed to the desktop version of the experiment navigated in the scene and selected objects with a mouse. Those using the VR gear performed the

seme actions using the headset (navigation by head movement) and the controllers (navigation and selection). The navigation with the controller was done by the teleporting function (see section 2). The selection was performed with the trigger button, as well as grabbing action. To grab an object was an option if the participant wanted to rotate it or see it closer. One participant at a time was exposed to the experiment due to the fact only one VR equipment was available. For the control group, one laptop and headphone were available at a desk, while for the VR group a walking space was provided free from obstacles.

The audio files for Maya's guiding were created in another AWS option called Amazon Polly. This service generated human-like speech MP3 files that were then incorporated as assets to the Sumerian host. Among the customization options for the 50 different voices from female and male characters from different countries[82], there are controls of prosody, i.e., pitch, speaking rate and volume, emphasis; and the possibility to add pauses and sounds of breathing. A state machine would evoke these files after a required action was executed by the participant, either in the desktop scenario or in VR one. For example, the fist step of the procedure was the participant to wear gloves, as instructed by the guide. If the glove box is not selected by the learner, the next audio file is not triggered in the state machine and therefore does not play.

When the object is clicked with a mouse or selected with the VR controller, a tag containing its name appears on the screen (for a reference, see Figure 9). The guiding is finished when all the steps are concluded and the patient thanks the learner.

5.2.6 Results of the vocabulary tests

After each group was exposed to the learning environments, either on the desktop or in the VR condition, a vocabulary post-test was applied to the participants, who were not allowed to make consultations of any kind. Learned words were considered if the participant correctly translated or provided English synonyms for in columns B and C of the test (*I have seen this word before and I think it means…*, and *I know this word. I know its meaning. The meaning is…*, respectively). These results

[82] These audio files are produced artificially by Polly in a way to mimic the human voice using SSML (Speech Synthesis Markup Language) tags in the text uploaded to the software.

were organized by the participants' three proficiency levels within each group, control and experimental.

The metric, percentage change, used for the calculations in Tables 13 and 14 is the same as the one applied in Experiment one, demonstrated in section 5.1.6. Besides, the percentages included in these tables, in the pre-test and post-test columns also followed the rule of three, considering the total number of target words equals to nine.

Table 13 – Results from the vocabulary pre-test and post-test: control group (desktop)

Proficiency levels	Pre-test (%)	Post-test (%)	Percentage change (%)
Elementary	0	17	200
Pre-intermediate	14.81	55.55	115
Intermediate	44.44	74.06	49

Source: The author (2021).

Table 14 – Results from the vocabulary pre-test and post-test: experimental group (VR)

Proficiency levels	Pre-test (%)	Post-test (%)	Percentage change (%)
Elementary	11.11	44.44	120
Pre-intermediate	7.40	44.44	142
Intermediate	33.33	55.55	50

Source: The author (2021).

Also, as in Experiment one, the difference between the final value and the initial value, x-y, is the learning difference. Thus, the final value is the number of words obtained by the post-test that the participant knew after the virtual tour, minus the number of words they already knew (as per the pre-test result).

Considering that Experiment two was designed from the technological point of view of the improvement, the following analysis answers the research questions in part approached by Experiment one: *Does VR contribute to short and long-term learning and recall of English vocabulary as a FL?* and, *Comparatively, which student benefits the most from VR for FL vocabulary learning – elementary, pre-intermediate or intermediate?* Moreover, Experiment two allows this research to compare the desktop environment to the virtual reality one, by answering the question *Which learning environment, Desktop or VR, is the most efficient for FL vocabulary learning?*

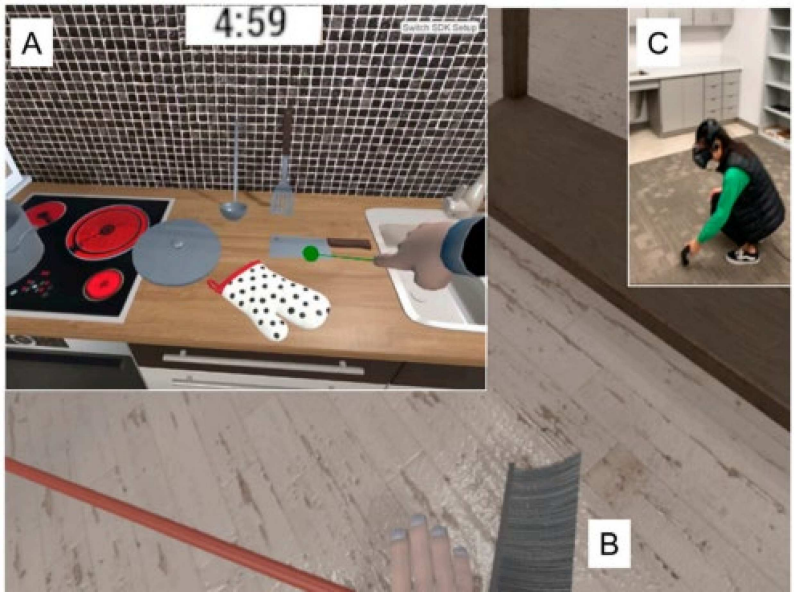
As it can be seen in tables 16 and 17 above, immersive VR, like mobile VR, promoted vocabulary learning. Regarding the different proficiency levels, when compared to the desktop condition, the percentage change indicates that vocabulary learning is more significant in the VR condition, except for the elementary level. Although the elementary level tends to benefit the most from hypermedia resources as seen in 5.1.6, a reason why they benefit less from VR than from a desktop application may be due to the nature of these two environments, in the way they were designed for Experiment two. In the VR condition, the participant was put in a situation where they had to multitask while managing the novelty of the environment. In this sense, an already mentioned conclusion by Mayer and Parong (2018), which considers immersive VR overwhelming stimuli, could help explaining the results of VR learners in Experiment two, in comparison to those from desktop learners.

Apart from this discrepancy, the trend mentioned in Experiment one seems to be valued in this analysis as well, meaning, the significance of learning measured by the post-test is higher in the elementary and decreases as the proficiency level increases. This means that in Experiment two the intermediate level is the least benefited in both conditions, probably by the same reasons as the ones pointed out at section 5.1.6 and corroborated by previous research (PROCÓPIO, 2016). As it was then explained, the elementary level is more likely to be benefited from hypermedia resources since these elements provide contextual and multimodal cues for the inference of new words when linguistic knowledge is not enough. This

knowledge tends to increase the proficiency in the target-language, which could explain why the intermediate levels did not present the same expressive percentage change in the post-test results, in both groups. Moreover, these results were virtually the same, which also indicates that no matter which media is used as a tool for intermediate learners, their capacity to infer the meaning of new words is strongly tied to linguistic knowledge and context. A parallel between this conclusion and a previous study in immersive VR, presented in section 2.1 can also be made. Legault et al (2019) concluded that the participants the authors called successful learners presented a lower degree of learning significance.

Also importantly is the comparison between the results of the Experiment two and the previous studies in immersive VR mentioned in section 2.1. The post-test applied immediately after the exposure of the groups to their respective learning environment showed that the participants in the VR condition had higher scores in two out of three groups. This result corroborates the comparative studies by Legault et al. (2019) and Cho (2018). Like the former, in Experiment two manipulation of objects was possible, although the environment created by the authors offered the participants the possibility of grabbing all the objects representing the target words (see Figure 28). In Experiment two, however, manipulation was much limited. Here, the primary form of interaction was by clicking, although clicking in VR simulates touch (a hand is showed on the screen as a cursor). An extensive manipulation may also explain why the vocabulary results of the experimental group, in Legault et al. (2019) were more expressive than the ones obtained by Experiment two.

Figure 28 – Scene of the vocabulary learning environment iVR Kitchen



Source: Legault et al. (2019, p. 12).

In Cho (2018), the author's design made use of a concept called Memory of Loci, according to which memories are stored in sequential locations of an imagined place. Cho built an environment where the objects, tagged with their names, were positioned in different rooms of an inhabitancy, placed as furniture relevant to the respective rooms. Learners could navigate from one room to another. Thus, in this case, the feature that was the most explored was navigation, even though the physical space was restrictive. This is because VR allows teleportation, as explained in chapter 2, within a scene and between scenes. In experiment two, besides teleportation within the whole area of the hospital room, the participants had certain freedom of movements in the physical space, such as walking.

The other two studies seen in section 2.1, by Vazquez et al. (2018) and Gupta (2016), did not present better results for the group exposed to a VR vocabulary learning environment. When looking at how the environments were designed, in Gupta's VR learning environment, there was no manipulation of the objects. Besides, navigation was very limited, both on the virtual and physical environments. In the latter, the participant could sit down in front of a desk. Vazquez et al. (2018), on the other hand, did not have objects at all since the target-words were verbs whose actions the participants had to perform. Thus, there was no need for manipulation or navigation in their narrative.

Another comparison Experiment two sought to do was a long-term recall of the learned words in the post-test applied immediate after the experience. For that measure, the calculations were as follows. In the second column of Table 15, the number of words correspond only to the learned words, i.e., it excluded the words the participant knew before the experiment and identified by the pre-test. The third column of the same tables presents how many, from the learned words, were recalled after three weeks.

Table 15 – Number of words recalled after three weeks from the experiment

Fluency levels	Desktop	VR
Elementary	100%	100%
Pre-intermediate	110%	110%
Intermediate	80%	83.33%

Source: The author (2021).

The results depicting the long-term recall of the words suggest a slight difference in favor of the VR environment. This difference was found only among intermediate learners. On the previous studies who investigated this variable (VAZQUEZ et al., 2018; GUPTA, 2016), the participants exposed to the immersive VR learning environment also showed a better score in comparison to the control groups (desktop and flashcards, respectively), seven days after the exposure.

Thus, the current analysis could find some facets within a general result. The first is that the pre-intermediate groups showed long-term results that exceed by 10% the number of words they had learned with the experiment. A plausible explanation for that is based on the way the immediate post-test was formulated, i.e., containing pictures and words to be translated. As described in section 5.2.3, the pictures were not always recognized by the participants. Even though the option of asking the applicant of the test which object the picture was referring to was available, it might be the case that the participant assumed it was a different object. On the other hand,

the late post-test had only words to be translated into Portuguese. Therefore, recognition was probably easier to occur.

Another facet lies in the fact that the recall of words in the late post-test was performed better in VR only among the intermediate group. A possible explanation could be found in the characteristic of VR mentioned in section 2.1, meaning, the ability to foster the recall of autobiographical memory. Since this type of memory lasts more than the working memory (STERNBERG, 2015) i.e., evoked for and during a specific task only, it seems reasonable that, in fact, all groups would retain more information after being exposed to a VR condition. However, the fact that only the intermediate group showed a difference can be due to a random event, since the experiment do not have statistical sufficiency[83], or to the indication of a particularity from the intermediate group. In this case, it is possible that, since it was not the learning difference being measured, but the ability to retain knowledge, the strength with which new associations are established in the brain at a long run is directly proportional to the amount of previous knowledge (SAITO, 2015). In this case, linguistic knowledge among intermediate learners.

5.2.7 Qualitative results: answers from the questionnaire

The same four questions evaluating affect (see Appendix I), from Experiment one, were addressed to 12 participants of the second experiment. Two participants from the experimental group did not answer this questionnaire. These questions were about what they thought of the environment; if they felt immersed in it, and why that was the case[84]; what features of the environment, among pre-selected options, they thought was the most relevant to learning; and if they felt any discomfort during the experience.

For the first question, “what did you think of the experience?”, Tables 16 and 17 show the adjectives the participants used[85] in their answers to give qualities to the experience, as well as the numbers of reoccurrences of the same adjective, presented according to the fluency levels and the division between the control and

[83] This will be addressed in more depth in the section regarding the limitations of the experiment.
[84] This second part of the question was added only in Experiment two, since it was important to understand which factors of VR would be perceived as immersive by the participants.
[85] In most cases, one participant gave more than one appraisal to the experience.

experimental groups. For a better understanding of the context in which these adjectives were given, a transcription of these answers is presented, with the English direct translation from Portuguese made by this author.

Table 16 - Adjectives used by the participants of the control group (desktop) to answer the first question of the qualitative questionnaire, *what did you think of the experience?*

Appraisal	Elementary	Pre-intermediate	Intermediate
Interesting (interessante, muito interessante)	0	0	2
Different (diferente)	0	1	0
Enjoyable (gostei muito/bastante)	1	1	0
Difficult [to understand] (não entendi muito bem as palavras)	1	0	0
Challenging (desafiador)	0	1	0
Very good (muito bom/boa)	1	1	0
Helpful (fixa mais o conteúdo, fixa o conteúdo aprendido)	0	1	1
Innovative (inovadora)	0	0	1

Source: The author (2021).

Table 17 - Adjectives used by the participants of the experimental group (VR) to answer the first question of the qualitative questionnaire, *what did you think of the experience?*

Appraisal	Elementary	Pre-intermediate	Intermediate
Interesting (interessante)	1	0	2
Different (diferente)	0	1	0
Enjoyable (adorei)	0	1	0
Incredible (incrível)	0	1	0
Challenging (desafiador)	0	1	0
Good (bom)	0	0	1
Helpful (facilidade do aprendizado)	0	1	0
Interactive (interativo)	0	0	1
Surreal (surreal)	0	1	0

Source: The author (2021).

The answers from the control group (desktop) are as follows. Participant 1: *I thought it was very good, I liked it a lot. However, I did not understand the words in English very much*[86]. Participant 2: *I thought it is a different way of learning, it seems that it fixates more the content*[87]. Participant 3: *Very good, it was great for us to know*

[86] Free translation of: “Achei muito boa, gostei muito. Porém, não entendi muito as palavras em inglês”.
[87] Free translation of: “Achei uma forma diferente de aprendizado, parece que fixa mais o conteúdo”.

terms that we will use a lot in our clinical practice[88]. Participant 4: *I liked it a lot, it was challenging*[89]. Participant 5: *Very interesting, I had never thought of studying another language this way*[90]. Participant 6: *Innovative and it fixates the learned content*[91]. Participant 7: *I thought it was interesting*[92].

The following are the answers from the experimental group (VR). Participant 8: *How interesting it is to see my learning reality, to study in another dimension with application in the English language*[93]. Participant 9: *I loved to be able to interact with the environment!*[94]. Participant 10: *I thought the experience was incredible, it is something surreal how you get to be immersed inside the environment and also the way you manipulate the objects, and the easiness of the learning which happened in this way*[95]. Participant 11: *Interesting, insofar as it brings a practical experience to the English learning environment. It is good as if we could learn English inside a hospital*[96]. Participant 12: *I thought it was very interesting, very interactive, even though it did not have the complete code and it was confusing in some moments* [97] (the code that Participant 12 referred to is the last step on the wound care procedure which did not work properly during the Participant's performance).

Tables 18 and 19 show the answers which sought to classify the relevance of the components from both experiences by asking "What most contributed to your vocabulary learning"? This question was a multiple-choice one, where participants were asked to rate from 1 (for what they thought it contributed the most) to 5 (what they thought it contributed the least). The number of times each option received the highest appraisals are depicted according to the levels of fluency. The VR group had

---

[88] Free translation of: "Muito boa, foi ótimo para conhecermos termos que utilizaremos muito em nossa prática clínica".
[89] Free translation of: "Gostei bastante, foi desafiador".
[90] Free translation of: "Muito interessante, nunca tinha pensado em estudar dessa forma outra língua".
[91] Free translation of: "Inovadora e fixa o conteúdo aprendido".
[92] Free translation of: "Achei interessante".
[93] Free translation of: "Como é interessante ver minha realidade de aprendizagem, estudar em outra dimensão com aplicação na língua inglesa".
[94] Free translation of: "Adorei poder interagir com o ambiente"!
[95] Free translation of: "Achei uma experiência incrível, é algo surreal como você fica imerso dentro do ambiente e também a maneira que você manipula os objetos, e a facilidade do aprendizado realizado desta forma".
[96] Free translation of: "Interessante, na medida em que traz uma vivência prática para o ambiente de aprendizagem do inglês. É bom como se pudéssemos aprender inglês dentro de um hospital".
[97] Free translation of: "*Achei interessante, bem interativo, apesar de não ter o código completo e de ser confuso em alguns momentos*".

an extra option, as showed on Table 19, which was added to verify the relevance of immersion for the perception of learning and joy.

Table 18 - Elements of the desktop environment which received the highest appreciation - desktop

What most contributed to your vocabulary learning?	Elementary	Pre-intermediate	Intermediate
The narration of the virtual guide	0	2	0
The way the words appeared in the environment	1	1	3
The chosen theme	0	0	0

Source: The author (2021).

Table 19 - Elements of the VR environment which received the highest appreciation - VR

What most contributed to your vocabulary learning?	Elementary	Pre-intermediate	Intermediate
The narration of the virtual guide	0	1	1
The way the words appeared in the environment	0	0	0
The chosen theme	0	0	0
The fact of being immersed in the environment and be able to manipulate the objects	1	1	1

Source: The author (2021).

Table 18 shows that in the absence of immersion, the way the words appeared in the environment had the most consideration among the participants, followed by the narration of the virtual guide. Like in Experiment one, the theme chosen for the narratives was not chosen by any of the participants, even though some considered relevant to have a contextual vocabulary lesson. It seems reasonable, also in comparison to experiment one, that the participant with elementary knowledge of the language would prefer the multimodal resources, writing and image, for vocabulary learning rather than relying on the audio recording. What differs in terms of the results in this category, when comparing the desktop to the mobile VR environment, is the preference of the intermediate group for the way the words appeared in environment rather than the listening strategy. Here, a possible explanation could be that non-immersive environments, regardless of the level of fluency of those who use them, benefits the most from the multimedia learning principle which states that humans learn best from words and pictures than just words alone (MAYER, 2001). In mobile VR, participants within the category intermediate sought to take advantage of listening more, probably because in that case, sense of presence interfere to make participants take the virtual environment as the real one, where their listening ability would be required more often in a context like being part of the guiding of a tour. Another possible explanation for this preference, also based on Mayer‘s multimedia learning principles, is the need to be free to explore the virtual environment without an attention break, as when the learner is required to read and explore at the same time. Table 19 reassures this perception. When immersion is present, the narration in audio files grows in importance among users of a learning environment, being the second choice among the participants of the experimental group, the first being immersion itself. At this time, not only the chosen theme was left aside consideration, but also the need for the written resource, the way the words appeared in the environment.

The question: *Did you experience any physical or psychological discomfort during the experience?* was made specially to verify a possible change in this perception with the improvement of the VR environment. The results showed that none of the participants, in neither of the groups, desktop and VR, mentioned any discomfort.

The last and open-ended question enquired the participants whether they felt immersed in the virtual environment, together with a justification for their answer. The

following are the translations of these answers, made by this author, from the control group (desktop). Participant 1[98]: *A little, because I did not understand everything that was said*; Participant 2: *So-so, there were lots of external noises*[99]; Participant 3: *No. Because as much as it is an activity in the computer, your senses such as hearing and vision still leave the "due" concentration, unlike virtual reality, in which you are immersed in it*[100]; Participant 4: *Yes, it seems that in a certain way we are living that and wishing to do it the right way*[101]; Participant 5: *No, I could neither visualize myself in the place nor see the objects normally*[102]: Participant 6: *In part, yes, but due to the fact that it was in the computer it seems like a game with goals, differently from being in the exposed reality*[103]; Participant 7: *A little, because the program simulated a situation virtually. However, there were still elements of the reality around me, which avoided a complete immersion*[104].

The following are the translations of these answers, made by this author, from the experimental group (VR). Two participants did not answer this question. Participant 8: *Yes, it seemed very real. How I wish to learn English this way*[105]; Participant 9: *I felt very excited and also curious to explore the environment around, and also very curious to think on how it would be the learning itself inside the virtual environment*[106]; Participant 10: *Yes, the VR helps immersion, to be able to interact with the environment too*[107]; Participant 11: *Yes, because I could interact with this*

---

[98] Free translation of: “Um pouco, porque não entendi tudo o que foi dito”.
[99] Free translation of: “Mais ou menos, tinha muitos barulhos externos”.
[100] Free translation of: “Não. Pois por mais que seja uma atividade através do computador, seus sentidos como audição e visão ainda saem da "devida" concentração, diferente da realidade virtual, em que você está imerso nela”.
[101] Free translation of: “Sim, parece que de certa forma estamos vivendo aquilo e queremos fazer da forma correta”.
[102] Free translation of: “Não, eu não consegui me visualizar no lugar e não consegui ver os objetos normalmente”.
[103] Free translation of: “Em parte sim, mas devido ao fato de ser no computador parece um jogo com metas, diferenciando de estar na realidade exposta”.
[104] Free translation of: “Um pouco, pois o programa simulava uma situação virtualmente, porém ainda existiam elementos da realidade a minha volta, impedindo uma imersão completa”.
[105] Free translation of: “Sim, parece muito real. Como gostaria de poder aprender inglês assim”.
[106] Free translation of: “Me senti bastante animado e também curioso para explorar o ambiente ao redor, e também bastante ansioso em pensar como seria o aprendizado em si dentro do ambiente virtual”.
[107] Free translation of: “Sim, o VR ajuda na imersão, poder interagir com o ambiente também”.

environment and to live the situation proposed[108]; Participant 12: *Yes. I was placed in the same height tan the real one and the environment was very well assembled, it seemed that I was indeed immersed in the hospital room*[109].

As expected, the experimental group reported a greater sense of presence described under the term *immersion*. This indicates that the techniques were properly executed during the making of the VR environment. Differently from Experiment one, where mobile VR, for some of the participants, still lacked the proper features for sense of presence to occurs fully and constantly, during the experience.

The answers from the qualitative questionnaire, as in Experiment one, sought to answer the following questions: *does affect influence English vocabulary learning in VR? What components in the VR learning environment can contribute to foreign vocabulary learning?* At this time, the participants' answers could be analyzed under the perspective of flow as well, according to the model proposed in this thesis (see section 4.2). Differently from Experiment one, Experiment two addressed participants' interest based on the assumption that they would be likely to be motivated in experiencing the language in the context of what they had chosen as career paths.

As in section 5.1.7, the first category of appraisal category to be analyzed under the model (see figure 15) will be *novelty*. None of the participants, in both control and experimental groups had had access to an immersive virtual reality device. Among the participants in the control group, novelty was cited, indirectly, by the following adjective and frequency, according to Table 16: different (1 mention) and innovative (1 mention). These adjectives were mentioned by participants in the pre-intermediate and intermediate levels, respectively. In the experimental group, VR users provided these novelty appraisals, as per Table 17: different (1 mention); incredible (1 mention), and surreal (1 mention), all of them given by participants in the pre-intermediate level.

Although Experiment two had only one participant within the elementary category of fluency in each group, it is interesting that neither of them elected novelty as a main appraisal for the experiences. This result differs from the one in the first experiment, where the elementary level of fluency was the one which highlighted novelty the most, possibly since motivation is partially driven by the novel

[108] Free translation of: "Sim, pois pude interagir com esse ambiente e vivenciar a situação proposta".
[109] Free translation of: "Sim. Eu fiquei na mesma altura que a real e o ambiente era muito bem montado, parecia de fato estar imerso na sala do hospital".

characteristic of the teaching medium (SCHUMANN, 1997). It was also conjectured, then, that this perception had to do with the fact that participants in the elementary group had the highest degree of learning. Due to the lack of symmetry among the levels, it is not possible to compare this result with the ones from the other levels.

The second category of the model is *pleasantness*. In this category, two characteristics are addressed, those being adequate immersion techniques, i.e., physical comfort, and subjective perception of pleasantness. As the analysis of Experiment one preconized, the latter can now be discussed under the theory of flow (CSIKSZENTMIHALYI, 1990). According to this theory, as discussed in chapter 4, flow and pleasantness are associated with a person's skills, which is frequently associated to what they chose to do as a profession.

About the first characteristic, none of the participants, either from the control or the experimental group, reported having physical discomfort, which is especially relevant for the analysis of immersive techniques applied on the experimental group. Besides, as the answers to the question *did you feel immersed in the environment?* reveled, all the respondents in the VR group said *yes* to this question, justifying this perception by mentioning the effects of the immersive techniques presented in chapter 2. In contrast, among the participants of the desktop group, six out of seven learners did not experience immersion. This result provides an interesting comparison to the answers to the same question in Experiment one. In that case, even though immersion techniques were not present, sense of presence was experienced by most participants. It was said then, based on previous research (BAÑOS, 2019) that of sense of presence itself is rather a subjective feature based on motivation. Nonetheless, it can also be said that mobile VR provides a higher sense of presence than a desktop application, if these two experiments are considered.

The second characteristic of the category pleasantness in the model, which accounts for the sense of flow, takes into account the adjectives from Tables 16 and 17, where some adjectives were displayed in terms of what the participants thought of the experience. The following are the adjectives grouped by what can be considered part of the pleasantness category, according to the definition of the term pleasant by the Cambridge Dictionary[110]. The first analysis is done from the answers

[110] Disponível em: https://dictionary.cambridge.org/. Acesso em: 27 fev. 2020.

provided by the participant in the control group (desktop), provided by Table 19: Interesting (2 mentions); Enjoyable/cool (2 mentions); and Very good (2 mentions). When these opinions are divided between the levels of fluency, the results are: elementary (2 mentions); pre-intermediate (2 mentions); and intermediate (2 mentions). Thus, the level of fluency does not seem to interfere in the perception of how pleasant the experience is. In addition, this category surpasses, in the number of mentions, the novelty category. When this analysis is corelated to the answers about the perception of immersion, as it was said previously in this section, most of the participants in the desktop condition did not experience sense of presence. In this way, it is not possible to conjecture flow as a result of the experiment for these learners.

On the other hand, the participants in the VR group classified the experience as pleasant using these adjectives, as per Table 17: interesting (3 mentions); enjoyable (1 mention); and good (1 mention). The intermediate group provided most of the mentions (three) in comparison to the pre-intermediate group (1 mention). The number of mentions is prominent in comparison to the ones in the category novelty. About the possible occurrence of flow, the transcript of the answers regarding immersion is suggestive for it, since all participants in the VR group experienced sense of presence related to immersion techniques.

As in Experiment one, Experiment two also verified that the higher the level of fluency is, the more pleasant sense of presence may be in the virtual reality environment. A plausible explanation for such a result continues to be that understanding the language better gives room to the enjoyment of immersion techniques.

The next category evaluated by the model in figure 15 is *goal/need evaluation*. This category measures subjectively if the task is important to the learner and evaluates if VR is a proper medium for that. A positively answer to the latter is an indication of the high relevance of the task. In Experiment 2 the virtual environment was planned towards a target audience of students, being considered an ESP lesson, and its content was produced having in mind a procedure that they will likely execute as professionals. The unique adjective[111] of Tables 16 and 17, from the

[111] Another possible option would be to include, among the answers from the experimental group, the term *interactive*. However, this interpretation would be open to debate.

desktop and the VR groups, respectively, representing goals and needs was *helpful* (1 mention in each group), provided by pre-intermediate learners.

The next and last category of the model is *self-compatibility check*, i.e., learners' access of their skills and knowledge in relation to the challenge. As explained in the qualitative analysis of Experiment one, motivation, according to Schumann (1997), observes the degree with which the task is challenging enough to excite but not to frighten, a factor that relies on levels of fluency since linguistic knowledge is important to cope with the task at hand. According to Table 16, two adjectives fulfill this category: Challenging (1 mention, pre-intermediate) and Difficult (elementary), while Table 17, presenting the comments from the VR group, only shows the term challenging, also reported by a pre-intermediate learner.

About these last two categories, what is perhaps the most surprising is the fact that the goal/need evaluation category was the least rated in importance in the appraisals given, which, according to the model proposed here, also presents what is included in the broad term of motivation. The surprising factor is because the lesson falls into ESP, which means that, hypothetically, the usefulness of the content towards the goals and needs of learners would be significant for how motivated they get when attending the lesson. The category self-compatibility check, as in Experiment one, was not regarded with importance either, although the control group, exposed to the desktop environment, reported it twice, one being a comment from an elementary learner who considered it difficult, a negative appraisal in comparison to the term challenging. Thus, it is interpreted that the VR environment is even more contextual than the desktop one since the learner is literally surrounded by images/clues.

In Experiments one and two, the appraisals novelty and pleasantness surpassed in mentions compared to the other categories, with Experiment two reporting pleasantness over novelty, even among participants from the VR group.

5.2.8 Limitations of Experiment two

Perhaps the most significant limitations are related to the sample chosen, a consequence of the difficulties faced, by this researcher, in keeping all learners enrolled until the end of all phases of the Experiment two. Due to the small number of remaining participants, it was not possible to select them in a balanced way, for each

group studied, in terms of levels of fluency and undergraduate courses. The latter can be a limitation if the Brazilian social-economic context is considered. Historically, the medicine school has been a competitive course, and much of its students have had the chance to study a foreign language in depth. The quotas law has been diminishing the gap of the entrance ratio in this course between the elite and other economic segments, but those who enter via the general competition are still part of a privileged population with access to good preparatory schools, media equipment and the internet.

Thus, ideally, this experiment should have the same number of participants from each healthcare course and level of fluency. Besides, a bigger sample would be desired for statistical sufficiency. A challenge would remain, though, in keeping all participants motivated to be in all phases of the experiment, since it lasted five weeks plus the late post-test which was applied three weeks after the English course was concluded. According to Brazilian ethics committees from federal universities, participants from experiments cannot be financially compensated, which differs from, for example, the regulations in German institutions, where participants must be compensated that way.

Differently from Experiment one, Experiment two did not experience as much technical issues, apart from an internet connection interruption at the time when the participants were performing their tasks in the virtual environments. This caused a delayed of several minutes, and it may have frustrated some of the learners. Another limitation, concerning the technical side of Experiment two is the fact that only one VR headset and laptop was available for the tasks. This delayed even more the application of the experiment. In fact, it would be impractical, in the context of a foreign language classroom, to have the same kind of lesson in immersive VR as part of the regular curriculum if it can only be experienced one student at a time. Therefore, this kind of limitation is actually within a bigger scope of the limitations in research budget faced by Brazilian educational institutions.

Another limitation refers to a theoretical one. The analysis considered flow as part of its work, even though the qualitative questionnaire did not have a clear way to measure it. Questions directed to evaluate this aspect were going to be formulate in Experiment three.

5.2.9 Partial considerations

A brief recall of the data analysis is provided here. The quantitative results of the experiment two followed the pattern of the ones in Experiment one considering the percentage change analyzed according to the three levels of proficiency. This means that the elementary is the level which had the most significant learning, followed by the pre-intermediate and the intermediate.

Nonetheless, Experiment two followed a comparative methodology and its results suggest that besides the repeated pattern there is a variation among groups, control and experimental. The latter showed a more relevant variation among pre-intermediate and intermediate groups, thus for the elementary level it was suggested that the desktop application would facilitate the learning gain more. Possible explanations for these scenarios were offered in section 5.2.6. In addition, one of the limitations described in the previous section, concerning the sample, might have interfered for the percentage change to be prominent in the elementary level of the desktop group. This level was represented by only one participant, which knew none of the words in the pre-test. Therefore, the bigger the difference between the initial and the final condition, the more significant becomes the percentage change.

Despite what has been highlighted as limitations, this comparative experiment brought new perspectives within this thesis, on how immersion techniques are perceived in terms of motivation. Based on the model proposed here for VR learning environments, it can be said that all categories of appraisals were present among the participants' answers in the experimental group. Although the category of flow could be better accessed in Experiment three, it is likely that the participants of the VR group experienced it, at least to some extent. This could be observed when participants seemed so engaged with the environment that when the task was finished, they demonstrated to have experienced loss of space and time track.

In comparison to Experiment one, novelty did not seem to interfere negatively in the way the immersive technology was accessed. A reason for this may be that the use of the VR headset and controllers was more intuitive than the cardboard in conjunction with smartphones. The VR headset was attached to the participant's head at all times, and no image interruption was experienced. All actions were performed with the controllers, where one button (the trigger button) needed to be pressed. On the other hand, perhaps due to the intuitive use of the VR system,

novelty soon ceased to be a motivational factor for being in the environment. As it was seen in the analysis of the categories of appraisals of the model, pleasantness assumed the place in importance that novelty had in Experiment one.

All things considered, Experiment two addressed all the limitations resulted from Experiment one, including the elimination of physical and psychological discomfort, suggesting these improvements were an important part of how participants associated sense of presence to learning and motivation.

The quantitative and qualitative results of Experiment two showed a difference favoring VR in almost every aspect enquired, except for the significance in learning of the elementary level. As the experiment lacks statistical significance, this is still a variable worth exploring in future studies. To start addressing this issue, the third experiment, implemented in this thesis only at the methodological level, due to the difficulties imposed by the COVID-19 pandemic, explained in the next section. This third VR environment made use of more interaction techniques, thus fostering immersion.

5.3 IMMERSIVE VR FOCUSED ON MANIPULATION AND REPETITION

Based on the results from Experiment two, a third experiment was intended to be applied among a much larger sample (around 100 students from a high school associated to the federal university of Juiz de Fora). The same environment was also used by the Nursing Faculty at Fachhochschule Bielefeld, Germany, continuing the partnership between the two universities and the University of Applied Sciences Emden/Leer. However, as explained in section 5, due to the COVID-19 pandemic, the application of Experiment three became impossible. Restrictions were imposed to Brazilian schools and universities which resulted in banning presential classes and any other student activity at educational facilities from March 17th, 2020, until November 4th, 2021, at UFJF, the research locus. The returning date, however, was set as a gradual transition between online to presential classes.

Facing this limitation until the present date, this section describes the implementation of improvements made in the VR vocabulary learning environment. Amazon Sumerian continued to be implemented for the making and publishing of the scene, for the same reasons explained in section 5.2.4.

Since a comparison study was seen as no longer needed, this reformulation of the environment aimed to target students of all proficiency levels but especially addressing the possible needs of learners at the elementary one. Thus, multimodal resources for vocabulary learning relied less on listening comprehension and more on interaction and repetition of the target words in context. As seen in chapter 2, manipulation is one of the characteristics of immersive VR which has been applied successfully in previous studies in the use of technology for FLL (LEGAULT et al., 2019) and, to some extent, in Experiment two described in the previous section. For the VR experience of a hypothetical Experiment three, interaction and repetition were thought of in terms of a more systematic manipulation of the wound care objects and the possibility of clicking on them several times to see their labels before the encounter with the virtual patient. So, a two-step procedure could also reduce the cognitive load of having to memorize vocabulary while executing a task. The way these steps were implemented can be visualized on Figure 29. Here, it is shown the two rooms at a VR hospital. The one on the left is a preparation room, whose objects and furniture were actually based on the real ones at the Skills Lab. On the right, there is the room where the patient waits for the nurse (the learner).

Figure 29 – The VR hospital rooms

Source: The author (2020).

Besides, for pre-intermediate and intermediate levels, the ones which take more advantage of and value the listening resource, as seen on Experiments one and two, the conversational feature with the virtual guide, Maya, was kept and also improved. Besides Amazon Polly (see section 5.2.5), a service for speech synthesis, AWS also offers the speech recognition API Amazon Transcribe. With Transcribe,

was possible to translate speech to text in real time. This means that during the wound care task, in the scene where the patient is treated, a conversation between the host, the user and the patient was implemented. This feature can be considered a complex one, where several keywords must be uttered to invoke the next step[112], and the step that follows is constrained by the process of the wound treatment. Therefore, a custom keyword search was implemented that parses the results for words that trigger the exact next step. The use of keywords as a form of evaluation of learner's utterances was chosen to reduce frustration in case they cannot pronounce an entire sentence correctly, especially in the case of learners with an elementary level of proficiency. Another function was added to the avatar so it can repeat what was said with an additional explanation of English words that might be difficult for the learner to understand. Since practicing with a real English native speaker could be a source of anxiety, as well as in classrooms role-plays of the kind (CASSADY, 2010), the fact that it is an avatar evaluating the learner's performance could increase their confidence in coping with the task.

During the phase of preparing the material that is needed for the task, the learner must match the objects to labels with their names, by pointing and selecting them with the controller. Additionally, the learner must interact with the objects whose names have just been learned when using them to treat the wound. This adds an extra input into the knowledge of a word, a non-linguistic variable related to affect: the ability to co-relate the recently acquired information with its usefulness in the simulation of a real task.

About the immersive techniques, besides what had been already implemented in Experiment two, the ability to manipulate more the virtual world and have adequate responsiveness from it and to experience a conversational interaction with a human-like avatar were the major changes. Depending on the user's willingness to be immersed in such a novel language learning environment, pleasantness might follow as the most prominent appraisal, as in Experiment two.

In the context of doing the research with students from a high school, the public of an intended Experiment three would not be necessarily aspiring healthcare professionals. It would be investigated if, among these students which do want to

[112] In order to trigger a following sentence in a programmed conversation, the programing language used (JavaScript) made use if listeners, functions that detect an expected element when it occurs.

follow this career path, motivation would be higher in trying the VR environment. This variable would, then, clarify if the theme chosen for a FLL immersive narrative could have any importance for the perceiving of learning since this factor showed no relevance in the first two experiments. In this case, the theory of flow could also be observed.

6 CONCLUSION

The purpose of this research was to investigate the potential of VR technology for FL vocabulary learning, based on the motivational theories of affect and flow. Each step of this research, concerning its goal, was guided by the following questions:

1) Does VR contribute for short and long-term learning and recall of English vocabulary as a FL?

2) Which learning environment, desktop or VR, is the most efficient for FL vocabulary learning?

3) Comparatively, which student benefits the most from VR for FL vocabulary learning – elementary, pre-intermediate or intermediate?

4) How does affect influence English vocabulary learning in VR?

The lack of studies in this niche, due to the novelty and acquisition cost of this medium, has led this research into the creation of four digital learning environments which added data to the formulation of answers for the research questions. The supporting theories for the making of these virtual environments were found in the realm of motivation as seen by Schumann (1997) and Csikszentmihalyi (1990), which were put together by a model developed in this thesis to guide the creation and testing of VR learning environments in the context of FLL.

The first environment made use of mobile VR as the simplest set of devices that could offer a degree of sense of presence in a simulation of an alternative reality. In this reality, English vocabulary was taught as part of a narrative taking place in a museum depicting the life and work of Mexican artist, Frida Kahlo. The sample who tested this environment was composed by 18 leaners of English as a FL. The second and third environments were part of a comparative experiment which had the same scenes depicted in two different modes, one accessed by desktop and the other by an immersive VR device. Vocabulary learning was specific of a task taught for healthcare students. The number of graduate students from health courses at UFJF, who participated in this experiment, was equal to 14. Finally, the fourth environment was made to improve the learning multimodal resources of the immersive VR scene built for Experiment two, adding to it more interactive instances and a conversational feature.

The first three research questions were answered as the following. The results of Experiments one and two provided data which supports the evidence that VR, both in its mobile modality and immersive one contributes for the learning of FL vocabulary. As in the comparative study, it was seen that immersive VR had a learning significance advantage over the desktop environment, except for the participants categorized with an elementary level of fluency, in the immediate pos-test. In the late post-test, after 21 days, the results suggested that both the desktop and the immersive VR learning environments had the same rate of retained learned words, except for the intermediate group which scored better among participants from the experimental group. Thus, immersive VR showed to be more relevant for this level in a long-term recall of FL vocabulary.

Considering the three environments created for the experiments and tested by them, it is possible to draw an efficiency hierarchy in general terms, meaning, looking only at the sum of the quantitative results. This scale has the immersive VR environment at one end as the most favorable media to the learning of English vocabulary, followed by the mobile VR and, at the other end, the desktop application. Nonetheless, even the desktop application favored learning, just not as much. Possibly, all the environments served their purposes and a learning facilitator because they followed the multimedia principles (MAYER, 2001).

About research question number 3, addressed by Experiments one and two, it was seen that in the immediate post-test of Experiment one, which used mobile VR as its media, the participants from elementary level were the ones that learned more target words. However, Experiment two and its immersive VR did not follow the same trend. Here, the pre-intermediate level was the one who had the most significant change in learning. A major difference between the two environments, in terms of what benefits the most the elementary learners of a FL, might be in the fact that the mobile VR tour was guided by the teacher and divided in many segments. Thus, the students could take advantage of the opportunity to check their understanding or ask about a word they did not know before they continued the tour. In other words, the experience was driven by their own pace, in addition to the fact that a segmented lesson is also a multimedia principle that has been proved to aid students in learning a content (MAYER, 2001).

In the case of Experiment two, using immersive VR, the fact that the participants within the pre-intermediate category were the ones to have the prominent

difference in learning is probably because they may still struggle with multitasking in VR (listening to the task instructions while exploring the environment), but not as much as the participants in the elementary level. Unlike Experiment one, the VR task did not have the aid of the teacher but of a virtual guide, which gave instructions only once. The learners tagged as the intermediate level did not show such a difference in percentage change because they already knew a considerable number of words, as measured by the pre-test. The same could be said about the results of this group in Experiment one.

On the other hand, the trend is inverted partially in the late post-test. Here, the intermediate was the only group to show a difference in the recall of the learned words after 21 days. The amount of linguistic previous knowledge, prior to the experiment, was cogitated as a reinforcement to memory of words the participants in this group learned from the experiment.

The fourth research question, about the influence of affect in the VR English learning, does not have a unique answer. A sum of factors can be analyzed under motivation. More specifically, under the model proposed by this thesis. It was seen that, according to Schumann (1997), motivation for SLL involves an array of appraisals, categories that can be qualitatively evaluated by learners. Both experiments reported all categories of the model, with the exception of flow, which could only be hypothetically verified in Experiment two.

In Experiment one, the categories that were elicited the most among the participants was novelty, followed by pleasantness. Besides what has been said in section 5.1.7, when the answers from the questionnaires were discussed, it is possible now to draw a comparison between this result and the one provided by experiment two, where pleasantness took the place of novelty as the most appraised category. It can be argued that since the immersion techniques were not fully adequate in Experiment one, and therefore discomfort was reported by some participants, pleasantness would not be expected as the first subjective evaluation of the environment. However, even though the sources of discomfort were said to be limitations in this experiment, the great majority of the participants reported feeling immersed in the environment, which was reported as something pleasant. In Experiment two, on the other hand, since immersion techniques were adequate and no discomfort was reported, pleasantness of being immersed was its main feature evaluated positively.

Regarding the other two categories based on Schumann's (1997) work, goal/need evaluation and self-combability check, it was pointed out in this thesis that the goal/need evaluation category in Experiment one was rated more often among participants of the intermediate level, probably due to the nature of the theme of the lesson. It was conjectured, then, that they have passed the urge of a vocabulary set towards daily-based activities, finding their needs in the expansion of vocabulary to other contexts. Even though participants on the lower levels of fluency had seen the usefulness of the lesson, it cannot be said that the knowledge obtained was pragmatic, as it was the case in Experiment two, which falls under the category of an ESP lesson. However, as pointed out, this category was not selected among the most appraised ones, suggesting that pragmatics alone are not enough to sustain motivation. This perception can also be taken from Schumann's (1997) work on the biographies of FL learners, as described in section 3.1, from where it can also be taken that pleasantness seems to be most important appraisal category followed by the fulfillment of goals and needs, at least in traditional FLL classrooms.

The self-combability check in VR appears as the least mentioned in both experiments, which suggests that the activity was not seen as frightening by neither the novelty of the environment nor the task itself. In this category another variable is at play, which is the methodology. In the case of Experiment one, a segmented lesson driven by the learners' pace, definitions of all target words provided within the environment and the aid of the teacher could have contributed to a feeling of management of the difficulties the participants had along the way. In Experiment two, despite the environment itself had provided less opportunities for the participants to clarify their questions, an English course was offered weeks prior the experiment where they had the chance to build confidence in the use of specific vocabulary for healthcare. In this experiment, the self-compatibility check category was only reported once, under the appraisal *challenging*. It was discussed, then, that this appraisal can have a positive connotation, as in opposition to *difficult*, mentioned in relation to the desktop experience.

Lastly, on the flow category, although it could not be directly verified by the questionnaire in Experiment two, it is still valid to highlight its relevance, at least theoretically, for the design of learning experiences in VR. Since flow is directly related to pleasantness and skills, a virtual environment which can foster the mastery of a given content by simulating a real-life task has in VR a suitable media. Not only

because of the multiple interaction possibilities but because immersive techniques offer a pleasant occasion for the learning to happen.

In fact, and despite the limitations of both experiments, already given in details on sections 5.1.8 and 5.2.8, it is possible to conclude that the analysis of both quantitative and qualitative results in the two experiments can contribute to further studies on the role of immersive technology in the teaching and learning of a FL. Thus, the practical contribution of this thesis relies on offering empirically based data for the design of VR vocabulary learning environments, while the theoretical one is related to how affect (SCHUMANN, 1997) and flow (CSIKSZENTMIHALYI, 1990) can take a technology-centered approach to learning and ground it on theories. Moreover, this thesis has elaborated a multimodal vocabulary testing, based on the understanding that images can be part of the knowledge of a word, i.e., besides it's the verbal definitions. In Experiment one, this contribution to the AL field could be noticed on the production side, when participants drew pictures for the words they remembered the meaning but not its name or spelling. In Experiment two, the image resource was offered in the immediate post-test as the contextual clue for some of the target words represented by objects. The experience showed that such a test must be carefully planned in terms of the pictures chosen (must be of a high definition, in color (for tests on paper) and of concrete words.

As it was seen in the literature review of this thesis, the question on how motivation could be on core of the VR experience design had not been sought. In addition, this is the first study that investigates the role of FL proficiency in immersive techniques. Based on this investigation, it was verified that the elementary level needs must be addressed carefully in a VR lesson, and that was the purpose of the third VR environment created for this thesis, but not implemented due to the restrictions imposed to research due to the COVID-19 pandemic. This environment paid close attention to the repetition of the target words, facilitated by the manipulation of objects they represent. Thus, learners would not need to rely so much in the listening ability. About the virtual agent and its oral guiding, the third environment has incorporated a repeat function to each audio file, so learners can listen to a given instruction the number of times they want.

Although the advance on the implementation of such immersive techniques, it also needs to be considered that mobile VR tends to be an effective resource considering the reality of this research locus. While access to state-of-the-art

immersive technology is not an option for schools and universities, especially the public ones, initiatives like a mobile VR lesson is relatively simple to execute and low cost, and as long as a stable internet connection is provided, students should not have trouble in following the lesson up. About cybersickness, perhaps less time looking at the screen, or an even more segmented lesson could reduce or even eliminate such a discomfort.

Still on the topic of affordable technology, one last question remains to be addressed, which is a product of all the effort of this thesis in exploring immersive VR as a tool for foreign language vocabulary learning. One could ask if such an endurance is worth pursuing any further. This research focused on motivational theories to explore the types of affordances that only immersion can provide. Thus, based on the overall quantitative results and the ones from the qualitative questionnaire, the answer to the hypothetical question is *yes, it is*. For the time being, in order to be pursued and implemented at schools and universities, immersive VR technology should be at least economically more accessible and public investment made in equipping laboratories with computers that can support software required for making immersive environments. It can be also said, however, that even though it is rather early to foresee this scenario, technology developments tend to gain the market continuously until devices are of common use. Their emergence has been leading research in applied linguistics to accommodate existent theories or propose new ones.

The research agenda that has been put in motion, regarding VR for foreign language learning, in time may also find its purpose for VR collaborative scenarios, where people from different locations can log in at a common interactive tridimensional space. In this set up, a foreign language vocabulary lesson, for example, could explore simulations of real-life tasks or situations in much more authentic conversations, i.e., a virtual agent could be replaced by the avatar of a human teacher anywhere in the globe. Such a possibility would combine the best features of both experiments conducted by this thesis: the assistance and guiding of a human, specially for beginner learners, and the positive appraisals by the multiple possibilities of the virtual world.

REFERENCES

ARAGÃO, Rodrigues Camargo. Emoção no ensino/aprendizagem de línguas. *In:* ANDRADE, Mariana R. Mastrella de. (Org.). **Afetividade e emoções no ensino/aprendizagem de línguas:** múltiplos olhares. Campinas: Pontes Editores, 2011.

ARNOLD, Jane. (Ed.). **Affect in Language Learning**. Cambridge: Cambridge University Press, 1999.

BAÑOS, R. M. *et al*. Immersion and Emotion: Their Impact on the Sense of Presence. **CyberPsychology & Behavior**, v. 7, n. 6, p. 734-741, 2004.

BARSALOU, Lawrence W. Grounded Cognition. **Annual Review of Psychology**, v. 59, p. 617–645, 2008.

BERGER, Markus; BILL, Ralf. Combining VR Visualization and Sonification for Immersive Exploration of Urban Noise Standards. **Multimodal Technologies and Interact.**, v. 3, n. 2, 2019. Disponível em: https://www.mdpi.com/2414-4088/3/2/34. Acesso em: 3 mar. 2021.

BROWNE, C; CULLIGAN, B. (2016). The TOEIC Service List 1.1. Disponível em: http://www.newgeneralservicelist.org/toeic-list. Acesso em: 15 mar. 2019.

CARL, E. *et al*. Virtual reality exposure therapy for anxiety and related disorders: A meta-analysis of randomized controlled trials, Journal of Anxiety Disorders, v. 61, p. 27-36, 2019.

CASSADY, Jerrell C. **Anxiety in schools:** The causes, consequences, and solutions for academic anxieties. New York: Peter Lang, 2010.

CHAPELLE, C. **Computer Applications in Second Language Acquisition**. Cambridge: Cambridge University Press, 2001.

CHINNERY, George M. Going to the MALL: Mobile Assisted Language Learning. **Language Learning & Technology**, v. 10, v. 1, p. 9-16, 2006.

CHO, Y. **How Spatial Presence in VR Affects Memory Retention and Motivation on Second Language Learning:** A Comparison of Desktop and Immersive VR-Based Learning. 2018. Dissertação (Mestrado em Media Studies)-Syracuse University, Syracuse, 2018.

CHUN, D. L2 reading on the Web: strategies for accessing information in hypermedia. **Computer Assisted Language Learning**, v. 14, n. 5, p. 367-403, 2001.

CLUS, Damien *et al*. The Use of Virtual Reality in Patients with Eating Disorders: Systematic Review, **Journal of Medical Internet Research**, v. 20, n. 4, 2018. Disponível em: https://www.jmir.org/2018/4/e157/. Acesso em: 25 ago. 2020.

CONCANNON, Brendan J.; ESMAIL, Shaniff; ROBERTS, Mary Roduta. Head-Mounted Display Virtual Reality in Post-secondary Education and Skill Training. **Frontiers in Education**, 2019. Disponível em: https://www.frontiersin.org/articles/10.3389/feduc.2019.00080/full. Acesso em: 3 mar. 2021.

CRAIG, S. *et al*. Affect and learning: an exploratory look into the role of affect in learning with AutoTutor. **Journal of Educational Media**, v., 29, n. 3, p. 241-250, 2004.

CSIKSZENTMIHALYI, M. **Flow**: The psychology of optimal experience. New York: Harper & Row, 1990.

CURCIO, I.; DIPACE, A.; NORLUND, A. Virtual realities and education. **Research on Education and Media**, v. 8, n. 2, 2016. Disponível em https://sciendo.com/pdf/10.1515/rem-2016-0019. Acesso em 14 set. 2018.

DALGALARRONDO, Paulo. **Psicopatologia e Semiologia dos Transtornos Mentais**. Porto Alegre, 2019.

DAMÁSIO, A. **O Erro de Descartes:** emoção, razão e o cérebro humano. São Paulo: Companhia das Letras, 1996.

_____. **O Mistério da Consciência:** do corpo e das emoções do conhecimento de si. São Paulo: Companhia das Letras, 2000.

DÖRNYEI, Z. **The psychology of the language learner:** Individual differences in second language acquisition. London: Earlbaum, 2005.

_____.; OTTÓ, I. Motivation in action: A process model of L2 motivation. **Working papers in Applied Linguistics**, v. 4, p. 43-69, 1998. Disponível em: https://nottingham-repository.worktribe.com/output/1024190/motivation-in-action-a-process-model-of-l2-motivation. Acesso em: 12 abr. 2021.

_____.; USHIODA, E. Motivation, Language Identity and the L2 Self: A Theoretical Overview. In: _____. (Eds.). **Motivation, Language Identity and the L2 Self**. Bristol: Multilingual Matters, 2009.

EDWARDS, L. **Solutions Placement Test**. Oxford: Oxford University Press, 2007.

EGBERT, Joy. A Study of Flow Theory in the Foreign Language Classroom. **The Modern Language Journal**, v. 87, n. 4, p. 499-518, 2003.

EVERETT, Daniel. **Language:** The Cultural Tool. London: Profile Books, 2012.

GARDNER, Robert C. **Motivation and Second Language Acquisition**: the social-educational model. New York: Peter Lang, 2010.

_____.; LAMBERT, W. E. Motivational variables in second language acquisition. **Canadian Journal of Psychology**, v. 13, p. 266–272, 1959. Disponível em: https://files.eric.ed.gov/fulltext/ED031968.pdf. Acesso em: 19 nov. 2020.

GUNNING, Tom. The Cinema of Attractions: Early Film, Its Spectator and the Avant-Garde. *In:* ELSAESSER, T. (Ed.). **Early Cinema:** Space Frame Narrative. London: British Film Institute, p. 56-62, 1990.

GUPTA, Sanika. **OGMA:** language acquisition system using immersive virtual reality. 2015. Dissertação (Mestrado em Computer Science)-The University of Texas at Arlington, Arlington, 2015.

HEDE, A. An integrated model of multimedia effects on learning. **Journal of Educational Multimedia and Hypermedia**, v.11, n. 2, p. 177-191, 2002.

HEDE, T.; HEDE, A. Multimedia effects on learning: Design implications of an integrated model. *In:* MCNAMARA, S; STACEY, E. (Eds.). **Untangling the Web:** Establishing Learning Links. Melbourne: Proceedings ASET Conference, 2002.

HERRERA, Fernanda *et al*. Building long-term empathy: A large-scale comparison of traditional and virtual reality perspective-taking. **PloS ONE**, v. 13, n. 10, p. 1-37, 2018. Disponível em: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0204494. Acesso em: 22 fev. 2021.

HUANG, Wen. **Investigating the Novelty Effect in Virtual Reality on STEM Learning**. 2020. Dissertação (Mestrado em Filosofia)-Arizona State University, Tempe, 2020.

HUANG, M.; Rauch, U.; Liaw, S. Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. **Computers & Education**, v. 55, n; 3, p. 1171-1182, 2010.

HULSTIJIN, J.; HOLLANDER, M.; GREIDANUS, T. Incidental vocabulary learning by advanced foreign language students: The influence of marginal glosses, dictionary use, and reoccurrence of unknown words. **The Modern Language Journal**, v. 80, p. 327-339, 1996.

IBHAR, Muhalida Zia; MAY, Low May; YUNUS, Melor Md. ESL Student's Perceptions Towards Vr 360° Learning Application to Enhance Vocabulary Learning. **International Journal of Innovative Research and Creative Technology**, v. 4, n. 3, p. 68-73, 2018. Disponível em: https://www.ijirct.org/papers/IJIRCT1801012.pdf. Acesso: 18 dez. 2019.

KAPLAN, R. (Ed.) **The Oxford Handbook of Applied Linguistics**. Oxford: Oxford University Press, 2010.

KENNING, Marie-madeleine. **ICT and Language Learning:** From Print to the Mobile Phone. Hampshire: Palgrave Macmillan, 2007.

KLEIMAN, A; CAVALCANTI, M. O DLA: Uma história de muitas faces, um mosaico de muitas histórias. *In:* _____. (Orgs.). **Lingüística aplicada:** suas faces e interfaces. Campinas: Mercado de Letras, 2007, p. 9-23.

KODA, Keiko. Development of second language reading skills: cross-linguistic perspectives. *In:* GASS, Susan. M.; MACKEY, Alison. (Eds.) **The Routledge Handbook of Second Language Acquisition**. Abingdon: Routledge, 2011, p. 303-318.

KRASHEN, S.D. **Second Language Acquisition and Second Language Learning**. Oxford: Pergamon Press Inc., 1991.

_____. **Principles and Practice in Second Language Acquisition**. Disponível em: http://www.sdkrashen.com/content/books/principles_and_practice.pdf. Acesso em: 5 dez. 2020.

_____; TERREL, T. **The Natural Approach: Language Acquisition in the Classroom**. New York: Phoenix ELT, 1995.

LAUFER, B; HILL, H. M. What lexical information do L2 learners select in a CALL dictionary and how does it affect word retention? **Language Learning & Technology**, v. 3, n. 2, pp. 58- 76, 2000.

LAVALLE, Steven M. et al. Head Tracking for the Oculus Rift. *In:* IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION (ICRA), 2014, Hong Kong. **Proceedings** […] [S. l.]: IEEE Robotics & Automation Society, 2014, p. 187-194.

LEGAULT, Jennifer *et al*. Immersive Virtual Reality as an Effective Tool for Second Language Vocabulary Learning. **Languages**, v. 4, n. 1, 2019. Disponível em: https://www.mdpi.com/2226-471X/4/1/13/htm. Acesso em: 29 mai. 2020.

LIN, T. J.; LAN, Y. J. Language Learning in Virtual Reality Environments: Past, Present, and Future. **Educational Technology & Society**, v. 18, n. 4, p. 486-497, 2015.

LOMBARD, Matthew; DITTON, Theresa. At the Heart of it All: The Concept of Presence. **Journal of Computer-Mediated Communication**, v. 3, n. 2, 1997. Disponível em: https://academic.oup.com/jcmc/article/3/2/JCMC321/4080403. Acesso em: 25 set. 2020.

LÓPEZ, M.; AGUILAR, A. Emotions as Learning Enhancers of Foreign Language Learning Motivation. **Profile**, v. 15, n. 1, p. 109-124, 2013. Disponível em: http://www.scielo.org.co/pdf/prf/v15n1/v15n1a08.pdf. Acesso em: 11 out. 2018.

MACINTYRE, Peter; CHAROS, Catherine. Personality, Attitudes, and Affect as Predictors of Second Language Communication**. Journal of Language and Social Psychology**, v. 15, n. 1, p. 3-26, 1996.

MADINI, A.A.; ALSHAIKHI, D. Virtual Reality for Teaching ESP Vocabulary: A Myth or A Possibility. **International Journal of English Language Education***,* v. 5, n. 2, p. 111-126, 2017. Disponível em: https://www.macrothink.org/journal/index.php/ijele/article/view/11993. Acesso em: 14 fev. 2020.

MARTIN, A.; WIGGS, C. L.; UNGERLEIDER, L. G.; HAXBY, J. V. Neural Correlates of Category-Specific Knowledge. **Nature**, v. 379, n. 6566, p. 649-652, 1996.

MAYER, R. **Multimedia Learning**. Cambridge: Cambridge University Press, 2001.

MILGRAM, P.; KISHINO, F. A taxonomy of mixed reality visual displays. **IEICE Trans. Inform. Syst.**, v. 77, n. 12, p. 1321–1329, 1994. Disponível em: https://cs.gmu.edu/~zduric/cs499/Readings/r76JBo-Milgram_IEICE_1994.pdf. Acesso em: 21 set. 2019.

MILTON, James; FITZPATRICK, Tess. (Eds.). **Dimensions of vocabulary knowledge**. Basingstoke: Palgrave McMillan, 2014.

MORENO, R.; MAYER, R. Virtual Reality and Learning: Cognitive and Motivational Effects of Students' Sense of Presence. *In:* INTERNATIONAL CONFERENCE ON HUMAN-COMPUTER INTERACTION, 9., 2001, New Orleans. **Proceedings** […] Pennsylvania: Pennsylvania State University, 2001. Disponível em: http://citeseerx. ist.psu.edu/viewdoc/download?doi=10.1.1.105.7125&rep=rep1&type=pdf. Acesso em: 1 jul. 2019.

MONTEIRO, Ana Maria Vieira. **Oculus Rift como dispositivo cinematográfico:** reflexões sobre as potencialidades das máquinas de realidade virtual. 2016. Dissertação (Mestrado em Comunicação)-Universidade Federal de Juiz de Fora, Juiz de Fora, 2016.

_____; RIBEIRO, Patrícia Nora. Realidade Virtual no ensino de vocabulário de inglês: um estudo exploratório sobre afeto no uso da tecnologia. **Trabalhos em Linguística Aplicada**, v. 59, n.2, p. 1310-1338, 2020. Disponível em: https://periodicos.sbu.unicamp.br/ojs/index.php/tla/article/view/8658170. Acesso em: 10 out. 2020.

_____. SALGADO, Ana Cláudia Peters. Translinguar de Fronteira: o falar e o ensinar de sujeitos entre-línguas do Brasil e da Venezuela. **The Especialist**, v. 39, n. 2, 2018. Disponível em: https://revistas.pucsp.br/index.php/esp/article/view/36556. Acesso em: 3 dez. 2018.

NATION, I. S. P. **Learning Vocabulary in Another Language**. Cambridge: Cambridge University Press, 2008.

PALMEIRA, E. et al. The Use of Immersive Virtual Reality for Vocabulary Acquisition: a Systematic Literature Review. In: CONGRESSO BRASILEIRO DE INFORMÁTICA NA EDUCAÇÃO, 9., 2020, Natal. **Anais** [...] Natal: Sociedade Brasileira de Computação, 2020, p. 532-541.

PARIBAKHT, T.; WESCHE, M. Vocabulary enhancement activities and reading for meaning in second language vocabulary. In: COADY, J.; HUCKIN, T. (Eds.) **Second Language Vocabulary Acquisition**. Cambridge: Cambridge University Press, 1997, p. 174-200.

PARMAXI A., STYLIANOU K., ZAPHIRIS P. Leveraging Virtual Trips in Google Expeditions to Elevate Students' Social Exploration. *In:* BERNHAUPT, R. *et al*. (Eds.). **Human-Computer Interaction – INTERACT 2017**. [S. l.]: Springer, Cham, 2017.

PARONG, J.; MAYER, R. E. Learning Science in immersive Virtual Reality. **Journal of Educational Psychology**, v. 110, n. 6, p. 785-797, 2018.

PELTEKOVA, E. V.; STEFANOVA E. P. Inquiry-based learning "outside" the classroom with virtual reality devices. **Modern Information Technologies and IT Education**, v. 12, n. 3, p. 112-116, 2016.

PIAGET, J. **Psicologia da Inteligência**. Rio de Janeiro: Zahar, 1977.

PROCÓPIO, R. **O uso do glossário hipermídia no ensino-aprendizagem implícito de vocabulário nos níveis elementar e intermediário de proficiência em inglês**. 2016. Tese (Doutorado em Linguística)-Universidade Federal de Juiz de Fora, Juiz de Fora, 2016.

_____. SOUZA, P. N. As tecnologias digitais no ensino e aprendizagem de línguas. Veredas On-line. v. 20, n. 1, p. 83-102, 2016.

RICHARDS, J. The role of vocabulary teaching. **TESOL Quarterly**, v. 10, n. 1, p. 77-89, 1976.

RICHARDS, J; SCHMIDT, R**. Longman Dictionary of Language Teaching and Applied Linguistics**. Harlow: Pearson Education Limited, 2010.

RIVA, Giuseppe. Virtual reality: An experimental tool for clinical psychology, **British Journal of Guidance & Counselling**, v. 37, n. 3, p. 337-345, 2009.

RIVA, Giuseppe; WATERWORTH, John A. Being presence in a virtual world. In: MARK; Grimshaw. (Ed.). **The Oxford Handbook of Virtuality**. Oxford: Oxford University Press, 2013.

RUS-CALAFELL, M. et al. Virtual reality in the assessment and treatment of psychosis: a systematic review of its utility, acceptability and effectiveness; **Psychological Medicine,** v. 48, n. 3, p. 362-391, 2018.

SAITO, Fabiano Santos. **Aprendizagem de vocabulário de inglês como língua estrangeira em ambiente hipermídia:** efeitos da retenção lexical a curto e longo prazo em uma abordagem de ensino e aprendizagem lexical implícita. 2015. Tese (Doutorado em Linguística)-Universidade Federal de Juiz de Fora, Juiz de Fora, 2015.

SAMPAIO, Leonardo Rodrigues; CAMINO, Cleonice Pereira dos Santos; ROAZZI, Antonio. Revisão de Aspectos Conceituais, Teóricos e Metodológicos da Empatia. **Psicologia:** Ciência e Profissão, v. 29, n. 2, p. 212-227, 2009. Disponível em: https://www.scielo.br/j/pcp/a/NKFMxtzhbKtMbYHWnW63pPc/?lang=pt&format=pdf. Acesso em: 24 nov. 2020.

SANTOS, W. O. *et al*. Flow Theory to Promote Learning in Educational Systems: Is it Really Relevant? **Revista Brasileira de Informática na Educação – RBIE**, Porto Alegre, v. 26, n. 2, p. São Paulo, v. 18, n. 4, p. 1-31, 2018. Disponível em: https://br-ie.org/pub/index.php/rbie/article/view/7106/5551. Acesso em: 26 jan. 2021.

SCARAMUCCI, M. V. R. **O papel do léxico na compreensão em leitura em língua estrangeira**: foco no produto e no processo. 1995. Tese (Doutorado em Linguística)-Unicamp, Campinas, 1995.

SHARAR, Sam *et al*. Circumplex Model of Affect: A Measure of Pleasure and Arousal During Virtual Reality Distraction Analgesia. **Games for Health Journal**, v. 5, n. 3, 2016.

SCHMITT, Norbert. Current Perspectives on Vocabulary Teaching and Learning. *In:* CUMMINS, J.; DAVISON, C. (Eds.). **International Handbook of English Language Teaching**. Boston: Springer, 2007, p. 827-841.

SCHUMANN, J. H. **The Neurobiology of Affect in Language**. Malden: Blackwell Publishers, 1997.

_____. A neurobiological perspective on affect and methodology in second language learning. *In:* ARNOLD, J. (Ed.). **Affect in Language Learning**. Cambridge: Cambridge University Press, pp. 28-42, 1999.

SHÖNE, Benjamin; WESSELS, Marlene; GRUBER, Thomas. Experiences in Virtual Reality: a Window to Autobiographical Memory. **Current Psychology**, v. 38, p. 715-719, 2019.

SIMPSON, J. (Ed.). **The Routledge Handbook of Applied Linguistics**. London: Routledge, 2011.

SOUZA, P. N. de **O uso da hipermídia para o ensino e a aquisição lexical no contexto da leitura em língua estrangeira**. 2004. Tese (Doutorado em Linguística) – Unicamp, Campinas, 2004.

SOUZA, P.; BRAGA. D. Os efeitos da hipermídia no aprendizado implícito de vocabulário em LE. *In:* SCARAMUCCI, M.; GATTOLIN, S. (Orgs.). **Pesquisas sobre vocabulário em língua estrangeira**. Campinas: Mercado de Letras, 2007, p. 155-174.

STERNBERG, Robert J. **Psicologia Cognitiva**. Trad. Anna Maria Dalle Luche, Roberto Galman. São Paulo: Cengage Learning, 2015.

STEVICK, E. W. Affect in learning and memory: from alchemy to chemistry. *In:* ARNOLD, J. (Ed.). **Affect in Language Learning**. Cambridge: Cambridge University Press, p. 43-57, 1996.

STOCKWELL, Glenn; REINDERS, Hayo. Technology, Motivation and Autonomy, and Teacher Psychology in Language Learning: Exploring the Myths and Possibilities. **Annual Review of Applied Linguistics**, n. 39, p. 40-51, 2019.

TORI, Romero; HOUNSELL, Marcelo da Silva. (Orgs.). **Introdução a Realidade Virtual e Aumentada**. Porto Alegre: Editora SBC, 2018.

VAZQUEZ, C. *et al*. Words in Motion: Kinesthetic Language Learning in Virtual Reality. *In:* INTERNATIONAL CONFERENCE ON ADVANCED LEARNING TECHNOLOGIES (ICALT), 18., 2018, Mumbai. **Proceedings** […] [S. l.]: IEEE ICALT, 2018, p. 272-276.

VYGOTSKY, L. **Psicologia Pedagógica**. Porto Alegre: Artmed, 2003.

WALLON, H. **A evolução psicológica da criança**. Lisboa: Edições 70, 1968.

WEECH, Séamas; KENNY, Sophie; BARNETT-COWAN, Michael. Presence and Cybersickness in Virtual Reality Are Negatively Related: A Review. **Frontiers in Psychology**, v. 10, p. 1-19, 2019. Disponível em: https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00158/full. Acesso em: 13 fev. 2020.

WILLIAMS, M.; BURDEN, R. **Psychology for Language Teachers:** A Social Constructivist Approach. Cambridge: Cambridge University Press, 1997.

YEE; J. *et al.* The Use of Immersive Virtual Reality in the Learning Sciences: Digital Transformations of Teachers, Students, and Social Context. **The Journal of The Learning Sciences**, v. 17, p. 102-141, 2008. Disponível em: https://stanfordvr.com/mm/2008/bailenson-IVE-learning.pdf. Acesso em: 22 jun. 2019.

YUN, J. The effects of Hypertext Glosses on L2 Vocabulary Acquisition: A Meta-Analysis. **Computer Assisted Language Learning**, v. 24, n. 1, p. 39-58, 2011.

APPENDIX A – Termo de Consentimento Livre e Esclarecido

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Gostaríamos de convidar você a participar como voluntário (a) da pesquisa **"O USO DA REALIDADE VIRTUAL PARA O ENSINO E APRENDIZAGEM DE VOCABULÁRIO DE INGLÊS COMO LÍNGUA ESTRANGEIRA"**. O motivo que nos leva a realizar esta pesquisa é a falta de estudos sobre as aplicações e implicações da realidade virtual no ensino e aprendizagem. Mais detalhadamente, nesta pesquisa pretendemos investigar se a realidade virtual contribui para o aprendizado de vocabulário em língua estrangeira.

Caso você concorde em participar, vamos fazer as seguintes atividades com você: 1) aplicação de um teste de proficiência. Como os participantes da pesquisa não serão, em nenhum momento, identificados, iremos fornecer um código individual no teste de proficiência, o qual será utilizado para a divulgação do seu resultado e para acesso às etapas subsequentes da pesquisa. 2) Questionário de práticas de estudo. 3) Sorteio: divisão dos participantes em dois grupos. 4) Pré-teste de vocabulário. 5) exposição aos ambientes virtuais pesquisados. 6) Pós-teste de vocabulário. 7) Questionário de avaliação da experiência. Esta pesquisa tem risco mínimo, por exemplo de você ser identificado, mas todos os cuidados serão tomados para preservar sua identidade. Você não será identificado em nenhuma das atividades mencionadas acima. A pesquisa pode ajudar os participantes a conhecerem seu nível de proficiência em língua inglesa, além de lhes proporcionarem uma experiência estimulante de aprendizagem. Para o ensino, a pesquisa irá fornecer dados empíricos sobre a utilização da realidade virtual no âmbito da aquisição de segunda língua.

Para participar deste estudo você não terá nenhum custo, nem receberá qualquer vantagem financeira. Apesar disso, se você tiver algum dano por causa das atividades que fizermos com você nesta pesquisa, você tem direito a indenização. Você terá todas as informações que quiser sobre esta pesquisa e estará livre para participar ou recusar-se a participar. Mesmo que você queira participar agora, você pode voltar atrás ou parar de participar a qualquer momento. A sua participação é voluntária e o fato de não querer participar não vai trazer qualquer penalidade ou mudança na forma em que você é atendido(a). O pesquisador não vai divulgar seu nome. Os resultados da pesquisa estarão à sua disposição quando finalizada. Seu nome ou o material que indique sua participação não será liberado sem a sua permissão. Você não será identificado(a) em nenhuma publicação que possa resultar.

Este termo de consentimento encontra-se impresso em duas vias originais, sendo que uma será arquivada pelo pesquisador responsável e a outra será fornecida a você. Os dados coletados na pesquisa ficarão arquivados com o pesquisador responsável por um período de 5 (cinco) anos, e após esse tempo serão destruídos. Os pesquisadores tratarão a sua identidade com padrões profissionais de sigilo, atendendo a legislação brasileira (Resolução Nº 466/12 do Conselho Nacional de Saúde), utilizando as informações somente para os fins acadêmicos e científicos.

Declaro que concordo em participar da pesquisa e que me foi dada à oportunidade de ler e esclarecer as minhas dúvidas.

Juiz de Fora, _____ de _____ de 20 .

_____ _____

Assinatura do Participante Assinatura do (a) Pesquisador (a)

Nome do Pesquisador Responsável: Ana Maria Vieira Monteiro
Campus Universitário da UFJF
Faculdade/Departamento/Instituto: Faculdade de Letras, Programa de Pós-Graduação em Linguística.
CEP: 36036-900
Fone: (32) 9 9120 3179
E-mail: anamvmonteiro@gmail.com

Em caso de dúvidas, com respeito aos aspectos éticos desta pesquisa, você poderá consultar:
CEP - Comitê de Ética em Pesquisa com Seres Humanos - UFJF
Campus Universitário da UFJF
Pró-Reitoria de Pós-Graduação e Pesquisa
CEP: 36036-900
Fone: (32) 2102- 3788 / E-mail: cep.propesq@ufjf.edu.br

APPENDIX B – Vocabulary test

Código: _____

Caro(a) participante,

Este teste tem como objetivo identificar as palavras que você talvez já conheça antes da pesquisa, a fim de avaliarmos seu aprendizado. Antes de completar o quadro abaixo, leia com atenção as instruções que seguem.
1 – Não faça consultas de qualquer tipo para verificar o significado das palavras.
2 – Escolha a opção que melhor indica seu conhecimento das palavras do quadro. Para a opção A, basta marcar um X. Para as opções B e C, você poderá escrever ou desenhar um significado possível para a palavra. A escrita pode ser um sinônimo ou uma tradução.

PALAVRAS	A. Eu nunca vi essa palavra antes:	B. Eu já vi essa palavra, mas estou em dúvida quanto ao seu significado. Eu acho que é:	C. Eu conheço essa palavra. Eu sei o seu significado. O significado é:
Self-portrait			
Bedridden			
Cast			
Courtyard			
Disease			
Hardships			
Struggle			
Strength			

Velvet			
Affairs			
Easel			
Foetuses			
Miscarriage			
Nips			
Sketch			
Ups and downs			
Whole			

APPENDIX C – Lesson plan

Lesson Plan: Experiment

Objective: Expose English students to implicit vocabulary teaching via oral tips of the words highlighted during a virtual tour.

Target-words: self-portrait; courtyard; bedridden; disease; cast; velvet; easel; affairs; nips; whole; struggle; foetuses; miscarriage; sketch; ups and downs; hardships; strength.

Time: 40 minutes each day

Materials: 08 Google cardboards; 08 smartphones

Procedures:

 Interaction between teacher and students without cardboards.

 Students explore the scene while teacher is guiding them or on their own.

 Text/audio students will see/listen to on the screen once they click on the following points of interest.

Part 1

 Max. Time: 05 minutes Introduction to activity	→ Teach them how to use the cardboard and present a briefing (on Prezi) of what they are about to see and the theme of the lesson. → Give each student the cardboard already assembled with the smartphones. Ask if they remember the procedures to change scene and access the written content from the points of interest. Answer whatever questions they might have.
 Max. Time: 10 minutes Scene 01 La Casa Azul Museum	**Teacher:** First, we are going to see three points of interest in this scene. After that, you can explore the **WHOLE** scenario freely, ok? You can now wear your cardboards. You are at the **COURTYARD** of Frida's family house in Mexico. Please turn your heads around and say what you see in this **COURTYARD**. *Students might say words like: garden, plants, people, trees etc.* **Teacher:** So now I would like you to look at the pyramid in the **COURTYARD** and click on the icon on it. You can read and listen to the text.

	Pre-Hispanic artifacts Numerous pre-Hispanic artifacts are displayed on the **COURTYARD** pyramid and throughout the gardens. **Teacher:** Did everyone see the icon and read the text? Why do you think Frida had these objects in her **COURTYARD**? *Sum-up answers saying that Frida valorized Mexican Pre-Colombian History.* **Teacher:** Now we are moving towards another interesting fact about Frida's biography. She lived in that house for most of her life, with **UPS AND DOWNS**: good moments and bad moments. Her life was full of **HARDSHIPS**: difficulties. But she had a lot of **STRENGTH** to fight these bad moments, and she transformed these **HARDSHIPS** in something colorful, beautiful and powerful through her art. She also had the chance of experiencing another culture that was very different from Mexico's at that time. Please locate another icon in the **COURTYARD** called "Between Two Worlds". You can click on it. Between Two Worlds The 1932 **SELF-PORTRAIT** reveals Frida's negative view of industrialization. Natural and cultural elements fill the Mexico side, while factories and a U.S. flag clouded by pollution fill the U.S. side. **Teacher:** Did everyone see the text? Based on what we know, she didn't live her **WHOLE** life at La Casa Azul. Where else did she live? *Sum-up answers saying that the **SELF-PORTRAIT** "Between Two Worlds" give us a hint that she also lived in the U.S.* **Teacher:** In that **SELF-PORTRAIT**, what are the elements representing Mexico? *Students might say: Pre-Colombian artifacts, a pyramid, flowers etc.* **Teacher:** As you will see in our tour, Frida painted a lot of **SELF-PORTRAITS** describing her state of mind about certain things. But she also painted portraits of people close to her. Now, the last point of interest in the **COURTYARD** is on the right, next to a green door. Please click on it. It is a portrait of Frida's father, Guillermo. Frida painted that portrait in 1951. The painting is simply called "Portrait of My father". La Casa Azul La Casa Azul was built in 1904 by Frida Frida's father, Guillermo. It was here that Frida was born, spent much of her life, and died. In 1958, La Casa Azul became a museum.

	Teacher: Frida was very close to her father. He was born in Germany and immigrated to Mexico where he met Frida's mother and started a family. Please look at the portrait of Guillermo again. What other information you can tell us about him? *Students might see that Frida painted a camera behind him, which tell us his profession: he was a photographer.* **Teacher:** Ok, you can now take off your cardboards.
 Max. Time: 05 minutes	→ Allow some time for students to rest their eyes. Ask them what they thought of the experience. Ask if they had any trouble accessing the images, texts and audio. → Explain that the next scene will take place inside La Casa Azul, where they can learn more about Frida's personal life through the events described in some of her paintings. **Teacher:** Before we enter one of the rooms of La Casa Azul, can you tell us if you already had a broken bone? I mean, a broken arm or a broken leg…? *Check students' comprehension and answers.* **Teacher:** When people break their bones, depending on the part of the body, they must wear a **CAST**. A **CAST** is a white and hard material used on legs and arms, for example, when they are broken after an accident. Do people usually paint or draw on a **CAST**? We usually ask people to sign their names on it. Don´t we? *Check students' comprehension and answers.* **Teacher:** OK, you can now wear your cardboard and look for Scene 2, Young Frida. Look for the icon Frida, age 12.
 Max. Time: 10 minutes Scene 02 Young Frida	 Frida, age 12 Frida was born on July 6, 1907. At age 6, she contracted polio and was **BEDRIDDEN** for 9 months. She recovered from **DISEASE** but her right leg was permanently thinner and shorter than the left. **Teacher:** A **DISEASE** sometimes makes people stay in bed until they get better. As you could see, Frida had a very serious **DISEASE** when she was a child. At that time, there wasn't a vaccine against polio and Frida had permanent consequences from it. **Teacher:** So, for how many months did Frida had to stay in bed for? What are common **DISEASES** today that can cause you to be **BEDRIDDEN**?

	Students might say for nine months; dengue, zika etc. **Teacher:** OK, so now we will see that Frida had to stay in bed again when she was 18 years old. Please look for the icon on the left of Frida's **SELF-PORTRAIT**. It says: "**BEDRIDDEN** again, Frida starts painting". **BEDRIDDEN** again, Frida starts painting In 1925, Frida, then 18, was in a bus accident and was badly hurt. Recuperating at home, she spent 3 months in a full body **CAST** and began painting to pass time. **Teacher:** You know that when a person has to stay in bed because of a **DISEASE** or an accident, we say that she or he is **BEDRIDDEN.** Have you ever been **BEDRIDDEN**? What did you do to pass time? What did Frida do to pass time? *Check students' comprehension and answers.* **Teacher:** To stay for so long **BEDRIDDEN,** Frida had to remain mentally strong**.** What, do you think, gave her **STRENGTH**? *Students will probably say she started painting. Make sure they hear that her art, her paintings might have given her **STRENGTH** to stay **BEDRIDDEN** for so long.* **Teacher:** Please go back to the scene and look again at the photo of Frida **BEDRIDDEN**. What is she painting? *Students might say she is painting a portrait. If they say so, explain that she is painting many portraits in one painting (she is painting her family members as in a family tree).* **Teacher:** While Frida was **BEDRIDDEN** she painted on her **CAST** too. Differently from many images we usually see on **CASTS**, like signatures and drawings, Frida painted very intricate images on the **CASTS** she had to use after the accident. Please have a look on the icon, on the right of Frida's photo as a child. It is a picture and information about Frida's **CASTS.** Painted **CAST** Many of the apparatuses Frida wore following the accident can be seen at the Museo Frida Kahlo. These objects help viewers understand Frida 's pain and suffering, and in turn, her art. **Teacher:** What part of the body was the **CAST** for? What images do you see on Frida's **CAST**? What would you say about them? *Students might say it was for the chest/thorax/torso; and that she had*

	*a baby or that she wanted to have a baby, she was a communist etc. It is probable that they will not see a detail about the painted baby. Say that it is hard to see if Frida painted one or two **FOETUSES**.* **Teacher:** Please go back to the image of her CAST and see the details of the images. What do you think? Did she paint one or two **FOETUSES**? *Allow students to answer freely.* **Teacher:** In your opinion, why did she paint **FOETUSES?** *Students might say she was pregnant or she wanted to have a baby. Make sure they hear she **STRUGGLED** for many years to have a baby. That means she wanted to have a baby, but it was very difficult for her.* **Teacher**: As you might know now, Frida had many **STRUGGLES** in her life: first, she had to fight against polio, then she had the accident and, as we are going to see soon, she **STRUGGLED** to maintain her marriage. That means she had to fight to keep on living and that she showed great **STRENGTH** and resilience. After all we have seen, do you think Frida was a happy person? Why or why not? *Allow students to answer freely.* **Teacher:** Now please wear your cardboards and turn your heads around until you see a window showing Frida's dresses. We have seen her life started with some difficulties, **HARDSHIPS**. But despite Frida's physical conditions, she was remembered as a cheerful person, somebody who enjoyed life and was very proud of her culture. Frida is also considered an inspiration for fashion. Please click on the icon next to the dresses. She liked the traditional clothing of Mexican woman, but in this **SELF-PORTRAIT** she is wearing a very different dress. **SELF-PORTRAIT** in a **VELVET** Dress Finished in 1926 while recovering from the accident, self-portrait in a **VELVET** dress is Frida's first **SELF-PORTRAIT**. **Teacher:** Look at the painting. Who painted it? *Students might say it was Frida.* **Teacher:** How do you know? *Students might reply it was Frida because it is a self-portrait or because of the style. Make sure the former is the elected answer.* **Teacher:** This painting shows her in a dress. How do you compare it

	with the other dresses in the museum? *Students might say it is red, classic, serious etc., and the other dresses are colorful, traditional, beautiful/ugly etc. Sum-up the answers saying that in her first **SELF-PORTRAIT** she is wearing a **VELVET** dress. **VELVET** is a type of fabric, such as cotton, jeans, polyester etc. **VELVET** is a very classic and European-style fabric, one that is very soft and can be seen on shoes as well as on furniture, life sofas. The dresses displayed in the museum are colorful, folk, maybe from light fabric.*
 Max. Time: 10 minutes	**Teacher:** we have now reached the first part of our tour. On our next class we will continue to see her story throughout her paintings. But before we go, can you tell the group your impressions about the tour? → Allow them to answer freely. → Apply vocabulary test.

Part 2

 Max. Time: 05 minutes	→ Give students sometime to remember a few things about Frida's story. **Teacher:** Hello again, everybody! Are you ready to continue our journey? Before we head on to the next scene at La Casa Azul, could you say what you remember from Frida's story? *Check if students will use new vocabulary (target words). If not, ask if they remember where they first visit in the museum. Also, if they know why Frida was **BEDRIDDEN** for long periods during her life; what were the images they saw on her cast (make sure they hear or produce the word **FOETUSES**).*
 Max. time: 10 minutes Scene 03 La Casa Azul, Courtyard	**Teacher:** You can now wear your carboards. You are looking at a familiar place inside La Casa Azul. What do you call this outside area? *Students might say it is a **COURTYARD**. If nobody says it, sum-up answers saying they are looking at the courtyard of La Casa Azul.* **Teacher:** On one of the walls of the ***COURTYARD*** you can see a text. What does it say in English? *Students might say "Frida and Diego lived in this house from 1924 to 1954".*

	Teacher: So now we see another name related to Frida. On the icon on the left of the sentence you've just read we are going to see new facts about her life. Please click on it.  Frieda and Diego Rivera, 1931 Frida first met Diego Rivera in 1922, but it wasn't until 1928 that they became romantically involved. They married in 1929. Over the years, Frida and Rivera's relationship had many dramatic **UPS AND DOWNS**. **Teacher:** What is the name of the painting? *Students will probably say the name of the icon: Frieda and Diego Rivera, 1931.* **Teacher:** As you could see, the name Frida is changed to Frieda. This is because Frida is a German name and she didn't want to be associated with the Nazi regime that was sweeping Germany at that time. Why, do you think, Frida had a German name? *Students might remember her father, Guillermo, was from Germany.* **Teacher:** Based on the painting of Frida and Diego together, what can you infer from Diego Rivera? *Answers might be that he was also a painter, older than her, very tall etc.* **Teacher:** What about the way Frida felt in relation to Diego? Was she happy in the painting? At that time, Frida was not a recognized artist yet. You can go back to the painting if you need to. *Wrap-up the answers saying some art critics see a very insecure Frida next to her famous husband (Diego was an artist too), who is unproportionable big in the painting.* **Teacher:** You also read that their marriage had many **UPS AND DOWNS**. That means they had good and bad moments in their relationship, especially because they had many love **AFFAIRS**. Frida registered many of the bad moments in very dramatic paintings. Please look for and click on the next icon called "A Few Small **NIPS**".  A Few Small **NIPS** Frida's 1935 painting - A Few Small **NIPS** - expresses her feelings about Rivera's numerous "small" **AFFAIRS**. **Teacher:** How would you describe the painting?

	Answers might be that the painting shows a woman with many cuts, there is blood, a man standing next to her etc. **Teacher:** What is the meaning of "small" **AFFAIRS**? Sum-up answers saying the love **AFFAIRS** might have lasted a short period of time or they didn't represent important romantic relationships. **Teacher:** Yes, in the painting we can see cuts made by a knife that the man is holding. These small cuts are **NIPS**. Considering Frida's life with Diego, what could these **NIPS** represent? *Answers might be that, symbolic, the NIPS represent Rivera's **AFFAIRS** as being painful events for Frida.* **Teacher:** There is another famous painting, an unusual self-portrait made by Frida. In this picture we can see the suffering caused by the **UPS AND DOWNS** of her marriage. Look to your right. Click on the icon, please.  Las Dos Fridas, 1939 Frida made this painting when she and Rivera divorced in 1939. The Frida in white, rejected by Rivera, has a broken heart, while the other Frida, holding Rivera's miniature portrait is **WHOLE**. **Teacher: "**Las dos Fridas" is an impacting painting, isn't it? What do you feel about it? Is it a beautiful painting? *Allow students to answer freely.* **Teacher:** What is the relation between "A few mall **NIPS**" and "The two Fridas"? What do they have in common? *Students might say the paintings show her suffering, describe her relationship etc. Sum-up answering saying the two paintings are an expression of her **UPS AND DOWNS** with Diego. She loved him, but she suffered a lot in their relationship.* **Teacher:** You may remember that I said "Las Dos Fridas" was an unusual **SELF-PORTRAIT**. What is a **SELF-PORTRAIT**? And why is it unusual? *Answers might be that a self-portrait is the own image of the painter; and that Las dos Fridas is unusual because there are two images of the same person. Sum-up saying that this painting has two selves: a **WHOLE-heart** Frida and a broken-heart Frida.* **Teacher:** Frida also had **AFFAIRS** during her marriage, but she only felt **WHOLE**, complete, when she was with him. Why, do you

	think, the two Fridas are holding hands? *Allow students to answer freely.*
 Max. Time: 05 minutes	→ Allow some time for students to rest their eyes. Check if they have questions about the texts and narration. → Ask them what paintings they liked the most and why. → Explain that the next scene will take place inside La Casa Azul, at Frida and Diego's art studio.
 Max. time: 10 minutes Scene 04 La Casa Azul, art studio	**Teacher:** Please wear your cardboards. What are some objects displayed at Frida and Diego's art studio? *Answers might include: pre-Hispanic artifacts, paints, brushes, books etc.* **Teacher:** If you look near the windows you will see a wheelchair and an **EASEL**. You might remember that when Frida was ***BEDRIDDEN*** she started to paint to pass time. When she had to stay in bed, her parents ordered a special support to hold her paintings. Please click on the first point of interest of the menu, called "Frida's **EASEL** and wheelchair".  Frida's **EASEL** and wheelchair Frida 's paint and brushes are neatly displayed behind her wheelchair and adjustable **EASEL**. The large window provides not only plenty of sunlight but also an inspiring view of the vibrant gardens outside. **Teacher:** The photo you are seeing shows Frida painting in bed with a special **EASEL**. Now, if you go back to the scene, the **EASEL** that you see is different, it as a regular, common **EASEL**. However, the **EASEL** is holding a painting very low, it was adjusted because Frida was painting in a wheelchair. Do you remember why Frida had a fragile physical condition? *Students might remember she had polio, which made her leg thinner and shorter. She also was in a bad accident when she was young. Sum-up saying Frida had permanent damage to her leg from a* ***DISEASE*** *and she also had many broken bones because of the bus accident.* **Teacher:** The past three paintings were about her marriage, which as a common theme for Frida's art. Another recurrent theme for Frida was very painful and personal too. Please find a poster on the scene that tell us about what else she painted. Please click on the

	icons next to the poster and check the information on them. Intra-uterine life poster While Frida did not create this poster, it reflects her life-long **STRUGGLE** to conceive a child and suggests the recurring images of **FOETUSES** in her paintings. **Teacher:** Do you remember what Frida painted on her **CAST**? *Check if students will remember the image of two **FOETUSES**.* **Teacher:** Now, based on the information near the poster, what is the word that refers to babies that are not born yet? *Check if they will say the new word "**FOETUSES**". Help them with pronunciation, if needed.* **Teacher:** Please go back to the painting "Henry Ford Hospital". What is it about? Henry Ford Hospital Soon after her **MISCARRIAGE**, Frida painted "Henry Ford Hospital". Naked and bloody in a hospital bed, she is surrounded by several figures, including the lost baby and her own pelvis. *Frida's **STRUGGLE** to have a baby was not successful. She tried many times, but the painting you just saw now tells us that every time Frida was pregnant she had a **MISCARRIAGE**.* **Teacher:** Can you say the difference between **MISCARRIAGE** and abortion? *If answers are not satisfactory, explain that Frida had **MISCARRIAGES** (spontaneous abortions) because she wanted to have a baby.* **Teacher:** What could be the reason for Frida's ***MISCARRIAGES***? *Students might say her body was very damaged by the accident, which, according to biographies about Frida, was the case indeed.* **Teacher:** Our last stop is by the bookshelves, among the pre-Columbian artifacts. After you read the text, please tell us: is that an image from a painting? Appearances Can be Deceiving This 1934 **SKETCH** depicts Frida's injured body covered by a transparent dress. Ironically, Frida - who appeared physically small and weak - displayed incredible **STRENGTH** and resilience to

	overcome the **HARDSHIPS** in her life. *After students read the text, they might say it is not a painting, it is a **SKETCH**.* **Teacher:** Looked at the image again. How would you describe a **SKETCH**? *Students might say a **SKETCH** is a drawing or an image on paper, made with a pencil. Sum-up answers saying a **SKETCH** is a quick, fast drawing of a person, a place or an object.* **Teacher:** What can you infer from who Frida was based on the **SKETCH** *Appearances Can be Deceiving* or, in Spanish, Las Apariencias Engañan? *Allow students to answer freely. Conclude saying that despite her fragile condition and her **HARDSHIPS** in life she was a very strong person. Her **STRENGTH** can be seen in her paintings, in the way she dressed, in her interest on politics and in the **STRUGGLE** to continue dedicated to her art until her death, in 1954.*
 Max. Time: 10 minutes	**Teacher:** thank you very much for taking the virtual tour with me. I hope Frida's life and art have inspired you. → Finish the lesson. → Apply second vocabulary test.

APPENDIX D – Qualitative questionnaire

Questionário avaliativo

Caro(a) participante,

Leia com atenção e responda as perguntas abaixo sobre o ambiente virtual de aprendizagem ao qual você foi exposto. Agradecemos a sua colaboração.

1 – O que você achou da experiência?

_____

_____

_____

_____

_____

2 – Você se sentiu imerso no ambiente? Justifique sua resposta.

_____

_____

_____

_____

_____

3 – Coloque em ordem crescente, de 1 a 5, o que mais contribui para o seu aprendizado de vocabulário durante a experiência (1 para o que mais contribuiu e 5 para o que menos contribuiu).

( ) A narração da professora/guia.
( ) A narração gravada, referente aos textos.
( ) A relação das palavras com as imagens do ambiente.
( ) O ambiente em realidade virtual (360 graus).
( ) O tema escolhido.

4 – Você experimentou algum desconforto físico ou psicológico durante a experiência?

( ) Não.
( ) Sim. Qual ou quais?

_____

_____

_____

_____

5 – Utilize o espaço abaixo caso você queira fazer algum comentário, crítica ou sugestão com relação ao ambiente experimentado.

_____

_____

_____

_____

_____

_____

_____

APPENDIX E – Poster of Experiment two

MÓDULO DE INGLÊS PARA SAÚDE

Local: Faculdade de Letras da UFJF
Duração: 04 semanas (uma aula por semana)

Público-alvo: estudantes da área da saúde, de qualquer nível de proficiência.

Vagas gratuitas, com emissão de certificado! **Inscrições até 30/09** pelo WhatsApp: (32) 92000 9492

EMENTA

Estruturas gramaticais e vocabulário da língua inglesa em contexto, a saber, no apresentar-se aos pacientes e obter deles informações básicas; no estabelecimento de comunicação bem-sucedida entre o(a) profissional de saúde e o(a) paciente, e na verificação de prontuário. Também serão praticadas situações comunicacionais envolvendo o vocabulário de partes do corpo, sintomas e lesões; da descrição e cuidados de ferimentos; da solicitação de movimentos, e da ala dos pacientes.

OBJETIVOS

- Ensinar a língua inglesa com o fim específico de trabalhar a comunicação entre o(a) profissional de saúde e o(a) paciente.
- Coletar dados para a pesquisa de doutorado da bolsista e ministrante do curso na forma de um estudo comparativo entre o aprendizado de vocabulário em ambiente hipermídia e em realidade virtual.

METODOLOGIA

- Aulas expositivas e aplicação de exercícios sobre os temas das unidades do curso.
- Aplicação de teste de proficiência (apenas para a análise de dados da pesquisa); questionário de identificação do perfil do aluno e de práticas de estudo; pré-teste de vocabulário; leitura e assinatura do Termo de Consentimento Livre e esclarecido; aplicação do experimento, ao final do curso, em ambiente hipermídia e em realidade virtual; pós-teste de vocabulário.

APPENDIX F – Termo de Assentimento Livre e Esclarecido

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

TERMO DE ASSENTIMENTO LIVRE E ESCLARECIDO

Gostaríamos de convidar você a participar como voluntário(a) da pesquisa "O uso da realidade virtual para o ensino e aprendizagem de vocabulário de inglês como língua estrangeira". O motivo que nos leva a pesquisar esse tema é a escassez de estudos sobre a realidade virtual no ensino de inglês, ainda que haja dados científicos que sugerem resultados positivos no uso da realidade virtual para fins pedagógicos. Nesta pesquisa, pretendemos comparar os efeitos do uso do computador com os efeitos do uso da realidade virtual na aprendizagem de vocabulário em língua estrangeira. Também faz parte da pesquisa investigar os aspectos afetivos que influenciam a aprendizagem de vocabulário em inglês como língua estrangeira nesses dois ambientes virtuais.

Caso você concorde em participar, vamos fazer as seguintes atividades com você: 1) aplicação de um teste de proficiência em língua inglesa. 2) Sorteio: divisão dos participantes em dois grupos: "controle", que irá fazer o experimento no computador, e "experimental", que irá fazer o experimento em realidade virtual. 3) Pré-teste de vocabulário. 4) exposição aos ambientes virtuais pesquisados. 5) Pós-teste de vocabulário. 6) Questionário de avaliação da experiência. 7) Pós-teste de vocabulário a longo prazo, três ou quatro semanas após a exposição aos ambientes virtuais.

Esta pesquisa apresenta risco mínimo, isto é, o mesmo risco existente em atividades rotineiras como conversar, tomar banho, ler etc. Mas, para diminuir a chance desses riscos, a pesquisadora estará presente em todas as etapas, lado a lado com os participantes, zelando para que o ambiente da pesquisa seja o mais seguro possível. A pesquisa pode ajudar a comunidade científica a produzir teorias sobre o papel da afetividade no ensino de língua estrangeira mediado por computador. Especialmente no caso da realidade virtual, esta pesquisa poderá incentivar o desenvolvimento de metodologias próprias para essa tecnologia.

Para participar desta pesquisa, o responsável por você deverá autorizar e assinar um termo de consentimento. Para participar desta pesquisa, você não vai ter nenhum custo, nem receberá qualquer vantagem financeira. Apesar disso, se você tiver algum dano por causadas atividades que fizermos com você nesta pesquisa, você tem direito a buscar indenização. Você terá todas as informações que quiser sobre esta pesquisa e estará livre para participar ou recusar-se a participar. Mesmo que você queira participar agora, você pode voltar atrás ou parar de participar a qualquer momento. A sua participação é voluntária e o fato de não querer participar não vai trazer qualquer penalidade ou mudança na forma em que você é atendido(a). O pesquisador não vai divulgar seu nome. Os resultados da pesquisa estarão à sua disposição quando finalizada. Seu nome ou o material que indique sua participação não será liberado sem a permissão do responsável por você. Você não será identificado(a) em nenhuma publicação que possa resultar. O responsável por você poderá retirar o consentimento ou interromper a sua participação a qualquer momento.

Este termo de consentimento encontra-se impresso em duas vias originais, sendo que uma será arquivada pelo pesquisador responsável e a outra será fornecida a você. Os dados coletados na pesquisa ficarão arquivados com o pesquisador responsável por um período de 5 (cinco) anos. Decorrido este tempo, o pesquisador avaliará os documentos com para a sua destinação final, de acordo com a legislação vigente. Os pesquisadores tratarão a sua identidade com padrões profissionais de sigilo, atendendo a legislação brasileira (Resolução Nº 466/12 do Conselho Nacional de Saúde), utilizando as informações somente para os fins acadêmicos e científicos.

Declaro que concordo em participar da pesquisa e que me foi dada à oportunidade de ler e esclarecer as minhas dúvidas.

Juiz de Fora, _____ de _____ de 2020.

_____ _____

Assinatura do Participante Assinatura da Pesquisadora

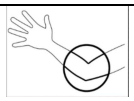
Nome da pesquisadora responsável: Ana Maria Vieira Monteiro
Campus Universitário da UFJF
Faculdade de Letras – Pós-Graduação em Linguística
CEP: 36036-900
Fone: 32 92000 9492 / E-mail: anamvmonteiro@gmail.com

Em caso de dúvidas, com respeito aos aspectos éticos desta pesquisa, você poderá consultar:
CEP - Comitê de Ética em Pesquisa com Seres Humanos - UFJF
Campus Universitário da UFJF
Pró-Reitoria de Pós-Graduação e Pesquisa
CEP: 36036-900
Fone: (32) 2102- 3788 / E-mail: cep.propesq@ufjf.edu.br

APPENDIX G – Vocabulary pre-test

Código do participante: _____

- Escolha a opção que melhor indica seu conhecimento das palavras abaixo, representadas pela escrita e por imagens. Se você escolher a opção A ou B, marque um X no campo correspondente.
- Para a opção C, onde há imagem, escreva o nome do objeto em inglês. Em alguns casos, pode ser que exista mais de um nome possível. Por favor, forneça quantos nomes você souber. Se você não entender o que está na figura, solicite ajuda para o(a) aplicador(a) do teste. Onde há a palavra escrita em inglês, você pode fornecer uma tradução (ou quantas souber), em português, ou desenhar o que a palavra representa.
- Os números 1 e 2 estão feitos como exemplos.

		A. Eu nunca vi essa palavra antes:	B. Eu já vi essa palavra, mas estou em dúvida quanto ao seu significado.	C. Eu conheço essa palavra. Eu sei o seu significado. O significado é:
1.				*ice*
2.	ELBOW			 (ou você poderia escrever a tradução) *cotovelo*
3.				
4.				
5.				
6.				

7.				
8.				
9.				
10.				
11.	COTTON BALL			
12.	WIPER			
13.	PATIENT FILE			
14.	DRESSING			
15.	PAIN			
16.	WOUND			
17.	JOINT			

APPENDIX H – Vocabulary post-test

Código do participante: _____

Caro(a) participante,

- Escolha a opção que melhor indica seu conhecimento das palavras abaixo. Se você escolher a opção A ou B, marque um X no campo correspondente.
- Para as opções C e D, escreva o nome da palavra em inglês. Em alguns casos, pode ser que exista mais de um nome possível. Por favor, forneça quantos nomes você souber.
- Para os itens 5, 7, 8 e 9, forneça a tradução (ou traduções da palavra) em português, caso marque as alternativas C ou D.

		A. Eu não vi essa palavra.	B. Eu vi essa palavra, mas não me lembro.	C. Eu vi essa palavra, mas estou em dúvida. Eu acho que é...	D. Eu vi essa palavra. A palavra é...
1.					
2.					
3.					

4.					
5.	wound				
6.					
7.	cotton ball				
8.	tweezers				
9.	mask				

APPENDIX I - Qualitative questionnaire

Caro(a) participante,

Leia com atenção e responda as perguntas abaixo sobre o ambiente virtual de aprendizagem ao qual você foi exposto. Agradecemos a sua colaboração.

1 – O que você achou da experiência?

_____

_____

_____

2 – Você se sentiu imerso no ambiente virtual? Justifique sua resposta.

_____

_____

_____

3 – Qual dos itens abaixo mais contribuiu para o seu aprendizado de vocabulário durante a experiência virtual? Marque apenas uma opção.

( ) A narração da guia virtual.
( ) A forma como as palavras apareceram no ambiente.
( ) O tema escolhido.
( ) O fato te estar imerso no ambiente e poder manipular os objetos. (MARQUE ESTA OPÇÃO APENAS SE VOCÊ ESTEVE NO GRUPO DA REALIDADE VIRTUAL).

4 – Você experimentou algum desconforto físico ou psicológico durante a experiência virtual?

( ) Não.
( ) Sim. Qual ou quais?

_____

_____

APPENDIX J – Late vocabulary post-test

Qual foi o ambiente que você experimentou?
Desktop ( ) Virtual Reality ( )

Caro(a) participante,

- Escolha a opção que melhor indica seu conhecimento das palavras abaixo. Se você escolher a opção A ou B, marque um X no campo correspondente.
- Para as opções C e D, traduza a palavra para o português. Em alguns casos, pode ser que exista mais de um nome possível. Por favor, forneça quantos nomes você souber.

		A. Eu não vi essa palavra.	B. Eu vi essa palavra, mas não me lembro.	C. Eu vi essa palavra, mas estou em dúvida. Eu acho que é...	D. Eu vi essa palavra. A palavra é...
1.	wiper				
2.	glove				
3.	towel				
4.	dressing				
5.	wound				
6.	Kidney tray				
7.	cotton balls				
8.	tweezers				
9.	mask				

ANNEX A – Proficiency test

Solutions

Placement Test

Elementary to Intermediate

Lynda Edwards

OXFORD

Placement Test

Grammar and Vocabulary

Complete the sentences with the correct answers.

1 My sister _____ very tired today.
A be **B** am **C** is **D** are

2 His _____ is a famous actress.
A aunt **B** uncle **C** grandfather **D** son

3 I'd like to be a _____ and work in a hospital.
A lawyer **B** nurse **C** writer **D** pilot

4 We _____ like rap music.
A doesn't **B** isn't **C** aren't **D** don't

5 There _____ a lot of water on the floor. What happened?
A are **B** is **C** be **D** am

6 He _____ TV at the moment.
A watches **B** is watching **C** watched **D** has watching

7 Helen is very _____. She doesn't go out a lot.
A bored **B** confident **C** angry **D** shy

8 Did you _____ to the beach yesterday?
A went **B** were **C** go **D** goed

9 Have you got _____ orange juice? I'm thirsty.
A some **B** a **C** any **D** the

10 Let's go into _____ garden. It's sunny outside.
A a **B** any **C** – **D** the

11 He's _____ for the next train.
A looking **B** waiting **C** listening **D** paying

12 Mark _____ his car last week.
A cleaned **B** did clean **C** has cleaned **D** is cleaning

13 I bought some lovely red _____ today.
A cabbages **B** cucumbers **C** bananas **D** apples

14 Which bus _____ for when I saw you this morning?
A did you wait **B** had you waited **C** were you waiting **D** have you waited

15 Where _____ you like to go tonight?
A do **B** would **C** are **D** can

16 That's the _____ film I've ever seen!
A worse **B** worst **C** baddest **D** most bad

17 My dad _____ his car yet.
A hasn't sold **B** didn't sell **C** doesn't sell **D** wasn't sold

18 I've been a doctor _____ fifteen years.
A since **B** for **C** until **D** by

19 Look at the sky. It _____ rain.
A will **B** can **C** is going to **D** does

20 If I _____ this homework, the teacher will be angry!
A am not finishing **B** won't finish **C** don't finish **D** didn't finished

21 This book is even _____ than the last one!
A most boring **B** boringer **C** more boring **D** far boring

22 I'll meet you _____ I finish work.
A if **B** when **C** as **D** so

23 We're getting married _____ March.
A in **B** on **C** at **D** by

24 If you _____ steak for a long time, it goes hard.
A cook **B** are cooking **C** have cooked **D** cooked

25 I _____ you outside the cinema, OK?
A 'll see **B** am going to see **C** am seeing **D** see

26 I _____ not be home this evening. Phone me on my mobile.
A can **B** could **C** may **D** should

Placement Test

27 The criminal _____ outside the hotel last night.
A was caught B has been caught
C is caught D caught

28 He asked me if I _____ a lift home.
A wanted B want C was wanting
D had wanted

29 If I _____ older, I'd be able to vote in elections.
A had B am C were D have

30 You _____ go to the supermarket this afternoon. I've already been.
A mustn't B can't C needn't D won't

31 Kathy drives _____ than her sister.
A more carefully B more careful C carefully
D most carefully

32 The _____ near our village is beautiful.
A country B woods C view D countryside

33 I'm _____ I can't help you with that.
A apologise B afraid C regret D sad

34 It was really _____ this morning. I couldn't see anything on the roads.
A cloudy B sunny C icy D foggy

35 Can you look _____ my dog while I'm away?
A for B at C to D after

36 If I'd started the work earlier I _____ it by now.
A would finish B had finished C will finish
D would have finished

37 This time next year I _____ in Madrid.
A am working B will work C will be working
D work

38 I wish he _____ in front of our gate. It's very annoying.
A won't park B wouldn't park
C doesn't park D can't park

39 He said he'd seen her the _____ night.
A last B before C previous D earlier

40 I _____ agreed to go out. I haven't got any money!
A mustn't have B shouldn't have
C couldn't have D wouldn't have

41 It was good _____ about her recovery, wasn't it?
A information B words C news D reports

42 I _____ the report by 5.00 p.m. You can have it then.
A have finished B will have finished
C finish D am finishing

43 Because of the snow the teachers _____ all the students to go home early.
A said B made C told D demanded

44 Thanks for the meal! It was _____.
A delighted B delicious C disgusting
D distasteful

45 Look! Our head teacher _____ on TV right now!
A is being interviewed B is been interviewed
C is interviewing D is interviewed

46 It's _____ to drive a car over 115 km/h in the UK.
A unlegal B illegal C dislegal D legaless

47 There's a lot of rubbish in the garden I need to get _____ of.
A lost B rid C cleared D taken

48 I'm afraid it's time we _____.
A leave B must leave C are leaving D left

49 He wondered what _____.
A is the time? B the time was
C was the time D is the time?

50 They _____ our salaries by 5%.
A rose B made up C raised D lifted

Mark /50

Placement Test

Reading

Read the text.

Saucy dragons

Levi Roots, a reggae singer from Jamaica, has a big smile on his face these days. In case you missed it, Levi recently appeared on the famous reality show for people with business ideas, *Dragon's Den*. The participants have to persuade the team of business experts that their ideas are excellent and hope that two or more of the team will decide to invest money in their business idea.

Levi did just that!

The singer, who has been a successful music artist for several years, also sells something he calls 'Reggae, reggae sauce'. It is made using special secret ingredients from his grandmother and is a hot Jamaican sauce that is eaten with meat. Until now it has only been possible to buy the sauce from Levi's website or once a year at the famous Notting Hill carnival. But now, thanks to the TV programme, that is all going to change!

Levi presented his business idea to the team and started with a catchy reggae song about the sauce to make them sit up and listen. He certainly got their attention! He then described his plans for the sauce. This part of his presentation didn't go so well. He made mistakes with his figures, saying that he already had an order for the sauce of 2 and a half million when in fact he meant 2 and a half thousand! But, the team were still interested and amazingly, two of the team offered to give £50,000 to the plan in exchange for 40% of the company. Mr Roots was ecstatic!

Levi is even happier today. It seems that two of the biggest supermarket chains in the UK are interested in having the sauce on their shelves. In addition to this, Levi is recording the 'Reggae, reggae sauce' song and we will soon be able to buy or download this. 'It's all about putting

1 **Are the sentences true or false?**

1 At the moment Levi isn't very happy. ___
2 Levi sells something we can eat. ___
3 His song is a big success. ___
4 He sang his song on TV. ___
5 Some supermarkets want to sell his product. ___

2 **Choose the best answers.**

1 *Dragon's Den* is a show about
  A cooking.
  B new business ideas.
  C famous people.

2 To make the sauce
  A you have to go to Notting Hill.
  B you have to ask a member of Levi's family.
  C you need a good recipe book.

3 When Levi presented his idea
  A he finished with a song.
  B two and a half million people were watching.
  C he talked about the wrong figures.

4 Some people on the team
  A own supermarkets.
  B didn't like the taste.
  C bought part of Levi's company.

5 Today Levi
  A is a millionaire.
  B has two things he can profit from.
  C prefers music to food.

Mark ___ /10

Writing

Imagine you have just returned from a two-week holiday. Write an e-mail to your friend telling him/her about the holiday. Include information about the journey, where you stayed, what you did and the people you met.

Mark ___ /10

TOTAL ___ /70