IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received 24 January 2023, accepted 22 February 2023, date of publication 27 February 2023, date of current version 7 March 2023.

*Digital Object Identifier 10.1109/ACCESS.2023.3249578*

RESEARCH ARTICLE

# Teaching EFL With Immersive Virtual Reality Technologies: A Comparison With the Conventional Listening Method

**BRUNO PEIXOTO[1,2], LUCIANA CABRAL P. BESSA[3,4,5], GUILHERME GONÇALVES[1,2], MAXIMINO BESSA[1,2], AND MIGUEL MELO[2]**

[1]Department of Engineering, University of Trás-os-Montes and Alto Douro, 5001-801 Vila Real, Portugal
[2]Institute for Systems and Computer Engineering, Technology and Science, 4200-465 Porto, Portugal
[3]Polytechnic Institute of Porto, 4200-465 Porto, Portugal
[4]Centro de Investigação Transdisciplinar Cultura (CITCEM), Faculdade de Letras da Universidade do Porto, 4150-564 Porto, Portugal
[5]Department Letters, Arts and Communication, University of Trás-os-Montes and Alto, 5001-801 Vila Real, Portugal

Corresponding author: Bruno Peixoto (bruno.m.peixoto@inesctec.pt)

This work was supported by the National Funds through the Portuguese Funding Agency, Fundação para a Ciência e a Tecnologia (FCT), under Project LA/P/0063/2020.

This work involved human subjects or animals in its research. The author(s) confirm(s) that all human/animal subject research procedures and protocols are exempt from review board approval.

**ABSTRACT** This paper investigates the impact of different immersive Virtual Reality (iVR) technological approaches in teaching and learning English as a Foreign Language (EFL). Specifically, this paper explores the passive iVR and interactive iVR in a real authentic learning context as didactic possibilities compared to the conventional method of listening, consisting of audio-only listening exercises. The study was conducted using university students of B1 level EFL classes. The dependent variables considered in the study were Knowledge Retention, Presence, User Satisfaction, Cybersickness, and Preferred Technology. Results indicated that users showed significant satisfaction and preference for using this technology for learning, revealing enjoyment and motivation which are vital factors when learning a foreign language. However, no significant differences were found between learning via traditional listening exercises or the virtual system. Correlation tests were conducted between the questionnaire subscales to understand better which elements can influence learning. The study concludes that using iVR-based learning tools to learn a foreign language as an alternative to audio listening can only produce a broader positive impact and greater motivation. The results also suggest that iVR can be a valuable tool in the education field for knowledge transfer and motivation when learning foreign languages.

**INDEX TERMS** Immersive virtual reality, education, foreign language education, virtual environments.

## I. INTRODUCTION

Virtual Reality (VR) is not a recent technology, and there are multiple works dated before the XXI century exploring its potential theoretically and practically [1], [2], [3]. However, at first, the technology and its price were not yet accessible to the average consumer, as VR was reserved mainly for research. Technology has improved over the years, providing us with a ratio of quality and price never seen before [4]. The current state of VR equipment and authoring tools increased the potential of VR to be further widespread and researched. Slater et al. [5] introduced the "sense of Presence" as a way to describe the psychological feeling of "being there" inside the virtual environment. More recently, Slater refined the presence definition with two new concepts: Plausability Illusion (PsI) and Place Illusion (PI) [6]. PsI refers to the "illusion that what is apparently happening is really happening". At the same time, PI is reserved for the previous

The associate editor coordinating the review of this manuscript and approving it for publication was Xiaogang Jin.

notion of presence - ''being in a place of despite the sure knowledge that you are not there''. When both illusions are at play, users tend to behave as if the virtual experience is accurate, which is one of the most leveraged factors in VR research and facilitates proper knowledge transfer. The same author mentions that Presence should not be confused with Immersion. In contrast, the latter refers to the extent the VR system can isolate users from the real world and how well it can provide them with high-fidelity stimuli and allow interactions and behaviours similar to the ones possible in the real world [6]. VR could therefore be divided in immersive systems (e.g. HMD, CAVEs), semi-immersive (e.g. large stereo displays) and non-immersive (e.g. laptops, smartphones, desktop computers).

Research shows that VR can improve learning and happiness in education. However, as immersive VR (iVR) is new and expensive, most previous studies have used non-immersive VR [7]. Foreign language learning with iVR is a new topic that needs more research. Despite the potential of iVR to improve foreign language learning, it's not widely used due to the high cost. More research is needed to understand the potential of iVR for foreign language learning and ways to make it more affordable for schools.

In this study, we examine the impact and didactic possibilities of passive and interactive iVR technologies compared to traditional listening methods in the real-world context of university students learning EFL from B1-level classes. We also aim to understand the technological differences between the two iVR approaches. Additionally, we investigate possible correlations between the technological and sociodemographic variables. The findings of this study will generate knowledge that will help build better practices when developing applications for teaching as EFL, as well as identify research opportunities within this topic.

This article will continue with a review of the background and related work in section II. Section III will outline our research methodology, including the experimental design, sample, materials, variables, instruments, and procedures. We will present the statistical procedures in Section IV, followed by the results and analysis in Section V. The discussion of the results found in the previous section will be covered in section VI. Lastly, the article is concluded in section VII.

## II. RELATED WORK

VR is being adopted to train professionals in several fields, offering a similar reality and yet safe environment where they can train [8], [9], [10]. Furthermore, other fields such as e-commerce and tourism [11], [12], [13] are also being researched in VR due to its potential to offer users to experience any environment from any place, with reduced logistics, costs and time constraints. These advantages of VR also motivated research in education, teaching and learning. Multiple studies have already addressed the educational component [14], [15], [16], [17] by offering users new ways to, visualise, process information, interact with it, and feel more motivated to learn. Luo et al. [18] conducted a systematic review of the use of VR in K-12 and higher education and performed a meta-analysis of the data. They concluded that VR had a medium effect on learning. The authors discuss practical implications, stating that VR should be used depending on the subject being assessed. In education, VR is more commonly used to address abstract concepts, procedural knowledge, and authentic problem-solving, which is the case for general science fields such as chemistry, physics, astronomy, etc. It also shapes the user's effect and attitude, potentially addressing cultural teaching.

Users' immersion in the foreign language culture (a sub-field of education) is shown to facilitate language learning [19], [20]. Exposure to a target foreign language environment is an essential factor in the process of foreign language learning [21], and, for students to effectively learn a foreign language, they must be given opportunities to practise and engage with the language in authentic situations, through meaningful language training tasks. Because VR allows users to experience almost any environment as if they were there, it is being used to teach foreign languages with promising results [16], [22], [23].

In a review by X.-Y. Qiu et al [24], the authors analysed over 150 language learning articles that used VR (or AR) to support language learning. The authors found that there has been a rapid growth in the number of studies in this area in the last six years, largely due to advancements in VR/AR technology. However, they also found that the use of immersive VR was relatively limited, with only 11 out of the 150 articles using headsets. The paper predicts that while non-immersive VR will continue to dominate in language learning studies in the near future, the use of immersive VR, mainly through headsets, will become more widespread and in-depth. The emergence of headset VR has opened new opportunities for immersive device usage in language learning studies in the future.

Cheng et al. [25] adapted a Japanese learning video game to iVR. The game embeds Japanese culture by teaching users how to bow. The authors compared the iVR and non-immersive VR versions of the game. Although they could not find an impact on learning outcomes, the sense of cultural involvement was higher in the iVR version. However, participants reported dizziness in the iVR version, which could have affected learning results (the sickness symptoms when experiencing iVR is further described in this article). Lan et al. [26] studied how immersion in the culture, using Second Life game, could improve Mandarin essay writing by learners of Chinese as a second language when compared to a control group without culture immersion. Subjects that explored the culture displayed a higher writing quality as increased motivation.

However, in normal circumstances, embedding oneself inside the culture of the language being taught requires travelling to the native country of that language, which would imply high logistic and financial costs. VR could help users experience parts of the culture [18] and therefore improve their learning without geographical limitations. Furthermore, interactable virtual avatars have improved foreign language learning [25], [27]. Adding lip-sync and gestures to these avatars has also been shown to improve learning [17], [28], [29], making the experience more enjoyable. Conventionally, this would imply the presence and time of native speakers and teachers to interact with. However, using VR, the same could be done (in part) autonomously (avatars fully controlled by the computer) or by having avatars controlled by native speakers and teachers in a collaborative environment from anywhere, reducing travel and time constraints. Objects in language teaching are often used to enhance learning. Doing games of search and find as a learning technique [30], [31] while having a text and/or audio attached to the object to better comprehend its meaning in the foreign language [32], situates learning within the context and improves the sense of Presence. In turn, a high level of Presence helps users become more focused on the activities inside the virtual experience, enhancing learning and long-term retention [33]. Collaborative experiences can also reduce social distancing between students [5], [34], [35].

Within foreign language learning, the listening comprehension method is meant to enhance understanding and comprehension of the language. Little can be found in the literature about listening comprehension in VR, however, recent studies indicate that VR could be used to substitute audio-only listening exercises [36].

Pinto et al. [22] hypothesized that VR could be used as a tool to learn a foreign language and would outperform conventional methods in this matter. A comparative study between iVR and audio listening was performed for English learners as a foreign language. The VR counterpart offered a contextualized environment and avatars speaking to each other. They concluded that knowledge retention in both groups was similar, thus confirming their hypothesis that VR could be used as an alternative to audio listening. However, it also means that VR did not outperform the traditional method, although, Presence and user satisfaction were higher in the VR condition. The authors argued that the novelty factor (also known as the ''wow factor'') might have influenced the results, with users distracted and amazed by what immersion VR offers.

In a study by O'Brien and Levy [7], the impact of virtual reality learning environments on college students' German language acquisition was examined. 42 Canadian first-semester college students were involved in a lesson on using commands in German. They played a game in a virtual reality world where they were tasked with finding and helping a kidnapped man by following directions. As gathered from questionnaires and interviews, the results revealed that the students were highly engaged in the VR learning environment and felt a sense of presence in the game. Additionally, their listening and pronunciation skills improved significantly. Furthermore, the virtual world experience enhanced students' understanding and appreciation of the target culture in a way that traditional classroom settings and other media-supported methods could not.

Tai and Chen [37] analysed listening comprehension by comparing VR (mobile HMD powered by a smartphone) to a control group with non-immersive video and audio displayed on a computer screen. They concluded that the listening comprehension and retention were higher than the video and audio groups. Subjects also reported that VR listening was more appealing.

Although VR has been used several times before with positive outcomes in the education field, Luo et al. [18] admit that a significant part of these works is only partially immersive because they did not use more advanced equipment (such as HMDs). In addition, many of these VR studies do not contemplate proper learning assessments, data gathering and collaboration, hindering the progress of VR in this field.

Moreover, VR can still also pose some disadvantages. Kavanagh et al. [38] identified several VR issues (such as the need for training, high costs, low realism, usability, and perceived ineffectiveness) that could compromise the use of VR in education, and therefore, foreign language learning. Furthermore, concerns about health issues such as cybersickness and misconceptions of VR could further prevent the widespread of VR [39]. Cybersickness symptoms are motion sickness-like symptoms that VR users can experience. The most common justification is due to a conflict between the vestibular and visual systems, where one can see themselves moving in the VR but feel they are stopped. This can lead to nausea and disorientation [40], [41]. However, this is avoidable by programming an environment that does not involve users moving through it while being stopped in the real world. Performance factors such as low refresh rates and system lag could further cause cybersickness. Nowadays, technology has evolved so that many of the presented concerns can be solved or avoided, and further developments in VR should mitigate these issues even more. The recent COVID-19 outbreak pushed VR research into how it could provide an educational environment and help students and professors in one of the most affected areas by the pandemic [42]. This opened doors for VR to be tested and adopted as a medium for learning. We should notice that VR does not aim to fully substitute other learning methods (as of now). Instead., it is aimed to be included as a component to enhance learning [18].

Overall, the literature indicates that iVR demonstrates the potential to improve knowledge transfer and satisfaction in the education field. However, as iVR cost reduction and development are relatively recent, most previous studies in this area have utilized non-immersive VR. Foreign language learning as an area of VR is still a topic currently being researched and needs to be better supported by state of the art. Despite the potential of iVR to improve foreign language learning, its underutilization in the field can be attributed to the high cost of the technology [7]. This highlights the need for further research to fully understand the potential of iVR in this area and to investigate ways to make it more accessible and cost-effective for educational institutions.

In previous studies [17], different technological variables were tested to determine which variables would be most valuable and beneficial in creating authentic cultural environments for learning a foreign language, both for passive and interactive examinations. Users displayed a more pleasing experience when avatars had realistic body animations, lip-sync [17], and interactive iVR while having a text attached to virtual objects for a better comprehension of its meaning in the foreign language [32]. Therefore, in this work, we study the impact of different approaches to VR technologies (passive iVR and interactive iVR) when compared to the conventional method of listening, as well as understand the difference between these two approaches at a technological level in a real usage context by having as sample university students learning English as a foreign language from B1 level classes. Moreover, this case study also aims to understand the impact of different technologies and correlations on user satisfaction, sense of presence, cybersickness, and personal preference concerning which technologies they would like to use in their future learning. The results will improve the body of knowledge in this field and promote future work.

## III. METHODOLOGY

### A. EXPERIMENTAL DESIGN

The impact of iVR on Listening exercises was studied via two learning activities compared in a between-subjects design: traditional listening exercise and iVR. Furthermore, two different conditions of iVR were evaluated: passive iVR and interactive iVR.

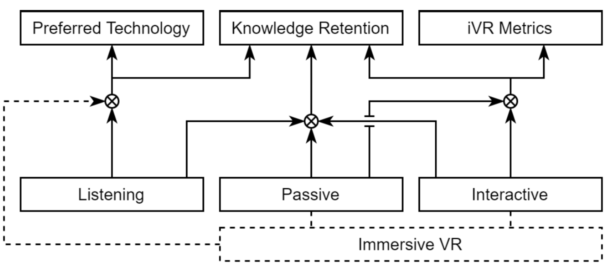


**FIGURE 1. Conceptual framework for the experience.**

A conceptual framework (Fig. 1) was created to visually depict the experimental design [43] and the variables being studied in this research. The independent variable, mode of learning, is depicted as Listening (conventional method) and Immersive VR. Within iVR, we further divided it into Passive and Interactive conditions. The chart illustrates the relationship between the variables, including Knowledge Retention, iVR Metrics (Presence, User Satisfaction, and Cybersickness), and Preferred Technology. The conceptual framework serves as a visual representation of the research and the connections between the different variables.

For this paper, we propose the following hypothesis:

- **(H1)** iVR-based learning tools are more effective regarding the students' learning outcomes when compared to the traditional methods, specifically listening exercises for EFL;
- **(H2)** Interactive iVR-based learning tools are more effective regarding the students' learning outcomes, when compared to Passive iVR-based learning tools;
- **(H3)** Students prefer iVR exercises when learning EFL than traditional exercises, more specifically listening exercises;
- **(H4)** Interactive iVR-based learning tools provide a higher sense of presence than Passive iVR-based learning tools;
- **(H5)** Interactive iVR-based learning tools deliver users greater satisfaction than Passive iVR-based learning tools;
- **(H6)** Interactive iVR-based learning tools elicit less cybersickness to users than Passive iVR-based learning tools;
- **(H7)** iVR-based learning tools increase motivation, and positive perceptions towards using VR.

Additionally, to increase the understanding of the results having into account the hypotheses proposed, a correlational analysis is made to understand the relationships between all the variables and identify their importance and influence in learning with iVR.

### B. SAMPLE

The sample consists of 27 male participants aged between 18 and 26 ($M = 20.1, SD = 2.074$), divided by the 2 conditions. The participants were students of the Higher Professional Technical Course in Development for web and mobile devices from the School of Management and Technology, Polytechnic Institute of Porto. They attended B1 English level (intermediate) classes. Seeing as the sample of the passive iVR condition overlapped with the sample of the interactive iVR condition, the ordering of the experiment was randomised. Informed consent was obtained from all individual participants included in the study. All participants reported normal or corrected-to-normal vision.

### C. MATERIALS

To support the study, two dialogue scripts similar to the ones commonly used in the English listening exercises were created by English teachers, who were also responsible for the character's voice for the audio used in both the listening exercise and the virtual environment. For the passive iVR condition, a VE representing a meeting in an office was developed using the Unity game engine, Fig. 2. For the interactive iVR condition, to investigate the effects of user interaction with specific objects, a VE consisting of a mall shop was developed. Both these scenarios were filled with contextual objects to illustrate them and avatars to meet the dialogue script.

**FIGURE 2.** Passive iVR experiment.

The user would be placed in the scene surrounded by the avatars as if they were part of the plot. The movement of the characters was produced with motion capture animation to ensure a realistic simulation, using an OptiTrack tracking system with 8 Prime 13 cameras. In the passive iVR experiment the user was placed sit at the table surrounded by the avatars. In the interactive iVR experiment on pre-defined segments of the dialogue, the user could teleport to pre-defined areas, e.g. Fig. 3, and interact with dialogue-related objects with text attached to them for a better comprehension of their meaning in the foreign language [32], to advance in the dialogue. Regarding the listening exercise section of the experiment, an audio file is played for the students and then gives them a multiple-choice test to complete. The students listen carefully to the audio file and then select the correct answer for each question on the test. The test is used to assess the students' comprehension of the audio file and determine if they have understood the information presented. The audio stimulus was provided by noise-cancelling headphones (Bose QuietComfort QC-35 II) connected to a laptop. The standalone HMD Oculus Quest 2 was used for the iVR experiment. This HMD features 6DoF, a resolution of 1832×1920px per eye and a refresh rate of 90 Hz. The audio stimulus was provided by the noise-cancelling headphones and connected to the HMD. The HMD's built-in speakers were not used due to the lack of noise cancellation and possible distractions. The controllers of this HMD system were used for interaction with the VE.

### D. VARIABLES

The independent variable is the learning mode: audio only (representative of the conventional learning mode) and iVR. The dependent variables are Knowledge Retention, Presence, User Satisfaction, Cybersickness and Preferred Technology. All of these were measured by multiple-choice post-test questionnaires.

### E. INSTRUMENTS

The adopted questionnaires were the following:

1) a sociodemographic questionnaire to describe the sample;


**FIGURE 3.** Screenshot of a user interacting with dialogue-related objects with text attached.

2) a 14 item 5-point Likert scale questionnaire based on the Portuguese version of the Igroup Presence Questionnaire [44] (IPQp) to assess Spatial Presence, Involvement, Experienced Realism and Presence;
3) a 6 item 7-point Likert scale custom questionnaire based on the After Scenario Questionnaire (ASQ) [45] to assess the user satisfaction, where lower scores are more favourable, plus adding two custom questions for the Overall Satisfaction.
4) a 16-item questionnaire based on Simulator Sickness Questionnaire [46] (SSQ) to assess Nausea, Oculomotor Discomfort, Disorientation and Cybersickness.

The questionnaires were presented in printed format in the participant's first language, Portuguese. Regarding knowledge retention assessment of the listening scenario and the interactive iVR scenario, a ten questions test (four multiple choices) was created for each scenario by an English teacher, based on the scenarios, designed to assess the student's knowledge retention after the experience. The test has a total value of 100%, where each answer has a value of 10%.

### F. PROCEDURE

All the equipment is disinfected before the experience, namely from the VR equipment to the pen the participants use to fill in the questionnaires. Participants were tested individually in a room with a controlled environment. A sociodemographic questionnaire was given before the start of the experience. The user would start the experiment with the listening exercise, and once the audio ended, the user would fill out the ten questions test based on the said scenario. The participant was then directed to the centre of the room to sit on a chair (passive iVR) or standing (interactive iVR), where a brief explanation of how to work with the Oculus Quest 2 controllers was given. The experiment was preceded by a tutorial scene, Fig. 4, without avatars. This scene aimed to allow the subjects, unfamiliar with virtual environments, to become accustomed to manoeuvring the HMD and learn how to use the controllers to teleport and interact. At the end of the assessment, the participant was assisted with removing the equipment and receiving instructions regarding completing the knowledge test based on the referred scenario and the dependent variables questionnaires. The whole exercise takes around 25 minutes.


**FIGURE 4.** Tutorial environment.

## IV. STATISTICAL PROCEDURES

Regarding learning with audio and learning with iVR, the data were not normally distributed and as such, the Mann-Whitney U test was used for unpaired data, and the Wilcoxon signed-rank test was used for paired data [47]. To verify the preferred technology for learning, a paired-samples T-test was executed. At last, Spearman's correlational analysis was used to understand the relationships between variables to identify their importance and influence in learning with iVR. The effect was calculated following the criterion using Cohen's [48] definitions of small ($.10 < r < .30$), medium ($.30 < r < .50$), and large effects ($r > .50$).

## V. RESULTS

For ease of reference, the results section was divided into three subsections. The first focuses on the impact of the iVR technologies compared to the conventional method of listening. For both the Knowledge test and User Preference, we analyse global results in Listening and iVR, delving into the different approaches separately (passive iVR and interactive iVR). The second subsection shows the impact of the different iVR technologies (passive iVR and interactive iVR) on the Knowledge Test, User Satisfaction, Sense of Presence and Cybersickness. Conclusively, correlations were computed to evaluate the relationship between all the variables.

### A. CONVENTIONAL LISTENING COMPARED TO PASSIVE IVR AND INTERACTIVE IVR

Regarding the Knowledge test results, for the Conventional listening vs Passive iVR a Mann-Whitney U test showed that there was no significant difference ($U = 80, p = 0.601$) between learning via the traditional listening or via the virtual environment.

Concerning Knowledge test results for Conventional listening vs Interactive iVR, a Mann-Whitney U test showed that there was also no significant difference ($U = 85, p = 1.000$) between learning via traditional listening or via the virtual environment.

The Knowledge test results for Global Listening versus Global iVR, a Wilcoxon signed-rank test showed that overall, learning with virtual reality did not change in a statistically significant manner the scores when compared with the overall traditional listening exercises ($Z = -0.935$, $p = 0.525$).

Regarding results from Users' Preference to use Conventional listening or iVR, one outlier was detected that was more than 1.5 box lengths from the edge of the box in a boxplot. Inspection of their values did not reveal them to be extreme and they were kept in the analysis. The difference scores for the global iVR learning preference and listening learning preference trial were normally distributed, as assessed by Shapiro-Wilk's test ($p = .072$). A paired-samples T-test was executed to verify the preferred technology for learning. The participants expressed a preference for learning using iVR ($M = 33{,}444$ $SD = 10.732$) when compared to traditional listening exercises ($M = 7.519$, $SD = 7{,}557$). Using iVR elicited a statistically significant mean increase of 25.926, 95% CI [18.901, 32.951] in the preference for learning when compared to traditional listening exercises, $t(26) = 7.586, p < .001$.

Analyzing in more detail, the participants expressed a preference for learning using Passive iVR ($M = 27.846$ $SD = 10.431$) when compared to traditional listening exercises ($M = 11.154$, $SD = 8.581$). Using Passive iVR elicited a statistically significant mean increase of 16.862, 95% CI [5.645, 27.740] in preference for learning when compared to traditional listening exercises, $t(13) = 10.276$, $p = .006$.

Concerning interactive iVR, the participants also expressed a preference for learning using Interactive iVR ($M = 38.643$ $SD = 8.335$) when compared to traditional listening exercises ($M = 4.143$, $SD = 4.555$). Using Interactive iVR elicited a statistically significant mean increase of 34.500, 95% CI [27.247, 41.753] in preference for learning when compared to traditional listening exercises, $t(14) = 10.276, p < .001$.

### B. PASSIVE iVR VS INTERACTIVE iVR

#### 1) KNOWLEDGE TEST

A Mann-Whitney U test was run to determine if there were differences in the Knowledge Test scores between iVR conditions. Median Knowledge Test score was statistically significantly different between passive iVR ($Mdn = 4$) and interactive iVR ($Mdn = 8$), $U = 21.5, z = -3.258$, $p = .001$.

### 2) PRESENCE

Scores from the IPQp questionnaire were analysed. The results, using the non-parametric method Mann-Whitney U, showed no statistically significant differences, ($U = 87$, $z = -.194$, $p = 0.846$). The same situation occurs in the subscales of the Spatial Presence ($U = 88$, $z = -.146$, $p = .884$), the Involvement ($U = 61.5$, $z = -1.440$, $p = 0.150$). However, the Experienced Realism subscale score was statistically significantly different between passive iVR ($Mdn = 2.75$) and interactive iVR ($Mdn = 2.00$), $U = 48.5$, $z = -2.070$, $p = .038$. Descriptive statistics can be found in Table 1.

**TABLE 1. Descriptive statistics for presence and user satisfaction.**

| | Mean | SD | Min | Max |
|---|---|---|---|---|
| IPQ: S. Presence | 3.803 | 0.813 | 2.000 | 5.000 |
| IPQ: Involvement | 2.796 | 0.744 | 1.750 | 4.500 |
| IPQ: E. Realism | 2.426 | 1.021 | 1.000 | 4.500 |
| IPQ: Presence | 3.008 | 0.607 | 1.806 | 4.278 |
| ASQ | 2.111 | 1.102 | 1.000 | 4.667 |
| Overall Satisfaction | 6.179 | 0.835 | 4.167 | 7.000 |

### 3) USER SATISFACTION

A Mann-Whitney U test was run to determine if there were differences in the User Satisfaction scores between iVR conditions. Median User Satisfaction score was not statistically significantly different between passive iVR and interactive iVR, neither in the ASQ subscale U = 71, z = −.988, p = .323, nor in the Overall Satisfaction subscale U = 77.5, z = −.662, p = .508. Descriptive statistics can be found in Table 1.

### 4) CYBERSICKNESS

Scores from the SSQ questionnaire were analysed for both global cybersickness values, as well as individually for the subscales. There are no statistically significant differences in global cybersickness ($U = 113$, $z = 2.254$, $p = 0.017$). The same situation occurring in the subscales Nausea $U = 89.5, z = -.101, p = .920$, Oculomotor Discomfort $U = 81, z = -.583, p = .560$, and Disorientation $U = 85.5, z = -.308, p = .758$. Descriptive statistics can be found in Table 2.

**TABLE 2. Descriptive statistics for cybersickness.**

| | Mode | Median | Mean | SD | Min | Max |
|---|---|---|---|---|---|---|
| Nausea | 0.000 | 0.000 | 2.120 | 4.042 | 0.000 | 9.540 |
| Oculomotor Discomfort | 0.000 | 0.000 | 5.615 | 8.818 | 0.000 | 30.320 |
| Disorientation | 0.000 | 0.000 | 7.733 | 12.997 | 0.000 | 41.760 |
| Cybersickness | 0.000 | 0.000 | 5.679 | 8.451 | 0.000 | 26.180 |

## C. CORRELATIONS

Spearman's correlations were computed to assess the relationship between all the variables. There were various correlations between User Satisfaction and Presence, specifically, positive correlations between subscale Overall Satisfaction (higher scores are more favourable) and Presence, and negative correlations between subscale ASQ (lower scores are more favourable) and Presence. This is, Overall Satisfaction and Spatial Presence ($rs(27)$=,755, $p$ =< 0, 001), ASQ and Spatial Presence ($rs(27)$ = -,662, $p$ =< 0, 001), Overall Satisfaction and Experienced Realism ($rs(27)$=,572, $p = 0, 002$), ASQ and Experienced Realism ($rs(27)$ = -,562, $p = 0, 002$), ASQ and Presence ($rs(27)$=,682, $p$ =< 0, 001), ASQ and Presence ($rs(27)$ = -,581, $p = 0, 001$).

A correlation between the Score in the iVR test was found with both Involvement ($rs(27)$=,434, $p = 0, 027$) and the Score of the Listening Test ($rs(27)$ = -,451, $p = 0, 021$).

There were various positive correlations between Listening Preference and the Cybersickness subscales, this is, with Nausea $rs(27)$=,444, $p = 0, 020$, Disorientation $rs(27)$=,390, $p = 0, 045$, and Cybersickness $rs(27)$=,399, $p = 0, 040$. It was also found negative correlations between Listening Preference and Spatial Presence ($rs(27)$ = -,526, $p = 0, 005$), and ASQ Global ($rs(27)$ = -,420, $p = 0, 029$).

Regarding iVR Preference, positive correlations were found with Presence ($rs(27)$=,387, $p = 0, 046$) and its subscale Spatial Presence ($rs(27)$=,586, $p = 0, 001$). There was also found positive correlations between iVR Preference and the Score of the Listening Test ($rs(27)$=,397, $p = 0, 045$), and ASQ Global ($rs(27)$=,391, $p = 0, 044$).

Correlations regarding data from the sociodemographic questionnaire and the other variables were found. A negative correlation between Age and Experienced Realism was found, $rs(27)$ = -,454, $p = 0, 017$. Correlations were found between Visual impairment and Disorientation ($rs(27)$ = -,396, $p = 0, 041$) as well as Computer Usage ($rs(27)$=,3967, $p = 0, 040$). There were various other negative correlations between Computer Usage and Cybersickness, this is, Oculomotor Discomfort ($rs(27)$ = -,421, $p = 0, 029$), Disorientation ($rs(27)$ = -,389, $p = 0, 045$), and Cybersickness ($rs(27)$ = -,385, $p = 0, 047$). A negative correlation was also found between said Computer Usage and User Satisfaction (ASQ), where lower scores are more favourable ($rs(27)$ = -,651, $p = 0, 042$).

For better readability, the main results of the correlations are found in Table 3, where subscales without a significant correction between them were also removed from the table. Values marked with *: Correlation is significant at the 0.05 level (2-tailed); Values marked with **: Correlation is significant at the 0.01 level (2-tailed). For both said significant levels, the values were highlighted according to Cohen [48], small effects highlighted in grey, medium effects highlighted in pink, and large effects highlighted in orange.

# VI. DISCUSSION

After reviewing the questionnaires answered by the participants, some interesting results were collected. In all the conditions, there was no significant difference between learning via traditional listening or iVR, rejecting H1. It was most students' first experiment with iVR, causing the novelty factor, which can lead to some natural distractions. We theorise that

**TABLE 3. Correlations between all variables: significant at the 0.01 level (**), significant at the 0.05 level (*), large effect (orange), medium effect (pink).**

| | Global Satisfaction | | ASQ | | Test Score: iVR | | Age | | Visual Imp. | | Freq. PC | | Satisfaction iVR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $rs$ | $p$ | $rs$ | $p$ | $rs$ | $p$ | $rs$ | $p$ | $rs$ | $p$ | $rs$ | $p$ | $rs$ | $p$ |
| IPQ: S. Presence | ,755** | <0.001 | -,662** | <0.001 | 0.209 | 0.306 | -0.098 | 0.627 | -0.118 | 0.559 | -0.023 | 0.908 | 0.610 | 0.061 |
| IPQ: Involvement | 0.069 | 0.732 | 0.026 | 0.898 | ,434* | 0.027 | -0.052 | 0.797 | -0.283 | 0.152 | -0.294 | 0.137 | 0.217 | 0.547 |
| IPQ: E. Realism | ,572** | 0.002 | -,562** | 0.002 | -0.133 | 0.516 | -,454* | 0.017 | 0.033 | 0.869 | -0.131 | 0.516 | 0.358 | 0.310 |
| IPQ: Presence | ,682** | < 0.001 | -,581** | 0.001 | 0.303 | 0.133 | -0.355 | 0.069 | -0.253 | 0.203 | -0.189 | 0.344 | 0.355 | 0.314 |
| SSQ: O. Discomfort | -0.165 | 0.411 | 0.075 | 0.710 | -0.065 | 0.754 | -0.106 | 0.600 | -0.380 | 0.050 | -,421* | 0.029 | 0.406 | 0.245 |
| SSQ: Disorientation | -0.193 | 0.334 | 0.138 | 0.492 | -0.117 | 0.571 | -0.161 | 0.422 | -,396* | 0.041 | -,389* | 0.045 | 0.132 | 0.717 |
| SSQ: Cybersickness | -0.230 | 0.248 | 0.155 | 0.441 | -0.028 | 0.894 | -0.113 | 0.573 | -0.357 | 0.068 | -,385* | 0.047 | 0.175 | 0.629 |
| Test Score: Listening | - | - | - | - | -,451* | 0.021 | -0.162 | 0.421 | -0.104 | 0.607 | -0.106 | 0.599 | 0.289 | 0.419 |
| Visual Imp. | - | - | - | - | - | - | - | - | - | - | ,397* | 0.040 | -0.167 | 0.645 |
| Freq. PC | - | - | - | - | - | - | - | - | - | - | - | - | -,651* | 0.042 |

this explains the lack of significant differences between the learning methods. While some participants were relishing the environment itself, they ignored the dialogue. Simultaneously, there was no negative significance either. This may suggest that the advantages of iVR for learning compensated for the distractions, indicating it is possible to use iVR-based learning tools to learn a foreign language. Concerning the knowledge test scores, results on interactive iVR were statistically higher than those on passive iVR, confirming H2. Although the teachers created the dialogue to maintain the same level of difficulty between scenarios and not be a variable that could influence these scores, future studies should evaluate this experiment using the same scenario for both interactive and passive to confirm the results of this paper.

Regarding presence, outcomes show that the passive iVR experience introduces significantly more experienced realism to users than the interactive iVR experience, rejecting H4. Since experienced realism shows the subjective experience of realism in virtual reality [49], we speculate that these adverse results happen because in the experiment with interaction, the user, besides interacting, was also asked to teleport, something that users can consider being unrealistic.

The research team was hopeful that the technological implementations in this study, such as high refresh rate and fps and realistic environments, avatars and animations, would mitigate possible cybersickness issues. This was verified with the outcomes (Table 2), as most cybersickness values were non-existent. This was mitigated for both iVR conditions as there were no statistically significant differences in cybersickness, rejecting H6.

When users were asked about their preference for using traditional listening exercises or iVR for learning, not only did the vast majority select iVR (92.5%) but there was a statistically significant difference between them, confirming H3. This preference for iVR, with the excellent user satisfaction revealed by the outcomes (confirming H5), shows the students' high enjoyment and motivation, confirming H7. This is crucial when learning a second language, and we should detour from anything that negatively disturbs motivation [50].

Spearman's correlation test was performed between the questionnaire subscales to understand better which elements can influence learning. However, it should be noted that the correlations found may not be due to linear relationships. Presence and user satisfaction were correlated in various subscales, corroborating the literature [11] and indicating a connection between these two metrics. We speculate this happens as presence also seems to be linked to the state of flow [51], this is, an activity so enjoyable that users become so deeply focused on what they are doing that they lose awareness of time and their surroundings. One would presume that such enjoyment could compel higher user satisfaction. However, the correlation between these variables does not imply causation. Without further studies, we cannot be sure whether presence improved user satisfaction scores or not.

Some interesting results were collected concerning correlations between the scores of the listening test and the iVR test. The research team was anticipating a positive correlation, as we suspected better students would have better scores on both tests and worse students would have worse scores on both tests. However, the correlation between the scores was negative, indicating that students with worse outcomes in the listening exercise had better iVR outcomes or vice versa. The research team assume that because an iVR learning system can enhance learners' motivation [15], [52], and motivation is a crucial factor when learning a foreign language [50], iVR allows learners to acquire knowledge better. In addition, the iVR test scores were positively correlated with involvement. This was expected as, although the correlation between these variables does not imply causation, a high presence level helps users become more attentive inside the virtual experience, enhancing learning [33]. This may also translate to iVR Preference, as users with a higher preference for using iVR for learning exercises also had higher presence scores.

Although most of students encountered no cybersickness, the users who did experience it ended up giving a better preference score to listening as a learning tool compared to other students. Although the research team cannot say the positive correlations between listening preference and cybersickness do not imply causation, we assume the students that experienced cybersickness had an adverse experience with iVR compared to the others, continuing then with greater regard for the traditional exercises. This logic may translate to presence and satisfaction as users with worse scores in said variables were again leaning towards a higher listening preference when compared to other users.

Overall, our study provides evidence that iVR-based learning tools can be useful for teaching EFL and that they can be incorporated into classrooms without negatively impacting learning outcomes.

## VII. CONCLUSION AND FUTURE WORK

With this study, we compared both passive iVR and interactive iVR, as experienced by university students learning English as a foreign language from B1 level classes and comparing it with their traditional audio-only listening exercises. This case study also aimed to study possible correlations and effects on user satisfaction, sense of presence, cybersickness, and the students' preference concerning which technologies they would like to use in the future of learning. In our previous studies, we did a pilot study that also compared traditional listening exercises with iVR [17]. In the referred study, different technological variables were tested to determine which variables would be most valuable and beneficial in creating authentic cultural environments for learning a foreign language, both for passive and interactive examinations. Users displayed a more pleasing experience when avatars had realistic body animations and lip-sync [17] and interactive iVR while having a text attached to virtual objects for a better comprehension of its meaning in the foreign language [32]. Although the outcomes revealed no significant difference between learning via traditional listening exercises or the virtual system, users showed significant satisfaction and preference when it comes to using this type of technology for learning, revealing enjoyment and motivation, critical factors when learning a foreign language. Thus, confirming that it is possible to use iVR-based learning tools to learn a foreign language as an alternative to the more traditional listening exercises only based on audio. However, we should notice that the aim of iVR is not to replace other learning methods fully but rather to be included as a complementary didactic tool to enhance learning.

Future work intends to expand on the current iVR-based learning tool by incorporating more activities and testing the same group of students over time to eliminate the potential impact of the ''wow factor'' on the results. This approach will provide a better understanding of the effectiveness of iVR in assisting with foreign language learning, free from limitations such as the novelty of the technology and potentially improve knowledge scores.

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**BRUNO PEIXOTO** received the B.S. degree in communication and multimedia and the M.Sc. degree in multimedia from the University of Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal, where he is currently pursuing the Ph.D. degree in informatics. Since 2019, he has been a Research Fellow with the Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), Porto, Portugal. His research interest includes virtual reality for education.

**LUCIANA CABRAL P. BESSA** received the master's degree in primary English teaching and the Ph.D. degree in didactics of languages. She is a Teacher of English for more than ten years. She is currently a Teacher of English with the Polytechnic Institute of Porto. She is a Research Member of the Transdisciplinary Research Centre: Culture, Space, Memory (CITCEM/FLUP). She is an author/coauthor of several scientific articles that focus on the very didactic tools for learning English as a second or foreign language. Her research interests include immersive contexts and virtual reality in learning and teaching languages, more precisely, English as a second/foreign language.

**GUILHERME GONÇALVES** received the M.Sc. degree in multimedia from the University of Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal, where he is currently pursuing the Ph.D. degree in informatics. Since 2018, he has been a Research Fellow with the Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), Porto, Portugal. His research interest includes multisensory virtual reality.

**MAXIMINO BESSA** received the Habilitation degree. He is an Assistant Professor with the Department of Engineering, University of Trás-os-Montes e Alto Douro, Portugal. He has been a Senior Researcher with the Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), since 2009, and the Director of the Multisensory Virtual Reality Laboratory MASSIVE. He has been a member of the Eurographics Association, since 2003, and the Vice-President of the Portuguese Computer Graphics Chapter, from 2016 to 2018.

**MIGUEL MELO** is an Assistant Researcher with the Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), specializing in computer graphics. He is the Manager of the MASSIVE Virtual Reality Laboratory and a member of the Eurographics Executive Committee. His research interests include computer graphics, HDR, and multisensory virtual reality.