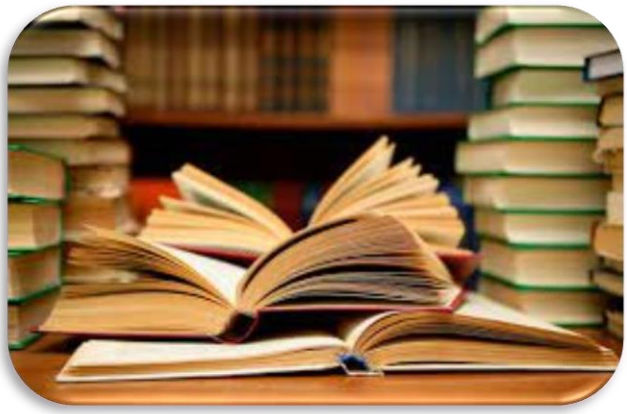
Journal of New Trends in English Language Learning (JNTELL)

Research Paper



Virtual Reality (VR) Assistive Technology Among EFL Learners With Expressive Language Disorder (ELD): Effectiveness, Feasibility, and Risks

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Received: 16 May, 2023 **Accepted: 30 August, 2023**

ABSTRACT

Based on Assistive Technology Theory (AST), this qualitative study investigated Virtual Reality (VR) as an assistive technology among EFL learners with Expressive Language Disorder (ELD) with regard to its effectiveness, feasibility, and risks. 18 Iranian pre-intermediate EFL learners with mild to moderate ELD were selected and exposed to a fully-immersive VR learning environment using Virtual-Reality Head-Mounted Displays (VR-HMDs) for 20 seventy-minute sessions. The VR-authored learning nuggets focused on speaking skills. Max Weber Qualitative Data Analysis (MAXQDA) was used to thematically analyze the data. The findings revealed the components of VR assistive technology with respect to (A) effectiveness (ICT literacy, preconceptions, technophobia or technostress, motivation, and quality of VR equipment); (B) feasibility (academic infrastructure, equipment price, customization features, types of content or context, and training); and (C) risks (various VR-induced physical and mental symptoms). TEFL, assistive and educational technology, and therapeutic education may benefit from the findings.

Keywords: EFL learners, Expressive Language Disorder, Virtual Reality

بر اساس نظریه فناوری کمکی(AST) ، این مطالعه کیفی واقعیت مجازی (VR) را به عنوان یک فناوری کمکی در بین زبان آموزان زبان انگلیسی مبتلا به اختلال زبان بیانی (ELD)با توجه به اثربخشی، امکان‌سنجی و خطرات آن بررسی کرد. ۱۸ زبان آموز انگلیسی زبان پیش از متوسط ایرانی با ELD خفیف تا متوسط انتخاب شدند و به مدت ۲۰ جلسه هفتاد دقیقه ای با استفاده از نمایشگرهای واقعیت مجازی Head-Mounted Displays (VR-HMDs) در محیط یادگیری واقعیت مجازی کاملاً فراگیر قرار گرفتند. قطعات یادگیری که توسط VR تالیف شده است بر مهارت های گفتاری متمرکز شده اند. برای تحلیل موضوعی داده ها از تحلیل داده های کیفی ماکس وبر (MAXQDA) استفاده شد. یافته‌ها مؤلفه‌های فناوری کمکی VR را با توجه به (الف) اثربخشی) سواد فناوری اطلاعات و ارتباطات، پیش‌فرض‌ها، فن‌هراسی یا استرس فنی، انگیزه و کیفیت تجهیزات (VR) نشان داد. (ب) امکان سنجی (زیرساخت های آکادمیک، قیمت تجهیزات، ویژگی های سفارشی سازی، انواع محتوا یا زمینه، و آموزش). و (C) خطرات) علائم فیزیکی و ذهنی مختلف ناشی ازTEFL .(VR) ، فناوری کمکی و آموزشی، و آموزش درمانی ممکن است از این یافته ها سود ببرند.

کلمات کلیدی: زبان آموزان زبان انگلیسی، اختلال زبان بیانی، واقعیت مجازی

INTRODUCTION

Since the COVID-19 pandemic, Assistive Technology (AT) has gained considerable attention due to the fact that activity limitations have led to the delivery of specific content, such as instructional or therapeutic material, to specific individuals, such as those with Learning Disorders (LDs), via various telerehabilitation platforms, which are merely one of the numerous assistive solutions. The experiences of the pre-and post-pandemic eras have resulted in a focus on therapeutic education as a practicable strategy to achieve academic and therapeutic goals for individuals with a wide spectrum of learning disabilities (Rinaldi & Mays, 2022). Virtual Reality (VR) platforms as nascent assistive solutions, particularly those with high immersion levels, have been shown to be beneficial for individuals with various types of LDs (Ravneberg & Soderstrom, 2017). Immersion levels in virtual reality platforms or VR authoring refer to the characteristics of the simulated environment and the number of sensory channels utilized by the user. Non-immersive, semi-immersive, and fully-immersive virtual reality platforms are available (Mihelj et al., 2014).

Non-immersive virtual reality refers to the creation of a computer-generated or 2D environment in which users cannot interact directly with the environment, such as video games. Fully immersive VR, on the other hand, is a virtual environment in which users can directly interact with a 3D-simulated environment and investigate it using Virtual-Reality Head-Mounted-Displays (VR-HMDs) and a pair of joysticks. In semi-immersive VR, there is a simulation of the actual world. However, the users do not interact directly with the environment, and their ability to move is restricted, as in VR simulations used primarily for training. According to the Cognitive Theory of Multimedia Learning (CTML), employing multiple sensory channels during learning increases the effectiveness of instruction and the achievement of intended educational objectives. This is because the additional cognitive burden is distributed across multiple sensory channels, thereby reducing the cognitive load on the brain's learning resources (Ashman, 2021). Therefore, it can be concluded that the use of completely immersive VR technology benefits individuals with LDs by reducing the adverse effects caused by their specific conditions.

There are various forms of language disorders, ranging from the simple, such as moderate stuttering, to the complex, such as dysarthria. Expressive Language Disorder (ELD) is one of the most common language disorders, characterized by the need for external assistance in verbalizing thoughts and intentions, as well as difficulties in daily communication regarding the use of complex linguistic structures, speech accuracy, and oral fluency (Brosseau-Lapré & Rvachew, 2018). Individuals with ELD have no defects in their articulation mechanism, whereas those with Receptive Language Disorder (RLD), another common speech disorder, who have difficulty understanding language, may have articulation deficiencies (Vess, 2021). According to Peeters (2019), a review of the associated papers published since 2015 revealed that virtual reality (VR) is a "game-changing method" in language learning, as it demonstrated significant improvements in learning English, especially in speaking and articulation skills. While VR technology has many benefits for individuals with various LDs, there are disadvantages in the form of various physical and mental disorders that VR users experience.

As a form of assistive technology, virtual reality has a variety of advantages, such as providing an authentic and engaging learning experience, such as simulated training courses, empowering users through remote learning and therapy, providing a user-oriented and communicative learning experience, and easing the process of researching complex subjects that require in-depth, realistic analysis. On the

other hand, there are disadvantages, such as a lack of adaptability, the high cost of fully immersive editions in certain situations, and the occurrence of various side effects, including postural instability, eye strain, general discomfort, headache, nausea, pallor, drowsiness, apathy, disorientation, stomach awareness, sweating, and vomiting. As the number of symptoms experienced by VR users varies from person to person, it was determined that various factors, including age, gender, ethnicity, previous experience, and motion sickness sensitivity, influence the intensity of VR-induced symptoms (Checa & Bustillo, 2020). Diverse solutions were proposed to reduce the number of disadvantages encountered by VR users, particularly in educational contexts where the function of VR technology varies from that of a motivating instructional tool to that of significant assistive assistance for individuals with a variety of learning disabilities (LDs).

This study is significantly different from the associated ones because of several reasons, such as (A) being interdisciplinary regarding connecting TEFL, educational technology, and assistive technology, (B) selecting a comprehensive qualitative design to meticulously examine the factors influencing effectiveness, feasibility, and risks of VR technology, (C) selecting participants from English learners suffering from ELD as one of the overlooked EFL communities, (D) utilizing fully-immersive VR authoring based on the micro-learning strategy to engage participants different sensory channels during the intervention phase and avoid creating an undesired experience for them as much as possible, (E) using available VR devices which are user-friendly and purchasable even in less-developed or developing settings of educational technology such as the Middle East and North Africa (MENA) region, and (F) following a series of well-founded theories regarding the associations among participants characteristic, role of intervention, and the RQ in focus that justify the objectives of this study. In the accompanying literature review, the theoretical foundation and related research are presented.

LITERATURE REVIEW

In this part, the theoretical background is discussed, the associated studies in the literature are reviewed, and their possible pros and cons are pointed out.

Theoretical Background

TEFL, assistive technology, and therapeutic education provide the theoretical foundation for this investigation. Concerning Speech and Cognition Theory (Turk & Shattuck-Hufnagel, 2020) states that the amount of learning resources used in the brain during the instruction process influences the ability to verbalize thoughts or ideas, and the use of appropriate teaching methods or educational technology solutions is advantageous for learners with verbal disorders to not only decrease the amount of cognitive overload but also assist them in oral expression or verbal communication. Focusing on the Assistive Learning Theory (Kouroupetroglou, 2014), this article argues that the use of specific instructional strategies or techniques can increase the independence of learners, which is crucial in the context of special education, where students struggle with a variety of learning disorders. When it comes to language acquisition, ALT is crucial, as the majority of individuals with speech disorders require assistance from their parents, teachers, or colleagues in communicating with others.

Related Studies

Several related studies will be presented in chronological order, with a focus on the effectiveness, viability, and risks of employing VR technology for educational purposes. In evaluating the viability of various learning solutions in distance education, Johnson et al. (2011) examined the applicability of three distinct distance-education modalities: the Learning Management System (LMS), the webinar, and the virtual reality learning environment. Participants in this survey were 109 native English speakers selected at random from a variety of institutions in the United States. According to a descriptive study, all participants used these platforms for a similar period of time. Before being used in this study, a Student Assessment of Learning Gains (SALG) questionnaire was piloted to assure its validity and reliability. The majority of students favored a virtual-reality learning environment, but the feasibility and effectiveness of the LMS platform were greater than those of the other two platforms. The virtual-reality learning environment appeared to confound students as to whether this platform had significant pedagogical effects in various educational contexts. This may be due to the participants' lack of prior experience with virtual reality technology.

Focusing on a specific form of virtual-reality learning solution, Freina and Ott (2015) examined the applicability and utility of immersive virtual reality in educational settings based on a 2013-2014 literature review of the associated studies. In the aforementioned years, virtual-reality technology was difficult to implement, particularly the immersive type, which required various spectacles or headgear, according to the results of a meta-synthesis. In addition, the analysis revealed that the majority of studies conducted during this time period focused on non-immersive 2D virtual reality games rather than immersive 3D platforms. With the emergence of various commercially available devices manufactured by various telecommunications companies in 2014, it was observed that virtual reality gradually gained a firm foothold in educational research. The associated studies focused primarily on adults without particular learning disorders, revealing a significant lack of research on the effects of immersive virtual-reality technology on younger individuals with cognitive or speech impairments.

Chang et al. (2020) examined the causes of virtual-reality-induced symptoms and the reliable method for determining their precise effects, based on the literature, in light of the possibility of illness resulting from virtual-reality-based learning platforms. This study classifies virtual reality symptoms into three primary domains: hardware-induced, content-induced, and personal-induced factors. Regarding the hardware, it was discovered that studies conducted in the 2000s reported various symptoms caused primarily by the hardware, such as eye dehydration, neck fatigue, and wrist pain due to helmets and eyewear that were less user-friendly, heavier, and non-adjustable. Due to a lack of synchronization between 2D or 3D object movement, cerebral perception, and the fundamental characteristics of devices or platforms, symptoms such as equilibrium issues have been reported. Regarding personal issues, a number of studies have identified technophobia as a significant issue resulting in unintended consequences for users who participated in a virtual-reality learning environment. The other objective of this study was to identify a critical lack of valid and reliable instruments for measuring the negative effects of virtual reality-based platforms.

Caserman et al. (2021) examined cybersickness in the use of virtual-reality head-mounted displays in 49 studies from 2013 to 2019 based on a meta-synthesis of the literature as one of the referential risks associated with the use of virtual-reality-based platforms. Cybersickness, in general, refers to the

potential symptoms and adverse effects a user of a specific technology may experience while using that technology or even after using it, whether in the short or long term. The symptoms are caused primarily by sensory discrepancies or an imbalance in received signals, especially when viewing a moving object or content in a virtual environment or primarily with high-end digital devices. Due to their updated display panel, user-friendly sensors, dimensions, and weight, they discovered that virtual reality head-mounted displays are the safest virtual reality-based devices across all varieties. Using older headwear and eyewear to experience immersive virtual reality was found to cause mild to moderate cybersickness in the form of ocular fatigue and vertigo, as well as depersonalization and derealization symptoms (Park & Lee, 2020; Peckmann et al., 2022).

Considering the use of the virtual-reality platform in language learning, Parmaxi (2023) conducted a comprehensive systematic literature review to investigate the various aspects of the virtual-reality platform for teaching English. A meta-analysis of 26 papers revealed that the number of relevant studies on TEFL was critically low, leading to various unanswered concerns regarding the effectiveness of this learning solution among English language learners. In addition, despite the fact that virtual-reality technology has experienced significant improvements in terms of accessibility, even in terms of immersive virtual reality, since 2015, the majority of related studies have shed light on the advantages of utilizing non-immersive or semi-immersive to learn English vocabulary in settings that have been fully developed with educational technology in mind. In addition, examining the feasibility and effectiveness of virtual-reality-based platforms was hampered by the lack of valid and reliable measures, as the majority of the associated studies relied solely on participants' feedback without specifying domains. This led to controversies as to whether the actual outcomes and feedbacks were due to the novel, interactive, and engaging nature of the platforms and the enthusiasm of the participant. Based on the literature's discussion of the benefits and drawbacks of related studies, this study sought to answer the following question.

RQ. *How do Iranian pre-intermediate EFL learners with e*xpressive language disorder *ELD perceive the effectiveness, feasibility, and risks of virtual reality assistive technology?*

METHODOLOGY

Design and Context

This study was conducted based on qualitative research by exploring the perceptions of Iranian EFL learners with mild to moderate levels of ELD regarding the VR assistive technology's effectiveness, feasibility, and risks. The participants who had access to VR-HMDs, experienced twenty 70-minute sessions, which were based on teaching one unit of the material across four learning nuggets; in those, one was distinguished for teaching the main lesson focusing on articulation or speaking skills, and three learning nuggets were allocated for performing speech drills in a fully-immersive VR environment based on the pre-intermediate book "Collins English for Life: Skills – Speaking," containing twenty units themed based on five general topics. Microlearning or learning nugget solution was picked for VR-authoring the material to avoid experiencing physical and mental adverse effects caused by VR technology as much as possible.

Participants

According to the objectives of this study, participants were required to have two qualities: first homogeneous levels of general English proficiency and second same levels of ELD. As the center in which this study was carried out offered different courses for learning various foreign languages, such as German, English, and French, prescribed by the language pathologist as a motivating way to enhance the articulation skills of the center users, determining the general English proficiency of them was not a complicated job. The participants who were purposefully selected due to their limited number were EFL learners that successfully passed the pre-intermediate level of the Oxford English File (Fourth Edition). The ELD levels of the participants were examined with the help of a Speech-Language Pathologist panel using Alberta University Special Education Coding-Criteria (SECC), 2020/21. Considering the dropout rate, 18 Iranian pre-intermediate EFL learners with mild to moderate levels of ELD were purposively selected. Considering the ethical guidelines, specific codes of conduct in research in social science (Weinbaum et al. 2018) were followed during the selection of the participants and carrying out this study.

Instruments

This study used two instruments, including a number of Virtual Reality Head-Mounted Displays (VR-HMDs) and a series of focus group interviews. The first one was used for VR authoring, and the second one was carried out to examine the perceptions of the participants.

VR-HMD

In this study, the participants experienced VR assistive technology through the use of two tethered VR-HMDs (binocular HMDs) with small display optics in front of each eye branded as VIVE Focus 3 with two controllers. This type of VR-HMD provides a fully-immersive VR experience with a 4K sharp resolution panel, a wide 120˚ field of view, 90Hz refresh-rate displays, adjustable Inter-Pupillary Distance (IPD), advanced cooling mechanism, immersive 3D dual-driver speakers, and microphone. In this study, the VR-HMDs were connected to a PC in which the 3D learning nuggets were authored with Trezi and Google scale software. The applications mentioned are user-friendly platforms to design different virtual-reality-based environments without special programming or computer network knowledge. As the VR-HMDs in this study had the feature of authoring the material in a fully-immersive environment, the material was developed according to fully-immersive interactive learning nuggets. It should be noted that this type of VR-HMD could detect fluctuations in pupil diameter by installing a particular software.

Focus Group Interview

A Focus group interview is a type of collaborative interview in which several similar individuals possessing certain qualities or experiences share their ideas to possibly provide the best answers to the questions in an interview (Flick, 2021). In this study, three open-ended questions were asked of all participants who experienced VR assistive technology in the form of two groups, each with nine participants. Considering the usefulness of the VR technology, the first question was, "To what extent do you think VR assistive technology is effective, and what variables potentially influence its effectiveness in the Iranian academic settings?". Concerning the feasibility of VR technology, the second

question was posited as "To what extent do you think VR assistive technology is viable, and what factors affect its practicability in the Iranian academic context?". Finally, the last question about the possible risks of VR technology was, "What do you think about the risks of VR assistive technology concerning mental and physical conditions in the Iranian academic setting?". At least one item was assigned to each construct, which was supposed to be measured to ensure the interview's validity. In addition, prior to developing the interview questions, they were verified by two associate professors who published significant interdisciplinary research in psychology and TEFL. In focus group interviews, the reliability is high due to its nature in which a group of participants is asked the same question, which makes the ground to not only supplement the responses of each other but also propose a different answer which the other individuals in that particular group did not mention.

Data Collection Procedure

After obtaining the required permissions for conducting this study, A series of focus group interviews were conducted for all participants to explore their perceptions about the usefulness, feasibility, and risks of VR assistive technology among EFL learners with ELD in the Iranian academic context. Two series of structured focus-group interviews, which lasted for one hour, were carried out in which each group included nine participants sitting in a small discussion room with the interviewer asked three questions regarding each construct in focus, and some parts of the conversations were recorded and transcribed for further analyses through Transkriptor application which is a high-accurate, fast, and accessible platform to covert audio into text. It should be noted that the validity and reliability of the instrument used in collecting the required data were examined and described in the "instruments" section prior to collecting data in each step to make reliable and generalizable outcomes.

Data Analysis Procedure

Max Weber Qualitative Data Analysis (MAXQDA) was used to thematically analyze the results regarding the three constructs in focus to check the respondents' answers regarding the themes in focus.

RESULTS

In this study, 18 participants who had used VR assistive technology were interviewed in focus groups about their perceptions of the utility, feasibility, and risks of this fully immersive platform in the Iranian academic setting. Following is a presentation of the results for each of the targeted constructs, with the most frequently mentioned perceptions, organized thematically. Five themes emerged regarding the factors reported to influence the effectiveness of VR technology in the Iranian EFL context: (a) ICT literacy and 21st-century skills, (b) preconceptions about VR platforms, (c) technophobia and technostress, (d) user motivation, and (e) quality of VR equipment. Concerning the variables thought to influence the viability of VR technology in the Iranian EFL context, five themes were developed: (a) academic infrastructure, (b) apparatus price, (c) customization or personalization, (d) type of content or context, and (e) trained operators and users. Concerning the risks associated with VR technology, two dominant themes emerged: (a) physical VR-induced symptoms such as vertigo, eyestrain, disorientation,

and headache; and (b) mental VR-induced symptoms such as anxiety, addiction and habituation, derealization, and social isolation.

A significant number of respondents believed that using VR learning-environments requires users to have sufficient levels of familiarity with computer, internet, and how computer-generated environments work. For instance, one of the participants (No. 3, female, 20 years old) stated that when educational technology fails to assist learners in achieving their desired educational goals, most of them blame the assistive instruments rather than investigating what variables may have influenced their performance during the use of these platforms or their academic achievements. Some of my friends, despite being digital natives, are unable to complete their daily tasks using portable devices such as mobiles and laptops. Similarly, during the COVID-19 pandemic, the majority of them were unfamiliar with Learning Management Systems (LMSs), despite the fact that, with a little exploration of the menus and options, you could easily solve all the problems that they consistently reported. I was dismayed that a significant number of my peers were unable to modify the brightness of their VR-HMDs or make the virtual controls appear and disappear when using VR, despite the fact that I did not anticipate the interface to be so simple to use. It appeared that some of them were extremely frustrated with the fundamental features of this environment, and as far as I am aware, they also performed poorly in their LMS-based courses. In this regard, I believe that familiarizing oneself with the structure of educational technologies such as VR and enhancing the users' 21st-century skills or ICT literacy is a crucial variable that impacts the effectiveness of these platforms.

Contrary to what was stated by one of the participants above, some of the participants stated that although using VR platforms was simple and no significant knowledge was required to benefit from these educational-assistive instruments, there should still be training courses teaching individuals, particularly digital immigrants, the fundamentals of educational technology or how various virtual platforms generated by computers can assist them in achieving their academic and professional goals. One participant (No. 16, male, 18 years old) reported that the lack of training courses for students and their parents to teach them about educational technology and the norms that it generates, other than providing a fun time while playing video games or communicating, is one of the critical factors that affect the outcomes of using these high-end assistive platforms. There should be some instructions for students and their parents to acquaint them with the culture of technology, particularly virtual reality, as the majority of parents view computers and electronic platforms as video-game consoles or contemplate using them for entertainment purposes. For example, when I discuss how beneficial educational technology is for me, especially with my ELD condition, they do not take it seriously because they do not have significant financial issues. Similarly, when we experienced VR assistive technology, some of my friends viewed it as "play-time," which stems from their perception that these platforms do not aid them in important aspects of their lives such as education. Then, they can take advantage of the plethora of benefits that VR learning environments offer for people with a learning or language disorder.

A small number of participants cited technophobia or technostress as variables that could potentially affect the effectiveness of VR technology as an assistive educational platform for individuals, including those from the Z-generation. Technophobia and technostress are the technical terms for the dread or stress that people experience when interacting with technological devices such as computers. For instance, one of the participants (No. 11, female, 17 years old) reflected that the presence of an irrational

dread regarding the use of VR technology and VR-HMDs was one of the issues that could alter the effectiveness of VR for me and some of my female peers. My dread of using VR spectacles stemmed from their proximity to my eyes and direct contact with my face. In addition, the moniker of VR technology was unfamiliar to me, which was a stimulus that exacerbated my anxiety. In addition, during the use of VR-HMDs, a cooling mechanism with a small quantity of noise that simulates an MRI scan is activated due to the heat generated by the VR-HMDs. In my case, I have a fear of confined spaces known as Claustrophobia. As the VR-HMDs limited my actual vision of the environment around me, VR amplified this fear and made it difficult for me to focus on the content that was created in the VR learning environment. Those with a phobia of heights are also terrified by a 3D VR learning environment. I believe users should have the option of experiencing either a 2D (non-immersive) or a 3D (semi or fully-immersive) version of virtual reality technology, as a 2D version is a better option for individuals like myself who not only benefit from VR technology but also encounter few or no difficulties.

The motivation of Iranian EFL learners toward the use of various educational technology-based instruments, such as VR technology, was revealed to be another factor deemed influential on the potential effectiveness of VR assistive technology, as reflected in some of the reports. One participant (No. 8, male, 19 years old) reflected, for instance, that motivation is crucial to the effectiveness of VR technology and a variety of assistive instruments or platforms used in educational contexts. Based on my observations during the COVID-19 era, the majority of my classmates lacked motivation and enthusiasm for using LMSs, which resulted in poor academic performance and impeded the learning process compared to their performance in face-to-face classes prior to the pandemic. Regarding the use of VR learning environments, I had the same experience as some of my classmates who were motivated to use VR technology and reported higher achievement in our interactions than those who had little or no motivation to use VR technology. Consequently, I believe that the user's motivation significantly influences the potential adverse or beneficial effects of VR technology. In addition, while improved speaking skills are the best intrinsic motivation for EFL learners like my peers and me, it is not a bad idea to trigger extrinsic motivation of the users by providing some rewards, for instance, after the VR experience playing a 3D serious-game is really engaging or motivating incredibly for minor users or for adult users experiencing a virtual trip to one of the fantastic locations in the world could be fun and motivational.

The quality of VR apparatus was the final theme that emerged from the focus group interviews regarding the effectiveness of VR assistive technology among Iranian EFL learners with ELD. For example, one participant (No. 9, male, 20 years of age) stated:

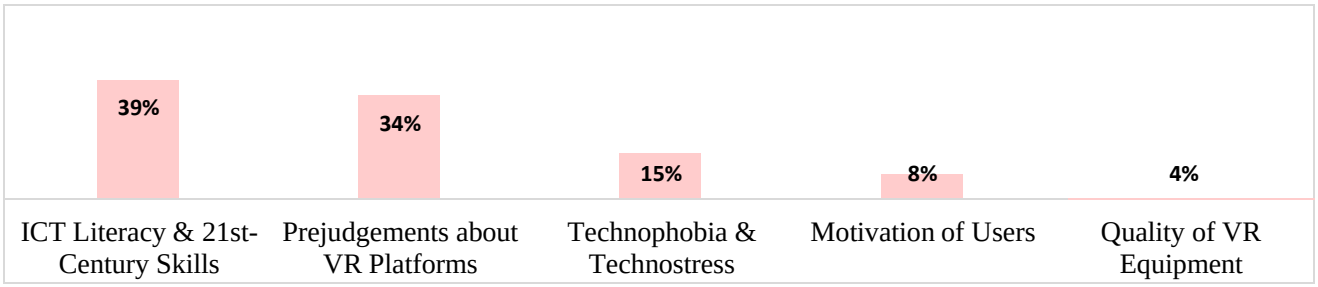
As I have previously played semi-immersive 3D video games on my game console and have also used VR assistive technology, and considering the high quality of the VR learning environment, I believe that the quality of the VR apparatus, particularly VR-HMDs, impacts the effectiveness of VR. Moreover, the quality of VR-authored content is crucial for engaging consumers. In addition, two joysticks are required for interacting with a completely immersive 3D environment, as was the case in this investigation. In addition, the weight of VR-HMDs and joysticks may impact the potential benefits of VR platforms. I have consistently encountered stiff neck and forearm discomfort while using VR-HMDs with video game consoles. Most VR-HMDs generate a substantial quantity of heat during use, but in this study, the

ventilation fan prevented me from losing concentration while performing speaking exercises. While high-end equipment is not required to experience 2D VR, a 3D VR learning environment requires high-quality VR-HMDs and user-friendly or easy-to-use joysticks. As users of VR technology include people of varying ages and physiques, the adaptability of VR apparatus is another variable that most benefits from the potential of VR technology.

To better understand the emerged influential factors on the effectiveness of VR technology among Iranian EFL learners, Figure 1 illustrates the related results.

Figure 1

Factors Influencing VR Effectiveness



As shown in Figure 1, the thematic analysis (Braun & Clarke, 2012) using MAXQDA to explore the transcription of the participants revealed that (a) ICT literacy and 21st-century skills (39%), (b) preconceptions about VR platforms (34%), (c) technophobia and technostress (15%), (d) motivation of users (8%) and (e) quality of VR equipment (4%) were the most frequently reported factors affecting the effectiveness of VR assistive technology among Irasc Reflected below is an analysis of the focus group interviews regarding the variables that may influence the viability of VR in the Iranian EFL context.

After examining the results of the focus group interviews regarding the potential factors influencing the effectiveness of VR assistive technology, and taking into account the results of the second question posed in the interviews, the variables potentially affecting VR feasibility were investigated. In this regard, the factor most frequently mentioned by participants was academic infrastructure, as they believed that the Iranian academic environment still requires significant improvements in order to fully benefit from various assistive technologies, particularly in regard to individuals with learning or language disorders.

As an example, one of the participants (No. 10, male, 22 years old) stated,

> As an EFL learner with a language disorder who experienced a variety of difficulties in different academic settings, primarily due to a lack of appropriate infrastructure or lack of assistive devices to benefit from educational technologies, I believe that the Iranian academic context is still at the beginning of the road to development and requires significant attention and considerations from educational institutions." In the majority of language institutes, I have encountered a paucity of portable devices and even headphones while learning a foreign language. My classmates and I have always been disregarded for having the essential technological devices to assist us in learning, which has resulted in significant, not-our-fault difficulties in our academic careers. Even in some language institutes in Tehran with some essential equipment, the majority of computers are inoperable, the internet speed is too slow with limited bandwidth, and the headphones and microphones require repair.

These issues impede the learning of specific subjects, such as English, for average individuals, let alone those with one or more disorders or difficulties. I believe there should be a minimum infrastructure standard for countries with underdeveloped or developing educational technology contexts.

On the one hand, participants cited academic infrastructure as a factor that affects the practicality of virtual reality; on the other hand, a large number of participants cited the high price of VR equipment as a significant factor when purchasing VR equipment for personal use. As anticipated, the financial issues appeared to have a significant impact on the viability of VR technology. A participant (No.4, female, 17 years old) provided the following example:

Unfortunately, the price of purchasing a basic model of VR-HMD is so high that it is nearly unaffordable, especially for unpaid students who rely on their parents for financial issues." While most companies attempt to produce VR packages that exclude some or all of the necessary equipment, these packages are still expensive because they are all imported and there is no domestic alternative. Even used VR-HMDs are difficult to locate, and if they are discovered, they are still prohibitively expensive for the majority of people in my country. I believe there must be financial aid programs, such as financing, for students and people with cognitive disorders in order for them to benefit from VR technology.

The COVID-19 pandemic demonstrated that the majority of parents were unable to provide their children with primary portable devices for participation in mandatory distance education programs. Some costly televisions are intelligent and provide their users with a 3D experience, primarily for viewing 3D films without a dynamic interface or user interaction. However, their VR environments cannot compete with those created by VR-HMDs, which are immersive and even semi-immersive.

In addition to academic infrastructure and the cost of purchasing a set of VR-HMDs, the participants determined that the ability of users to customize or personalize this platform was a significant factor in determining the feasibility of virtual reality. Despite the fact that various types of VR platforms have distinct features, participants require more customization options. As an example, one of the participants (No.1, female, 18 years old) reported that despite the VR-HMD's ability to be adjusted for size, it was not properly positioned on her face when she used it. In addition, if it were possible to adjust the focus of the VR-HMD lenses for those with potential vision issues, it would be advantageous. Aside from personalization, the majority of consulting institutes are established to prevent individuals with learning or language disorders from purchasing expensive VR sets. Therefore, domestic products should serve as substitutes for imported VR devices. Moreover, if there were VR sets designed specifically for individuals with different languages or learning disorders, with a focus on therapeutic aspects of VR technology rather than enhancing their graphic capacity with a lower price, the majority of underdeveloped academic contexts could benefit from various educational and therapeutic advantages of VR technology. Most recently produced VR packages labeled "cost-effective" or "economical" lack one or more required components, such as joysticks, but still have a significant graphical capacity that is not necessarily required to benefit different individuals; therefore, if they had the ability to be customized, especially in terms of their hardware, they would be cheaper and more accessible to a wider range of people who can benefit from VR technology. Participants reported that the context or type of content

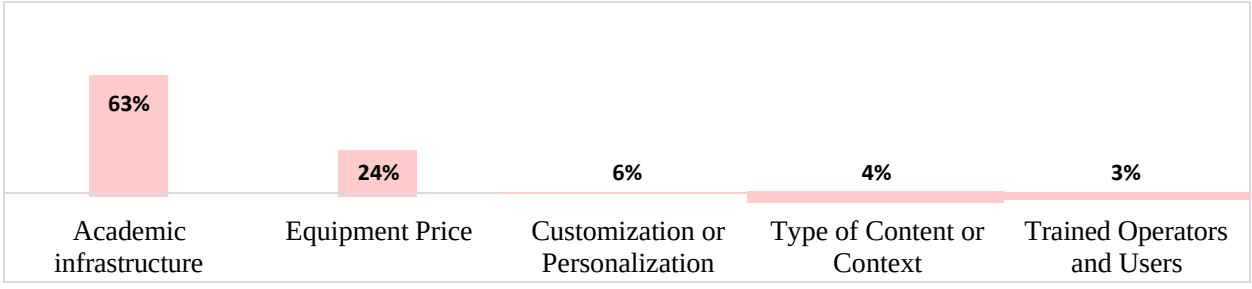
created by VR technology was another factor that affected the viability of VR technology among them. They believed that VR technology is not applicable to all academic contexts or subject matter. For example, one of the participants (No. 17, male, 18 years old) stated that while using expensive VR technology in under-developed and developing environments in terms of educational technology with a limited budget or financial support for a large number of users is nearly impossible, implementing it for a limited number of users in academic and non-academic settings where some users benefit from VR-technology is feasible. In addition, VR technology is more suitable for certain scientific disciplines, and VR-authored content can be utilized. Comparing geography and learning a foreign language with mathematics and physics, for instance, reveals that the former are more suitable for presentation in a VR learning environment than the latter. Exploring different geographical phenomena across various locations in a VR environment or completing language tasks with native speakers in a themed VR environment reflected in a 3D platform appears to be more effective than simply viewing a series of mathematical or physical formulas through VR sets. Diverse individuals in a variety of academic contexts have diverse characteristics and objectives, necessitating the need for specific VR presentation strategies to make it feasible.

The presence of trained operators and even users was the final point derived from the focus-group interviews with the participants that were considered to have some bearing on the viability of VR technology in academic settings. Some participants believed that in certain contexts, consumers must be conversant with the culture of virtual reality technology, and operators must be trained to make it possible. For example, a participant (No. 16, male, 18 years old) stated that for each nascent technology that was introduced to users in countries, especially those in the MENA region where the infrastructure of that technology is not fully developed, there should be some experienced individuals to introduce the culture of that technology, which in the case of virtual reality (VR) technology, would be gamers. The majority of people in our country view virtual reality technology as a gaming platform, in my opinion. Even the majority of our instructors are not conversant with the educational benefits of this technology, and in the few instances where they are, they do not know how to utilize these VR-based possibilities. Experienced operators instruct users, whether they are the primary users of AR platforms or end-users, on how to work with AR platforms, diagnose common problems with these platforms, and even restore them at the most fundamental levels. Training individuals prior to implementing augmented reality technology has a significant impact on its viability in various contexts and for various purposes.

Considering a clear picture of the emerged variables on the feasibility of VR technology among Iranian EFL learners, Figure 2 shows the associated results.

Figure 2

Factors Influencing VR Feasibility



As depicted in Figure 2, the thematic analysis (Braun & Clarke, 2012) using MAXQDA to explore the transcription of the participants revealed that (a) academic infrastructure (63%), (b) equipment price (24%), (c) customization or personalization (6%), (d) type of content or context (4%) and (e) trained operators and users (3%) were the most frequently mentioned factors affecting the feasibility of VR assistive technology among Iranian pre-service teachers. The following section provides an analysis of the focus group interviews regarding the dangers of incorporating VR into Iranian EFL instruction.

> According to the results of the interviews, the most frequently mentioned risk of VR technology was physical side effects, including a variety of cybersickness and visually-induced-motion-sickness symptoms such as nausea, loss of balance, sweating, dizziness, stiff neck, headaches, wrist pain, dry eyes, and vomiting. Numerous participants cited these symptoms as the most significant risks associated with VR technology. As an illustration, one participant (No. 8, male, 17 years old) stated that physical symptoms are the most significant drawbacks of using VR technology. I encountered irritated eyes while using VR-HMDs due to the dehydration induced by the light and heat of VR-HMDs. In addition, I had some minutes of impaired vision after using it. The combination of a moderate headache and dehydrated eyes caused me to experience general discomfort. As I personally experienced and observed among my colleagues, loss of balance was an additional negative consequence of VR-HMDs. It was as if you could not move in a straight line. I cannot identify it as disorientation or vertigo, but it lasted only a brief period of time and progressively subsided. As the VR-HMD is wirelessly connected to the internet and the joysticks are wirelessly connected to the VR-HMD, I believe that exposure to this radiation may pose short- and long-term health risks, particularly to the brain mechanism. In my case, I experienced the majority of the physical symptoms after using VR-HMDs, whereas some of my classmates reported experiencing moderate nausea during some sessions of VR-HMD use. I was the only participant to experience allergic reactions and a skin condition as a result of the coating material used on the VR-HMD and joysticks, which I had never encountered before.

The physical symptoms reported by males differed somewhat from those reported by females. While the majority of male participants experienced symptoms of visually-induced motion sickness, females reported issues with the weight and girth of the VR-HMD and joystick. A participant (No. 11, female, 17 years old) reported, for example, that

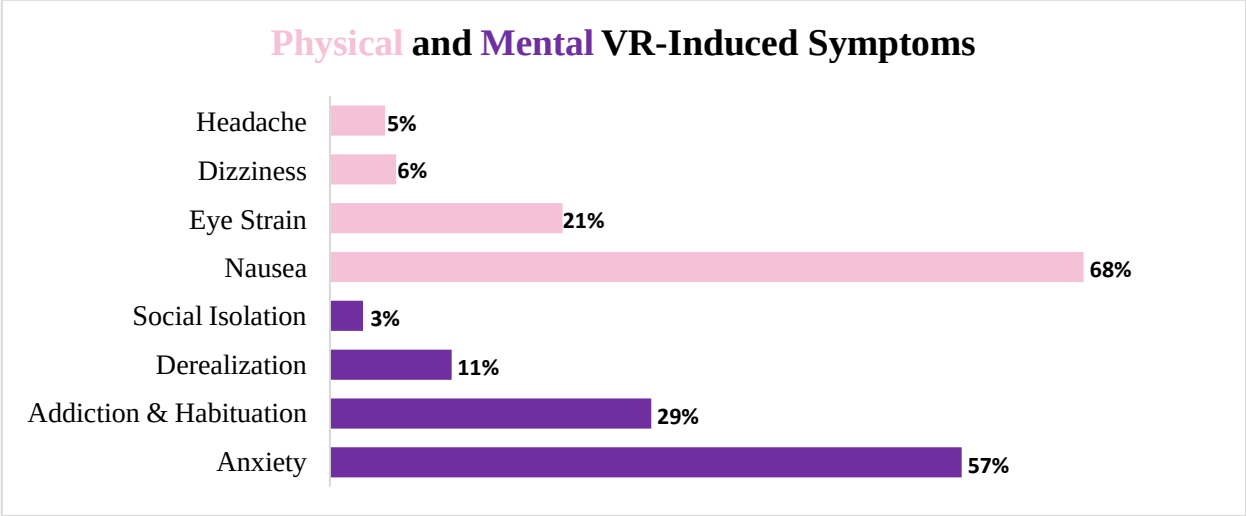
> the time I spent on each learning morsel was brief, but holding onto the joysticks after each session caused wrist discomfort. Despite the fact that VR-HMD had the ability to be adjusted based on the size of the cranium, I still had issues in this regard. I, along with some of my female peers, had difficulty managing the weight of the VR-HMD while wearing a hijab, resulting in frequent misplacement of the VR-HMD, which I had to mitigate by altering the orientation of my neck, resulting in a rigid neck on multiple occasions. In addition, the heat and radiation emitted by the VR-HMD caused me to perspire and experience moderate discomfort, similar to what I observed among my female peers. In addition, I encountered vertigo and vomiting during a few sessions. It should be noted that some of my female classmates had pale features after using VR-HMD, which may have resulted from a decrease in blood flow to their cranium due to the VR-HMD's weight. If VR-HMD

enabled users to take more than a few steps instead of standing still, I believe the issue of insufficient blood flow to the cranium would be resolved.

Aside from physical symptoms, some participants addressed a series of psychologically-induced symptoms, including anxiety, addiction or habituation, social isolation, depersonalization, and de-reality, that they experienced or believed VR technology would impose on them long-term. For example, one of the participants (No. 10, male, 22 years old) reported feeling moderate anxiety while being taught in a VR learning environment because he had never experienced it before. Nevertheless, I believe that the use of VR technology may cause anxiety and tension because you are aware that you are in a virtual environment with limited mobility. In my opinion, it may induce or exacerbate anxiety levels in individuals who are susceptible to tension. Moreover, because 3D environments are dynamic, immersive, and captivating, they may cause addiction, particularly in users who use them without any criteria or schedule, especially when using fully immersive platforms. Moreover, despite the fact that VR technology simulates a real-world environment devoid of effective communication with others, it may cause users to feel socially isolated, which may contribute to certain types of depression. This isolation may serve as a foundation for derealization; that is, you feel lonely because you are separated from other people in the majority of VR strategies. These symptoms cause significant parental concern regarding the educational use of virtual reality. Therefore, additional research is required to determine whether utilizing VR technology for educational purposes is worthwhile.

Figure 3

Risks of VR Assistive Technology: Physical and Mental VR-Induced Symptoms



As shown in Figure 3, following the criteria for thematic analysis (Braun & Clarke, 2012) using MAXQDA to analyze the participants' transcriptions, it revealed that regarding the physical symptoms (a) nausea (68%), (b) eye strain (21%), (c) dizziness (6%), and (d) headache (5%) were the most reported VR-induced physical symptoms proposed as one of the dominant risks of VR assistive technology. Besides, considering the other dominant classification, anxiety (57%), addiction and habituation (29%), derealization (11%), and social isolation (3%) were the most pointed-out mental symptoms of VR assistive technology placed under the category of "VR risks".

DISCUSSION

The research question posed was, "How do Iranian pre-intermediate EFL learners with ELD perceive the effectiveness, feasibility, and risks of VR assistive technology? According to reports, the factors that influence VR assistive technology are (a) ICT literacy and 21st-century skills of the users, (b) preconceptions about VR platforms, (c) technophobia and technostress, (d) user motivation, and (e) the quality of VR equipment. In accordance with the findings of Johnson et al. (2011), the technology skills, digital and information literacy, and prior VR experience of VR users are crucial to the potential effectiveness of VR learning environments. According to Mihelj et al. (2014), for a modern and dynamic technology such as VR to be effective in terms of the goals for which it was developed or for the purposes of using it in various fields of science or experiments, users must acquire the fundamental ups-and-downs of VR technology, ranging from software to hardware knowledge, as well as the necessary skills to experience its positive outcomes.

According to some studies (e.g., Geweke 2012; Yu & Lagnado, 2012), initial beliefs of individuals or their presuppositions of a discussion topic significantly influence their point of view, judgments, and decisions regarding the benefits and drawbacks of that specific topic in question. The results are consistent with those of Chang et al. (2020), who determined that technophobia and technostress are critical factors influencing the effectiveness of VR technology among its consumers. While further research is required to determine whether fear of technology stems from specific psychological conditions or is one of the adverse effects of information technology on individuals (Brosnan, 2002), it is essential for technophobic individuals to fully benefit from VR technology and other educational technology platforms. Several studies (e.g., Hartnett, 2016; Hoffman, 2015) have confirmed the significance of motivation in the actual and perceived effectiveness of a face-to-face or distance learning platform.

The variables academic infrastructure, equipment price, customization or personalization, type of content or context, and trained operators and users were identified as the influential factors on the feasibility of VR technology in Iranian academic contexts, according to the participant-reported variables that may influence the technology's applicability. According to a number of studies (e.g., Freina & Ott, 2015; Parmaxi, 2023), the financial issues associated with the implementation of VR technology, its required infrastructure, and the customizability of VR learning platforms and associated devices were the most influential factors affecting the viability of VR technology. According to some feasibility studies (Baporikar, 2014; Weber & Hamlaoui, 2018), the MENA region was not an ideal location for implementing virtual reality (VR) learning platforms, and a significant number of students in higher education did not have the opportunity to experience this emerging educational assistive technology. In addition, Bailey et al. (2022) reported that, despite the fact that the effectiveness and viability of VR technology as an educational assistive technology varied for different individuals in different settings, it was extremely beneficial for children, adolescents, and even adults with communication disabilities in overcoming their difficulties in this regard.

Considering the risks of using VR technology in academic contexts for consumers of VR learning environments, several factors emerged. They were divided into two categories, including physical and psychological dangers. Mental risks included anxiety, addiction and habituation, derealization, and social

isolation, while physical risks included vertigo, eye strain, disorientation, and headache. The findings are consistent with those of a number of studies (Chang et al., 2020; Park & Lee, 2020; Peckmann et al., 2022), in which VR users experienced a variety of VR-induced symptoms, including ocular irritation, vertigo, and derealization symptoms. Several theories (postural instability and sensory conflict theories) and causes (high input latency, low frame-per-second, and accommodation-vergence conflict) support the occurrence of VR-induced symptoms, as described in the discussion of RQ4's results. In addition, the results are justifiable for what was referred to as VR illness syndromes (Saredakis et al., 2020; Somrak et al., 2019), which comprised most of the previously mentioned VR-induced symptoms. In the section entitled "Conclusion," the results of this investigation are discussed.

CONCLUSION

The findings of this research highlighted the elements that maybe affect VR effectiveness and feasibility. Then they pointed out the possible risks of adopting VR technology in the Iranian EFL environment. The findings also emphasized the aspects that perhaps impact VR effectiveness and practicality. Literacy in information and communications technology (ICT) of users, initial attitudes and prejudgements about VR platforms, technological anxiety or stress among VR users, motivation of VR users, and quality of VR equipment were reported to assess the effectiveness of VR technology in the Iranian English as a foreign language (EFL) context. The academic infrastructure that is necessary for VR technology, the price of VR equipment, the ability to customize or personalize VR equipment, the different types of content or context that can be used for VR authoring, and trained VR operators and users were the most frequently mentioned factors that were supposed to influence the feasibility of VR technology in the Iranian EFL context. When taking into consideration the dangers of using virtual reality technology within the Iranian EFL community, two primary themes arose. The first of these was a set of physical symptoms that were brought on by virtual reality, and these included nausea, eye strain, dizziness, and headaches for those who used VR. The second one was virtual reality-induced mental symptoms, which included virtual reality anxiety, virtual reality addiction or habituation, derealization or depersonalization, and a sensation of social isolation that was experienced by those who used virtual reality.

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