Immersive Virtual Reality In Tertiary Level Efl Education: A Systematic Review Of Recent Applications

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Abstract

The use of virtual reality in foreign language learning has captured the attention of many researchers in recent years. However, because virtual reality is still a relatively new technology in language learning, the number of recent systematic reviews focusing explicitly on English as a foreign language (EFL) education and Virtual Reality is scarce. This paper provides a systematic review of 21 research articles, published between the years 2017 and 2022, that address teaching and learning English as a foreign language through the use of VR. The main purpose of this systematic review is to identify contexts, features and strategies of VR in foreign language education at higher education institutions, and to interpret them in terms of their effects on English language learners. In particular, the review focuses on the study contexts, the aim of VR integration, the type of VR technology integrated, the strategies used, the effects on student performance, and future directions included in the research articles. The review demonstrates that VR technologies have a significant positive impact on performance boost in the EFL context. The article concludes with limitations such as being confined to English as a foreign language context and addresses directions for future research.

Keywords: Virtual reality, language learning, higher education, systematic review, EFL

Üniversite Düzeyi Yabancı Dil Eğitiminde Sürükleyici Sanal Gerçeklik: Son Uygulamaların Sistematik Bir İncelemesi

Özet

Yabancı dil öğreniminde sanal gerçekliğin kullanımı son yıllarda pek çok araştırmacının dikkatini çekmektedir. Bununla birlikte, sanal gerçeklik dil öğreniminde hala nispeten yeni bir teknoloji olduğundan, yabancı dil olarak İngilizce (EFL) eğitimi ve Sanal Gerçeklik üzerine açıkça odaklanan son sistematik incelemelerin sayısı azdır. Bu makale, 2017 ve 2022 yılları arasında yayınlanan, VR kullanımı yoluyla İngilizce'nin yabancı dil olarak öğretilmesi ve öğrenilmesini ele alan 21 araştırma makalesinin sistematik bir incelemesini sunmaktadır. Bu sistematik incelemenin temel amacı, yükseköğretim kurumlarında yabancı dil eğitiminde VR'nin bağlamlarını, özelliklerini ve stratejilerini belirlemek ve bunları İngilizce öğrenenler üzerindeki etkileri açısından yorumlamaktır. İnceleme özellikle çalışma bağlamlarına, VR entegrasyonunun amacına, entegre edilen VR teknolojisinin türüne, kullanılan stratejilere, öğrenci performansı üzerindeki etkilerine ve araştırma makalelerinde yer alan geleceğe yönelik yönlere odaklanmaktadır. İnceleme, VR teknolojilerinin EFL bağlamında performans artışı üzerinde önemli bir olumlu etkiye sahip olduğunu gösteriyor. Makale, yabancı dil olarak İngilizce bağlamıyla sınırlı kalmak gibi sınırlamalarla sonuçlanıyor ve gelecekteki araştırmalara yönelik yönlendirmelere değiniyor.

Anahtar Sözcükler: Sanal gerçeklik, dil öğrenimi, yüksek öğrenim, sistematik inceleme, EFL

1. Introduction

Prior to the digital era, education was confined to classroom settings, and the notion of instruction was conflated with the conventional education system that relied primarily on teachers and printed books. Advances in digital technology in the last decades have made it possible for learning and teaching to go beyond and above the classroom environment. Among a number of digital developments, Virtual Reality (VR) has emerged as one of the most prevalent technological affordances as it allows educators to overcome various challenges in education such as time constraint, authenticity, anxiety, etc. Although it is commonly considered a recent technology in language learning, VR technologies appeared in the 1980s. Due to its high cost, size and fragility features, the use of VR technologies were formerly regarded as unsuitable for learning in educational settings (Tax'en & Naeve, 2002). As a result of recent technology advancements and cost reductions, VR technologies are now much more accessible and widespread in the field of education.

1.1. Background

1.1.1. Virtual Reality (VR) in Education

Various definitions of VR technologies have been proposed in the literature over time, yet it is mostly considered as tools which provide a three-dimensional virtual environment (VE) that individuals involved in and interact with in this dynamic virtually created visual stimuli (Carrozzin, & Bergamasco, 2010; Çavaş et al., 2004). According to Burdea and Coiffet (2003), VR technologies are three-dimensional environments that allow users to be extremely creative and involved. Hay (1997) defined VR as a technology that uses a computer and a variety of tools to create authentic situations in which individuals can interact with other people, machines, or artifacts.

VR systems are classified as non-immersive, semi-immersive, or immersive depending on their level of immersion (Bamodu & Ye, 2013). Immersive VR is the most expensive system as it provides the utmost level of immersion. This system enables the users to experience the virtual world as if it were real, providing them with a higher level of immersion and thus "sense of presence" (Bowman & McMahan, 2007). In terms of foreign language learning, the existing VR related literature, however, mainly consists of low-cost non-immersive VR providing the users to interact with a monitor, keyboard and mouse.

Kayapa and Tong (2011) categorized the VR technology in terms of its components including visual providers, VR robots, interaction tools, and positional tracking. VR technologies have been used in various fields including medicine, advertising, and tourism. Similarly, due to its distinct characteristics such as immersion and engagement, VR-based applications are widely used in education to improve a wide range of skills and abilities. Çavas et al. (2004), in this respect, classified the use of VR in the field of education such as special education, science and mathematics, and military and airline industry etc. Recent studies have shown that the use of VR technologies has been highly effective in particularly foreign language education. Previous research findings in the literature have demonstrated that VR can provide a number of benefits for foreign language learning in a variety of ways (Boetje & Ginkel, 2020; Chen, 2016; Yamazaki, 2018; Yeh et al., 2020). One of the most significant features of VR is immersion as it does not require a physical presence as in traditional classrooms. Due to this feature, foreign language learners are provided with an opportunity to have an intercultural experience without geographical limitations (Wang et al., 2017). Another important aspect of VR technology in education is that it allows language learners to interact with each other.

1.1.2. The use of VR technologies in EFL context

The use of VR technology in the context of English as a foreign language (EFL) has recently grown in popularity. However, there is a relatively small body of literature on the impact of VR in foreign language education. Further research is needed as the existing literature shows that this technology offers several advantages for language learners. VR technology provides the learners a virtual learning environment that increases motivation, engagement and interest (Chen et al., 2019; Demir et al., 2022). For example, Chen et al. (2021b) reported that sophomore students who were taught with a VRassisted problem-based learning

(PBL) approach had a higher level of English-learning motivation than students with a non-VR-assisted PBL approach.

In another study by Carrero *et al*. (2017) regarding the attitudes of EFL students towards the use of virtual environments, students reported that VR technology considerably improved their vocabulary retention, grammar, and reading skills. Furthermore, a study conducted with 60 proficient EFL college students from Taiwan found that the features of VR technology, such as audio, interaction, and panoramic, helped students acquire higher intercultural awareness.

Zhang (2020) conducted a study with 100 participants aiming to improve the learning effect of spoken English which is a major issue for Chinese students to develop robust oral communication fluency. In her study, learners were exposed to a 3D virtual learning environment which was indistinguishable from the world. The results indicated that the virtual environment greatly contributed to boosting students' enthusiasm for spoken English and thus improving learning performance.

Parmaxi (2020) performed a systematic review of the published literature between 2015 and 2018 on Virtual Reality as an emerging technology in language teaching and learning and reviewed a total of seventeen high-impact journals and conferences in the fields of Computer-Assisted Language Learning (CALL) and educational technology. This research shows how VR is utilized in language learning and capitalizes features of VR used for a variety of tasks. Parmaxi (2020) argues that VR is an invaluable technology for language classrooms because it not only improves learning but also nurtures the necessary 21st-century skills.

In a meta-analysis by Chiu (2013), the effect of second language vocabulary instruction through CALL was examined. Empirical research from the period 2005-2011 was used to assess the data from the databases such as IEEE, Google Scholar, Chinese Periodical Index. The obtained results showed that computer-assisted language learning had significantly positive effects on enhancing the vocabulary skills of the learners.

This systematic review is a follow-up of other studies pursued by the academic community as to how and why VR technology is used in learning a foreign language at higher educational institutions. Due to the insufficient number of systematic reviews in this area and with the rapid advance in VR technology, additional studies in this area are essential. Moreover, it is crucial to analyze research studies to gather the most updated synthesized collection of those studies. Since VR offers numerous potentials for foreign language learning, this systematic review is likely to contribute to researchers and educators presenting recent findings of the related studies conducted from 2017 to 2022 in the field. More specifically, the objectives of this systematic review are to examine the VR integration in higher education EFL courses in terms of study context, aim of VR integration, VR technology integrated, strategies used and effects on students' performance, and to provide suggestions for future research directions. Based on this objective, the research questions of the study follow as:

1. In which contexts the studies on VR integration in higher education level EFL courses were conducted?
2. What are the aims, strategies and technologies that the recent studies on VR integration in higher education level EFL courses include?
3. What are the effects of VR integration on learning performance of students studying in higher education level EFL courses?
4. What are the future directions based on the studies on VR integration in higher education level EFL courses?

2. Method

To interpret the recent research on virtual reality in EFL learning at the university level, a systematic literature review was conducted utilizing the PRISMA statement (Page et al., 2021). Articles published between 2017 and 2022 were included in the study. The review process started with specifying the research

scope as virtual reality used in English language learning in higher education. Two sets of keywords used as filters while searching were “Virtual Reality” and “higher education”.

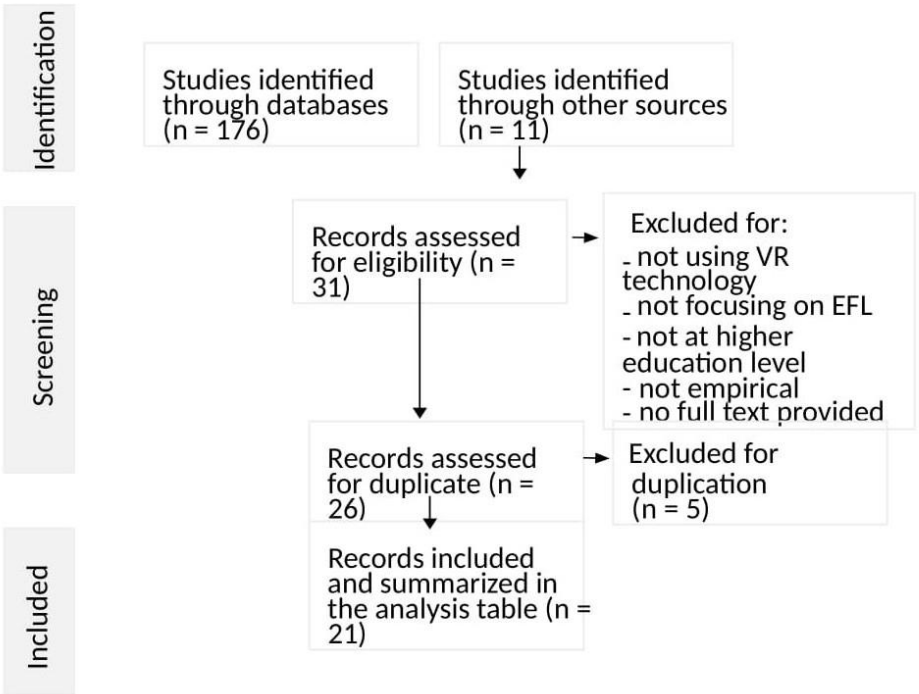
Accordingly, eligibility criteria were determined. Inclusion criteria that were required for studies to be included in our systematic review were as follow:

- empirical and peer-reviewed,
- written in English,
- published as a journal article between 2017-2022 and
- having virtual reality/VR, EFL/English and
- higher education/university or words with equivalent meanings, following in its title.

Based on the given eligibility criteria, one of the authors searched databases including ERIC, JSTOR and Web of Science with the keywords “VR”, “EFL”, and “higher education” or the expressions with the same meanings. Additional records were identified by two of the authors identified by examining the websites of Computers & Education Journal, British Journal of Education Technology and Taylor and Francis and Google Scholar. Database records (n = 176) and additional records (n = 11) revealed potential articles for review (n = 31). The articles were screened in terms of eligibility criteria and duplicity, articles were removed accordingly. The final version of the list included articles reached (n = 21) and recorded in the analysis table. The articles were summarized under the titles of author(s)/publication year, purpose, participant(s)/context, method, results and discussion. Figure 1 summarizes the systematic review process followed for the study.

Figure 1.

Diagram of review process



3. Findings

The results of this systematic review about the VR use in higher education EFL courses are provided below under the titles of study context,

1. the aim of VR integration,
2. type of VR technology integrated,
3. strategies used,
4. effects on student performance and
5. future directions.

3.1. Study Contexts

Study contexts of the articles included in the review are presented in terms of participants (number, level and discipline), research design, the aim of VR integration, and factors investigated.

- As the number of participants were examined, it ranged from 20 students to 274 students in different studies.
- The level reported also varied from undergraduate to postgraduate among articles.
- The departments of the students participating in the reviewed studies could be classified as English Language Teaching (ELT), non-ELT, both, and not provided.
  As can be seen in Table 1, the studies mostly adopted
- experimental (n = 7) or
- quasi-experimental research design (n = 6).
  Different types of mixed-method research design were also reported to be used (n = 5) such as
- explanatory (Damio & Ibrahim, 2019; Ebadi & Ebadijalal, 2020),
- exploratory (Dolgunsöz et al., 2018) and
- pragmatic (Shadiev et al., 2020) in order to investigate VR in higher education EFL learning environments.
  Factors investigated in different studies include
- oral skills, writing skills, reading comprehension, vocabulary learning, culture learning, communication skills, attitudes, motivation, retention, problem-solving, decision making and presence.

Table 1.
Study contexts of the reviewed articles

Study	Participants	Research Design	Dependent Variables
Boetje and Ginkel (2020)	35 students graduate educational consultancy	experimental	oral presentation skills
Chen et al. (2021a)	84 students undergraduate engineering	quasi-experimental	vocabulary acquisition, motivation and problem-solving
Chen and Hsu (2020)	274 students - science and technology	quasi-experimental	vocabulary knowledge, listening and reading comprehension
Chen et al. (2021b)	42 students undergraduate -	experimental	English oral anxiety
Damio and Ibrahim (2019)	24 postgraduates TESL	explanatory mixed-method	students' attitudes

Dolgunsöz et al. (2018)	24 students undergraduate ELT	sequential exploratory mixed method	writing performance and remembering the details
Ebadi and Ebadijalal (2020)	20 students - non-language disciplines	sequential explanatory mixedmethods	oral proficiency
Franciosi (2017)	84 students undergraduate -	quasi-experimental	vocabulary learning
Gao et al. (2021)	50 students - -	experimental	culture learning
Liaw (2019)	20 students - -	-	intercultural communication
Lin and Wang (2020)	39 students - non-English departments	mixed-methods	creative self-efficacy intrinsic motivation
Linet al. (2021)	18 students - ELT	quasi-experimental	retention of visual decision making
Shadiev et al. (2020)	60 students - -	pragmatic mixed-methods	intercultural learning
Wang et al. (2017)	80 students - -	experimental	sense of presence in VR experiences
Wang et al. (2021)	98 students - -	experimental	reading comprehension, learning attitude, motivation, and anxiety
Wu et al. (2019)	47 students undergraduate -	quasi-experimental	communicative skills
Yeh et al. (2020)	60 students - -	-	intracultural learning
Yıldırım et al. (2019)	18 students - ELT	-	retention and decision making
York et al. (2021)	30 students 26 undergraduate 4 graduate computer science	experimental	foreign language anxiety
Yükseltürk et al. (2018)	62 students - -	quasi-experimental	attitude toward English, beliefs of self-efficacy
Zhang (2020)	100 students	experimental	spoken English

3.2. Independent Variable Analysis

Among twenty-one reviewed articles, seventeen of them aimed to integrate virtual reality. These studies varied in terms of VR integration purposes mainly focusing on interactivity (n = 5), content presentation (n = 4), game-based learning environment (n = 4), practice (n = 2) and design content (n = 2).

To suggest an interactive learning environment through VR, Gao et al. (2021) provided Christmas activities, Chen et al. (2021a) let students view and solve problem-based learning scenarios, Damio and Ibrahim (2019) supported students establish and develop communication environment with a native English-speaking instructor and Liaw (2019) provided a social networking site. In the study of Boetje and Ginkel (2020), the aim of the integration included feedback coupled with practice.

Table 2.
Aim of VR integration in the reviewed articles

Aim of VR Integration	Studies
To practice	Boetje and Ginkel (2020), Zhang (2020)
To create an interactive learning environment	Gao et al. (2021), Chen et al. (2021a), Chen et al. (2021b), Damio and Ibrahim (2019): Liaw (2019)
To present content	Dolgunsöz et al. (2018), Ebadi and Ebadijalal (2020), Lin et al. (2021), Yıldırım et al. (2019),
To watch and design content	Shadiev et al. (2020), Yeh et al. (2020)
To create a game-based learning environment	Chen and Hsu (2020), Franciosi (2017), Wang et al. (2017), Yükseltürk et al. (2018)

3.3. Type of VR Technology Integrated

As the virtual reality technology of the studies was analyzed, it can be concluded that virtual reality content was provided through various settings such as VR applications (n = 3), EduVenture® VR platform (n = 3), VR videos (n = 3), VR games (n = 2), Google Expeditions (n = 2), online platforms (n = 2), Google Tour Creator (n = 1), vTime social networking site (n = 1) and 3D virtual immersive simulation (n=1). Almost half of the studies developed their own VR environments (n = 8). Unity (n = 3) and Opensimulator (n = 1) were used to develop VR environment tools. In addition, Google Cardboards (n = 4), Samsung VR Goggles (n = 2), and HTC Vive (n = 1) were utilized as head-mouth display units. Kinect technology was also integrated to support VR games (Yükseltürk et al., 2018).

3.4. Strategies Used

A relatively small number of articles (n = 7) built the VR learning environment in conjunction with an instructional strategy among the articles reviewed. The instructional/learning methods used in conjunction with virtual reality for English learning were game-based learning (Chen & Hsu, 2020; Franciosi, 2017; Yükseltürk et al., 2018), peer-tutoring (Chen et al., 2021b), problembased learning (Chen et al., 2021a), situated learning (Zhang, 2020), dyadic learning (Lin et al., 2021), self-regulation (Chen & Hsu, 2020), scaffolding (Wang et at., 2021) and collaboration (Wu et al., 2019).

3.5. Effects on Student Performance

The effects of the virtual reality learning environments on student performance were investigated from different aspects; language skills and attitudes.

English speaking performance was the most frequently focused skill (n = 5) and almost all the studies reported a positive impact of VR on oral skills (Chen et al., 2021b; Boetje & Ginkel, 2020; Ebadi & Ebadijalal, 2020; Lin et al., 2021; Zhang, 2020). However, apart from suggesting a substantial potential for developing oral presentation skills, Damio and Ibrahim (2019) determined that VR speaking application is not the most effective technique to improve oral skills. Investigating the effect on cultural skills, virtual

reality integration was found to support both intracultural (Yeh et al., 2020) and intercultural (Liaw, 2019; Shadiev et al., 2020) skills. On the contrary, Gao et al. (2021) reported no effect of VR application use on cultural learning performance. Reading comprehension was investigated only by one of the studies and found to be positively affected by VR integration (Wang et at., 2021).

A positive impact on problem-solving (Chen et al., 2021a) and writing skills in terms of complicated vocabulary (Lin et al., 2021) were reported in VR-integrated EFL learning environments. Additionally, vocabulary learning was found to be developed through problembased virtual reality environment (Chen et al., 2021a) and supported with VR game-based learning (Franciosi, 2017). The study of Yildirim et al. (2019), on the other hand, revealed that VR videos have a positive impact on long-term retention despite having no additional effect on short-term retention compared with traditional videos.

The studies also focused on further aspects such as attitudes (n = 6), self-efficacy (n = 2) and motivation (n = 3) while investigating the effect of virtual reality in learning English as a foreign language. English learning attitude was reported to be positively affected through VR learning environments (Chen & Hsu, 2020; Ebadi & Ebadijalal, 2020; Wang et at., 2021; Yükseltürk et al., 2018) In specific, anxiety was reported to be reduced through VR learning environments (Chen et al., 2021a; Wang et al. 2021; York et al., 2021) but no statistically significant difference of impact was revealed when compared to video supported learning environments (York et al., 2021). For student motivation, contradictory results were reported as Chen et al. (2021a) and Wang et al. (2021) stated a significantly positive impact while Chen et al. (2021b) stated no significant impact on English learning motivation. Student self-efficacy was found to be increased through VR integrated learning settings (Chen et al., 2021a; Lin & Wang, 2020).

4. Future Directions

4.1. Combining VR Use with Instructional/Learning Strategies

A small number of articles among the interviewed ones designed the VR learning environment in combination with an instructional/learning strategy. VR is conflated with connecting to another gamified world with relatively little cost. Educators, however, do not put enough emphasis on instructional or learning strategies that might accompany the field practices. This triggers a low rate of learning performance, a loss of retention, and an absence of application in the target subject. As Robyler (2015) explains, technology makes sense as long as it is combined well with the appropriate instructional strategies and settings, and also high-quality instructional materials. Future research could be best drawn with the appropriate matching of instructional strategies with virtual reality integration.

4.2. VR Environment Development Based on Learning Needs

The findings of the study revealed that educators mostly developed their own VR materials. This implies that available mediums have obstacles to reaching intended instructional outcomes. In other words, VR environments that are not initially created by taking educational considerations into account may bring about challenges for better learning opportunities. Educators, thus, need to pay attention to how to transform the current environment or build a new periphery.

4.3. Utilizing Technology Integration Models

None of the reviewed articles reported to follow one of the technology integration frameworks such as PICRAT or SAMR. The models present a framework to integrate the technology into the learning environments in the most effective way. Educators could benefit better from VR by following steps of models or adjusting the integration based on the aims and activities. Future studies could be implemented by considering one of the technology integration models, which is likely to increase the effect sizes.

4.4. More Research on Writing Skills

A positive impact on writing skills in terms of complicated vocabulary (Lin et al., 2021) was reported in VR-integrated EFL learning environments. This rests on the fact that virtual worlds are designed with oral communication as well as a large body of short phrases. This makes elaboration on in-depth writing tasks difficult. In this respect, future directions can seek for an engaging way to transform writing tasks in a virtual environment.

4.5. Further Investigation of the Effects on Cultural Skills

Investigating the effect on cultural skills, virtual reality integration was found to support both intracultural (Yeh et al., 2020) and intercultural (Liaw, 2019; Shadiev et al., 2020) skills. On the contrary, Gao et al. (2021) reported no effect of VR application use on cultural learning performance. Further investigation on culture in VR can expand this discussion and allow researchers to draw meaningful conclusions.

4.6. Further Investigation of the Effects on Language Learning Motivation

For student motivation, contradictory results were reported as Chen et al. (2021a) and Wang et al. (2021) stated a significantly positive impact while Chen et al. (2021b) stated no significant impact on English learning motivation. Well-designed mixed-method research studies can add to the literature of motivation in VR. It would be better to analyze the motivation from varied aspects including self-determination, intrinsic and extrinsic motivation.

5. Discussion and Conclusion

From 2017 to 2022, this article has offered an outline of virtual reality in terms of improving learning English as a foreign language. The comprehensive review of the literature using the PRISMA technique revealed a total of 21 research studies that indicated a proper fit with the selection criteria.
The benefits of VR have been reported as being effective on students' performance by utilizing various instructional methods such as game-based learning, which refers to manipulating gaming elements and implementing them in authentic settings to engage learners, situated learning, which refers to cooperative and collaborative practice in meaningful contexts, scenario-based dyadic learning, which refers to learning through scenarios, and peer-tutoring, among others. The performance boost has been influential in improving predominantly speaking, reading, vocabulary retention, culture learning and problem solving as well as increasing motivation and self-efficacy.

Virtual reality integration into foreign language learning environments is exponentially growing (Parmaxi, 2020). It could be attributed to the fact that learning a foreign language requires time investment, persistence, concentration, and drive to acquire a language, which could be augmented through the affordances of virtual reality (Craddock, 2018). The affective aspect has long been an important component of foreign language instruction (Krashen, 1981). Thus, there is a strong need to contextualize the learning process to increase the sense of authentic situated learning. Many would argue that language learning occurs best in an actual environment. However, it is impossible for the majority of learners when considering the millions of people who struggle to learn a language in an artificial classroom environment. In this respect, VR offers real-life-like learning for those who are unable to be present in surroundings in which many native speakers are available in a meaningful context.

Another reason for the tremendous leap of VR is the gradual immersion by which students lose track of time and place and are engaged in another world rather than the actual one. Immersive simulations have been shown to foster constructivist learning and involvement of students via selfmonitoring and assessment (Yeh et al., 2020). A gamified scenario supports the positive attitudes towards the medium. Immersion also leads to a state of flow by providing a sense of control to users along with tasks to be completed (Chen & Hsu, 2020). This promotes entertainment in foreign language learning. Learners are, therefore, engaged in the learning process within strongly designed high-quality interactive visuals that attract learners.

In terms of the VR environment, it was outstandingly found that half of the studies took place in a virtual environment created by the researchers or users. This implies that the current virtual environment might not be appropriate for foreign language education since ready-made objects could be limited to achieve the instructional purposes of the subject. The premise that students learn better in a virtual environment mainly depends on to what extent the environment as the medium of learning is suitable for instructional purposes (Lin & Lan, 2015). It could be attributed to the fact that instructors feel more comfortable when they design a nearby environment based on students' profiles, subjects, and content (Lloyd et al., 2017). In addition, many open platforms allow users to create their own environment, which makes it more appealing for users. Therefore, it could be concluded that virtual reality presents an excellent landscape that could be adjusted according to users' decisions and be improved with a growth mindset.

It was also noticed that virtual learning embedded in mobile devices such as Google Cardboard and Samsung VR goggles received greater attention due to their relative ease of use and affordable prices, although the degree of immersion is not as deep as sophisticated headmounted displays such as HTC Vive or Oculus. These devices have accelerated massive expansion in the adoption of VR in daily life (Statistica, 2015) and make it possible for users to experience tasks that are hard to perform or access in daily life settings. They allow more inclusion compared to personal computers or game consoles (Wang, 2021). This is in line with the findings of York et al. (2021), who indicated relatively easy communication in VR.

It is noteworthy to observe a hype in game-based learning in virtual settings (Chen & Hsu, 2020; Franciosi, 2017; Yükseltürk et al., 2018). These are usually massively multiplayer games in which there are a great many three-dimensional avatars capable with abilities to complete tasks with a sense of community through communicating with others. That's to say, the high degree of the social environment in this kind of game offers unique opportunities to be employed for instructional purposes. The need for communication in following a game scenario drives user to develop a set of skills to survive until the end of the game. This notion proposes a better way to improve oral communication in terms of fluency and accuracy and constitutes evidence of transferability of skills (Wang et al., 2017).

6. Strengths and limitations

VR emerges as a recent innovation that engages users by manipulating virtual visualization strategies. That's to say, high-quality evidence pertaining to VR-assisted instruction is observed. Additionally, this paper presents tangible conclusions in terms of efficiency resulting from the use of VR. Involving an in-depth analysis of experimental research studies is the main strength of the current paper. The searching process was conducted by three researchers independently. The risk of bias was also considered while selecting articles.

The study is limited to the use of VR in foreign language education. The effects and trends in VR could be better understood by including the VR adoption within different fields of study. In addition, the selected studies are based on experimental research design, indicating robust findings. The type of research methods used in the studies might be diversified to gain better insights into VR. It is also hard to assess the grade differences due to insufficient number of articles emphasizing their association in performance and engagement. Last but not least, the results do not shed light on the comparisons of different VR environments in terms of user experience, effectiveness, and immersion.

Conflicts of interest

Ethical approval is not applicable, because this article does not contain any studies with human or animal subjects.

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