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Virtual reality in language learning: a systematic review and implications for research and practice

Antigoni Parmaxi

Cyprus University of Technology

The increasing popularity of Virtual Reality (VR) has provoked scholars' and educators' interest to explore its potential as a learning environment for various fields of education. Along this line, several literature reviews have analysed and synthesised the educational use of VR; however, scholar activity is lacking a recent review of VR on a specific field of interest such as language learning. Thus, this paper delineates the contour of scholarly literature on Virtual Reality as an emerging technology in language teaching and learning. Using seventeen high-impact journals and conferences in the fields of Computer-Assisted Language Learning and Educational Technology as a source, 26 scholarly manuscripts were retrieved from 2015-2018, analysed and synthesised under the following foci: (a) technologies used, language learning settings and duration of educational activities; (b) benefits and limitations from using VR as an educational tool in the language classroom; (c) future research directions regarding the educational use of VR based on the reviewed literature. Findings of this study demonstrate how virtual reality is utilised in language learning and capitalise features of VR employed for different types of activities. This paper argues that VR is an invaluable tool in the language classrooms but entails challenges regarding its technical configuration, as well as its pedagogical grounding. The study concludes with some discussion and implications for researchers and practitioners.

Keywords: virtual reality; VR; pedagogy; immersive VR; language learning; 21st century skills; Computer-Assisted Language Learning

1. Introduction

Virtual Reality (VR) is considered one of the emerging and highly promising technologies for learning and training (Yang, Chen, & Jeng, 2010; Parmaxi et al., 2013; Loup, Serna, Iksal, & George, 2016). The incorporation of the specific technology in the instruction confronts researchers with endless opportunities in terms of access to experiences that would be otherwise inaccessible (e.g. visit to the moon or standing in front of the muscular system). Even though several researchers have underlined the positive impact of VR in education, there is also evidence which demonstrates that teachers and trainers still hesitate to incorporate it in their teaching practice due to the need of advanced technical knowledge or the high cost of VR devices (Parmaxi, Stylianou, & Zaphiris, 2017).

The academic community has systematically aggregated VR research findings to gain a better understanding of how the specific technology is supporting learning and training programmes (Barbour, & Reeves, 2009; Dalgarno & Lee, 2010; Peterson, 2011; Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014); however, scholars are lacking a recent review of VR on a specific field of interest such as language learning. The most recent report on VR research and language learning comes from Merchant et al. (2014) who highlighted the importance of considering instructional design principles when designing virtual reality-based instruction. However, with the rapid advancement of VR, it is crucial to maintain an updated synthesised collection of research for the specific field, so that scholarly community can remain current with regards to the advancement of VR and its impact on students' learning. Moreover, it is of paramount importance for researchers to keep adding scholarly knowledge to the growing corpus of academic literature by investigating unexamined or under-examined questions surrounding VR. Given the increasing interest in studying the educational affordances of VR on a specific field of interest such as language learning, the author considers this work timely and relevant for researchers and practitioners.

This review captures the current state of the art in VR empirical research in the field of language learning from 2015 to 2018, aiming to map recent research findings and stimulate further inquiry for addressing current research challenges. More specifically, the current systematic literature review aims to:

- (a) map the technologies used for VR, the language learning settings being used and the duration of educational activities;
- (b) find potential benefits and limitations from using VR as an educational tool in the language classroom;
- (c) suggest future research directions regarding the educational use of VR based on the reviewed literature.

2. Methodology

Aiming at capturing a wide overview of the topic, articles published during the period 2015-2018 were searched electronically. Although the new generation of Virtual Reality was proposed in 2012, this study limited its timeframe to capture only recent development of VR. Figure 1 summarises the workflow regarding the three systematic review steps, together with their inputs and outputs. The methodology of this review was informed by previous studies such as Parmaxi and Zaphiris (2017) who reviewed the use of Web 2.0 technologies in the field of Computer-Assisted Language Learning (CALL); Spolaôr and Benitti (2017) who reviewed quantitatively assessed robots applications, grounded in learning theories, in tertiary institutions and Sourmelis et al. (2017) who systematically explored the use of Massively Multiplayer Online Role Playing Games (MMORPGs) in alignment with the 21st century skills.



Figure 1. Workflow of this systematic review.

2.1. Manuscripts identification

Aiming at understanding scholarly activity in the use of VR in language learning classroom, relevant manuscripts from January 2015 until September 2018 were selected which compiled the VR corpus. The corpus included research manuscripts related to the use of VR from fifteen high-impact journals in the fields of Computer-Assisted Language Learning (CALL) and Educational Technology and high impact conferences and journals from the IEEE database, a database that provides access to literature in engineering and technology. The selection of journals was informed by Smith and Lafford (2009) who evaluated scholarly activity in CALL aiming at ranking CALL-specific and applied linguistics journals based on the quality of their articles and their contribution to the field, as well as on the 2018 five-year h-index and h-median metrics of Google Scholar in the aforementioned fields. The following top ranked journals and conferences were selected for inclusion (See Table 1).

Table 1. Journals and conferences selected for identification of the VR corpus of manuscripts.

1.	Computers & Education
2.	British Journal of Educational Technology
3.	The Internet and Higher Education
4.	Journal of Educational Technology & Society
5.	Journal of Computer Assisted Learning
6.	The International Review of Research in Open and Distributed Learning
7.	Educational Technology Research and Development
8.	International Conference on Learning Analytics And Knowledge
9.	Australasian Journal of Educational Technology
10.	International Journal of Computer-Supported Collaborative Learning
11.	IEEE Transactions on Learning Technologies
12.	Language, Learning & Technology
13.	ReCALL
14.	Computer Assisted Language Learning
15.	CALICO Journal
16.	International Conference on Virtual System & Multimedia (VSMM)
17.	International Conference of Educational Innovation through Technology (EITT)

2.2. Search terms

Appropriate manuscripts for inclusion were selected via manual keyword search in manuscripts' title, abstract, and given keywords. The keywords derived from definitions of Virtual Reality in the literature and were grouped into two categories related to ("Virtual Reality") AND ("language learning"):

- 1) Virtual Reality related keywords: ("Virtual Environment" OR "immersive environment" OR "Virtual Reality Learning Environment" OR "Virtual Reality Environment" OR "virtual world" OR "VR" OR "VRLE" OR "virtual classroom" OR "virtual class")
- 2) Language learning related keywords: ("language learning" OR "computer assisted language learning" OR "technology-enhanced language learning" OR "language learning" OR "language courses" OR "language classroom")

2.3. Search results

The initial search yielded 34 manuscripts published between 2015-2018 that were related to the use of virtual reality in language learning.

2.4. Application of inclusion and exclusion criteria for refining the VR corpus

Studies were eligible for inclusion in the VR corpus if they conformed with the following criteria:

1. Include empirical data related to the application of Virtual Reality in a language course (thus literature reviews, editorials, or book/product reviews were excluded).
2. Date from January 2015 to September 2018
3. Belong to an academic venue and include an abstract

This stage facilitated the optimisation of the VR corpus, as we excluded articles that were incorrectly selected in the search process (false positives), as well as articles reporting on non-empirical studies. The final VR corpus included 26 manuscripts.

Table 2

Total number of papers identified from each journal/conference and number shortlisted as relevant.

Journal	Number of papers identified in the search	Number of papers meeting inclusion criteria
1. Computers & Education	1	1
2. British Journal of Educational Technology	1	1
3. The Internet and Higher Education	0	0
4. Journal of Educational Technology & Society	1	1
5. Journal of Computer Assisted Learning	0	0
6. The International Review of Research in Open and Distributed Learning	0	0
7. Educational Technology Research and Development	2	2
8. International Conference on Learning Analytics And Knowledge	0	0
9. Australasian Journal of Educational Technology	2	2
10. International Journal of Computer-Supported Collaborative Learning	0	0
11. IEEE Transactions on Learning Technologies	3	2
12. Language, Learning & Technology	8	5
13. ReCALL	14	7
14. Computer Assisted Language Learning	2	2
15. CALICO Journal	2	1
16. International Conference on Virtual System & Multimedia	1	1
17. International Conference of Educational Innovation through Technology (EITT)	1	1
Total	37	26

2.5. Screening and information retrieved

Each manuscript was carefully screened and information was retrieved related to publication identification, activities reported in the publication, educational basis of the publication and evaluation described in the publication (see Table 3). The four categories were adopted from Spolaôr and Benitti (2017) as they provide information extracted (IE) to synthesise the manuscripts and organise the results and discussion in the sections that follow.

Table 3. The four categories adapted from Spolaôr and Benitti (2017) for screening and retrieving information from the VR corpus.

Group 1. Publication identification	Group 2. Activities reported in the publication
IE1. Publication title IE2. Publication ID IE3. Year of publication IE4. Authors' name IE5. Students' educational institution IE6. Publication objective IE7. Publication source	IE8. Duration of Virtual Reality activities IE9. Virtual Reality used IE10. Knowledge areas/subjects taught through Virtual Reality IE11. Skills taught through Virtual Reality
Group 3. Educational basis of the publication	Group 4. Evaluation described in the publication
IE12. Learning theory used IE13. Justification for using the learning theory	IE14. Major findings IE15. Future directions

2.6. Synthesis strategy

The data retrieved were qualitatively synthesized under the items in section 2.5, following Spolaôr and Benitti's (2017) strategy. The synthesis was based on the information extracted (IE) from the selected papers (see supplementary data). The analysis of the VR corpus, shows some essential indications, that refer to our research queries:

- (a) map the use of VR technologies, the language learning settings and the duration of educational activities;
- (b) find potential benefits from using VR as an educational tool in the language classroom;
- (c) suggest future research directions regarding the educational use of VR based on the reviewed literature.

3. Findings

3.1 Use of VR technologies

The VR technologies used by researchers from the VR corpus vary. Fifteen studies (15/26 manuscripts) employed Second Life and five studies (5/26 manuscripts) employed OpenSimulator or customised virtual environments for meeting the needs of the specific course and students (for example, Zheng, Schmidt, Hu, Liu, & Hsu, 2017). Other studies employed a platform based on the cloud, a hybrid virtual environment which encompassed short video clips featuring virtual world avatars (4/26 manuscripts), or Google Street View virtual environment for exploring culture learning (1/26 manuscripts). A more sophisticated virtual reality system was also employed by Vázquez, Xia, Aikawa, and Maes (2018) and included a kinesthetic language learning platform for virtual reality that leveraged the connection between body and mind to enhance second language vocabulary acquisition (1/26 manuscripts)..

At this point, there is a need to distinguish between several kinds of VR technologies. Based on Ma and Zheng (2011), there are three distinguished types of immersive VR systems. A non-immersive VR system includes a desktop computer based 3D graphical system, allowing the user to go through the VE with the use of a keyboard, a mouse and a small computer screen. A semi-immersive system is an advanced system; where a graphical display is projected on a large screen. In a semi-immersive system there might be some forms of gesture recognition system for natural interactions. Finally, the third type of VR is fully-immersive head mounted system where users' vision is fully enveloped, creating a sense of full immersion. From the list of VR systems being employed in the VR corpus, there seems to be a lack of studies on fully immersive VR systems that can be more efficient in terms of learning and richer in terms of users' experiences. As low cost immersive systems are currently available (e.g. Google cardboards and Google Expeditions) they could provide an accessible immersive system to any language classroom and merit attention by future researchers and practitioners.

3.2 The language learning settings being used

The language learning settings in which VR was used again varied. With regard to students' educational institution (see Information Extracted 5, IE5, in Table 3), the majority of the studies included university students (12/26 manuscripts) followed by primary school students (6/26 manuscripts) and vocational training (5/26 manuscripts), whilst limited studies involved secondary (1/26 manuscripts) school students and early childhood education (1/26 manuscripts). One study did not refer to the setting where the study took place. Virtual reality opens up opportunities for innovation at all educational levels, thus more studies need to be pursued in primary and secondary education, with an eye to provide shareable knowledge to the scientific community.

3.3 Languages being explored

The majority of studies conducted had English as their target-language (16/26 manuscripts), either English as a Foreign Language (12/26 manuscripts), English for specific academic purposes (1/26 manuscripts), or English as a second language teacher training (1/26 manuscripts). Virtual exchanges were also of interest to the research corpus, where two languages have been explored (4/26 manuscripts). Less interest has been received for Spanish (2/26 manuscripts), Chinese (2/26 manuscripts), Japanese (1/26 manuscripts) and French (1/26 manuscripts) as a target-language.

3.3. Duration of the educational activities

With regard to the duration of the educational VR activities (IE8), the majority of the manuscripts employed VR for approximately 1-10 tasks or sessions. More specifically, the majority of the studies employed VR for up to 5 tasks or sessions (8/26 manuscripts), or for 6-10 tasks or sessions (6/26 manuscripts). Five studies (5/26) employed VR for 11-15 weeks and four (4/26 manuscripts) for 6-10 weeks. Only two studies (2/26) employed VR for more than 16 weeks, and only one (1/26) employed VR for less than 5 weeks. It is worth noting here that some studies referred to the overall duration of the VR project -rather than on the task or session of the VR task.

3.4 Skills being investigated

The language skills being investigated by the manuscripts in the VR corpus vary, from basic communication in the target language (e.g. Yamazaki, 2018) to communication for specific academic purposes (e.g. Park, 2018) or students' immersion and presence in a virtual environment (e.g. Wang, Petrina, & Feng, 2017). More specifically, the VR corpus has demonstrated that the majority of studies (8/26 manuscripts) deal with speaking and less studies deal with listening (2/26 manuscripts) or vocabulary (1/26 manuscripts). None of the studies investigated other language learning related skills such as writing or reading, but employed VR for communicative purposes either generic (3/26 manuscripts) or specific purposes (2/26 manuscripts). Twenty-first century skills, such as collaboration and cultural learning, are also under the microscope of researchers (3/26 manuscripts). For example, in the study of Zhang et al. (2016) the affordances of VR are being explored for supporting the needs of Chinese learners in western education with an eye to foster cross-cultural collaboration, and social inclusion. Six manuscripts (6/26) deal with more than one skill, for example Lan, Hsiao, and Shih (2018) studied vocabulary and sentence structure for Mandarin. Technology-related experience and more specifically immersion and presence is also being explored in only one manuscript (Wang, Petrina & Feng, 2017).

3.5 Benefits from using VR as an educational tool in the language classroom

Virtual Reality as an educational tool in the language classroom comes with both benefits and drawbacks. Scholars and practitioners see VR as an extraordinary means that can boost students' learning and reform the learning and teaching experience. Yet, both practitioners and researchers need to be aware of what VR has to offer, its limitations and delimitations. In other words, before delving into new education programs, we need to understand exactly what is that VR has to offer to the educator.

In general, the VR corpus demonstrates cases where the use of VR has brought significant increase not only in student learning, but also in the development of 21st century skills -for example, the study of Mroz (2015) found that the use of a collaborative virtual learning environment in which students had to communicate in the target language to solve a problem led to language gains and increased critical thinking skills for the participants. The potential of VR in providing access to places and situations hardly accessible in a traditional classroom has also been explored. Park (2018), for example, investigated

Virtual Reality as a means to assess aviation English. This study yielded positive impact of virtual reality, demonstrating that virtual interactive tasks in a virtual world facilitated the employment of a variety of strategy types as well as a positive relationship between participants' test scores and the number of cognitive and metacognitive strategies. On the other hand, the articles also demonstrate cases where the use of VR has not brought any significant increase in student learning, as can be observed in studies of specific situations. For example, the study of Tan, O'Halloran and Wignell (2016), raises the issue of the relative effectiveness of 3-D virtual worlds for language teaching and learning, putting forward the need to address the complexity of multimodal learning environments and the various challenges for CALL. Table 4 summarises the benefits of Virtual Reality, as they are reflected in the VR corpus. As demonstrated in the Table, Second Life provides a wide range of benefits in terms of authenticity in the assessment of target language, fostering interaction, motivation, task engagement, vocabulary acquisition and promotion of cultural learning and decrease Foreign Language Anxiety levels. Similarly, other Virtual Worlds (e.g. Virtual worlds developed in OpenSimulator) can cultivate communicative competence and learner autonomy, build a sense of immersion and presence and facilitate collaborative exchanges. Yet, limitations need to be noted for different types of VR and include unstable technical difficulties (Chen, 2016a) and lack of multimodal resources (Tan, O'Halloran & Wignell, 2016).

Table 4. Summary of benefits and limitations of VR aligned with the different types of VR system employed in the VR corpus.

Type of Virtual Reality	Benefits				Limitations
Second Life [15]*	Provide authentic assessment of target language (Park, 2018)	Promote cultural learning (Chen, 2018)	Offer oral practice in the target language (Chen, 2016a; Melchor-Couto, 2018; Lan, Kan, Sung & Chang, 2016)	Enhance vocabulary acquisition in the target language (Lan, Hsiao, & Shih, 2018)	Lack of multimodal resources (Tan, O'Halloran & Wignell, 2016)
	Enhance listening performance (Lan, Fang, Hsiao, & Chen, 2018)	Facilitate student participation through teacher's different discourse functions and roles (Wang, 2015)	Foster communicative competence (Lan, 2015; Hsiao, Kao, Tsai, Lin, & Lan, 2016)	Stimulate task-based interaction, enhance motivation and task engagement through meaningful and authentic communication tasks (Chen, 2016b)	Negative experience of VW anonymity by students with high self-efficacy beliefs (Melchor-Couto, 2018)
	Help students construct agentive experiences of storytelling (Liang, 2018)	Decrease Foreign Language Anxiety levels (Melchor-Couto, 2016)	Progress toward higher levels of critical thinking (Mroz, 2015)		Unstable technical difficulties (Chen, 2016a)

Virtual world developed in a platform for hosting virtual worlds (e.g. OpenSimulator) [5]	Develop sense of immersion and presence (Wang, Petrina & Feng, 2017)	Promote learner autonomy (Yeh & Lan, 2018)	Facilitate collaborative exchange (Zheng, Schmidt, Hu, Liu, & Hsu, 2017)	Acquire contextualized communicative competence (Yamazaki, 2018)	Time-consuming and complex tool in its alignment with pedagogical goals (Kozlova & Priven, 2015)
	Facilitate teacher training (Kozlova & Priven, 2015)				
Words in motion [1]	Promote vocabulary acquisition in the target language (Vázquez, Xia, Aikawa & Maes, 2018)				
Google Street View virtual environment [1]	Enhance cultural learning and raise positive attitudes towards the target culture (Shih, 2015)				
Combination of tools [4]	Facilitate collaborative exchange (Levak & Son 2016; Dooly & Sadler, 2016)	Promote cultural learning (Zhang, et al., 2016)		Enhance learning through immersion and immediate feedback (Guo & Chen, 2018)	

*Number of studies under each VR system.

3.6. Future directions

Based on the panorama of the literature on VR for language learning, future directions can be suggested.

A summary of suggestions for future research directions is provided below:

- a) *Real-life task design*: task design and its alignment with theory and pedagogy has been noted as an area that merits future attention. For example, the development of real-life tasks within a virtual world would allow for authentic language production in situations in which language learners would need to use the language, rather than performing mechanic, fill-in-the-gap activities. Moreover, the use of language in the case of teaching a language for specific academic purposes (e.g. English for aviation) merits more attention. Park (2018) notes the need to create real-life tasks in Virtual Worlds (VW) to motivate and encourage task-based researchers, language testers, and computer-assisted language learning practitioners.
- b) *Alignment of VR features with learners' strategies, cognitive processes and practices*: Scholars note the need to further explore the effects of the multimodal features afforded by VW, as well as the strategies employed and language used by learners in these worlds (Chen, 2016b; Shih, 2015; Chen, 2018). The development of a language meta-cognitive planning tool for assisting learners with the selection of online tools to enhance their learning based on their actual affordances is also recommended. In the area of virtual exchanges, Zheng, Schmidt, Hu, Liu and Hsu (2017) prompt future research to look into how participants engage in bi-directional exchange in 3D spaces and places, as well as other further exploration on the cognitive processes occurring in a VW in order to gain a deeper understanding of how people do things in virtual spaces.

- c) *Cross-discipline research*: Cross-discipline research, such as the cooperation among the researchers in e-learning, second language acquisition, and neuroscience research, is also suggested in order to gain knowledge from different perspectives to uncover the effects of virtual interaction on humans' learning (Lan, Fang, Hsiao, & Chen, 2018).
- d) *Large-scale studies*: Researchers raise the need for large-scale studies that will involve larger samples (Park, 2018; Melchor-Couto, 2018; Lan, Fang, Hsiao, & Chen, 2018; Yamazaki, 2018; Lan, Hsiao, & Shih, 2018) for a longer period of time (Lan, Fang, Hsiao, & Chen, 2018) in different contexts (Lan, 2015). More research is also sought on the combination of technology development and teacher professional development (Yeh & Lan, 2018) with large samples of trainers in different contexts (Kozlova & Priven, 2015).
- e) *Intercultural enhancement*: Levak and Son (2016) call for further research on the potential of Second Life to enhance intercultural schema and to reduce culture shock, and the strategies that pertain to virtual worlds and how they are used. On the same line, Shih (2015) points to the need for further research into the similarities and differences between virtual and real-world cultural experiences.
- f) *Experimental studies*: Researchers also invite further experimental studies (Lan, 2015; Lan, Kan, Sung, & Chung, 2016) in order to strengthen the internal validity of their findings using, for example, pretest-posttest and control groups. For example, Lan, Kan, Sung, and Chung (2016) call for future experimental studies for understanding (a) the effects of task complexity on language learning, (b) the correlation between the characteristics of language tasks and learners' skills, (c) the effects of the language environment outside the classroom on learners' performances and motivation in virtual worlds, and (d) the correlation of learning styles and their performance and motivation in virtual worlds. Moreover, there is a need for the development of standardized tests, if the impact of VR is to be assessed.
- g) *21st century skills*: Future research on 21st century skills and more specifically on Critical Thinking is also sought (Mroz, 2015). Moreover, future research is needed to investigate further the impact of Virtual Worlds on the social aspects of collaborative learning in these worlds.
- h) *Design principles for accessible and effective virtual worlds*: Lan, Hsiao, and Shih (2018) invite further investigation on increasing accessibility to VW for people with disabilities. More specifically, there is a need to obtain more detailed design principles for turning 3D virtual worlds into a more effective learning environment for disabled learners.
- i) *Kinesthetic virtual reality*: Vázquez, Xia, Aikawa, and Maes (2018) suggest additional research on kinesthetic language learning in virtual reality that can positively impact language education.
- j) *Innovation in all levels of education*: The majority of the studies from the VR corpus have taken place in tertiary education. However, all levels of education can be appropriate places for innovation. Thus, new approaches to integrate virtual reality in teaching in all educational levels should be pursued, with an eye to provide shareable knowledge with the scientific community.
- k) *Affordable Virtual Reality*: The majority of studies in the VR corpus have used Second Life. Additional research with Virtual Reality needs to take place with low cost virtual reality (e.g. Google cardboards) using trending topics and providing access to immersive virtual reality experiences (e.g. through Google Expeditions). Such studies need to assess these tools as educational supporting tools in real-life classrooms.
- l) *Fully-immersive virtual experiences*: Current literature on VR for language learning is focusing mainly on non or semi immersive VR. Thus more research is needed on fully immersive systems that are currently available which can provide a richer and more efficient learning experience. Moreover, further empirical research on the measurement of immersion and presence and the investigation on the relationship between immersion/presence and learning is also needed (Wang, Petrina, & Feng, 2017).

4. Discussion-Conclusion

This work provided a panorama of virtual reality in language learning from 2015-2018. In the end, 26 papers that met all selection criteria were selected for inclusion in the VR corpus. Potential benefits indicated in the VR corpus, in terms of learning and skills improvement, were synthesised. It was noted that virtual reality provides ample opportunities for supporting language learning and teaching, as well as for supporting skills and competences not directly related to language learning but necessary for 21st century learners such as teamwork, autonomy and cultural awareness. The VR corpus has also

demonstrated the limited usage of fully-immersive VR in language learning, noting the need to shift from technologies that can not afford full immersion of the learner to fully immersive technologies. Moreover, better alignment of the affordances of these tools with pedagogy and learning theories is also sought in order to allow for pedagogically solid implementations.

As VR technologies continue to grow, their potential is promising in providing a dynamic learning experience. Recent studies employed spherical video-based virtual reality (SVVR) applications which harness 360-degree videos or photos for representing the virtual environment that can be viewed through a head-mounted display. For example, Chien, Hwang and Jong (2020) demonstrated that the use of SVVR system for English-speaking training with the peer assessment approach can enhance English-speaking performance, motivation and critical thinking. On the same line, Sun, Pan, Wan, Li, and Wu (2018) demonstrated that placing students in SVVR environments impacted positively on their higher order thinking.

The rapid advancement of the features of VR renders innumerable possibilities for language instructors. The main contribution of the present study is to show that VR has a growing potential in the language classroom. Areas that merit attention by future researchers and practitioners pertain to the alignment of the features of VR with a sound pedagogical background, alignment of VR features with learners' strategies, cognitive processes and practices, investigation of less-researched skills such as writing, reading, cultural awareness and critical thinking, as well as the employment of fully-immersive, affordable virtual technologies.

Implications for researchers

The use of virtual worlds by researchers has given a wide range of benefits. Still there are gaps that merit attention and future research is sought for informing future scholarly activity. Most studies in the VR corpus employed short-term programmes in specific contexts. Future studies should extend the duration and sample of the studies, providing opportunities to understand the long term effects of VR interventions. In addition, more quantitative studies are needed for understanding the effect of the use of virtual reality. Moreover, future research is also needed to explore and align the affordances of VR with specific pedagogically grounded tasks. As noted by Peterson (2011, p. 78) "the new forms of interaction made possible by virtual worlds, remain to a significant degree, unexplored". As these technologies offer great opportunities for students pertaining to language learning and 21st century skills, future studies might contribute in understanding which specific features of virtual worlds can contribute to the enhancement of specific skills. The investigation of less-researched skills such as writing, reading, cultural awareness and critical thinking, should also be added in the future agenda of the scholarly community. Existing research also pays little attention to low-cost fully immersive virtual reality. Researchers should increasingly acknowledge the impact of immersive virtual reality systems as a tool that can enrich the learning experience and provide real-life simulations within the classroom walls. Thus, there is a need for further research investigating the issues and barriers for using low-cost fully immersive virtual worlds in the classroom.

In addition, the possibilities offered by 3D learning objects and mixed reality education spaces, that is spaces combining both virtual and augmented reality techniques, need more attention in future research as they can provide a dynamic, affordable and multi-sensory learning experience (see for example, Campbell, Santiago, Hoo, & Mangina, 2016; Mangina, 2017). Such environments have the potential to offer high quality experiential learning, going beyond traditional, passive teaching and learning environments and may engage learners actively in multi-sensory digital learning ecosystems (Mangina, 2017).

Implications for practitioners and policymakers

The excellent potential of virtual worlds offers educators plentiful opportunities for new ventures in their classrooms. More practical implementations are needed in real-life classrooms in order to fully understand the use of virtual worlds for enriching the classroom environment. Collaborative virtual reality experiences need further exploration in order to understand patterns of collaboration in such environments. Furthermore, applying virtual reality under well-established theoretical frameworks and methodologies can sustain the assumption that application of virtual worlds under well-established theoretical frameworks support learning outcomes. Moreover, instructional designers and interface architects need to further explore the design of virtual experiences that will be accessible by the elderly and people with disabilities. Specific features of VWs also need further attention in order to contribute to the enhancement of specific skills such as reading and writing. Examiners may also consider the development of real-life tasks in VWs, whilst course leaders can enrich their classroom environment

with collaborative VR experiences. Moreover, the potential of futuristic applications of emerging technologies such as VR for Special Educational Needs students merits more attention as they are a fertile ground for building personalized environments for students, whilst it helps educators and policy makers to better meet their students' needs (Mangina, Chiazzese, & Hasegawa, 2018; Luna, Treacy, Hasegawa, Campbell, & Mangina, 2018; Chiazzese, et al., 2018).

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References

- Barbour, M. K., & Reeves, T. C. (2009). The reality of virtual schools: A review of the literature. *Computers & Education*, 52(2), 402-416.
- Campbell, A. G., Santiago, K., Hoo, D., & Mangina, E. (2016). Future mixed reality educational spaces. In *2016 Future Technologies Conference (FTC)* (pp. 1088-1093). IEEE.
- Chen, J. C. (2016a). The crossroads of English language learners, task-based instruction, and 3D multi-user virtual learning in Second Life. *Computers & Education*, 102, 152-171.
- Chen, J. (2016b). EFL learners' strategy use during task-based interaction in Second Life. *Australasian Journal of Educational Technology*, 32(3), 1-17.
- Chen, J. C. (2018). The interplay of tasks, strategies and negotiations in Second Life. *Computer Assisted Language Learning*, 31(8), 960-986.
- Chiazzese, G., Mangina, E., Chifari, A., Merlo, G., Treacy, R., & Tosto, C. (2018). The AHA Project: An Evidence-Based Augmented Reality Intervention for the Improvement of Reading and Spelling Skills in Children with ADHD. In *International Conference on Games and Learning Alliance* (pp. 436-439). Springer, Cham.
- Chien, S. Y., Hwang, G. J., & Jong, M. S. Y. (2020). Effects of peer assessment within the context of spherical video-based virtual reality on EFL students' English-Speaking performance and learning perceptions. *Computers & Education*, 146, 103751.
- Dalgarno, B., & Lee, M. J. (2010). What are the learning affordances of 3-D virtual environments?. *British Journal of Educational Technology*, 41(1), 10-32.
- Dooly, M., & Sadler, R. (2016). Becoming little scientists: technology enhanced project-based language learning. *Language Learning & Technology*, 20(1), 54-78. Retrieved from <http://ilt.msu.edu/issues/february2016/doolysadler.pdf>
- Howard, M. C. (2017). A meta-analysis and systematic literature review of virtual reality rehabilitation programs. *Computers in Human Behavior*, 70, 317-327.
- Spolaôr, N., & Benitti, F. B. V. (2017). Robotics applications grounded in learning theories on tertiary education: A systematic review. *Computers & Education*, 112, 97-107.
- Kozlova, I., & Priven, D. (2015). ESL teacher training in 3D virtual worlds. *Language Learning & Technology*, 19(1), 83-101. Retrieved from <http://ilt.msu.edu/issues/february2015/kozlovaprive.pdf>
- Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, 23(4), 1515-1529.
- Lan, Y. J., Kan, Y. H., Hsiao, I. Y., Yang, S. J., & Chang, K. E. (2013). Designing interaction tasks in Second Life for Chinese as a foreign language learners: A preliminary exploration. *Australasian Journal of Educational Technology*, 29(2).
- Lan, Y. J., Fang, W. C., Hsiao, I. Y., & Chen, N. S. (2018). Real body versus 3D avatar: the effects of different embodied learning types on EFL listening comprehension. *Educational Technology Research and Development*, 66(3), 709-731.
- Lan, Y. J., Kan, Y. H., Sung, Y. T., & Chung, K. E. (2016). Oral performance language tasks for CSL beginners in Second Life. *Language Learning & Technology*, 20(3), 60-79. Retrieved from <http://ilt.msu.edu/issues/october2016/lanetal.pdf>
- Levak, N., & Son, J. B. (2017). Facilitating second language learners' listening comprehension with Second Life and Skype. *ReCALL*, 29(2), 200-218.
- Lan, Y. J. (2015). Contextual EFL learning in a 3D virtual environment. *Language Learning & Technology*, 19(2), 16-31.

- Lan, Y. J., Hsiao, I. Y., & Shih, M. F. (2018). Effective Learning Design of Game-Based 3D Virtual Language Learning Environments for Special Education Students. *Journal of Educational Technology & Society*, 21(3).
- Liang, M. Y. (2018). Beyond elocution: Multimodal narrative discourse analysis of L2 storytelling. *ReCALL*, 1-19.
- Loup, G., Serna, A., Iksal, S., & George, S. (2016, September). Immersion and persistence: improving learners' engagement in authentic learning situations. In *European Conference on Technology Enhanced Learning* (pp. 410-415). Springer, Cham.
- Luna, J., Treacy, R., Hasegawa, T., Campbell, A., & Mangina, E. (2018, August). Words Worth Learning-Augmented Literacy Content for ADHD Students. In *2018 IEEE Games, Entertainment, Media Conference (GEM)* (pp. 1-9). IEEE.
- Ma, M., & Zheng, H. (2011). Virtual reality and serious games in healthcare. In *Advanced Computational Intelligence Paradigms in Healthcare 6. Virtual Reality in Psychotherapy, Rehabilitation, and Assessment*, 169-192. Springer Berlin Heidelberg.
- Matsangidou, M., Ang, C. S., & Sakel, M. (2017). Clinical utility of virtual reality in pain management: a comprehensive research review. *British Journal of Neuroscience Nursing*, 13(3), 133-143.
- Parmaxi, A., Stylianou, K., & Zaphiris, P. (2017, September). Leveraging Virtual Trips in Google Expeditions to Elevate Students' Social Exploration. In *IFIP Conference on Human-Computer Interaction* (pp. 368-371). Springer, Cham.
- Parmaxi, A., & Zaphiris, P. (2017). Web 2.0 in computer-assisted language learning: a research synthesis and implications for instructional design and educational practice. *Interactive Learning Environments*, 25(6), 704-716.
- Peterson, M. (2011). Towards a research agenda for the use of three-dimensional virtual worlds in language learning. *Calico Journal*, 29(1), 67.
- Mangina, E. (2017). 3D learning objects for augmented/virtual reality educational ecosystems. In *2017 23rd International Conference on Virtual System & Multimedia (VSMM)* (pp. 1-6). IEEE.
- Mangina, E., Chiazese, G., & Hasegawa, T. (2018, December). AHA: ADHD Augmented (Learning Environment). In *2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALe)* (pp. 774-777). IEEE.
- Melchor-Couto, S. (2018). Virtual world anonymity and foreign language oral interaction. *ReCALL*, 30(2), 232-249.
- Melchor-Couto, S. (2017). Foreign language anxiety levels in Second Life oral interaction. *ReCALL*, 29(1), 99-119.
- Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, 70, 29-40.
- Mroz, A. (2015). The development of second language critical thinking in a virtual language learning environment: A process-oriented mixed-method study. *calico journal*, 32(3).
- Shih, Y. C. (2015). A virtual walk through London: culture learning through a cultural immersion experience. *Computer Assisted Language Learning*, 28(5), 407-428.
- Sourmelis, T., Ioannou, A., & Zaphiris, P. (2017). Massively Multiplayer Online Role Playing Games (MMORPGs) and the 21st century skills: A comprehensive research review from 2010 to 2016. *Computers in Human Behavior*, 67, 41-48.
- Sun, F. R., Pan, L. F., Wan, R. G., Li, H., & Wu, S. J. (2018). Detecting the effect of student engagement in an SVVR school-based course on higher level competence development in elementary schools by SEM. *Interactive Learning Environments*, 1-14.
- Tan, S., O'Halloran, K. L., & Wignell, P. (2016). Multimodal research: Addressing the complexity of multimodal environments and the challenges for CALL. *ReCALL*, 28(3), 253-273.
- Vázquez, C., Xia, L., Aikawa, T., & Maes, P. (2018, July). Words in Motion: Kinesthetic Language Learning in Virtual Reality. In *2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT)* (pp. 272-276). IEEE.
- Wang, Y. F., Petrina, S., & Feng, F. (2017). VILLAGE—Virtual Immersive Language Learning and Gaming Environment: Immersion and presence. *British Journal of Educational Technology*, 48(2), 431-450.
- Wang, A. (2015). Facilitating participation: Teacher roles in a multi-user virtual learning environment. *Language Learning & Technology*, 19(2), 156-176. Retrieved from <http://ilt.msu.edu/issues/june2015/wang.pdf>

- Yamazaki, K. (2018). Computer-assisted learning of communication (CALC): A case study of Japanese learning in a 3D virtual world. *ReCALL*, 30(2), 214-231.
- Yeh, Y. L., & Lan, Y. J. (2018). Fostering student autonomy in English learning through creations in a 3D virtual world. *Educational Technology Research and Development*, 66(3), 693-708.
- Zheng, D., Schmidt, M., Hu, Y., Liu, M., & Hsu, J. (2017). Eco-dialogical learning and translanguaging in open-ended 3D virtual learning environments: Where place, time, and objects matter. *Australasian Journal of Educational Technology*, 33(5).