A Review of 3D Virtual Environments for Language Learning: New Teaching Practice and Research Trend

Chun-Ping ZHENG*, Ling-Yu XU, Meng-Ya GAO, Qian-Qian CHENG, Zi-Tong YANG & Li-li WANG
School of Humanities, Beijing University of Posts and Telecommunications, China
*zhengchunping@bupt.edu.cn

Abstract: Three dimensional virtual environments (3DVEs) have been noted as effective learning space for promoting learners' language acquisition and academic performance. This paper reviewed a total of 33 empirical studies published in the *Language Learning & Technology, ReCALL, Computer-assisted Language Learning, System, CALICO Journal and Computers & Education* from 2010 to 2017. At first, the current study explored the yearly publication trend of the journals and the research productivity of different countries. Then, based on systematic content analyses, the present paper shows that a majority of the studies employed the mixed research method and only a few articles adopted pure quantitative or qualitative method. The potential affordances of the 3DVEs include enhancing language learners' overall language proficiency, language performance or target language output as well as non-linguistic knowledge and skills. Drawing upon the synthesized research findings, we claim that the 3DVE has become a burgeoning area of research with great potential for innovating language education. Pedagogical implications were summarized and suggestions for future pedagogical innovations were also discussed at the end.

Keywords: Content analysis; three dimensional virtual environments (3DVEs); language education; virtual reality; augmented reality

1. Introduction

With the unprecedented momentum of technological development, scholars are calling for a better understanding of applying emerging technologies for educational purposes. Three dimensional virtual environments (3DVEs) or virtual world (VW) have been noted as positive learning space which promotes learners' knowledge construction and meaningful learning. The newest generation of virtual environments was featured by multiple interaction channels, such as voice or video-based synchronous online communication, simulated avatars, and virtual reality systems (Shih, 2014). Compared with conventional text-based or voice-based CMC technology, these innovative technologies provided more possibilities for transformative language learning and teaching, facilitating the transmission of symbols to convey users' meaning (e.g., Shih, 2014; Stevens, 2006). These innovations also represent major improvements upon traditional classroom settings which usually cannot create authentic or required conditions for specific language learning contexts (Chen et al., 2011; Clarke, Dede, & Dieterle, 2008).

2. Research Methodology

The 3DVEs refer to "immersive, three-dimensional (3D), multimedia, and multi-person simulation environments, where each participant adopts an alter ego and interacts with the world in real time" (Wagner and Ip, 2009, p. 250). In the field of applied linguistics, the application of 3DVEs is still an emerging research topic. Peterson (2012) made a preliminary comparison between the 2D virtual worlds and the 3DVEs and revealed the superior characteristics of the latter learning environment: (1) 3D interfaces with high representational fidelity may improve learner engagement; (2) multiple communication channels (synchronous and a synchronous textual, audial or visual interactions) could

promote target language production; (3) virtual representation of language learners (usually in the form of avatars) improve learners' social presence, alleviate their foreign language anxiety and further motivate their TL learning. 3DVEs were perceived as "stimulating environment for learners to undertake a range of beneficial forms of social interaction involving collaborative dialogue in the Target Language (TL)" (Peterson, p. 37). The use of 3DVEs in CALL has becoming an increasingly interesting topic and researchers are calling for more further research on how this dynamic and interactive context could enhance learners' target language development (Peterson, 2012). Since there are still few systematic review studies on the use of virtual environments for foreign language learning and teacher, this study aims to reveal the general publication trend of the studies published in key CALL journals from 2010 to 2017. Moreover, we are going to analysis the affordances of 3DVEs for linguistic and non-linguistic knowledge and skills.

3. Methodology

3.1 The process of identifying journals

This research adopted the systemic content analysis as the major method for reviewing studies. We selected six representative refereed journals in the field of technology-enhanced education, in particular, language learning as follows: Language Learning & Technology (LLT), The Journal of EUROCALL (ReCALL), Computer Assisted Language Learning (CALL), The CALICO Journal (CALICO), System (System), Computers & Education (C&E).

Drawing upon the selection criteria by Hsu, Hung and Tsai (2013), we select the above six journals with following features:

- All the journal articles are fully refereed;
- All the journals have a strong devotion to the application of technology for educational purposes, and the first four journals have a particular focus on the application of technology to language teaching and learning;
- Five of the journals are indexed in Social Science Citation Index (SSCI), and the CALICO journal is also chosen for its professional reputation in the field of computer-assisted language learning;
- All the journal articles are published in English;
- All the journals have international readership and authorship.

3.2 The process of data coding and data analyses

In the first stage, we formed a panel of five researchers, one senior researcher and four assistant researchers in the field of CALL. The researchers manually screened publications (from 2010 to 2017) in the above six journals by referring to the titles and the abstracts. When extracting articles, we only selected regular full-length research articles, excluding book reviews, technical reports or commentaries. Moreover, we only screened articles involve two sets of key words: (1) 3D virtual/interactive learning environments, virtual reality (VR), virtual worlds, virtual characters or Second Life; (2) target/foreign language (such as English, French, etc.), (first/second/foreign) language teaching (teachers), (first/second/foreign) language learning (learners), (second/foreign) language education or computer-assisted language learning (CALL). Since the application of virtual reality technology to language education is still a burgeoning research area, only 37 journal articles were identified after the first stage.

In the second stage, we followed the coding framework by Chai, Koh and Tsai (2013), integrating with the analytical framework summarized by Macaro, Handley and Walter (2012), and postulated the preliminary framework for content analysis. Then, we divide the four assistant researchers into two groups (two people in one individual group), and asked them to use the preliminary framework for initial article analysis. Researchers in each group were asked to code the articles independently, without any discussion before the final coding was completed. One article from each of the above journals was selected, and in total six articles were piled for the initial analysis. After the researchers completed the preliminary coding, disagreement and revising suggestions for the analytical framework were proposed for the whole panel discussion. The disagreements were resolved and revision upon the preliminary

analytical framework was amended after the panel discussion. The following table shows the finalized coding framework for in-depth content analysis.

In the third stage, the research panel followed the coding process in the preliminary analysis stage and completed the coding based on the finalized coding scheme. The disagreements were discussed and further resolved in the end. To identify three major types of language play and their subcategories, I, the author, independently coded individual students' data with the help of one trained research assistant. We then discussed data turn by turn by looking at their previous and subsequent discourse.

The Social Science (SPSS 22.0) and Nvivo 11.0 were used to conduct the content analysis in this study. The SPSS was used to do the descriptive data analysis for the coded items.

4. Results

4.1 Number of empirical studies published from 2010 to 2017

According to Table 1, there are in total of 33 empirical studies related to the applications of 3D virtual environments for language learning published in the six journals during 2010 to 2017. In the past eight years, Computers & Education (C&E) and Computer Assisted Language Learning published the largest number of studies (eight studies each). As further indicated by Figure 1, all the six journals have papers published concerning the applications of virtual learning environments to the language education. The solid lines show the yearly publications in the six journals while the dotted line indicates the total number of publications in the six journals. It's quite obvious that the total number of articles published concerning the integration of 3DVEs to language learning is still quite small, largely due to the virtual reality as an emerging technology and its well-recognized complexity of being integrated to the language classrooms (e.g., Kramsch & Steffensen, 2008; Mroz, 2015). Moreover, the year of 2016 witnessed the largest number of publications, in which, seven studies were published in five journals.

Table 1

Numbers of empirical studies published by six journals (2010 to 2017)

	2010	2011	2012	2013	2014	2015	2016	2017	Total
Computers & Education	1	2	0	1	1	0	1	2	8
Computer Assisted Language Learning	1	2	2	1	0	1	1	0	8
Language Learning & Technology	0	1	0	0	1	3	2	0	7
ReCALL	1	0	2	2	0	0	2	0	7
System	0	0	0	0	1	0	0	0	1
The CALICO Journal	0	0	0	0	0	1	1	0	2
Total	3	5	4	4	3	5	7	2	33

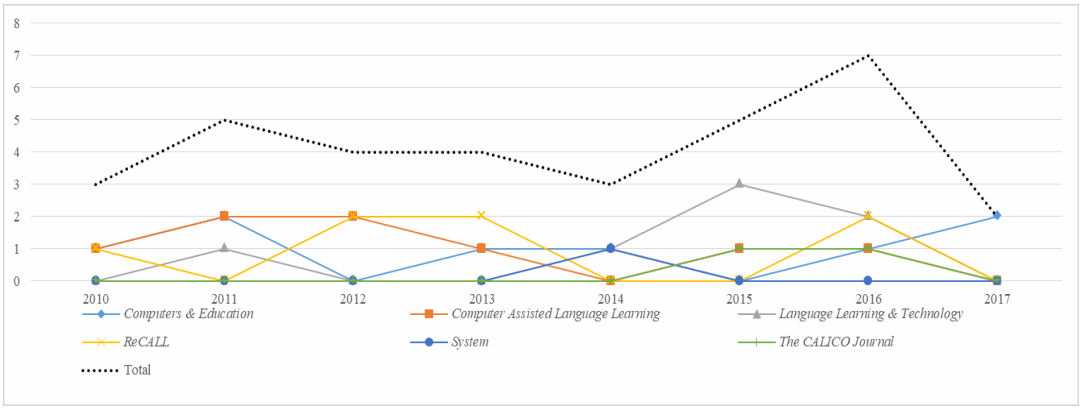

Figure 1. Numbers of empirical studies published by six journals (2010 to 2017).

4.2 Number of empirical studies published from 2010 to 2017

Figure 2 presents the countries or regions of the first author for the 33 empirical studies. It is quite interesting to see that thirteen studies were contributed by scholars from Taiwan, which accounts for over one third of the research in the previous seven years. Researchers from the US (four studies) and Japan (three studies) were also quite active in exploring the application of 3DVEs in language learning. No related investigations were contributed by authors from developing countries. In general, use of styles rather than manual formatting is preferable to enable us to give the proceedings a uniform appearance.

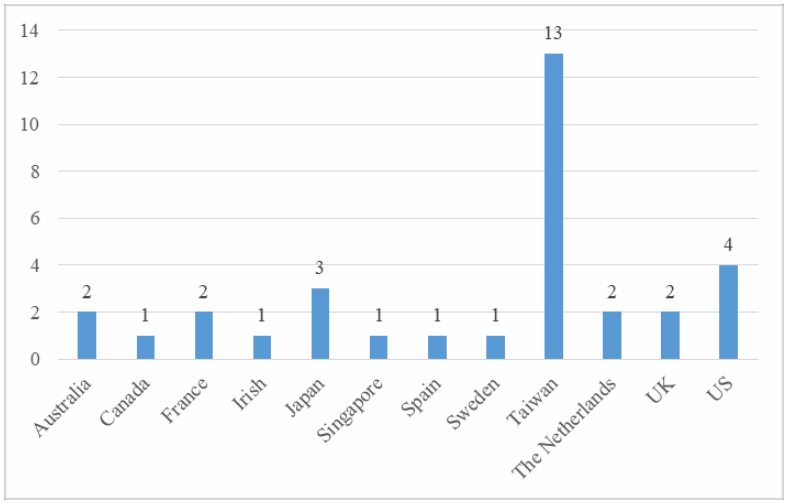

Figure 2. The country or region of the first author

4.3 Research sites of the empirical studies from 2010 to 2017

Quite similar to the Figure 2, about one third of the empirical studies were carried out in Taiwan (thirteen studies). Four studies were conducted in the US, three studies in Japan, and two in the Netherlands and Australia respectively. Morton and Jack (2010) conducted the only cross-country study and evaluated the application of a 3D virtual environment among French language learners in Scotland and EFL learners in mainland China. The environment combines "virtual worlds and virtual agents with automatic speech recognition technology" (Morton & Jack, 2010, p.296), and provides language learners with a unique platform for both verbal and non-verbal communications. Their study further investigated learners' attitudes and motivations towards the environment and the nature of learner discourses when interacting with others within the virtual setting.

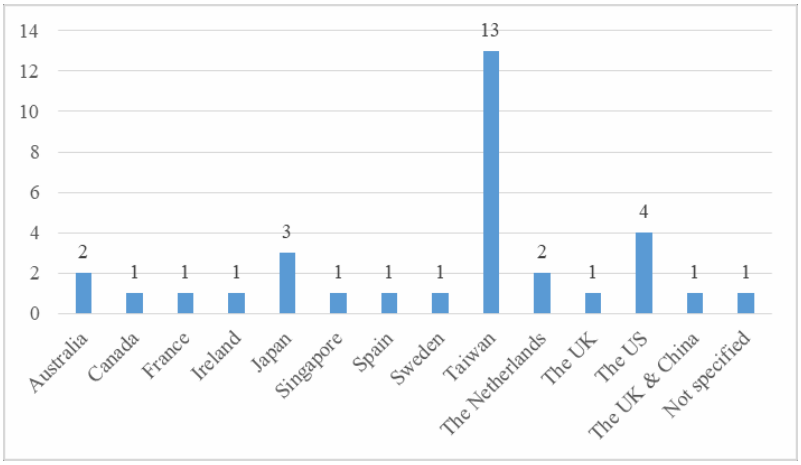

Figure 3. The research sites of the empirical studies

4.4 Target languages of the empirical studies from 2010 to 2017

As suggested in Figure 4, among the 33 empirical studies, it is quite obvious that English is the dominant target language (16 studies). English has already become the lingua franca of the world and its popularity in

the academic, economic and technological field has been well accepted (e.g., Lan, 2015; Lan, Sung, & Chang, 2007; Su, 2006). Therefore, how to learn English well with emerging technologies will still remain as the central topic in the field of CALL.

Worthy of note is that a sizable amount of research (five studies) has explored how to learn Spanish with VR technologies. Three studies explored learning Chinese in 3DVEs and since Chinese is gaining more popularity and we expect the related research may increase in the next few years. Five studies addressed the language education among speakers of different languages. For instance, Levak and Son (2017) investigated the effectiveness of using Second Life and Skype for improving Croatian and English language leaners' listening comprehension. Jauregi, Graaff, and Canto (2011) reported learners' experience in a two-year cross-cultural language exchange project, in which sixty interactional tasks were designed for learners of Dutch, Portuguese, Russian and Spanish. In their study, positive negotiations of social and cultural meanings were revealed through the cross-cultural interactions between language learners and native student teachers.

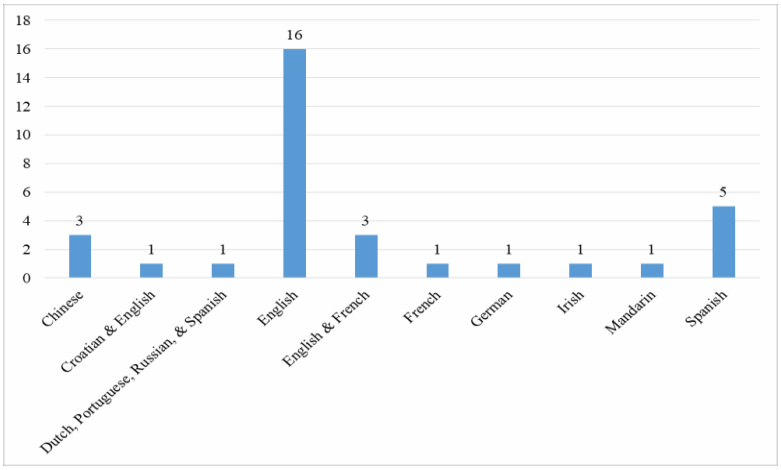

Figure 4. The target language of the empirical studies

4.5 Research settings of the empirical studies from 2010 to 2017

More than half of the articles we reviewed were conducted in high education settings, indicating the popularity of applying the 3DVEs to the language education among adult students. It is easy to understand since adult learners may be more familiar with 3DVEs or be more competent with new technological innovations. An interesting research trend is that researchers have started to realize the potential effectiveness of applying VR or more recently, AR technologies to promoting young learners' performance in learning language (either their mother tongues or a second or foreign language).

As indicated in Figure 5, five studies were conducted in the primary education setting while three studies were carried out in secondary education setting. As Lan (2015) summarized, although plenty of research has focused on the possibility of applying VR technologies, particularly game-based role playing for enhancing language learners' performance, few studies focus on supporting students in elementary schools to improve their self-directed learning. She further proposed three key design principles ("Individuality," "adaptability," and "scaffolding") for improving elementary students' performance in a VR-supported contextual learning environment, providing learners with more individualized and flexible learning experiences. Dalton and Devitt (2016) adopted an action research approach and further elaborated children's learning experience of and attitudes towards 3DVEs. Their findings further indicate that child language learners may prefer a more game-like 3DVE with clearly defined learning objectives and tasks (Dalton & Devitt, 2016). Cheng and Tsai (2014) explored children and parents' reading of picture books equipped with augmented reality (AR) technology, and revealed four interesting behavioral patterns as well as their corresponding cognitive attainment. As they suggested, more studies should be conducted to investigate factors that may affect children's learning behaviors when traditional learning materials integrated with VR or AR technologies (Cheng & Tsai, 2014). Hsu (2017) investigated learners variables, such as cognitive load, foreign language anxiety and effectiveness of learning among third-graders in primary school and offered experimental data for a better understanding of children learners' learning styles when engaged in AR educational games.

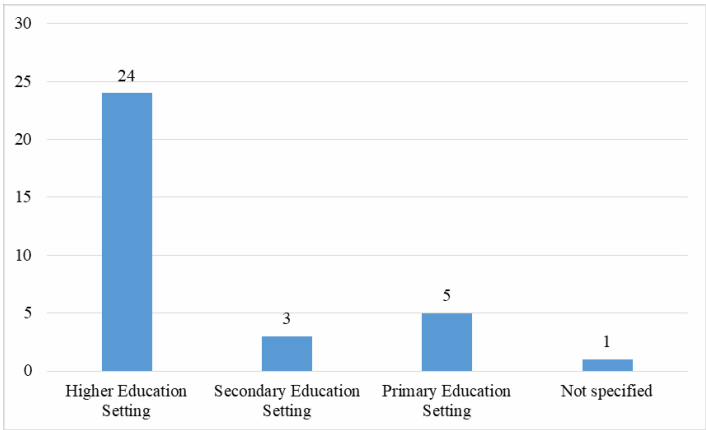

Figure 5. The research settings of the empirical studies

4.6 Affordances of 3D Virtual Environments for Language Learning

4.6.1 Affordance of 3D Virtual Environments for Linguistic Knowledge and Skills

Among the reviewed articles, we found nineteen studies focusing on the affordance of the 3DVEs for improving language learners' linguistic knowledge and skills. As we can see from Figure 6, over half of these studies (thirteen articles) explored the potential benefits of the 3DVEs for enhancing language learners' overall language proficiency, language performance or target language output. Others dealt with specific linguistic skills achieved through effective learning tasks in the 3DVEs or AR materials, such as listening (Levak & Son, 2017), speaking (Lan, 2014; Lan et al., 2016; Morton & Jack, 2010), writing (Collentine, 2011; Wang, 2017) and vocabulary retention (Franciosi et al., 2016).

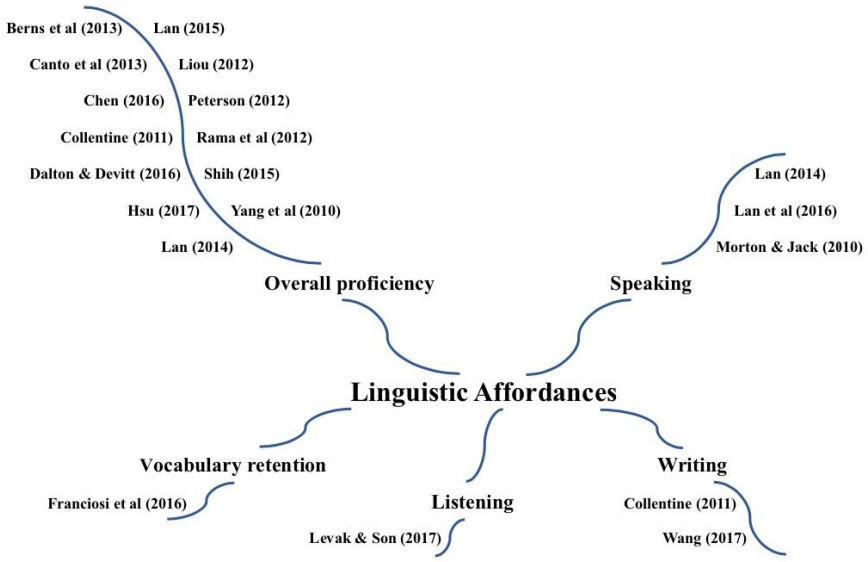

Figure 6. Distribution on the topic of affordances of 3DVE for linguistic skills

4.6.2 Affordance of 3D Virtual Environments for non- Linguistic Knowledge and Skills

Fourteen studies were identified as to explore the affordance of virtual reality technology for improving learners' non-linguistic knowledge and skills (Figure 7). A variety of aspects concerning their

non-linguistic knowledge and skills were discussed, among which, a majority of studies (eleven articles) centered on fostering language learners' communicative skills, strategies or their social cultural interactions through the applications of 3DVEs. The benefits of 3DVEs for other non-linguistic knowledge and skills also include boosting learners' critical thinking (Mroz, 2015), their cognitive attainment when using AR materials or playing AR games (Cheng & Tsai, 2014; Hsu, 2017), cultural learning (Shih, 2015), and collaborative learning skills (Ho et al., 2011; Kozlova & Priven, 2015). Be more specific, (Shih, 2015) discussed how learners' learning experience through the virtual environment may impact their cultural knowledge acquisition, positive attitudes toward the target culture and their cross-cultural adaption or adjustment. (Ho et al., 2011) explored leaners' collaborative skill in the 3DVE while 27 proved teachers' collaborative learning through a 3DVE.

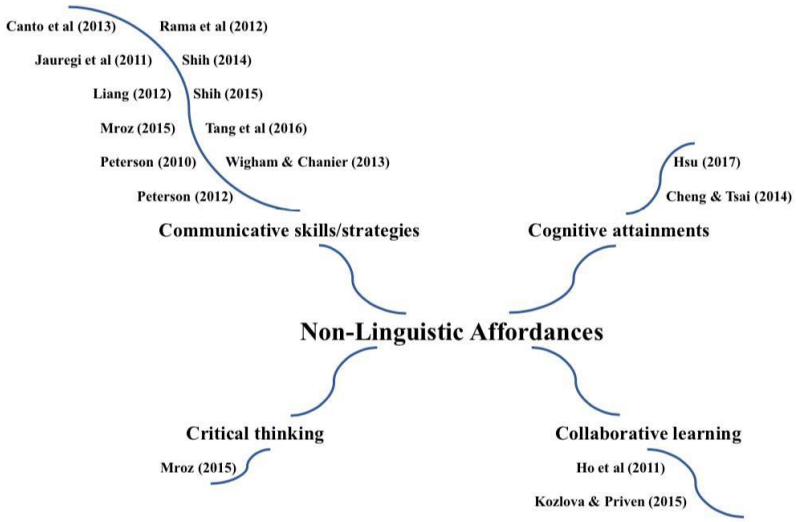

Figure 7. Distribution on the topic of affordances of 3DVE for non-linguistic skills

5. Conclusion

The present research is a systematic review of 33 empirical studies selected from six high-impact academic journals concerning the application of 3D virtual environments in language learning. Content analysis method was employed and a coding scheme was constructed from aspects of publication trend, location distribution of the first author, research sites, target language, research settings, and affordances of 3DVEs for language learning. Drawing upon the findings, we conclude that two essential issues on the application of 3DVEs in language learnings are "why to use it" and "how to use it". The key to the application of 3DVES in language teaching lies in the design of teaching activities. It requires the cooperation of front-line teachers, SLA schalors as well as technical specilists to fully realize the potential of 3DVES in fostering better language teaching effect.

Acknowledgements

This research is funded by Fok Ying Tung Education Foundation (161093) and Postgraduate Teaching Reform Project of Beijing University of Posts and Telecommunications (2019Y002) awarded to Dr. Chunping Zheng.

References

Berns, A., Gonzalez-Pardo, A., & Camacho, D. (2013). Game-like language learning in 3-D virtual environments. *Computers & Education, 60*(1), 210-220.

Canto, S., Jauregi, K., & van den Bergh, H. (2013). Integrating cross-cultural interaction through video-communication and virtual worlds in foreign language teaching programs: Is there an added value?. *ReCALL, 25*(1), 105-121.

Chai, C. S., Hwee Ling Koh, J., & Tsai, C. C. (2013). A review of technological pedagogical content knowledge. *Journal of Educational Technology & Society, 16*(2).

Chen, J. C. (2016). The crossroads of English language learners, task-based instruction, and 3D multi-user virtual learning in Second Life. *Computers & Education, 102*, 152-171. doi:10.1016/j.compedu.2016.08.004

Chen, J. F., Warden, C. A., Tai, D. W.-S., Chen, F.-S., & Chao, C.-Y. (2011). Level of abstraction and feelings of presence in virtual space: Business English negotiation in Open Wonderland. *Computers & Education, 57*(3), 2126-2134. doi:10.1016/j.compedu.2011.05.017.

Cheng, K. H., & Tsai, C. C. (2014). Children and parents' reading of an augmented reality picture book: Analyses of behavioral patterns and cognitive attainment. *Computers & Education, 72*, 302-312.

Clarke, J., Dede, C., & Dieterle, E. (2008). *Emerging technologies for collaborative, mediated, immersive learning*. In International handbook of information technology in primary and secondary education (pp. 901-909). Springer, Boston, MA.

Collentine, K. (2011). Learner autonomy in a task-based 3d world and production. *Language Learning & Technology, 15*(3), 50-67.

Dalton, G., & Devitt, A. (2016). Irish in a 3d world: engaging primary school children. *Language Learning & Technology, 20*(1), 21-33.

Franciosi, S. J., Yagi, J., Tomoshige, Y., & Ye, S. (2016). The effect of a simple simulation game on long-term vocabulary retention. *Calico Journal, 33*(3).

Ho, C. M., Nelson, M. E., & Müeller-Wittig, W. (2011). Design and implementation of a student-generated virtual museum in a language curriculum to enhance collaborative multimodal meaning-making. *Computers & Education, 57*(1), 1083-1097.

Hsu, T. C. (2017). Learning English with augmented reality: Do learning styles matter? *Computers & Education, 106*, 137-149.

Jauregi, K., Canto, S., De Graaff, R., Koenraad, T., & Moonen, M. (2011). Verbal interaction in Second Life: towards a pedagogic framework for task design. Computer Assisted Language Learning, 24(1), 77-101. Kozlova, I., & Priven, D. (2015). ESL teacher training in 3d virtual worlds. *Language Learning & Technology, 19*(1), 83-101.

Kramsch, C., & Steffensen, S. V. (2008). *Ecological perspectives on second language acquisition and socialization.* In Encyclopedia of Language and Education (pp. 2595-2606). Springer, Boston, MA.

Lan, Y. J., Sung, Y. T., & Chang, K. E. (2007). A mobile-device-supported peer-assisted learning system for collaborative early EFL reading. *Language Learning & Technology, 11*(3), 130-151.

Lan, Y. J. (2014). Does second life improve mandarin learning by overseas Chinese students?. *Language Learning & Technology, 18*(2), 36-56.

Lan, Y. J. (2015). Contextual efl learning in a 3d virtual environment. *Language Learning & Technology, 19*(192), 16-31.

Lan, Y. J., Kan, Y. H., Sung, Y. T., & Chang, K. E. (2016). Oral-Performance Language Tasks for CSL Beginners in Second Life. *Language Learning & Technology, 20*(3), 60-79.

Levak, N., & Son, J. B. (2017). Facilitating second language learners' listening comprehension with Second Life and Skype. *ReCALL, 29*(2), 200-218.

Liou, H. C. (2012). The roles of Second Life in a college computer-assisted language learning (CALL) course in Taiwan, ROC. *Computer Assisted Language Learning, 25*(4), 365-382.

Macaro, E., Handley, Z., & Walter, C. (2012). A systematic review of CALL in English as a second language: Focus on primary and secondary education. *Language Teaching, 45*(1), 1-43.

Morton, H., & Jack, M. (2010). Speech interactive computer-assisted language learning: a cross-cultural evaluation. *Computer Assisted Language Learning, 23*(4), 295-319.

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), 528-553.

Peterson, M. (2010). Learner participation patterns and strategy use in Second Life: an exploratory case study. *ReCALL, 22*(3), 273-292.

Peterson, M. (2012). EFL learner collaborative interaction in Second Life. *ReCALL, 24*(1), 20-39.

Rama, P. S., Black, R. W., van Es, E., & Warschauer, M. (2012). Affordances for second language learning in World of Warcraft. *ReCALL, 24*(3), 322-338.

Shih, Y. C. (2014). Communication strategies in a multimodal virtual communication context. System, 42, 34-47. Shih, Y. C. (2015). A virtual walk through london: culture learning through a cultural immersion experience. *Computer Assisted Language Learning, 28*(5), 407-428.

Stevens, V. (2006). Second Life in education and language learning. TESL-EJ, 10(3), 1-4.

Stockwell, G. (2007). A review of technology choice for teaching language skills and areas in the call literature. *Recall, 19*(2), 105-120.

Su, Y. C. (2006). EFL teachers' perceptions of English language policy at the elementary level in Taiwan. *Educational Studies, 32*(3), 265-283.

Wagner, C., & Ip, R. K. (2009). Action learning with second life--A pilot study. *Journal of Information Systems Education, 20*(2), 249.

Wang, Y. H. (2017). Exploring the effectiveness of integrating augmented reality-based materials to support writing activities. *Computers & Education, 113*, 162-176.

Wigham, C. R., & Chanier, T. (2013). A study of verbal and nonverbal communication in Second Life–the ARCHI21 experience. *ReCALL, 25*(1), 63-84.

Yang, J. C., Chen, C. H., & Jeng, M. C. (2010). Integrating video-capture virtual reality technology into a physically interactive learning environment for English learning. *Computers & Education, 55*(3), 1346-1356.