10th International Conference of the Immersive Learning Research Network
Selected Academic papers for the iLRN Proceedings

DOI: https://doi.org/10.56198/U6C0WVIKE

Work-in-Progress—The *Piazza Italiana* as a Site of VR-Based Linguistic and Cultural Learning

Lucia Binotti[1] and Amy Chambless[2]

[1,2]University of North Carolina at Chapel Hill, USA
lbinotti@ad.unc.edu[1]
achamble@ad.unc.edu[2]

Abstract. As immersive learning becomes increasingly important to education globally, it holds particular value for foreign language learners, who find themselves at a remove from the authentic spaces where their languages are lived and spoken. Given the need to develop capacities to communicate (with rich idiomatic language) while navigating social spaces, providing more realistic 3D virtual environments for students to interact in will result in improved levels of language ability. In this forum, the co-authors discuss their newest project, Piazza italiana, a live-in textbook for elementary Italian. This work-in-progress foresees the time in which a great deal of learning will happen in the metaverse. In this project, students access WebXR/VR spatialized environments, custom built in Mozilla Hubs, where they practice language topics immersed in a social VR task-based scenario that leverages haptics, kinetics and 3D objects to enhance a sense of presence and cultural belonging. Together with the development of these VR environments, the co-authors are also developing instruments to test student receptivity and motivation and how effective these experiences will be in helping students achieve the linguistic and cultural learning objectives of their course.

Keywords: AR/VR, Italian, Task-Based Learning, VLanguage, WebXR.

1 Introduction

In his bestselling book *The Metaverse. And How It Will Revolutionize Everything* (2022) Matthew Ball [1] asserts that the disruptive impact of the Metaverse, a three-dimensional version of the Internet driven by spatialized computing and immersive technologies, will have its most visible effect on Higher Education. To be sure, the Extended or Immersive Realities (XR), an umbrella term that includes Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) and Artificial Intelligence (AI), are already transforming the academic institution from within [2].

The coauthors are language and culture scholars and educators who have experimented with the theoretical and practical implications of integrating XR in classrooms and research agendas for almost a decade. During this time, they have seen the relevance of their skillset increase exponentially, along with a growing interest among colleagues to better understand what is at stake when embracing an XR-enabled educational mindset. The authors are motivated by the desire to direct both colleagues and students towards research findings, guidelines for standards, best practices, use-cases, and prototypes that can model and motivate their fruitful participation towards innovative and equitable Ed-XR in the future.

In this forum, they discuss their newest project, *Piazza italiana*, a live-in textbook for elementary Italian. This project foresees the time in which a great deal of learning will happen in the metaverse. In this project, students access WebXR/VR spatialized environments, custom built in Mozilla Hubs, where they practice language topics immersed in a social VR task-based scenario that leverages haptics, kinetics and 3D objects to enhance a sense of presence and cultural belonging. Hand-in-hand with the development of these VR environments, the authors are also developing

©2024 Immersive Learning Research Network

instruments to test student receptivity and motivation and how effective these experiences will be in helping students achieve the linguistic and cultural learning objectives of their course.

A *piazza* in Italy is much more than a geographical entity. Traditionally the site of the town's main municipal buildings and a church or cathedral, the piazza is host to a variety of commercial buildings, shops, restaurants, cafes, statues, fountains, and benches. It is both a social and transactional space, foundational to the business of the town but also to the important relationships among those who live there. Even in the smallest town in Italy, people fill the streets in both day and evening, walking, talking, and participating in public life. We chose the *piazza* as the site of our virtual experiences for these very properties.

2 Foundations of XR in Language and Culture Learning Use

A 2021 systematic review of foreign language learning with immersive technologies [3] identified key research findings relating the use of immersive technologies for foreign language and intercultural learning at cognitive, affective, and conative levels (p.132). The findings revealed significant research gaps in the area of virtual reality (VR) and in the use of the XRs for inter- and transcultural learning and teaching. Both reviews also identified the challenge of interdisciplinary cooperation among pedagogy, foreign language didactics, and Human-Computer Interaction to achieve innovative teaching-learning formats and a successful digital transformation. Interestingly, its meta-analysis found that immersion programs primarily address the cognitive and affective dimensions of learning; future studies need to include formats addressing the conative dimension as well. Similarly, a 2023 follow-up review [4] of Virtual Reality Assisted Language Learning (VRALL) practice and research, highlights VRALL's significant potential in enhancing language education, emphasizing the need for language educators to become proficient in VR technologies to effectively integrate them into their teaching methodologies. It suggests that developers should focus on creating more user-friendly VR platforms and materials that account for the diverse characteristics of learners, such as gender and language proficiency, to maximize the benefits of VRALL. The importance of immersion as a key factor in learner engagement is underscored, with recommendations for increasing the immersive quality of VR platforms. Furthermore, expanding the range of languages and courses available through VR platforms could cater to a broader spectrum of learners, including those with special needs or those learning for specific purposes. For researchers, the review identifies a gap in the study of VRALL across different language learning settings and a broader range of learner demographics beyond traditional school environments. It calls for more comprehensive research to explore the universal mechanisms behind VRALL's effectiveness and its impact on various learner groups, including those learning additional languages in multilingual contexts. Additionally, understanding learners' experiences and the sociocultural dynamics within VR environments is highlighted as crucial for improving VRALL's efficacy. The review also emphasizes the need for longitudinal and experimental studies with delayed post-tests to better understand the long-term effects and inherent nature of language learning through VR technology.

We now know that AR and VR extend language learning by involving the physical self in the interaction between virtuality and reality. Rather than engaging with resources at a cognitive level only, AR and VR support "embodied" and "extended" cognition, both of which emphasize the inextricable connection between the mind and the environment and "cognitive activity as grounded in bodily states and activities" (*Wikipedia*, s.v. Virtual Reality). What these conceptions of cognition have in common is the role of the physical world in our thinking, and, by extension, in our linguistic and cultural communication. For example, spontaneous gestures have been shown to support thinking and learning, and there is evidence that designed gestures, as well as manipulation of objects (e.g., on a screen or in a VR environment) can have an impact on learning, moreover, spontaneous gestures are deeply connected to linguistic and cultural behaviors and expectations [5]. In the context of behavioral change, Hein, Wienrich & Latoshik [3, p.118] propose the BehaveFIT framework to describe four potentials of VR to support behavior change processes: (1) self-representation (e.g., perspective-taking); (2) context-representation (e.g., showing different environments); (3) representation of others (e.g., showing diverse others), and the representation of objects (e.g., including personal everyday objects).

When these potentials are transferred to a language teaching and learning context, immersion and presence in VR enable an active exploration of distant and diverse learning contexts; the highlighting of achieved milestones; and the possibility to change roles and to encounter the unknown in a tangible way. In turn, these potentials of immersive technologies leverage the same modern pedagogic principles focusing on competence- and action-orientated learning, as well as situated learning, connectivity, and co-construction, all evidence-based learning sciences principles that

support e-Learning Design for language, culture, and heritage in line with the most updated guidelines of Clark and Mayer [6] foundational book on designing for e-learning (4th edition, 2016).

3 Use Case: The *Piazza Italiana*

With the support of a Lenovo grant, the authors embarked on the creation of an innovative immersive environment conceptualized as an all-inclusive ecosystem for learning elementary Italian. They started with a set of research questions that focused on innovation in the practice of teaching languages and cultures, as well as on issues of technology transfer, sustainability, and scalability of the model.

- *How complex should the world be?* Current social VR technology presents limitations on how detailed an environment can be before it causes performance problems. This is especially the case for software like Mozilla Hubs that runs on the browser (as opposed to an application you must download and install) and which is accessible on mobile devices.
- *What does a human-centered design look like for students attending a virtual campus?* The authors aimed to design the experience according to the abilities, goals, and expectations of the prototype's intended users, beginning Italian students. This meant working with a limited number of textual inputs that relied on previous exposure to vocabulary relevant to transactions and interactions within the chosen community settings; it meant allowing students exposure to authentic exchanges that they could then duplicate, as is conventional for the learning-through-modeling paradigm.
- *Which tasks and activities performed within a virtual spatialized environment most enhance linguistic and cultural learning?* As mentioned above, the authors are experimenting with role-play, tactile and kinetic presence, soundscapes, visual-to-grammar embodi-ment, and VR immersion to cultural situatedness. In contrast to the role-plays that happen in the non-immersive environment the role-play in an immersive environment has a novel character: students must synthesize the lexical elements and sequencing of them while confronting a dynamic visual environment while ensuring that their spatial location in consistent with that demanded by the interaction. Navigation and mediation of visual elements is occurring as they respond to auditory queues.
- How can one leverage students' native literacy of digital and immersive worlds? Increasingly students are spending more of their time participating in, contributing to and even crafting online and immersive communities of knowledge and content creation, from Instagram to Roblox. Piazza Italiana's design engages these novel skills to envision optimal learning environments for the metavers-ed ☺

The authors set about creating the *Piazza Italian* with VR units designed to satisfy the following conditions: (1) develop skills in synthesizing information; (2) developing confidence asking questions; (3) learning how to negotiate meaning; (4) reflecting on unique cultural environments; (5) making comparisons between the local and global; and (6) developing skills and areas of knowledge that bridge disciplines.

The Task-Based Language Teaching (TBLT) approach seemed the ideal pedagogical framework, wherein tasks are defined as activities "where meaning is primary; there is some communicative problem to solve; some sort of relationship with real-world activities; and the assessment of task is in terms of a task outcome" [7, p.38, 8]. This student-centered approach lends itself particularly well to VR, as students are able to use the infinite range of virtually recreated real-life contexts to support the way they develop their speaking and listening skills in particular.

We chose Spoke [9] by Mozilla to create the *Piazza* 3D environments. Spoke can incorporate gifs, audio files, 3D models, panoramic images, PDF documents, and more, all of which can be published to a Mozilla Hubs space. It is in these spaces, which are publicly accessible through a web-browser on almost any device on PC, smartphone, and on a VR headset, that students may begin to think more three-dimensionally about aspects relating to the subject they study. Given the importance for language learners to develop deeper, more idiomatic language in order to demonstrate their aptitude in speaking and writing, providing more realistic 3D virtual models of objects which are found in similarly three-dimensional form in the real world will result in equally improved levels of language ability, as demonstrated by the kinesthetic language learning on the Words in Motion platform [10].

To date, we have created two environments on Mozilla Hubs to represent the social and cultural spaces in which students in a second-semester Italian language class might interact: a *gelateria* (ice-cream shop) [figs.1-4] and a *mercato* (outdoors food market) [figs. 5-9]. These two social and cultural spaces relate to the chapters on food and shopping in the elementary textbook students are using for the course. The experiences employ the task-based learning pedagogy with the evolving XR pedagogy in order to develop familiarity with lexical and grammatical structures and build overall communicative fluency. For example, procuring an ice-cream in Italy demands two separate transactions,

choosing a size and shape of the ice-cream (cup vs. cone and different quantities) and paying for them before proceeding to the ice-cream counter to select the flavors. Choosing food products in a market involves a new approach to decision-making and thinking about quantity. Not only is there less pre-packaging and more autonomy for the customer in deciding how much of every product they need, but American students also have to adapt to a new system of measurement (in metric units rather than pounds). In the *mercato* environment, students also learn about a system of grading wines and food products based on their conformity to a set of guidelines assuring that the products are produced in specific geographical areas and according to specific production procedures.

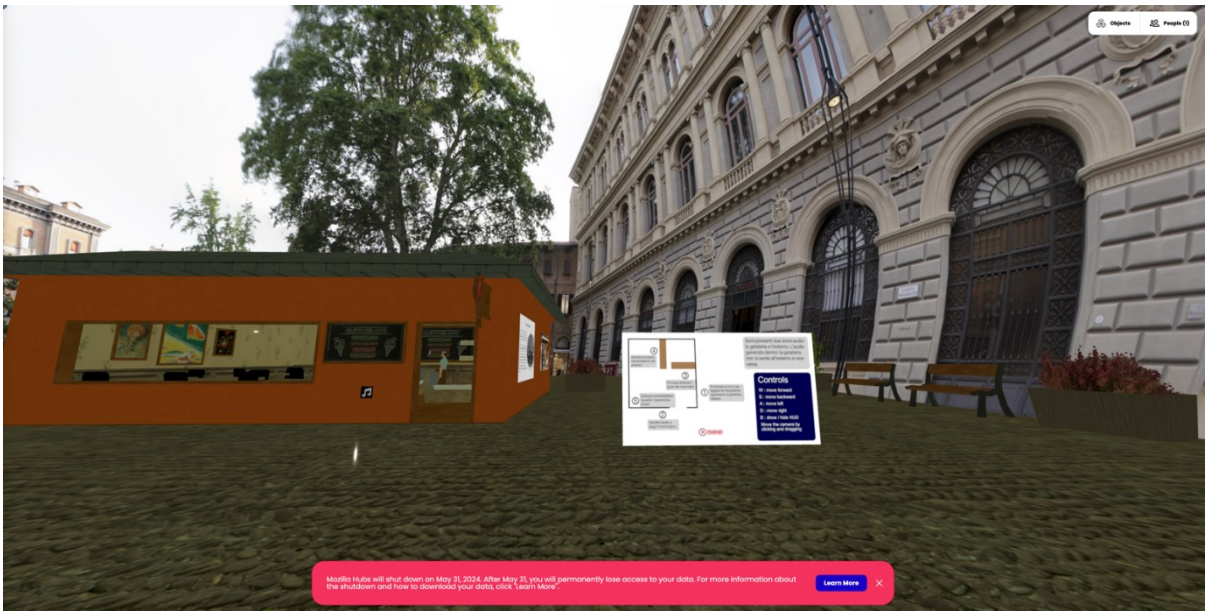

Fig. 1. *Gelateria.* Activity map.

Fig. 2. *Gelateria.* Listen to gelato menu.

Fig. 3. *Gelateria.* Match the flavors with its corresponding labels.

Fig. 4. *Gelateria.* Buy your gelato and sit to chat.

Fig. 5. *Mercato*. Activity Map.

Fig. 6. *Mercato*. Put your groceries in these boxes.

Fig. 7. *Mercato*. Learn about D.O.C. and D.O.P.

Fig. 8. *Mercato*. Learn about grams and kilograms.

Fig. 9. *Mercato*. Panoramic view.

Below is a summary of the tasks that comprise each experience, with focus on how they meet both the pedagogical goals of the task-based learning model as well as those envisioned by the XR environment.

Table 1.

Gelateria (Ice-cream Shop)	Mercato (Out-doors Food Market)
Pedagogical goals •Identify flavors •Express preference •Compare formal and informal modes of address •Learn about the cultural practices surrounding the Italian gelateria	**Pedagogical goals:** •Learn lexicon related to shopping •Experience transactions within a shop •Make polite requests •Learn about the cultural practices surrounding artisanal food production and quality control •Navigate between metric systems
Experience Elements: •Match colors to flavors, recalling Italian vocabulary •Listen to an audio as a model for a conversation between customer and client •Practice formal vs informal role-plays between customer and client •Have an interpersonal conversation comparing knowledge of cultural practices gained from this experience	**Experience Elements:** •Make a grocery list by deciding what kind of minestrone to serve for a dinner party •Load Vegetables into a basket after a prompt that teaches students metric system of weight in kilograms and 100-gram portions •Select ingredients for a dessert and practice expressions of quantity (different ways of expressing "some" in Italian) •Learn about different denominations of wine quality in Italy
XR Learning: •Navigating kinetically/spatially through two positions unique to the transactional space of the Italian gelateria •Manipulating 3D objects •Synthesizing audio content and replicating it in role-play fashion •Learning to communicate in a realistic virtual environment in the presence of spatial audio fitting to that local space	**XR Learning:** •Manipulating 3D objects •Reading about products in a form visually similar to a 3D brochure •Making choices about navigating through a virtual space as they relate to priorities in shopping (as one might do in a real market) •Interacting with co-present users to share recipes

In the innovative convergence of Task-Based Language Teaching (TBLT) and virtual reality (VR), the use of immersive environments like the Gelateria and Mercato in Mozilla Hubs significantly enhances various areas of language learning. This mixed approach leverages the strengths of TBLT—focusing on meaningful communication through real-life tasks—within a controlled, interactive VR setting, thus providing a rich linguistic and cultural context

that mirrors actual experiences in Italy. Moreover, integrating TBLT within VR environments increases learner engagement through immersive simulations where students interact using avatars, making the learning experience not only more engaging but also emotionally resonant [11]. This heightened engagement is crucial for motivation and long-term retention. Similarly, the kinetic and haptic tasks available in VR, such as holding a gelato cone, or walking from specialty stand to specialty stand filling a box of purchased groceries, enrich the learning by integrating physical actions with language skills, which enhances memory retention and recall [12]. Moreover, this approach allows for differentiated learning, where tasks can be adapted to suit various proficiency levels, enabling personalized learning pathways. Real-time feedback, another advantage of VR, provides learners with immediate corrections and suggestions, which accelerates the learning process and helps solidify correct usage [13]. Additionally, the safe and controlled environment of VR reduces the anxiety often associated with speaking a new language, thereby encouraging risk-taking and experimental learning. Finally, the use of VR and TBLT together fosters cultural immersion and contextual learning. Students are not merely learning language in abstraction; they are practicing it in culturally rich, contextually meaningful settings that prepare them for real-world interactions. This method not only develops linguistic competences but also intercultural communicative competence, a critical aspect of language learning today [14].

4 Observations

We would like to point out two examples of the ways in which XR learning is central to both linguistic and cultural learning of this course. Central to our philosophy of teaching culture is the idea that culture involves more than cultural products (say a Renaissance painting or an aria of an Italian opera), but fundamentally cultural processes, that is the way in which people living in a specific cultural community carry out activities, including social activities, central to their everyday lives. One of the fundamental cultural lessons students learn in the *gelateria* is that procuring an ice-cream in Italy demands two separate transactions: choosing a size and shape of the ice-cream (cup vs. cone and different quantities), and paying for them, on the one hand; and then subsequently, proceeding to the ice-cream counter to select the flavors. The movement of students within this 3D virtual environment trains them in the kind of spatial navigation-within-interactions that occurs in a real gelateria. Secondly, choosing food products in a market involves a new approach to decision-making and thinking about quantity. Not only is there less pre-packing and more autonomy for the customer in deciding how much of every product they need, but American students also have to adapt to a new system of measurement (in metric units rather than pounds). In the *mercato* environment, for example, students learn about a system of grading wines and food products based on their conformity to a set of guidelines assuring that the products are produced in specific geographical areas and according to specific production procedures.

5 Affordances and Limitations

This ideation and implementation process has required long-term collaboration among software engineers, 3D designers, and pedagogues. An involved trial and error analysis was conducted to better understand the affordances of the chosen platform (Mozilla Hubs) as well as its limitations. Recognition of the importance of user-centered design to cognitive learning [15] was extended to the language sciences, and great consideration was given to how this would map on to existing theories of foreign-language pedagogy [16, 17]. In the case of Mozilla Hubs, the function and usability of two sets of affordances were studied, on one hand those directly provided by the Hubs Rooms template architecture: kinetic movement, haptics, manipulatable 3D objects, a mirror, sound pods, co-presence, 2D video screens and 360 video bubbles; on the other, the affordances for participants to interact and leave their digital footprint in the room (similar to Zoom but in 3D Space), such as voice interactions, chat, camera, avatar selfie, sharing, casting and the ability to add their 3D objects and other 2D materials in the individually cloned room/working spaces [18]. Further tryouts were conducted to imagine how best to exploit the Hubs affordance that permits one to tether a room/class to a class/group-dedicated Discord space as a separate channel. On Discord, students' activities in Hubs Rooms can be live streamed as well, with stream recordings moved to YouTube. This suite of interconnected functionalities permits instructors to manage, direct, evaluate and assess the work students are doing in VR during the entire semester.

6 Conclusion

At the time of writing this paper, the project's prototyping phase is ending. At this point, prior to roll out its empirical research phase and first pilot study, the Piazza Italian project team plans to address two important aspects related to the project's sustainability. First, in response to Mozilla's decision to shut down Hubs, we, need to take several crucial steps to ensure our project's continuity. We will use the tool Mozilla is developing to download all our project-related data, including media files and published scenes, linked to our email addresses. It is vital to secure our assets before the shutdown. We will stay alert for the release of open-source assets and .blend files from the Hubs team, which could enrich our project. Transitioning to the Community Edition of Hubs is another key move. We will dive into the provided documentation to set up our independent instance, maintaining our project's accessibility and operation outside Mozilla's ecosystem. Participating in Mozilla's upcoming community meetups and information sessions will be beneficial for gaining insights and guidance on the transition. Additionally, we plan to engage with the community and seek support through "Community Edition Setup" meetings and collaboration opportunities with developers and companies offering migration services found in the Hubs Discord server. This collaborative approach will help us navigate the transition smoothly, ensuring the Piazza Italian project thrives in its new environment.

Next, building on the assessment framework for measuring the effectiveness of teaching college level courses in Virtual Reality (VR) recently proposed by Udeozor et al. [19], we will integrate key insights from the Constructive Alignment (CA) and Evidence-Centered Design (ECD) frameworks with pedagogic and usability principles derived from Gagne's Nine Events of Instruction model and Nielsen's usability heuristics as laid out by Ansone et al. [20] to create an assessment framework that measures the effectiveness and pedagogic feasibility of teaching college level language courses in VR . This holistic approach ensures that the framework not only focuses on the educational outcomes and alignment of learning objectives, activities, and assessments but also on the usability and interactive quality of VR language learning environments. The framework consists of three core components:

Pedagogic Effectiveness: This component evaluates the instructional design of VR language learning applications against Gagne's Nine Events of Instruction. It assesses how well these applications capture learners' attention, provide relevant information, facilitate learning retention, and enable the transfer of knowledge into practical language use. Pedagogic effectiveness also examines the incorporation of feedback and assessment mechanisms that are aligned with learning objectives, as guided by the CA principle.

Usability and Interaction Design: Drawing from Nielsen's usability heuristics, this component focuses on the user experience within the VR environment. It includes ease of navigation, intuitive interface design, error management, and the overall satisfaction of the learner in interacting with the VR application. This ensures that the technology enhances rather than impedes the language learning process.

Immersive Learning Experience: This novel component specifically addresses the unique affordances of VR for language learning. It measures the degree of immersion and presence felt by learners, the authenticity of language use contexts, and the opportunities for meaningful interaction and communication in the target language. The immersive experience is evaluated for its contribution to engagement, motivation, and ultimately language acquisition.

Assessment within this framework employs a mixed-methods approach, combining quantitative measures such as pre- and post-tests of language skills, usability surveys, and engagement metrics, with qualitative feedback from learner interviews and observational data. This allows for a comprehensive understanding of the effectiveness, appeal, and areas for improvement in VR language teaching. We will start by gauging the extant prototype's significance, for which we have already laid out the mix of qualitative and quantitative indicators that will organize and measure of our data when testing the effectiveness of the pedagogical framework, the cognitive and conative impact of the *VRPiazza*, student receptivity and motivation when working with/in XR, and how effective these new learning environments are in helping students achieve the linguistic and cultural learning objectives of their course [21].

To ensure practical applicability, our framework will also include guidelines for educators and developers on how to design, implement, and evaluate VR language learning experiences. This encompasses best practices for constructive alignment of learning objectives with VR activities and assessments, considerations for maximizing usability and learner engagement, and strategies for creating immersive and pedagogically sound language learning environments.

References

1. Ball, M.: The Metaverse. And How It Will Revolutionize Everything. Liveright Publishing Corporation (2022).

2. Sprigg, S.: XR Trends 2022 (9/12): AI, Machine Learning and Virtual Beings. AWE EU 2022. Retrieved from: https://www.awexr.com/blog/494-xr-trends-2022-9-12-ai-machine-learning-and-virtual (Accessed May 5, 2022).
3. Hein, R. B., Wienrich, M., and Latoschik, E.: A systematic review of foreign language learning with immersive technologies (2001-2020). AIMS Electronics and Electrical Engineering, 5(2), 117–145 (2021). doi: 10.3934/electreng.2021007.
4. Hua, C., and Wang, J.: Virtual reality-assisted language learning: A follow-up review (2018–2022). Front. Psychol., 14:1153642 (2023). doi: 10.3389/fpsyg.2023.1153642.
5. Bonner, E., and Reinders, H.: Augmented and virtual reality in the language classroom: Practical Ideas. Teaching English with Technology, 18(3), 33–53 (2018). Available at http://www.tewtjournal.org.
6. Clark, R. C., and Mayer, R. E.: E-learning and the Science of Instruction. 4th ed. John Wiley & Sons (2016).
7. Skehan, P.: A Cognitive Approach to Language Learning. Oxford University Press, Oxford (1998).
8. Jackson, D. O.: Task-Based Language Teaching. Cambridge University Press, Cambridge (2022).
9. Spoke by Mozilla (2018). Available at: https://hubs.mozilla.com/spoke.
10. Machado, C. D. V.: Kinesthetic Language Learning in Virtual Reality. MIT Media Lab (2018). Available at: https://www.media.mit.edu/posts/kinesthetic-language-learning-in-virtual-reality/.
11. Huang, H. M., Rauch, U., and Liaw, S. S.: Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. Computers & Education, 55(3), 1171–1182 (2010).
12. Sweller, J., Ayres, P., and Kalyuga, S.: Cognitive Load Theory. Springer (2011).
13. Chen, N. S., Teng, D. C. E., and Lee, C. H.: Augmenting paper-based reading activity with direct translations: A new approach to ELT (English Language Teaching). Educational Technology & Society, 14(3), 205–219 (2011).
14. Thomas, M., and Reinders, H. (Eds.): Task-Based Language Learning and Teaching with Technology. Continuum (2010).
15. Gullikse, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J., and Cajander, Å.: Key principles for user-centred systems design. Behaviour & IT, 22, 397–409 (2003). doi: 10.1080/01449290310001624329.
16. Hasani, L. M., Sensuse, D. I., Kautsarina, and Suryono, R. R.: User-Centered Design of e-Learning User Interfaces: A Survey of the Practices. In: 3rd International Conference on Computer and Informatics Engineering (IC2IE), pp. 1–7 (2020). doi: 10.1109/IC2IE50715.2020.9274623.
17. Alfadil, M.: Effectiveness of virtual reality game in foreign language vocabulary acquisition. Computers & Education, Volume 153, 103893 (2020). ISSN 0360-1315, https://doi.org/10.1016/j.compedu.2020.103893.
18. Basso, G., and Binotti, L.: A use-based comparison of collaborative VR environments building platforms. unpublished (2022).
19. Udeozor, C., Dominguez Alfaro, J. L., Glassey, J.: Assessment Framework for Immersive Learning: Application and Evaluation. In: Bourguet, M. L., Krüger, J. M., Pedrosa, D., Dengel, A., Peña-Rios, A., Richter, J. (eds) Immersive Learning Research Network. iLRN 2023. Communications in Computer and Information Science, vol 1904. Springer, Cham (2024). doi: 10.1007/978-3-031-47328-9_15.
20. Ansone, A., Dreimane, L.F., Zalite-Supe, Z.: Framework of Pedagogic and Usability Principles for Effective Multi-user VR Learning Applications. In: Bourguet, M. L., Krüger, J. M., Pedrosa, D., Dengel, A., Peña-Rios, A., Richter, J. (eds) Immersive Learning Research Network. iLRN 2023. Communications in Computer and Information Science, vol 1904. Springer, Cham (2024). doi: 10.1007/978-3-031-47328-9_7.
21. Choi, P.M.S., and Lam, S.S.: A hierarchical model for developing e-textbook to transform teaching and learning. Interactive Technology and Smart Education, 15(2), 92–103 (2018). doi: 10.1108/ITSE-12-2017-0063