Immersive Experience Through Virtual Reality App to Generate Spaces for Synchronous Interaction

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Abstract. This research analyses the potential of the use of a virtual reality app developed by the same university in the context of providing an immersive student-teacher and student-student interaction space that replicates the Huancayo campus and the university's classrooms that allows to overcome the nostalgia of not "attending" the university campus and having a digital means of interaction. For the evaluation of the same, an adapted questionnaire was administered to the students from the subject who attended regularly and to the teacher an interview about the benefits and difficulties arising from the use of the app. The results reveal a high degree of student satisfaction on the scales consulted: dynamization of the teaching-learning process, personal relationships, motivation and content acquisition; the biggest drawback manifested stems from the student's connectivity and data plan for greater dedication and usage.

Keywords: Mobile App, Virtual Reality, Inmersive, Experience

1 Introduction

In 2016, only 2% of U.S. teachers had used VR in their classes, up from 60% who intended to incorporate it as part of the educational process [1]. This data shows that Virtual Reality is a fledgling technology but with a high recognition of its potential on the part of the teaching community. In the same survey, 83% of teachers are convinced that Virtual Reality will help improve academic outcomes, with a better understanding of the concepts taught (77%), an improvement in collaborative processes (71%) and an increase in student motivation (84%) [1].

1.1 Virtual reality

Virtual reality doesn't have a single concept; for example, we can cite three interesting conceptualizations; [2] It defines it as "the complete immersion of human sensomotor channels in a vital computer-generated experience", for [3] "virtual reality, is a new way to explore reality. An extension of the senses by which we can learn or do something with reality that we could not do before", finally for [4] "Virtual Reality is a simulation of a three-dimensional environment generated by computers, in which

the user is able both to see and manipulate the contents of that environment". These concepts present some elements in common: a) is a computer-generated simulation, b) is three-dimensional and c) is interactive. According to [5], a virtual reality system has three phases: passive (cannot be controlled), exploratory (allows a user journey) and interactive (allows you to experiment and explore the environment in addition to modifying). There is a number of researches that recognize the contribution of virtual reality in education; [6] For example, they highlight the implication of virtual reality in the added motivation for the student, as they will encourage them to learn and continue exploring the virtual world, while watching and listening at the same time. They cite researchings [7], [8] and [9] that have shown that the learning curve with virtual aids is faster and achieves greater and better assimilation of content than traditional teaching tools, mainly because students use almost all their senses in the process of learning a subject.

For [5], a virtual reality system is immersive when it gets "the user to feel like they are within the environment generated by the computer. For this the equipment used must be equipped with devices capable of deceiving (or stimulating) as many senses as possible", although the developed system allows access from oculus glasses, the social distancing originated as a result of the Covid-19 pandemic has motivated the development of the app version to be accessed by low-cost glasses.

1.2 Contextualization and description of the experience

This work is primarily aimed at highlighting the potential of using a virtual reality app in higher education. To do this, an experience has been designed consisting of student-teacher and student-student interaction in a classroom on the Huancayo campus replicated in 3D through virtual reality. In total, four learning sessions were held in this virtual space for student-teacher interaction and the space was open throughout the academic period to facilitate student-student interaction; participants were the students and the teacher of the Business Solutions Development subject of the Professional Career in Business Engineering. In the first class through this app, five questions were asked to students in order to know the resources and previous knowledge. 80% of students had a computer, 90% had a smartphone and 93.5% had an Internet connection, 10% who did not have a smartphone used the Nox emulator (see Fig. 1). As far as virtual reality is concerned, only 15% knew or had notions of what virtual reality is, only 3 out of the 32 students had participated before in some virtual reality experience, in both cases through video games. Based on these results, it can be said that students are especially receptive to the use of new technologies, but this does not mean that everyone is digitally trained for the use and exploitation of all tools. Therefore, the first class had to be dedicated to explain the various access methods (smartphone and Nox emulator). In the last session, a survey was applied to know the perception of student satisfaction in five topics (student participation, dynamization of the teaching-learning process, social relations, motivation and content acquisition).

Fig. 1. Screenshot of the Nox emulator and the installation of the UC VR app

The simulated experience is to generate a virtual space that facilitates interaction in learning and is a major part of the teaching-learning process. Actually, as noted by [10], it is the interaction that exists in an educational experience that defines how the student learns about the content, his peers and the teacher; that is, the interaction can be student-content, student-student and teacher-student.

As for student-teacher interaction, the essential part that is always motivating for a culture where the teacher's figure and intellectual opinion is appreciated is reflected in the facilitator's interaction with his students [10]. The most relevant moments are when instructions are given, the learning process is guided, a specific topic is presented, it is explained or exemplified, links are created, reflection questions are asked, schemes are proposed, activities are organized or participations, tasks or jobs [10] are given feedback. The following table 1 details the simulated student-teacher interaction experiences.

Table1. Details of the immersive experience to generate student-teacher interaction.

Type of interaction	Description	Participating students
Student – teacher (Class 1)	Week 4 - Extended Reality	30 students
Student – teacher (Class 2)	Week 7 - Review of various topics prior to partial evaluation	29 students
Student – teacher (Class 3)	Week 11 - Emerging Technologies	31 students
Student – teacher (Class 4)	Week 15 - Review of various topics prior to the final evaluation	27 students

As for student-student interaction, the “best means of promoting learning is the interaction that occurs between several apprentices” [10]. “The primary part of the constructivist approach that promotes knowledge building arises at a time when students interact with each other to reach conclusions, create, evaluate, form judgments, research, solve problems and carry out other cooperative learning means. That's where the teacher's intervention focuses on guiding this process of negotiation and knowledge management” [10]. Team, couple or full-class cooperation creates a socio-effective and intellectual environment that promotes openness, tolerance to diversity and teamwork for intellectual development. “The active part of the student

and the teacher's guidance and framing create a very productive intellectual and affective practice" [10].

As Moreno points out [11], "intersubjective access in interpersonal relationships generates a dynamic of demands and expectations that influences the ways of acting and thinking of the people involved in the process". Table 2 shows the details of the experience of using the application to generate student-student interaction, some data is shown such as number of accesses and number of students synchronously connected to the app per week during the academic period.

Table 2. Details of the immersive experience to generate student-student interaction.

Week	Access Numbers	Number of synchronously connected students
Week 4	24 students	18 students
Week 5	20 students	08 students
Week 6	28 students	12 students
Week 7	29 students	19 students
Week 8	15 students	11 students
Week 9	28 students	12 students
Week 10	25 students	19 students
Week 11	31 students	21 students
Week 12	24 students	16 students
Week 13	26 students	15 students
Week 14	22 students	18 students
Week 15	27 students	19 students
Week 16	07 students	5 students

2 Developed app

To understand the development of the app, it's necessary to present the architecture of the solution for the virtual reality platform [12], Oculus Rift, which uses the helmet (HDM) for video output and the Oculus Touch controls (Fig. 2), as an input device, this was the architecture of the virtual reality experience solution and initially conceived. However, due to social distancing and the impossibility of using Oculus equipment, a systems component was implemented for the mobile app, which would allow access and experience from a mobile app. Below will be presented a series of screenshots, to know the main images of the immersive experience.

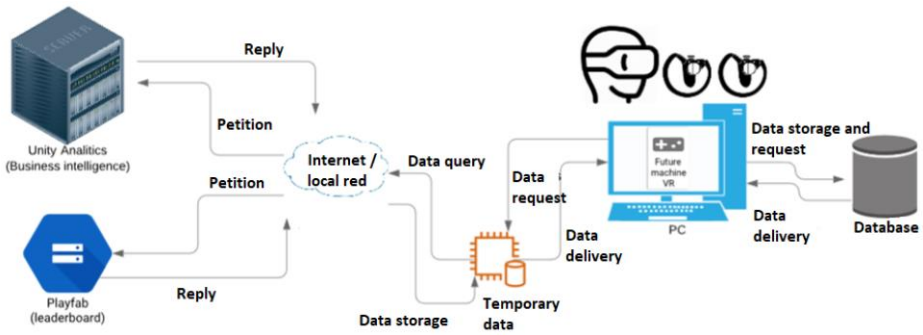

Fig. 2. Project solution architecture (Virtual reality)

The application makes use of a local database serialized in binary format, consisting of several files stored within the persistent folder on the device where the application is running. Each new scene will have its own data file, there will also be a local file to store the data requested from the remote Playfab server, which is a BAAS (back-end as a service). Finally, some application metric data is sent to Unity Analytics, a business intelligence service. The application requires Internet access to communicate with the Playfab and Unity Analytics servers. At the design level, it should be noted that it was designed in 3D from the plan of the physical campus of the university and the one-person tables and chairs, doors, curtains, among other elements are similar to the shapes, colors and textures of these elements of the campus in Huancayo.

Fig. 3 shows the Continental University campus, in the city of Huancayo; which is a replica of the real campus that exists in this city; with regards to pavilions, the pavilions B and C have been simulated.

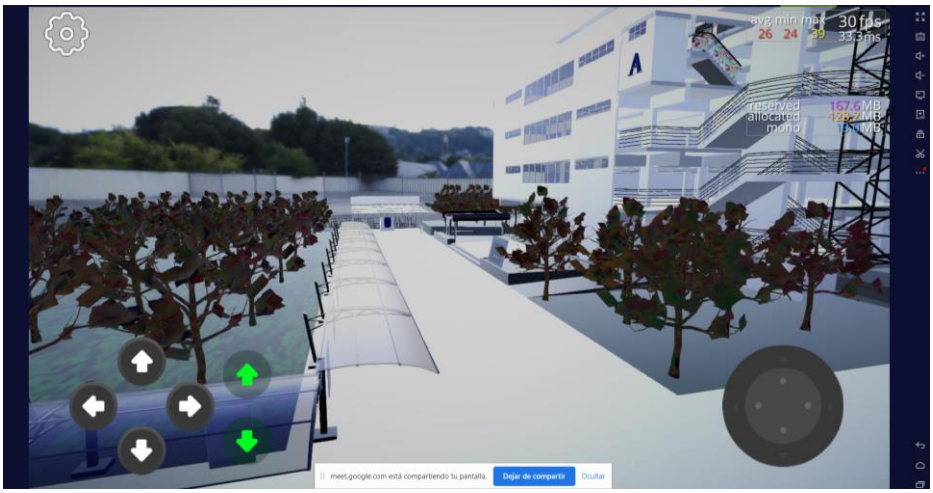

Fig. 3. Campus tour in virtual reality

In Fig. 4, an interface for the logging and registration of new users is shown.

Fig. 4. Screen for user logging and registration

Finally, Fig. 5 shows a simulated class in the app within a classroom that is also a replica of a physical classroom, in which the user interface is observed and options for managing the quality of the resolution of the the 3D components, scrolling controls, microphone, and viewfinder mode in any glasses that support the placement of the smartphone within these glasses.

Fig. 5. Screen showing the simulation of a class

3 Methodology

This research was aimed at knowing the assessment that students and teachers make of the app in a subject, in relation to the promotion of participation, the dynamization of the teaching-learning process, social relations, motivation and the acquisition of content in their training as future teachers. For the evaluation of learning experiences, a questionnaire was administered to the students of the subject, adapted from Durán [13]. The questionnaire consisted of 46 Likert items grouped into five scales: participation, dynamization of the teaching-learning process, personal relationships, motivation and content acquisition.

These items offer 4 response options, with the intention of forcing the student to lean in one direction their rating. The four possible alternatives are: totally agree, moderately agreed, moderately disagreed and totally disagreed. The questionnaire is completed with 4 overall rating questions of the app, which students had to answer by completing a score scale between 0 (minimum negative value) and 10 (maximum positive rating). The questionnaires were answered voluntarily and anonymously by the students. In total, the students who participated and collaborated in the research were 28. The data analysis mainly used univariate descriptive statistics techniques, mainly percentages and central trend (average) statistics using the SPSS statistical program for Windows. The teacher's assessment was based on an open interview with two issues related to the benefits and difficulties identified in the use of the app, taking particular attention to the five topics that constituted the scales of the student questionnaire.

4 Results: Learning Experience Assessment

The information obtained in the student survey refer to very favorable results and a high degree of satisfaction in the five topics (scales) consulted.

- On scale 1 (student participation) student participation was valued considering visits and entries in the virtual reality app. An acceptable number of the app's visits to interact with your peers is reflected. 90% of respondents entered the app for student-student interaction; and 100% of them entered the app for student-teacher interaction classes.
- In the analysis of scale 2 (dynamization of the process teaching - learning) we can highlight the excellent assessment that students make of the app as an dynamizing tool of the teaching-learning process; thus, it exceeds 90% those that indicate that it stimulates the follow-up of the subject, stimulates the search for new information on the subject, facilitates the expression of ideas and opinions on current topics related to the subject, encourages the participation of students in the subject, promotes critical thinking and promotes creative thinking. The item "the app favors the resolution of doubts regarding the subject" receives a less high rating, although with a positive trend; 30.4% express moderately disagree with such a proposition.
- The current education system generated by the pandemic has limited the development of social competences. The analysis of scale 3 on social relationships

sets an opposite trend, clearly indicating that students perceive that the app promotes personal relationships, establishing new modalities of teaching-student relationship, as well as increasing the possibilities of contact between the group of students. Thus, over 80% students who appear to be totally or moderately in agreement on proposals such as: facilitates contact with the teacher; enhances collaboration with the teacher; facilitates communication between students; encourages personal relationships with peers; encourages the student to feel part of the group; stimulates new forms of relationship. It stands out that 93.5% perceive that the app favors the interaction and collaborative work of the students.

- Scale 4 (motivation) represents the results of students in the face of the app usage as a tool that favors motivation. None of the included propositions gets negative assessment, presenting, on the contrary, a clearly positive trend in relation to fostering interest in healthy habits, deepening the subject, performing activities of the subject, using new technologies.
- With the last scale, it is intended to know the suitability of the app in the acquisition of content. One of the most positive aspects of the use of this resource in teaching is that it facilitates the acquisition of specific content of the subject, both theoretical and practical; positive attitudes to educational innovations and practice as future teachers; the development of less specific knowledge (relating to New Technologies), and, fundamentally, in this information society, is that to the 88.8% it favors the construction of new knowledge, new thoughts.
- Finally, with regards to the global issues about the app and its usage (on a scale of 0 to 10) students make a remarkable assessment of the app as a tool ($\bar{X} = 7.1$); they significantly rate ($\bar{X} = 8.2$) the teacher's use and value their participation by 7.5. Finally, we find that they consider positive ($\bar{X} = 7.8$) the interest that, to them, have the virtual reality app in teaching practice.
- The teacher welcomes positively the experience, he believes that students have improved competencies such as: increased interest in health education, better self-learning capacity and greater responsibility. She recognizes the existence of meaningful learning and states that she improved the abilities not only of the students but also of herself.
- Regarding the difficulties, the teacher identified that not all students have a smartphone and that most of them have recurring frequencies of slow internet during the day or with limited megabytes, which restricts or limits the usability of the app. only 20% of students have a virtual reality goggle that gives them an even more immersive experience.

5 Conclusions

- First, the use of the virtual reality application contributed to generating participation processes, assuming high rates of student participation; The use of the application as an educational resource has impacted, opens up and brings them

closer to participation channels and offers them new perspectives inside and outside the classroom, coinciding with similar research results [14, 15, 16, 17].

- Secondly, it can be considered an adequate practice to maintain an active role of the student, allowing reflection and contrast of their own and other people's ideas and facilitating the student to be more autonomous as indicated [18, 19].
- Third, the experience was also favorable for the development of social skills in the collaborative construction of knowledge. Virtual reality can become a tool for collaboration and communication, as suggested by research [20, 21, 22, 23].
- Fourth, the application has become an easy-to-use tool that increases motivation. Students obtain benefits when using the 3D application, since their interests and motivation increase due to the interaction and feedback with their classmates and teachers, this conclusion is reinforced with similar results and research conclusions [24, 25, 26, 27, 29, 30]
- Fifth, the cognitive benefits cannot be overlooked either; The application facilitated the acquisition of content, helping to improve understanding and dictation of the subject, serving as a support for teaching. However, there is a great opportunity to continue improving the application so that it is not only limited to the transmission of content but also in the acquisition of abilities or skills, as shown by the following investigations [31, 32, 33, 34].

6 Future work

- We are aware of the limitations of this research: limited number of subjects, a single teacher, exclusively students from a career where these emerging technology topics are addressed so it is necessary to expand the research in this line, which considers aspects such as the teaching style, use of the app in the pedagogical model, characteristics of the students, educational level, history of use.
- It also seems necessary to delve into some of the drawbacks of using the app that may arise from this study: the "investment" of work and time that the teacher spends in designing a learning session with the app; the use of technology as a tool and not as a goal in itself in teaching-learning processes; changes in educational practices with the use of the app; potentialities versus app usages.
- At the technological level, the app has great opportunities to improve, such as the possibility for each user to select or customize their avatar, the possibility to generate actions such as walking, flying, sitting, raising their hand, among other actions to fine-tune and improve the user experience.

References

1. Elesapiens Blog, Realidad Virtual en educación. ¡El futuro ahora!, https://www.elesapiens.com/blog/realidad-virtual-en-educacion-el-futuro-ahora/, last accessed 2020/11/21.

2. Biocca, F. and Levy, M. Virtual reality as a Communication System en Communication in the age of Virtual Reality. Lawrance Erlbaum Assoc., Hillsdale, N.J. (1995) 15 – 31 DOI: 10.5555/207922.207924
3. Pimentel, K, and Texeira, K. Virtual Reality. Through the New Looking Glass, Intel/McGraw-Hill New York (1992); 2ndEdic.1995, 438
4. Roehl, B. Special Edition Using VRML. Mc Millan Computer Publishers (1996).
5. Levis, D. What is virtual reality? (2006)
6. Ocete, G. V., Carrillo, J. A. O., & Gonzalez, M. A. B. Virtual reality and its teaching possibilities. Etic@ net: Electronic Scientific Journal of Education and Communication at the Knowledge Society (2003) 12
7. De Antonio, A., Villalobos, M. and Luna, E. When and How to Use Virtual Reality in Teaching. Journal of Teaching and Technology. (2000) 26-36
8. Echeverria, J. Avatars, Virtual Reality and Digital Education, Proceedings of the first international digital education congress (2000). Bilbao (Spain)
9. La Cruz, M. others. Education and new technologies before the 21st century, magazine Comunicación y Pedagogía (2000) 164, 25-39. Barcelona (Spain)
10. Guevara, I. Interaction in learning. Journal of Scientific and Technological Disclosure of the Veracruz Inuversity (2011)
11. Moreno, C. Thinking and interaction in teaching-learning processes. (1999). Wikibooks.
12. Fernández D. Future-machine video game in space skills training with support for platforms, virtual reality Oculus Rift and personal computers. Thesis. Continental University. Peru (2019) 147 - 148
13. Duran, J. The contribution of edublog as a didactic strategy. Electronic Journal of Research in Educational Psychology (2011) 9, 1, 331-356. http://www.investigacionpsicopedagogica.org/revista/articulos/23/espannol/ Art_23_494.pdf DOI: 10.25115/ejrep.v9i23.1440
14. Deutsch, J., & McCoy, S. W. Virtual reality and serious games in neurorehabilitation of children and adults: Prevention, plasticity and participation. Pediatric physical therapy: the official publication of the Section on Pediatrics of the American Physical Therapy Association, 29 (Suppl 3 IV STEP 2016 CONFERENCE PROCEEDINGS), S23 (2017) Doi: 10.1097/PEP.0000000000000387
15. De Rooij, I. J., Van de Port, I. G., Visser-Meily, J. M., & Meijer, J. W. G. Virtual reality gait training versus non-virtual reality gait training for improving participation in subacute stroke survivors: study protocol of the ViRTAS randomized controlled trial. Trials, 20(1), 1-10 (2019). https://doi.org/10.1186/s13063-018-3165-7
16. Heldal, I. Supporting participation in planning new roads by using virtual reality systems. Virtual Reality, 11(2-3), 145-159 (2007).
17. Petric, J., Maver, T. W., Conti, G., & Ucelli, G. Virtual reality in the service of user participation in architecture (2002).
18. Gonzalez-Franco, M., Perez-Marcos, D., Spanlang, B., & Slater, M. The contribution of real-time mirror reflections of motor actions on virtual body ownership in an immersive virtual environment. In 2010 IEEE virtual reality conference (VR) (pp. 111-114) (2010). IEEE.
19. Heeter, C. Reflections on real presence by a virtual person. Presence: Teleoperators & Virtual Environments, 12(4), 335-345 (2003).
20. Monahan, T., McArdle, G., & Bertolotto, M. Virtual reality for collaborative e-learning. Computers & Education, 50(4), 1339-1353 (2008) doi:10.1016/j.compedu.2006.12.008
21. Jackson, R. L., & Fagan, E. Collaboration and learning within immersive virtual reality. In Proceedings of the third international conference on Collaborative virtual environments (pp. 83-92) (2000).

22. Kan, H. Y., Duffy, V. G., & Su, C. J. An Internet virtual reality collaborative environment for effective product design. Computers in Industry, 45(2), 197-213 (2001).
23. Piumsomboon, T., Lee, Y., Lee, G., & Billinghurst, M. CoVAR: a collaborative virtual and augmented reality system for remote collaboration. In SIGGRAPH Asia 2017 Emerging Technologies (pp. 1-2) (2017) https://doi.org/.1145/3132818.3132822
24. Harris, K., & Reid, D. The influence of virtual reality play on children's motivation. Canadian journal of occupational therapy, 72(1), 21-29 (2005).
25. Kim, M. J., & Hall, C. M. A hedonic motivation model in virtual reality tourism: Comparing visitors and non-visitors. International Journal of Information Management, 46, 236-249 (2019) https://doi.org/10.1016/j.ijinfomgt.2018.11.016
26. Sattar, M. U., Palaniappan, S., Lokman, A., Hassan, A., Shah, N., & Riaz, Z. Effects of Virtual Reality training on medical students' learning motivation and competency. Pakistan journal of medical sciences, 35(3), 852 (2019) doi: 10.12669/pjms.35.3.44
27. Mei, H. H., & Sheng, L. S. Applying situated learning in a virtual reality system to enhance learning motivation. International journal of information and education technology, 1(4), 298-302 (2011).
28. Huang, Y. C., Backman, S. J., Backman, K. F., McGuire, F. A., & Moore, D. An investigation of motivation and experience in virtual learning environments: a self-determination theory. Education and Information Technologies, 24(1), 591-611 (2019).
29. Sattar, M., Palaniappan, S., Lokman, A., Shah, N., Khalid, U., & Hasan, R. Motivating medical students using virtual reality based education. International Journal of Emerging Technologies in Learning (iJET), 15(2), 160-174 (2020).
30. Butt, A. L., Kardong-Edgren, S., & Ellertson, A. Using game-based virtual reality with haptics for skill acquisition. Clinical Simulation in Nursing, 16, 25-32 (2018) DOI:https://doi.org/10.1016/j.ecns.2017.09.010
31. Aggarwal, R., Grantcharov, T., Moorthy, K., Hance, J., & Darzi, A. A competency-based virtual reality training curriculum for the acquisition of laparoscopic psychomotor skill. The American journal of surgery, 191(1), 128-133 (2006) doi:10.1016/j.amjsurg.2005.10.014
32. Lohre, R., Bois, A. J., Athwal, G. S., & Goel, D. P. Improved complex skill acquisition by immersive virtual reality training: a randomized controlled trial. JBJS, 102(6), e26 (2020) http://dx.doi.org/10.2106/JBJS.19.00982
33. Suebnukarn, S., Haddawy, P., Rhienmora, P., & Gajananan, K. Haptic virtual reality for skill acquisition in endodontics. Journal of endodontics, 36(1), 53-55 (2010) doi:10.1016/j.joen.2009.09.020
34. Debes, A. J., Aggarwal, R., Balasundaram, I., & Jacobsen, M. B. A tale of two trainers: virtual reality versus a video trainer for acquisition of basic laparoscopic skills. The American journal of surgery, 199(6), (2010) 840-845 doi:10.1016/j.amjsurg.2009.05.016