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Chapter 10
Virtual Reality With Horizons Architecture for Educational Innovation

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ABSTRACT

Encouraging the creation of new products, methods, and services of value for social impact involves processes of educational innovation. This chapter aims to analyse different types of innovation in two scenarios of graduate classes aimed at innovation and entrepreneurship. The question that guided the study was: What kind of educational innovation do students perceive as principal in graduate courses that integrate virtual reality? The method used was based on the analysis of two groups of graduate students participating in a class that integrated virtual reality and the strategy of horizons architecture. Through these observations, the authors analysed the perception of educational innovation by students who had the task of building innovative entrepreneurial projects to contribute to the objectives of sustainable development (ODS). The results show the types of educational innovation, the link with the strategy of architecture of horizons, and with the use of virtual reality in distance scenarios.

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INTRODUCTION

In the fields of education, educational innovation is presented as a process to establish the necessary improvements. Innovation in education has been impacted by the introduction of artificial intelligence, the impact on driving lifelong learning, the application of neuroscience to analyze how people learn, and the growth of investment in the education industry. Specifically, the instructional design for learning environments requires consideration of strategies, methods, techniques and resources that support the conduct of a creative and motivating user.

This chapter focuses on the analysis of the integration of educational innovations in the strategy and resources, in a course given in two different moments. Within the realm of innovative designs, we can find the Horizons Architecture framework (Barroso, Molina & Poiré, 2019). It proposes an adaptive model to assist in a qualitative and quantitative way the capacity to generate strategies (decision making), ventures (public) and future scenarios in complex systems and high certainty, within a specific period. This model is developed over time and through a simultaneous complexity integrated by the following axes: legacy, community, learning, technology, context and projects. Based on this initiative, a transfer was made to the field of educational entrepreneurship to work on postgraduate courses, integrating the management axis. This axis was added after researching the results of the development of entrepreneurial competencies in the first moment of the course (Ramírez-Montoya and González Padrón, In press).

The objective of this chapter is to analyse the perception of educational innovation by graduate students, with an innovative design course that integrated conceptual ideas from the Architecture of Horizons framework, as well as emerging virtual reality technologies, for the construction of entrepreneurial projects that contribute to the Sustainable Development Goals (UNESCO, 2015). The guiding question of the study in What kind of educational innovation do students perceive as principal in graduate courses that integrate virtual reality? The study begins by presenting a theoretical basis of educational innovation, virtual reality, then raises the method of cases that led the research, the results are presented and closes with conclusions that invite further study of the subject.

BACKGROUND

Educational Innovation

Educational institutions focus on pedagogical, technological, methodological and organizational transformations, identifying the most effective innovative strategies, methods and resources to change and improve the teaching-learning processes and the academic achievements of the students (Essien, Akpan & Obot, 2015; Fidalgo-Blanco & Sein-Echaluce, 2018; Pila, Andagoya & Fuertes, 2020). Furthermore, they promote the construction and reconstruction of knowledge by students, inviting them to acquire skills to cope with everyday situations and solve new problems in blurred scenarios. Thus, "student-centred learning and the commitment of teachers to quality training and innovation in teaching and learning methods" (Rodríguez, Rodríguez & Altamirano, 2019, p. 149), require initiatives that provide answers to socio-educational needs. The universities, as organisations of the digital society and knowledge transfer, are called upon to build an innovative culture (Zhu, 2015), whose members are committed to: making changes and improvements in their educational, academic and organisational practices; working towards

a digital culture in line with current demands and; generating social practices that generate ubiquitous and connected knowledge (Kaya & Sagsan, 2016; López-Martín, Dias & Tiana, 2017).

Focusing on the concept of educational innovation, this could be understood as "the synergetic sum of creating something new, the process in which it is applied and the contribution of an improvement as a result of the process" (García-Peñalvo, 2016, p. 2), sustainable over time and transferable to other practices, integrating pedagogical and technological knowledge in a cross-sectional way in the current educational ecosystem (Sein-Echaluce, Fidalgo and García-Peñalvo, 2014; Cobo, 2016). The integration of new methodologies, such as Challenge-Based Learning, linked to the use of technologies and the entrepreneurial approach, can contribute to the development of transversal skills such as teamwork and communication. (Portuguez-Castro & Gómez-Zermeño, 2020a; 2020b). Thus, educational innovations are not isolated practices and appear spontaneously. To this end, García-Peñalvo (2015) drew up a map of trends in educational innovation (Figure 1) composed of four perspectives: a) the institutional perspective, related to decision-making, strategic planning and management of technology and innovation itself, with a flexible and adaptive technological ecosystem; b) the perspective of the teaching staff, highlighting the methodologies, strategies and resources related to the curricular content (gamification, flip teaching, mobile learning, challenge-based teaching, among others); c) the development of transversal competences, related to soft skills, highlighting teamwork, computer thinking and service-learning and; d) institutional extension, relating the university to companies, entrepreneurship, transfer and different areas of society.

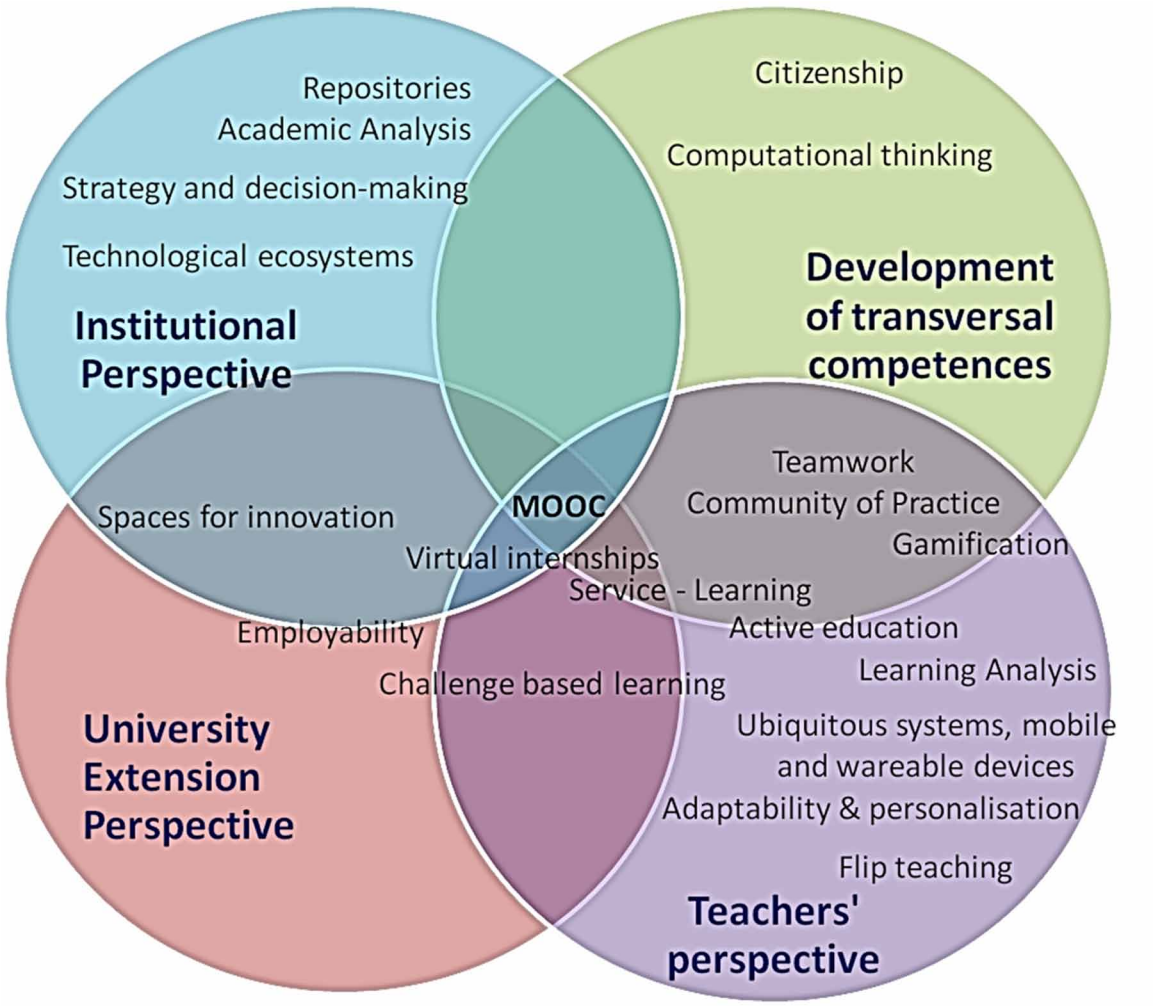
The trend map shows us how technological advances design a digitalised society, favouring collaboration, networking, critical thinking, diversity of communication in different contexts, giving rise to a technological ecosystem. Thus, educational innovation generates processes of change and improvement in citizenship, and in the training of teachers and students (Gros, 2016); moving from a society/university that teaches to a society/university that learns (Raad, 2016), focusing on learning processes and the personalised and comprehensive development of people.

Virtual Reality

Society, immersed in the fourth Industrial Revolution -a time when technologies are blurring the physical, digital and biological limits-, is experiencing technological transformations that are opening the way to the demand for new professional skills linked to: extended reality, robotics, artificial intelligence, biotechnology, edge computing, programming, and the internet of things, among others (Schwab, 2016). The Horizon Report 2020 (Brown et al., 2020) points out five major trends (social, technological, economic, higher education and political) which are combined in four scenarios (growth, limitation, collapse and transformation), helping to understand and monitor the incipient technological advances. González-Izard et al. (2020) used new technologies, such as computer vision and artificial intelligence for segmentation algorithms and augmented and virtual reality for the implementation of visualization techniques, and designed a comprehensive platform to solve this problem and enable medical professionals to work more frequently with 3D anatomical models obtained from medical images. In a study carried out in higher education, Mariscal et al. (2020) evaluated the impact of virtual reality simulation on student learning and satisfaction in two cases carried out at the European University of Madrid (EMU), locating the differences when these technologies were implemented and compared with traditional education. This new panorama of adapting to the changes and facing the new challenges of the fourth Industrial Revolution, gives us the opportunity to update knowledge, design contexts, create new opportunities in

higher education, and offer continuous education not only for current students, but also for those who arrive at the universities, according to the present needs (Tecnológico de Monterey, 2019).

Figure 1. Map of trends in educational innovation
(Source: García-Peñalvo, 2015)



This technological revolution invites us to innovate in the educational field, transforming not only the pedagogical materials, but also the practices and processes of teaching and learning. In this line, Veletsianos (2010) pointed out how emerging technologies "tools, concepts, innovations and advances used in various educational contexts at the service of various purposes related to education" (p. 3), guide "our thinking, research and practice" (p. 6); and require emerging pedagogies understood as "the set of pedagogical approaches and ideas that emerge from the use of ICT in education and that try to take advantage of all their communicative, informative, collaborative, interactive, creative and innovative potential within the framework of a new learning culture" (Adell and Castañeda, 2013, p. 15). In a study by Sanchez-Sepulveda et al (2020) found that the value of satisfaction in the use of advanced visual-

ization technology in the classroom reveals a high level of motivation, in general, with differentiation between students in their first and last phase of studies. In our case, Virtual Reality (VR), a concept that is encompassed within Extended Reality (XR), is perceived as an innovative technology in different areas of society, and especially in education.

The concept of VR can be understood as "an interactive medium composed of computer simulations, which detects the position and actions of the participant and replaces or augments the response to one or more senses, giving the sensation of being mentally immersed or in the simulation a virtual world" (Sherman & Craig, 2003, p. 38). Although the meaning of this continues to evolve as new ways of using it are found. Jacobson (2008) presents his definition of RV by establishing the following criteria: three-dimensional space, autonomy, interaction (or navigation), thematic presence (concrete place in the virtual environment) and sensory presence (sensation of being in the environment). For the author, Virtual Reality "generally refers to using a computer to interact with a virtual environment" (p. 5). Understanding that the Virtual Environment (VE) is "an artificial space, an imaginary or illusory world, created and maintained by appropriate computer applications" (p. 3); in which the user can interact with other objects or actors that are in the VE.

Stevenson & Lindberg (2015) defined Virtual Reality as "the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors" (p. 431). Thus, the VR platform, following Zhang, Liu, Kang and Al-Husdsein (2020), can be classified into three paradigms: 1) head-based (VR device in the form of a helmet, screen or glasses displaying images and with a position-tracking sensor); 2) stationary (VR platform fixed in one place, with projectors or screens to display visual information of the experience); 3) hand-held (device held with hands, e.g., tablets, mobiles).

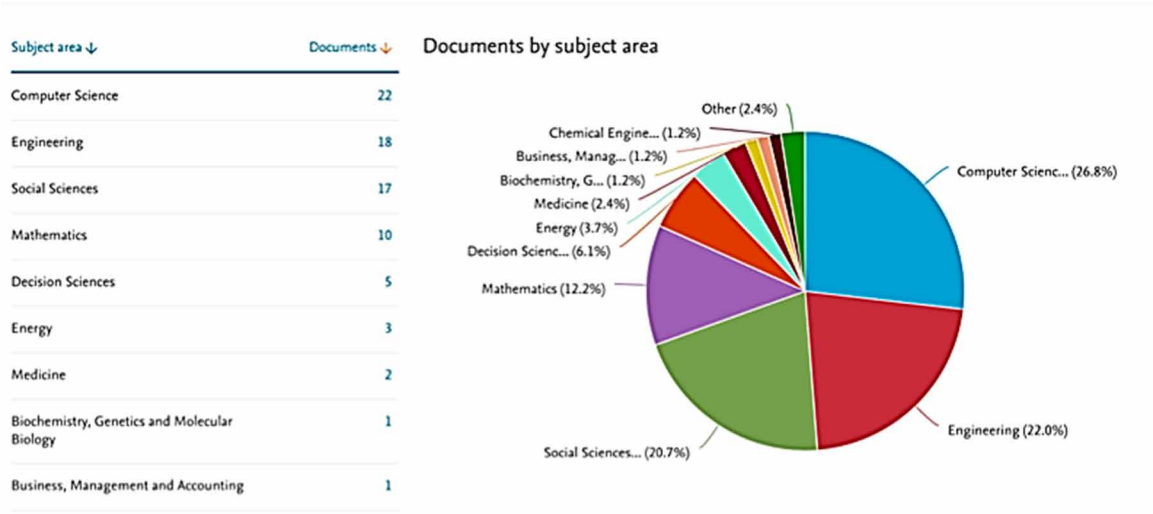
Focusing on Education, Liu et al (2017) visualize RV as immersive interfaces underlie a growing number of formal and informal learning experiences; and "provide sensory immersion, at present focusing on visual and audio stimuli with some haptic (touch) interfaces. The participant can turn and move as they do in the real world, and the digital setting responds to maintain the illusion of presence of one's body in a simulated setting" (p. 3). RV in order to be integrated and used in education needs to be well defined in its approach and theories of learning. To do so, it starts with constructionism, placing students at the centre of teaching-learning, being active agents, building knowledge and meaning (Fowler, 2015); and teachers as mentors - guides and accompaniers in the learning process. A teaching staff that is a creator of digital resources for learning, a pedagogical advisor, to clarify doubts and formulate questions; a transmitter of knowledge; an explorer and curator of resources; an instructional designer to elaborate stimulating and challenging activities; an innovator of new educational possibilities and; a critical thinker (Tecnológico de Monterey, 2017). Another of the theories in RL is autonomous or self-regulated learning, the student establishes his/her learning objectives and methods, and evaluates his/her own learning process. Thus, VR "provides resources necessary for autonomous learning, allowing students to select a suitable learning environment based on their learning requirements, to take an unlimited number of repetition and practice, and to check learning outcomes by receiving feedback from the environment" (Liu et al., 2017, p. 110). Thus, the practical application of RL starts with learning through observation, operational learning, social learning and academic research.

Some pedagogical trends for the use of RV in education are: digital materials, gamification, experiential learning, mobile learning, hybrid learning, among others. And the benefits it brings to students are: maintaining attention, memory, improving understanding, effectiveness in the pace of learning,

content creation, practical experimentation with theory, greater motivation and personalisation of learning (Johnson et al., 2016; Tecnológico de Monterey, 2017; Bower, DeWitt & Lai, 2020). Sein-Echaluce et al. (2020) identified a need in the field of educational innovation where they emphasize that, in order to meet the demands of an educational sector, the target audience for which the innovation is designed must be global, so that it is designed worldwide, can be applied locally and transferred to other contexts.

The link between virtual reality and educational innovation, in the field of literature is an emerging theme, still growing. In an analysis of the Scopus database, where the terms "education innovation" or "educational innovation" and "virtual reality" were searched, both in English and Spanish, from 2010 to 2021. In November 2020, when the search was performed, 39 documents were located, where the publications by authors from Mexico (19 documents) stood out, followed by Spain (6 documents), and Colombia (4 documents), with an increase since 2017, mainly with conference papers (64%), followed by journal articles (28%). The publications stood out in the areas of Computer Science and Engineering (Figure 2), which represents an area of opportunity for the field of applications in education.

Figure 2. Educational Innovation and Virtual Reality Publications
(Scopus, 2020).



Subject area	Documents
Computer Science	22
Engineering	18
Social Sciences	17
Mathematics	10
Decision Sciences	5
Energy	3
Medicine	2
Biochemistry, Genetics and Molecular Biology	1
Business, Management and Accounting	1

Horizons Architecture in the Framework of Educational Innovation

Educational innovation based on emerging technologies, such as virtual reality, is fostered with multidisciplinary collaboration, and having in mind an impact-generation perspective. To attain this goal, there is a great aid potential by using the Horizons Architecture. This architecture is based on the complexity of realities, on research and innovation. Barroso, et. al, (2019) have conceived it as an adaptive model that supports the proposal of long-range projects, geared towards the support of decision making and idea construction, applied mainly in the areas of public undertakings and future scenarios in complex systems of high uncertainty, within a specific period. This framework has been transferred to encourage educational innovation in educational environments, with a view to entrepreneurship and innovation

(Ramírez-Montoya and González-Padrón, In press). Educational enterprises can be of different types and levels of innovation.

There are several types of innovations that can be projected with horizons architecture:

1. Continuous: involving small routine changes and forming part of the processes of continuous improvement, with deviations from educational practices that, by themselves, do not change it to any great extent, but when they accumulate they translate into deeper changes);
2. Systemic: methodical and ordered where the scope and novelty of its changes can vary and even lead to substantial changes with the implementation of tools or strategies that have been successful in other markets or industries;
3. Disruptive: associated with the introduction of completely new services or radical new ways of doing things, with new contributions to the world and generating fundamental changes in the activities, structure and functioning of the organization; and
4. Open: collective creations that seek solutions within and outside the entity that triggers the change, with strategic alliances with third parties: partners, customers, technology suppliers, intermediaries, research centers, universities, librarians, designers, and even competitors (González-Pérez, Ramírez-Montoya, & García-Peñalvo, 2019; Valencia & Valenzuela-González, 2017).

The Horizons Architecture was applied to the field of humanities and education to propose projects that aided the attainment of the objectives of sustainable development (ODS) of the 2030 agenda established by UNESCO (2015). Furthermore, it was used to promote the linkage between the academic, governmental, business, society and environmental sectors. A long-range projection was intended for the above-mentioned project, including the following elements (Figure 3):

- Legacy: What value do you want to contribute? Focus the long-range view where you want to contribute and contribute, mainly because of the need for progress in this field. To locate the aspirational and utilitarian objectives, as well as the motivations of the creators, communities or entrepreneurs. This includes personal interests, vocation and objectives of people, communities and organizations within a project. In the educational field, the legacy can locate an innovative contribution for an ODS, which indicates what you want to achieve, the sector where you want to impact (government, industry, academia, society or environment) and the type of innovation (continuous, systemic, disruptive, open).
- Community: Who can help? Locate the networks and people who can contribute to the legacy. Analysis and mapping of the network of people who have a particular goal in common, a sense of partnership as a result of shared attitudes, interests, and objectives. People who are aware of their role in the collective endeavour, especially in the context of economic activities, social values and civic responsibilities, around the legacy.
- Learning: What is required to know? Identify the knowledge needed to address and sustain the legacy. Learning denotes what needs to be learned and by what means. Identifying relevant sources from specialized libraries with journals, books, and articles that support knowledge building. It covers the relevant tools and skills to develop, grow and manage individual or collective projects. Particularly important, tools relevant to the digital economy and to sustainability.
- Technology: With which emerging resources? Search for the latest technologies that can support the project. It is the set of technological investment and awareness to make the best decisions,

necessary to develop and sustain a project in a context of rapid technological change, in a specific time frame. A platform to locate the latest technologies (Goldfire, for example), can also be located in specialized libraries, technology and development companies.

- Context: In which scenario? Stage the place where the innovative project will be carried out. Identify the socio-economic, political, and environmental factors in which the projects operate, paying attention to the influence that local reality and environmental conditions have on the growth of the projects. Record with numerical data and descriptions of how the site is historically, economically, the location, government areas, what the school grade is, type of population, etc.; that is, describe the context and participants.
- Projects: With what activities? Locate plans what can be done to achieve the stated legacy. It will be important to document projects that have already been carried out around the theme, in order to decide which new projects can be carried out to add value. Delineate an individual or collaborative company that is designed to create value -social, economic, public, environmental...-, achieving a particular end, to contribute to the legacy.
- Management: With what resources? Visualize the human and financial resources required to achieve the legacy and possible risk models in social organizations, in order to delineate sources of funding and strategic development. It will be important to seek support to establish goals and logistics for administration, accounting and financial knowledge for the development of an enterprise, financing sources and marketing strategies. Management is the human and financial resources that will support the legacy, as well as marketing strategies and funds that they can support and projects denote what they can do to achieve the stated legacy.

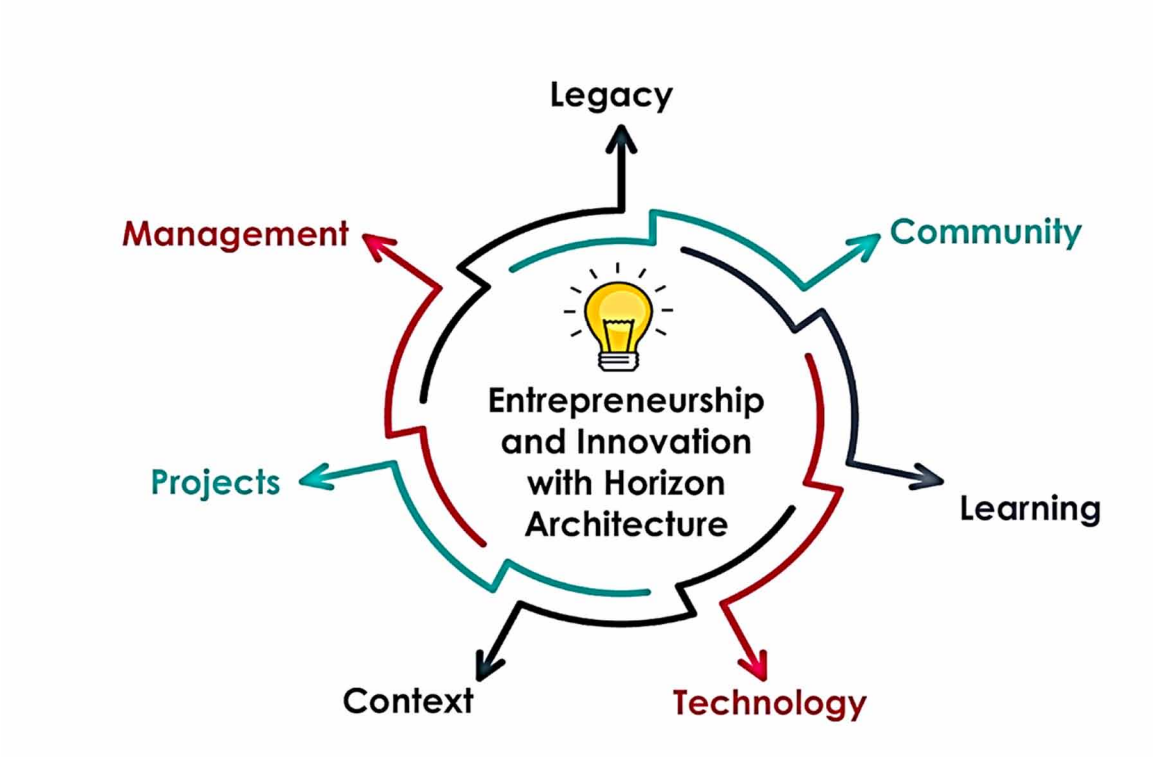
The Horizon Architecture model can increase the scope of educational innovation. There are three substantial elements: vision, innovation, and research. The vision for knowledge to impact society, through a shared legacy; by locating a community of experts in various countries who have worked on the issue of the target legacy; by identifying learning to inform actions and to be able to learn about what has already been done and to inform, through research, to take steps forward; detecting technologies that can support growth in the legacy and be able to establish communications to reach a wide population; analyzing the context of advocacy, formulating projects and looking for opportunities to manage and carry out, the projects, in a sustainable way.

METHOD

The method used was based on the analysis of two groups of graduate students, participating in a class that integrated virtual reality and the strategy of architecture of horizons. Through these observations, we analysed the perception of educational innovation by students who had the task of building innovative entrepreneurial projects to contribute to the objectives of sustainable development (UNESCO, 2015). These projects produced the materials to be presented in the virtual reality platform.

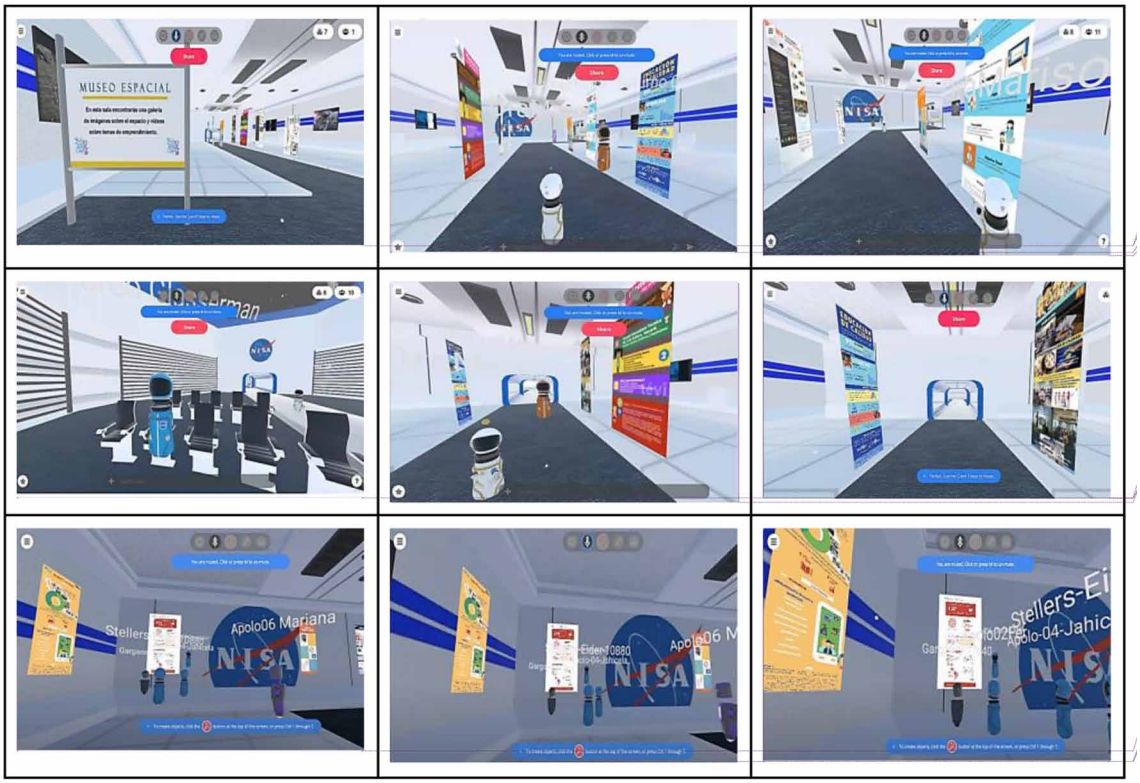
In these groups, the innovative object to be evaluated was the course itself, which integrated virtual reality for the presentation sessions, and the horizons architecture for material production. A virtual reality scenario was created that allowed for the interaction of the participants, so that they could present their class deliveries (infographics, videos and digital prototypes that they were in charge of creating) and to carry out interactive sessions between teachers and students (Martínez-González, 2019).

Figure 3. Architecture of Horizons in the framework of educational innovation
(based on Ramirez-Montoya, In press)



The scenario was a spacecraft simulation that was called NISA, where participants had to choose space suits to get started. This scenario, or virtual reality platform, was modelled in 3D, using Maya and Blender software tools, and was implemented on the Mozilla Hubs platform. Students and faculty interacted in the virtual scenario during project presentations, sharing materials with the group, exploring the projects and teaching the class, thus encouraging student participation (Figure 4). The materials that were presented by the students were previously developed using three phases to apply the horizons architecture method: diagnostic, development, and validation. In the diagnostic phase, students dealt with the definition of the legacy, community, and learning components for their project. The development phase required them to propose technology, context, project activities, and resource management. Finally, the validation phase required them to contact individuals within their target user group to assess their proposals and determine their pertinence. Observations were made for each one of the steps. To prepare them to use this new space, an explanatory video was sent to them, and a test session was held, prior to the official presentation session of the course. The participants commented that they felt they were really gravitating, and that the experience was different from other media such as the Zoom or Canvas platforms.

Figure 4. NISA scenario with virtual reality



The population of the first group was 64and for the second group it was 108. Figure 5 shows the geographical location of the participants, and Figure 6 their gender distribution.

The guiding question of the study was: *What kind of educational innovation do students perceive as principal in graduate courses that integrate virtual reality?* A validated instrument to measure their perception was applied (García-González & Ramírez-Montoya, 2019a, 2019b), consisting of 28 indicators, and structured in two parts. On the one hand, the elements of innovation (change/novelty, and added value), and on the other, the types of educational innovation (incremental, systematic, disruptive and open). The instrument used is a Likert-scale questionnaire, aiming at the evaluation of an object of educational innovation from the perspective of its users.

The instructions for requesting a response to the questionnaire were: "In order to assess the type of innovation in our course, we will make an intermediate assessment of how innovative you consider the training experience you are living in the course, referring to the scenarios with virtual reality built to present their infographics, videos, challenges, and projects. In the question of the *Innovative Object* put the name of the course *Entrepreneurship and Innovation* and place yourself in the experience you live in our course to answer the questions. Please give an individual answer to the Innovation Tool (Link to the Tool link)"

The observations obtained were then analysed and interpreted with descriptive statistics.

Figure 5. Geographical density of course participants

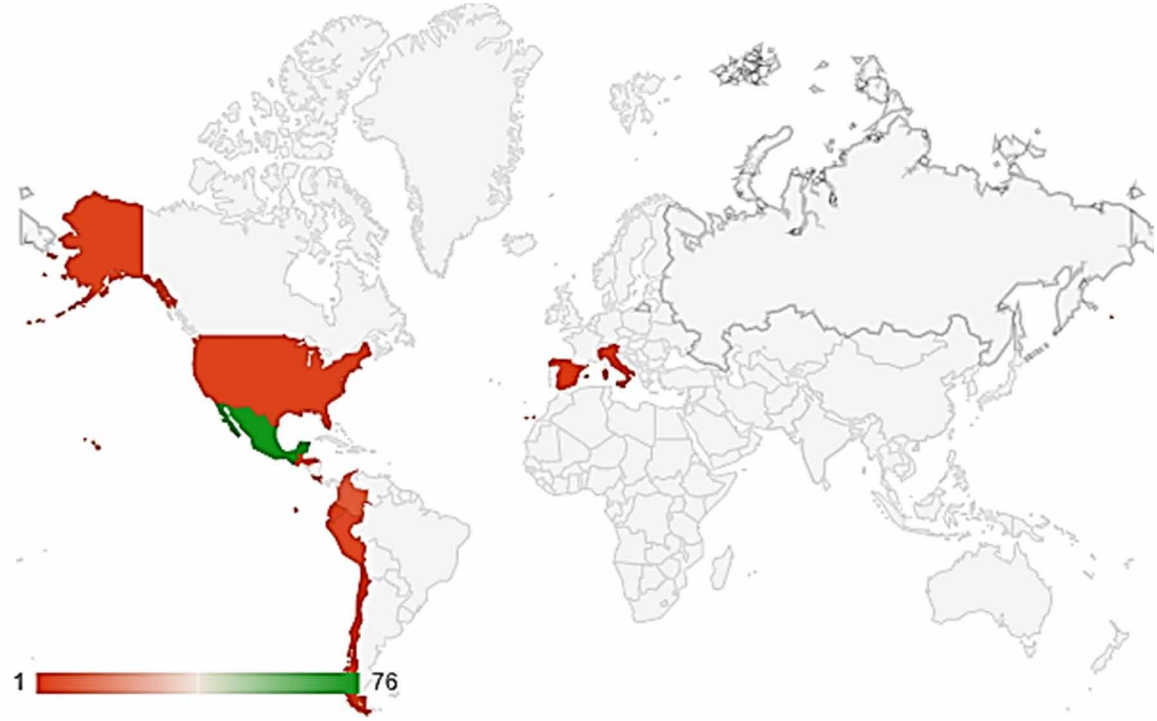
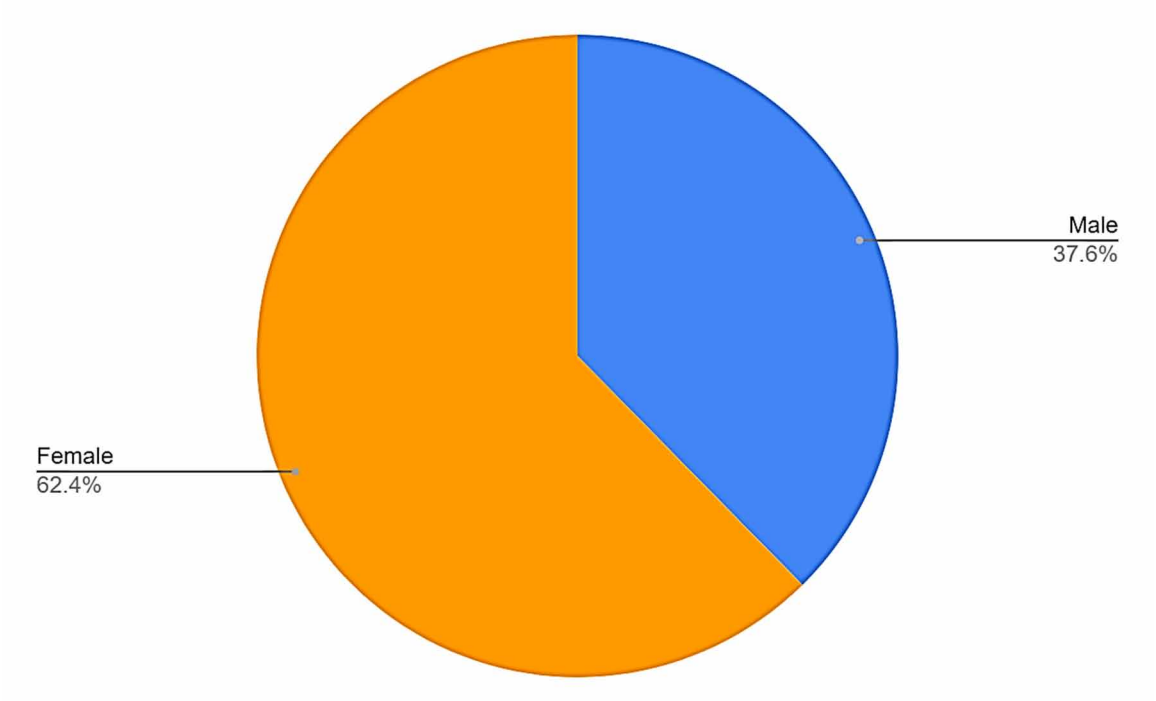


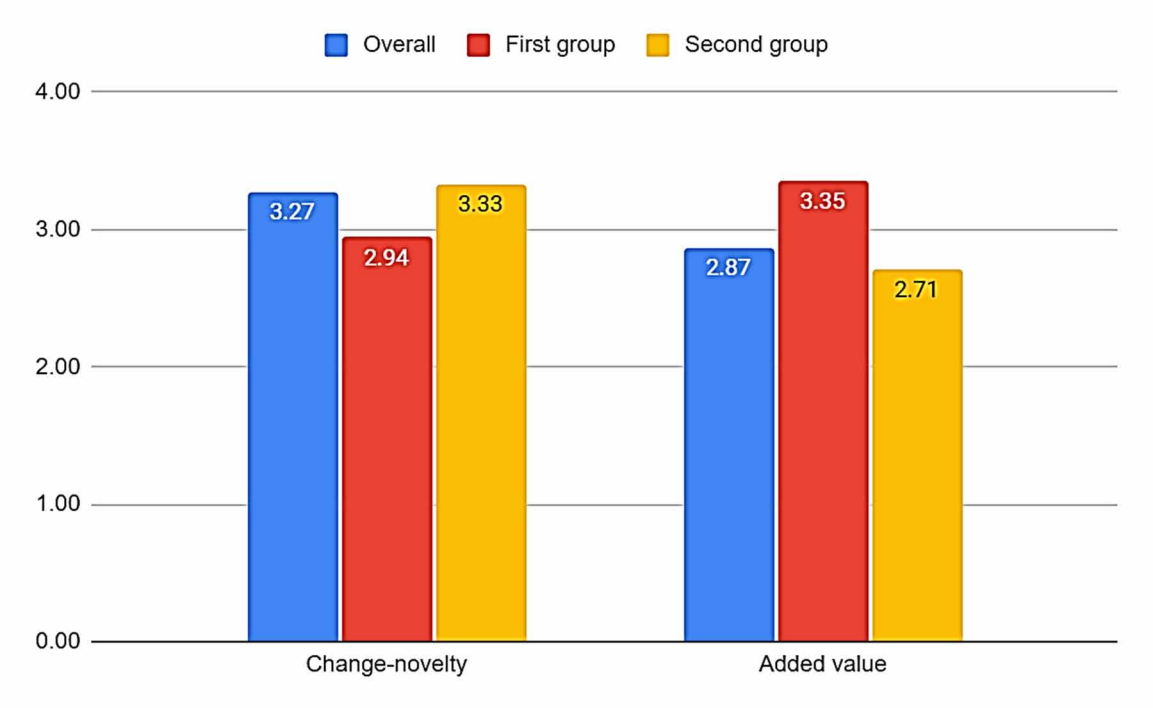
Figure 6. Gender distribution of course participants



RESULTS

After completion of each course, students were asked to fill out the survey instrument. 22 out of 64 did in the first group, and 78 out of 108 in the second group. Overall, it was observed that members of the first group perceived the innovation as more valuable than those of the second group. Figure 7 shows the overall scores for the elements of innovation, that is change-novelty, and added value. It can be observed that students are more leaned towards considering the innovation a novelty, but they don't see the added value in the same proportion. When analysing this result only for the first group, the proportions are reversed. This may be the result of technical problems faced during the sessions for group two. The virtual reality platform presented problems when the number of users passed 100. This was not observed in the first group due to its size, and it was not foreseen for the second. As a consequence of the technical trouble, the group had to be divided in two, altering the smooth consecution of activities. This might have altered the perception of the students, since they may not be fault-tolerant enough.

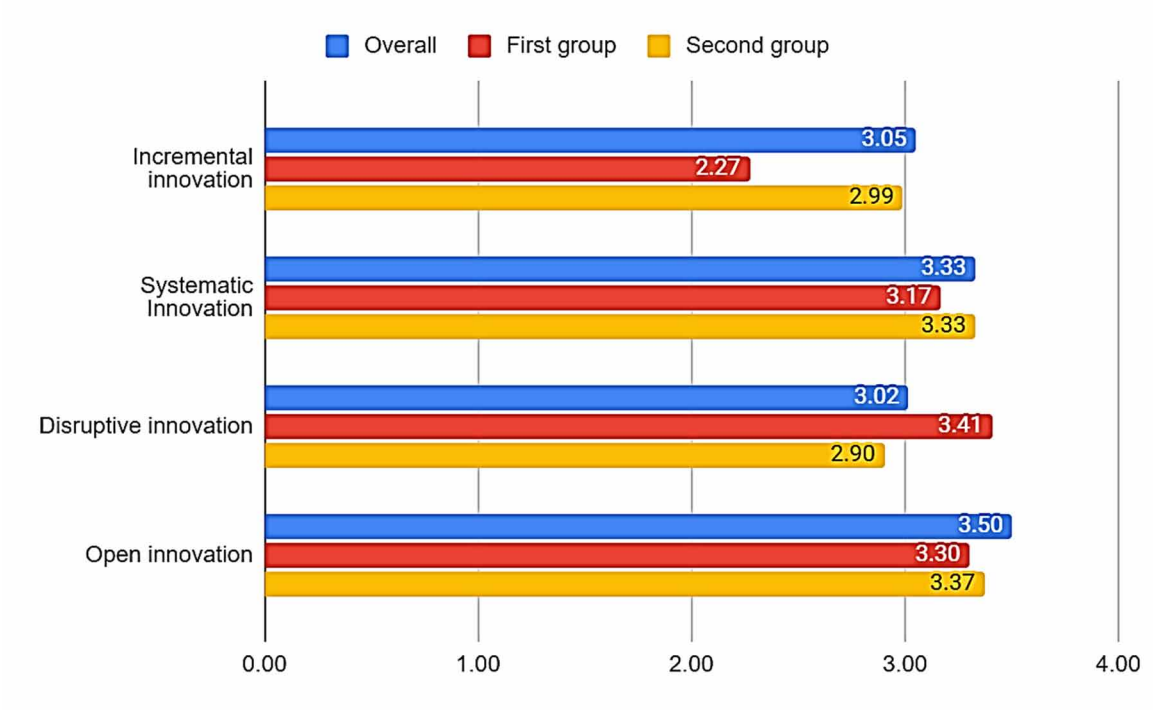
Figure 7. Values obtained for the components of innovation



As for the types of innovation, Figure 8 shows that students ranked open innovation as the highest, followed by systematic innovation. It can be inferred that the interaction intended among students, and between teachers and students for the session was an effective factor to foster the input of ideas from the group, therefore improving the results of the process. Since virtual reality environments are relatively familiar to young people, it is somewhat expected that they consider this innovation as incremental,

rather than disruptive, explaining why the systematic innovation ranked higher, understanding it as the result of continuous improvement.

Figure 8. Students range for the types of innovation



The phases of the horizon architecture method were monitored by the teaching staff, and in-depth interviews and focus groups were conducted to gain insights about the process. For the first phase, the diagnostic one, students perceived a great deal of satisfaction in how the method aided them to clearly define the legacy that they intended to create with the innovation project. This was very well tied to the definition of the community, which in turn helped them define a specific and well identified target user group. Additionally, they were able to determine what they and the target users would require to learn to make a successful implementation of the proposed innovative solution.

The development phase required them to generate intelligence about the emerging and exponential technologies that would have the greatest potential to positively impact their innovation proposals. This was accompanied by the definition of the context, that is the conditions under which the innovation would be implemented to provide the greatest benefit, and they were able to plan the necessary resources and activities, as well as the potential financiers for making the project happen. Perhaps defining the context was the hardest goal to achieve by the students, provided its unstructured nature. Nonetheless, once this goal was attained, it represented one of the most beneficial steps during the project, in terms of the understanding that it would create for the students.

Finally, the students had to undertake a validation of the proposed innovation by building a prototype, and putting it to the test with potential users of the target group. This experience proved to be

most enriching for them, regardless of the fact that they had to go back and make changes in previous phases, due to a clear message on unsuitability of some components of their innovation proposals that was delivered by some of the test users.

Overall, students believe that this method gave them the clarity and direction that they needed to conduct a successful innovation proposal project for a social enterprise in a relative short period of time. On the downsize, it was observed that many of the participants tended to get frustrated easily when the results did not come through quickly enough.

It is likely that open innovation became a very well rounded concept in their minds, as a result of the constant interaction with many actors, both within and outside their teams. This was strengthened by the constant petition that they received from the teachers to register their deliverables under a Creative Commons license, so that they could be uploaded in a university open repository.

SOLUTIONS AND RECOMMENDATIONS

The integration of a managerial component is a key element that must be at a first level when designing projects. This component was integrated within the projects component, in the first version that applied horizon architecture. The results showed the absence of management elements and funds to support the proposed projects. In the second version, Management was placed in the first level, and the results of projects that proposed sustainability and fundraising were evident.

It is advisable to generate learning environments that use technologies, and promote innovation and linkage with various sectors (academic, government, business, society, and environment), in order to support the generation of the transversal competences of creativity, critical thinking and problem solving. Similarly, attention to real problems, such as the ODS of the UNESCO agenda, provides an opportunity to encourage social commitment. This impulse must be present in the activities that are developed and whose impact can be measured and evaluated.

FUTURE RESEARCH DIRECTIONS

The present work attempted to provide a mix of methods for obtaining as much triangulation as possible. Nevertheless, it is clear that it remains in an exploratory phase, and it requires many additional actions to strengthen the findings.

The first issue to address is the nature of the sample. It consisted of graduate students in Humanities and Education in a distance learning environment. It is reasonable to assume that the students are familiar with technologies, and they are exposed to innovations and innovation processes quite often, although it would be interesting to observe differences based on their previous educational background. Extending the study to other contexts to improve the external validity of the study is paramount. This could be achieved through samples from businesses, as well as students from other levels and disciplines. Also, the distribution of gender of the sample did not help for gender equity observations, which would be important to explore today.

Furthermore, the fact that this study is qualitative and exploratory, allows for maximizing the richness of context. As such, it should be expected that the phenomenon can be observed in detail, though restricted to a narrow context. Further replications could allow for increasing such understanding, so that

a causal model could be derived, and later on tested through quantitative confirmatory analysis. Such model should include the effects that the innovation types, and the components of horizons architecture have on each other. To be able to do that, there should be validated measures of each element as an independent construct. Even though this is already available for innovation type, that is not the case for the horizons architecture components.

Alternative methods like neural networks could also be explored to complement the qualitative analysis of the focus groups and in-depth interviews. This application of neural networks could be later extended for prediction purposes, once the appropriate codification mechanisms were put in place.

This type of research lends itself, as well, to the use of action research or design-science research, where the objective of the intervention in the group is clearly identified and measured, and under constant reflection and scrutiny of a group of researchers, in cycles of improvement until an objective is attained, via the application of an artefact.

Finally, a combination with ethnographic research techniques should not be discarded, should further understanding of the student's behaviour be the objective of enquiry.

CONCLUSION

As mentioned above, the guiding question for this chapter is: What kind of educational innovation do students perceive as principal in graduate courses that integrate virtual reality? Now we will briefly enunciate the main elements of the emerging answer.

The students were led by the technological tool to identify mainly open innovation. The students highlighted the fact that virtual reality is suitable for solutions that trigger change in the learning process. Relevant learnings were achieved in the development of this proposal. In addition, the students considered the innovation mainly a novelty, and to a lesser extent they did not consider the added value to be significant, or at least in the same proportion as the novelty.

It is of great importance to guarantee that the interaction with the technology is robust, regardless of the class size. In our study, a disruption in the functioning of the virtual platform in the second group, mainly due to class size, had a confounding effect on the perception they had for the value added by the virtual reality scenario. Hence, the students from the first group perceived a greater value of the innovation, rather than just seeing it as a novelty, as the students from the second group did.

Another aspect to consider is that the use of virtual reality may be well positioned among younger generations, somewhat reducing its categorization as disruptive, due to its familiarity. This is especially true when we consider the vast amount of gaming scenarios that they grew up accustomed to.

Additionally, as mentioned above, it is important to establish metrics that can be analysed for the characteristics of the horizons architecture concept. Even when the students' interventions were accompanied with sufficient information, explained and guided until their development in the aforementioned products, it is necessary to be able to compare the level of development presented by each proposal to clarify the quality or level demonstrated at the end of its execution.

Is very important to mention that, as an important part of any scenario where an educational innovation is sought after, the management component should not be left out, it must be considered at all stages when designing projects, so that an efficient resource planning is taken into consideration to make them feasible.

As shown in this chapter, and based on the results obtained, the use of Virtual Reality as an innovative, and sometimes disruptive technology, that contributes to the improvement of the educational process, increasing learning, academic performance and student motivation. It turns out to be a tool for inclusion and attention to user diversity, and for the presentation of contents from a different position than usual.

Finally, the application of the horizons architecture in this type of innovative studies for learning, as well as the experience of carrying them out, allows us to observe a very wide range of characteristics in their implementation, which should be considered in future works, as already mentioned. It is pertinent and relevant to continue undertaking studies that help support the impact of educational innovations, based on evidence.

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KEY TERMS AND DEFINITIONS

Continuous Innovation: Involving small routine changes and forming part of the processes of continuous improvement, with deviations from educational practices that, by themselves, do not change it to any great extent, but when they accumulate they translate into deeper changes) (Valencia & Valenzuela-González, 2017).

Disruptive Innovation: Associated with the introduction of completely new services or radical new ways of doing things, with new contributions to the world and generating fundamental changes in the activities, structure and functioning of the organization (Valencia & Valenzuela-González, 2017).

Educational Innovation: The synergetic sum of creating something new, the process in which it is applied and the contribution of An improvement as a result of the process (García-Peñalvo, 2016, p. 2).

Horizons Architecture: It proposes an adaptive model to assist in a qualitative and quantitative way the capacity to generate strategies (decision making), ventures (public) and future scenarios in complex systems and high certainty, within a specific period (Barroso; Molina & Poiré, 2019).

Open Innovation: Collective creations that seek solutions within and outside the entity that triggers the change, with strategic alliances with third parties: partners, customers, technology suppliers, intermediaries, research centers, universities, librarians, designers, and even competitors (González-Pérez, Ramírez-Montoya, & García-Peñalvo, 2019).

Systemic Innovation: Methodical and ordered where the scope and novelty of its changes can vary and even lead to substantial changes with the implementation of tools or strategies that have been successful in other markets or industries (Valencia & Valenzuela-González, 2017).

Virtual Reality: The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors (Stevenson & Lindberg, 2015, p. 431).

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