Enhance Your Student's Perceived Learning, Attention and Motivation With Immersive Activities and Metaverse – Based Learning

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The European Conference on Education 2023
Official Conference Proceedings

Abstract
This research was designed to test the effectiveness that immersive tools and activities, specifically metaverse-based activities, has on student learning. For this research, an experiment was designed with a control group and an experimental group in the course EM1009 - Business Model Innovation that is an Online Course lasting 5 weeks and was imparted in the semester of August-December 2022. The experimental group performed certain activities within the metaverse. In the control group, the same activities were carried out, but with a traditional teaching method (without metaverse). Comparisons between both groups were made using parametric and non-parametric hypothesis testing and surveys were also carried out to assess the perception of the learning process of the students who used the metaverse. The results showed that, although in general, there are no significant differences between the amount of learning of both groups, students who work within the metaverse perceive that their learning process has a greater impact in them. They feel more motivated and pay more attention when carrying out innovative activities with state-of-the-art technologies to learn in their classes.

Keywords: Metaverse, Technology, Education, State-of-the-Art

Introduction

Theoretical Framework

It is important to incorporate cutting-edge technologies in education because they offer unique opportunities and significant benefits for the teaching-learning process. It has the potential to improve the learning experience of students, it guarantees them access to global resources and knowledge, it allows the development of skills and competences that are generally considered useful for the 21st century, it encourages adaptation to work in digital environments allowing the innovation and experimentation of new teaching techniques.

The use of the metaverse and virtual reality in educational environments is addressed, since this technology has the potential to transform learning in education in different ways, which makes it a relevant and powerful tool, as it guarantees students to learn in an interactive and practical environment through immersive experiences. The use of these technologies allows the development of learning activities with a high degree of personalization and adaptability, by guaranteeing access to global resources. Finally, it has been observed that the change of stimuli and the unusual experiences in the classes positively affect the motivation and commitment that students show during the course.

This research focuses specifically on the use of the metaverse and virtual reality, the term of which first appeared in the 1992 science fiction novel "Snow crash" by Neal Stephenson and also appeared in the book and film of "Ready player one" by Ernest Cline. Go et al. (2021) defines the metaverse as a 3D-based virtual reality where daily activities and economic life are carried out through avatars that represent reality itself. It is a universe made up of a network of virtual environments where you have an immersive online experience. Users are represented by avatars and can interact with other people and items that are also in the same environment. It could be said that this term is a new construction, an environment where one can live digitally (Recker et al., 2021).

The use of the metaverse has multiple applications, but in the near future, it could be much more (Donaldson, 2011). Here are some key reasons why using it can significantly improve the learning process:

Immersive Experiences: Virtual reality allows students to immerse themselves in realistic, three-dimensional virtual environments that simulate real-world situations. This provides the opportunity to experience complex or dangerous scenarios in a safe and controlled manner that would otherwise be difficult to reproduce in a traditional learning environment. According to Sattar et al. (2020), virtual reality is a computer-generated interactive experience that takes place in a simulated environment. Users can experience immersive perception and can explore the scenery developing fun and interactive learning. For example, students can explore the human body in 3D, visit historical sites, or participate in hands-on simulations such as spaceflight or science experiments.

Interactive and Hands-On Learning: Instead of just reading or listening, the metaverse and virtual reality allow students to interact directly with the concepts and objects of study. They can manipulate virtual objects, conduct experiments, solve problems, and collaborate with other students, which encourages hands-on, active learning. This hands-on, active participation can improve comprehension and retention of information. Studies have shown

that virtual reality can improve student comprehension, knowledge retention, and engagement as well as student motivation and attention span (Clegg, 2023).

Personalization and Adaptability: Virtual reality and metaverse technology can be tailored to individual student needs and learning styles. Virtual environments can be adjusted to provide instant and personalized feedback, offering specific activities and exercises for each student. This allows for a more personalized approach and greater attention to each student's strengths and weaknesses, which can lead to more effective learning. Immersive learning engages and holds students' attention for longer because it is more engaging. Traditional learning methods can be boring, however, immersive learning makes students feel right at the center of the action (Buljan, 2022).

Access to Global Resources: The metaverse allows students to access a wide range of educational resources from around the world. They can connect with experts, researchers, and professionals from any field, participate in virtual conferences, and access virtual libraries. This expands learning possibilities beyond the physical limits of traditional classrooms and provides students with a global and up-to-date perspective.

Motivation and Engagement: Virtual reality and the metaverse have the potential to make learning more engaging and exciting for students. By providing immersive and engaging experiences, students' intrinsic motivation and engagement in the learning process can be increased. This can lead to greater participation, interest and dedication on the part of students, which, in turn, can improve academic results. One study suggests that students retain more information and are better able to apply what they have learned after participating in virtual reality exercises (Krokos, Plaisant, & Varshney, 2019).

Description of the Innovation and Research Methodology

The objective of this research was to compare different business model alternatives to bring innovation to market using patterns from different industries in an emerging or newly created context to assess whether the use of the metaverse positively influences learning and experience. of the students.

The composition of both groups is described below:

Experimental Group	Control Group
Classes in the metaverse Tec Virtual Campus + training session	Flexible Interactive and Technology-driven (FIT) Classes (Zoom)
Duration: 5 Weeks / 10 Sessions	Duration: 5 Weeks / 10 Sessions
Teacher: Rocío Cortez	Teacher: Rocío Cortez

28 students (Campus Toluca, México City, State of Mexico, Santa Fe, Monterrey, Chihuahua, Guadalajara, Sinaloa, Sonora) 17 male / 11 female Average grade previous to taking the EM1009 course: 85.65 First semester: 5 Second semester: 15 Third semester: 9	30 students (Campus Hidalgo, Puebla, Querétaro, State of México, Santa Fe, Monterrey, Aguascalientes) 13 male/ 17 female Average grade previous to taking the EM1009 course: 92.08 First semester: 5 Second semester: 17 Third semester: 6 Fourth semester: 1 (CPF) Sixth semester: 1 (IIS)

Table 1: Information of the experimental and control groups.

For the experimental group, a series of activities were developed that had to be carried out by the students of the Tec de Monterrey, in the metaverse called Tec Virtual Campus, so that they could meet the skills required to pass the course. They also did a Pre-Test at the beginning of the course and a Post-Test in the last class. This activity allows us to evaluate the knowledge of the student prior to the activities and to compare it against the knowledge of the same student after the activities. They carried out various activities in the Tec Virtual Campus, such as "The blender", "Emerging economies and the 55 business models" and they made an evidence at the end to demonstrate that the students acquired the necessary skills to pass the course. For the control group, the same activities were carried out, but were adapted to be carried out outside of Tec Virtual Campus.

A comparison was also made between the results of the student opinion surveys (ECOA's) regarding the course to check if there were differences between the general opinions of the students in both groups.

The research variables that were used were:

- Grades of the activities: The blender, Emerging economies and final evidence
- Final grades
- Learning gain score (session 1 with pre-test and session 10 with post-test)
- Student satisfaction end of the course poll

Subsequently, the students' results were compared by doing a series of parametric and non-parametric statistical tests and symmetry tests depending on the characteristics and shape of the data distribution. These tests make it possible to compare whether there are statistically significant differences between the results of the control group and the experimental group.

The students of the EM1009 Business Model Innovation course in the FIT modality in the August – December 2022 semester lived an innovative and memorable experience when they connected to their classes in the metaverse of Tecnológico de Monterrey, Tec Virtual Campus. One of the main premises is that the design of the activities to be carried out are appropriate to the virtual and interactive environment where the student becomes an active participant and the teacher is a guide - facilitator in the learning process. It also sought to enhance the learning and engagement of the group through different scenarios such as the Team Suite, Arena, Meeting Room, or having the great opportunity to take the class in the tallest building on the TecVirtual Campus. Students learned to identify and apply methods and tools in business models taking into account the megatrends and technologies of different

industries, as well as develop the Business Model Canvas based on what was learned in the course. At the end, the students presented their evidence in a video pitch that was projected in the Showroom inside the Tec Virtual Campus Gallery, where they selected the best works of their classmates.

The work plan prior to implementation in the experimental group is described below:

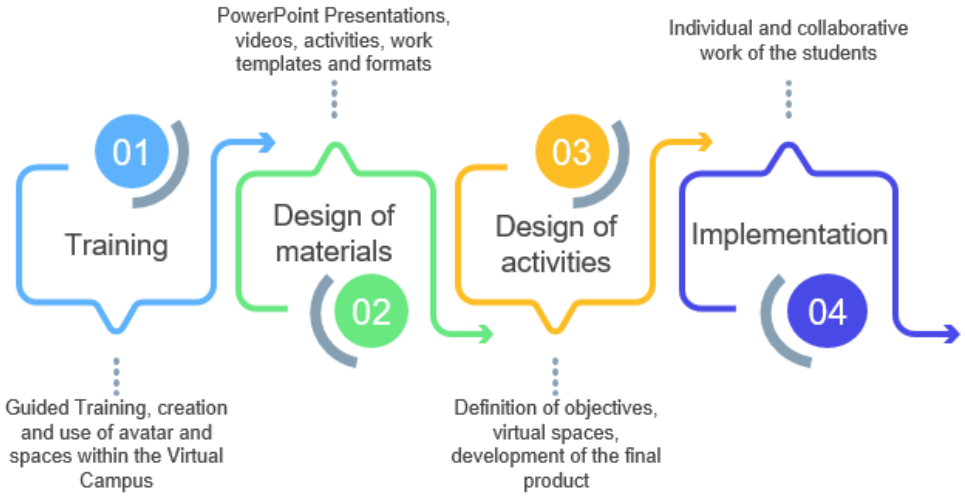

Figure 1: Implementation of the activities in the metaverse.

1. Training was received with the objective of knowing the tool, creation of an avatar, handling it, reactions, use of chat, teleportation to the different scenarios, voice, among others. Likewise, time and space were allocated so that the students also received said 30-minute training with a guided tour.

2. The preparation of materials consists of developing the supports for the class, the templates that the students will use to work, the videos that are used as resources for the class and interactive dynamics to involve the students in the contents.

3. The activities carried out in both the control and experimental groups were the following:

Activity	Objective	Scenario	General Description
The Blender	Identify and apply elements (methods and tools) to take into account in processes of creativity and innovation in Business Models, while making use of megatrends/technologies in different industries.	Meeting Room Arena Team Suite	Selection (in teams) of an industry and type of technology. The students turn on their mental blender to develop a proposal for a new business model, which is reflected upon and presented to the group.

Emerging economies and the 55 business models	Apply the 55 Business Model patterns suggested by the Business Model Navigator Apply and develop the Business Model Canvas and choose 3 of the 55 business models for a selected idea from those generated in the previous class.	Auditorium Roof Hall Team Suite	The results of the "Blender" activity are discussed as a team and an outstanding idea is selected to develop the BMC. At least 2 of the 55 Business Models that could start the idea are selected and describe how its development would be.
Virtual Showroom and Evaluation of the Business Model	Contribute to the development of the following sub-competences and mastery levels: • Business model (B) • Business model (C) • Innovation (A)	Forest Campsite Gallery	Individually, students prepare a Video-Pitch that includes the value proposition and the elements of the business model aligned to it, as well as mentioning what type or mix of business model patterns they are using. Videos are uploaded to Tec Virtual Campus spaces and students review them in the Gallery and vote for their favorite

Table 2: Activities of the EM1009 Business Model Innovation course used f
or the investigation.

It should be noted that these activities in the control group were carried out in Zoom, through the breakout rooms tool to start working as a team, and in the experimental group they were carried out in the Tec Virtual Campus metaverse.

1. Regarding the implementation, the classes have a duration of 2 hours, being 100 effective minutes, in which 28 students participated in the experimental group and 30 students in the control group.

Figure 2: Tec Virtual Campus.

To analyze the data and produce the results, for each sample an exploratory analysis was conducted using Minitab to characterize the sample. A symmetry plot was also generated for each sample to assess the shape and behavior of the data. If the samples showed symmetry, then the T-Student hypothesis test was preferred. If the samples were not symmetrical but had similar distributions a non-parametric Mann-Whitney test was used. If the samples were not symmetrical and did not possess similar distributions, a T-Student test was used, noting that the results might not be 100% reliable.

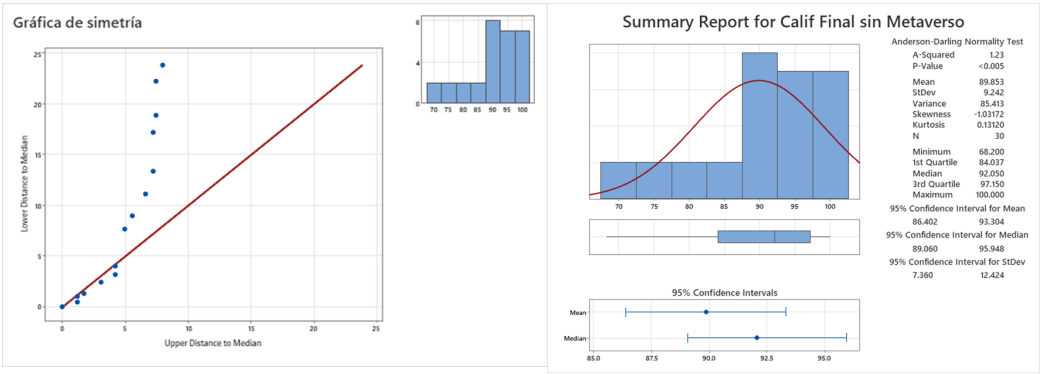

Figure 3: Examples of the Exploratory analysis and Symmetry plots that were used for the investigation.

Results

After an exploratory analysis of the collected data, a Mann-Whitney test was performed to compare the final grades of the control group vs. the experimental group and the grades that the students obtained in the course evidence of both groups.

Comparison	Median (Metaverse)	Median (w/o Metaverse)	Significant difference?	P-Value
Final Grade	92.975	92.050	No	.581
Evidence	92	90	No	.304

Table 3: Results for Final Grade and Final Evidence.

- **Although the average favors the experimental group, there is no significant difference in the activities, final grade or in the final evidence.**

The Pre-test and Post-test of the course were carried out with the Kahoot! within class hours, being a synchronous activity. For the Pre-test, the number of correct answers between both groups was compared and a comparison of the "score" was also made, which, in addition to taking into account whether the question is correct or not, assigns a score depending on the time it takes the student. answer correctly. A T-Student test was performed to compare the averages of the number of correct answers and the score, and the summary of the results is presented below:

Comparison	Average using Metaverse // (std dev)	Average w/o Metaverse // (std dev)	Significant difference?	P-Value
Score	27.71 (10.18)	35.08 (13.63)	Yes	.043
Correct answers	36.7 (14.0)	44.8 (15.6)	No	.061

Table 4: Pre-Test results.

- **There is no significant difference in the knowledge results in the Pre-Test. However, if the time and agility with which they responded (score) is taken into account, there is a difference: the control group arrived better in terms of this item.**

For the Post-test, the number of correct answers between both groups was compared and a score comparison was also made, which, in addition to taking into account whether the question is correct or not, assigns a score depending on the time it took the student to answer. correctly. A T-Student test was performed to compare the averages of the number of correct answers and the score, and the summary of the results is presented below:

Comparison	Average using Metaverse // (std dev)	Average w/o Metaverse // (std dev)	Significant difference?	P-Value
Score	57.93 (9.30)	66.55(13)	Yes	.027
Correct answers	67.0 (11.7)	73.9 (13.8)	No	.109

Table 5: Post-Test Results.

- **There is no significant difference in the knowledge results in the Post-Test, but there is a difference in the score (time and agility) and it favors the control group.**

Finally, A Mann-Whitney and T-Student tests were performed to compare the progress of the students, comparing the pre-test against the post-test and estimating the statistical difference predicted by the model.

Comparison	Pretest Average	Post-test Average	Significant difference?	P-Value
Score with metaverse	27.71 (Average)	57.93 (Average)	Yes (Est. diff 30.22)	0
Score w/o metaverse	33.46 (Median)	69.815 (Median)	Yes (Est. diff 31.35)	0
Correct with metaverse	36.7 (Average)	67.0 (Average)	Yes (Est. diff 30.3)	0
Correct w/o metaverse	44.8 (Average)	73.9 (Average)	Yes (Est. diff 29.09)	0

Table 6: Results for student progress between the Pre-Test and the Post-Test.

- **In the comparison between Pre-Test and Post-Test, there is a significant difference in how much they learned, but the difference in score is greater in the control group. However, in the correct answers, the difference is greater with the experimental group.**

A general summary of relevant data from both groups is shared, which includes the ECOA Survey evaluation, average final grade, pre-test and post-test results, as well as the learning gain score.

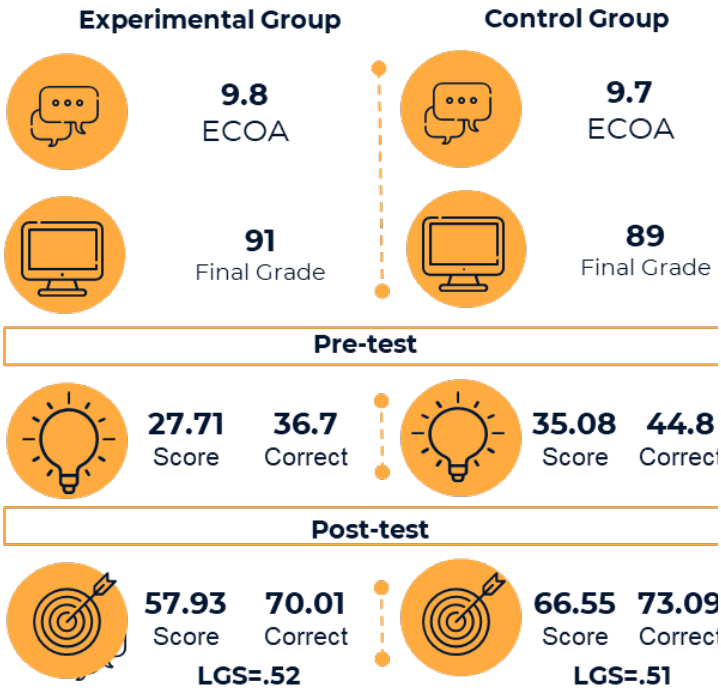

Figure 4: Summary of the results obtained in the comparisons of the activities carried out.

At the end of the course, the students of the experimental group were asked to answer a survey in the Qualtrics tool with the aim of knowing their perception of the metaverse and carrying out activities within this immersive space. The most outstanding results are presented in Figure 4 below.

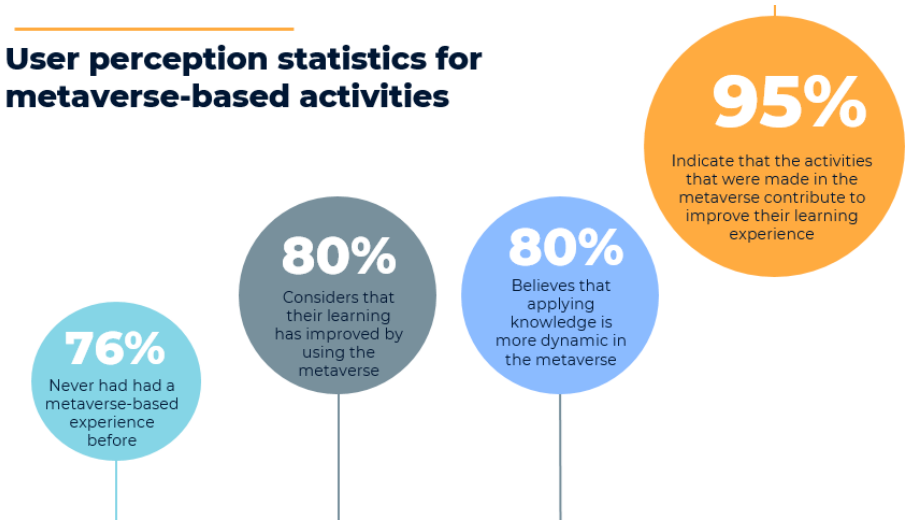

Figure 5: Results on students' perception of their activities within the metaverse.

The results indicate that more than half of the group (76%) had not had any experience in the metaverse, which they had no expectation of and the surprise factor was captive. 80% of the students consider that they deepened their learning and that it is more dynamic to apply what they have learned in the metaverse, therefore, it is perceived as a very effective tool for learning. In addition to this, 95% mention that the metaverse contributes to improving the experience, which can be translated into a greater motivation to learn more about the topics reviewed in class.

Conclusion

By integrating cutting-edge technologies into education, you can improve the quality of learning, promote student engagement, and prepare students for an increasingly digital world. However, it is important to note that these technologies need to be used in a balanced way, with a strong pedagogical approach and adequate support to maximize their benefits and minimize potential challenges.

The metaverse and virtual reality offer advantages in improving students' attitudes towards learning in education. Proper guidance from teachers and careful integration into the curriculum are critical to making the most of their potential and ensuring they are used effectively for the benefit of students.

Although the results of working in the metaverse did not show a significant difference in terms of overall student learning, the impact it had on the perception of their own learning reflects very positive results. The students expressed feeling more motivated, immersed and attentive to what was expected of them during their learning process.

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