Virtual World as a Resource for Hybrid Education

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Abstract—This article addresses the issue of the design, development and implementation of a virtual or metaverse world in an educational environment under the Scrum methodology, which explores its viability as a complementary digital tool to the teaching-learning process in the university environment, where the flexibility of access to synchronous and asynchronous information presents an alternative way of transmitting and/or acquiring knowledge through technological means. In this sense, the metaverse was designed emulating a real university institution as didactic support for students of the Faculty of Systems Engineering, taking into account the hybrid and mobile learning models changed with the inverted and collaborative class.

Keywords—Blended-Learning, Emerging technologies, Flipped Classroom, Metaverse, Mobile-Learning, SCRUM.

1 Introduction

The word Metaverse appears for the first time in the novel Snow Crash, published in 1992 by cyberpunk writer Neal Stephenson. [1] For [2] metaverses are virtual spaces for real-world recreation where users, normally under an avatar or a pseudonym, interact with other users in endless everyday situations. [3] defines metaverses as virtual environments also known as MUVE (MultiUser Virtual Environments), which have a format that derives from the MMORPG (Massive Multiplayer Online Role-Playing Games) although unlike these, no they have a priori an objective or goal to meet as happens in a video game. As indicated [4] metaverses are fictitious constructions in which participants interact through avatars created by themselves trying to reproduce participation or real life in a virtual metaphor environment without space-time limitations.

The concept of metaverses or virtual world goes beyond the commercial and entertainment, the idea in the future is to create true virtual societies, where digital users or avatars are our alter ego, thus tending to the creation of artificial societies in an environment digital [5], giving way to what [6] points out as digital artificial life. Therefore, the main characteristic of metaverses is based on the fact that these are created in the image and likeness not only of the programmer, but of the user, where fantasy, science fiction and multimedia technology combine to create fantasy and or exotic scenarios, where physical laws may or may not exist, or simply establish another extension of the real world in which we live experiencing in the third person interactivity and immersion in a digital space that has no limit, exploring new experiences with a digital ego alter.

For [7] Metaverse is an immersive, three-dimensional, virtual and also multi-user environment online, which allows people to interact with each other, socially and economically, regardless of their location, using computational tools such as personified agents and simulation. Under this definition, it is observed that the metaverse is a virtual world to explore, where the user can interact in different ways through his avatar exploring different contexts of ways of life.

As a particular case, the use of virtual worlds in higher education [8], [9] has been a recurring theme for several years, allowing the teacher and student to explore new methods for the teaching-learning process, where ICTs and emerging technologies [10, 11] adopt a main role in this regard, maintaining interactivity and immersion as the main premise, which are fundamental in this process. To this end, the virtual world market has been diversifying into augmented reality applications, mirror worlds, metaverses and Lifelogging platforms; which can be proprietary or free, so their developments and applications are diverse, ranging from industrial and commercial, through leisure, to education at different levels and modalities. With this variety of virtual worlds, the path is marked in terms of its development itself, since each platform contributes its own well in its implementation, innovation, development and resources when it comes to taking them to an operational level.

2 Characteristics of the Metaverses

There are three fundamental characteristics of the metaverses established by [12], which are interactivity, embodiment and persistence; which have remained in force to date with certain adjustments as the technology evolves, as explained below based on the experience of the research carried out:

- Interactivity: The user is able to communicate with others and interact with the metaverse. This implies that their behaviors can exert an influence on the objects and on the behaviors and opinions of other users, which is reciprocal. This type of action is carried out through the implementation of a social network within the virtual world, although other resources such as Instagram, Snapshat, etc., can now be implemented, expanding the possibilities of personal or global interaction. An additional aspect is that you can implement and/or link virtual learning platforms within the virtual world, making it a dynamic educational scenario of autonomous and collaborative learning with access to the resources available on that platform, without the need to leave of the virtual world in no time.
- Corporeity: Users are represented by avatars. Corporeity consists in the presence of that avatar on that space that also has limits, since it is subject to certain laws and has limited resources within the virtual world. These limitations are more associated with the lack of computing resources than the virtual world itself, which is gradually being overcome with the incorporation of new servers and bandwidth ideal for metaverses to present to their users a high degree of immersion and interactivity.

Similarly, the scenarios are becoming more realistic in terms of their definition, whose idea is to become equal or superior to 3D games.

- Persistence: The program continues to function and develop even though its members are not connected. In addition, the position, conversations, property objects, etc., are saved and will be retrieved once the user is reconnected to the virtual world. Ideally, in the future the avatar will integrate with artificial intelligence, where it learns from its user and makes decisions within the virtual world while it is disconnected.

The Metaverses can range from small atomic and molecular systems, to cities (Victorian, contemporary or futuristic) and/or worlds bordering on fantasy. Similarly, metaverses can be found in which scenarios for military training, vehicle driving and transportation in general, city design, landscaping, etc. are built. Also, there are metaverses focused on the sale of services and accessories, such as shopping centers, where the avatar can make purchases equivalent to the real world (for Second Life, the Linden Dollars is the official currency for commercial transactions) , attend entertainment venues (music, fashion, dating and concerts) or meals represented in exotic restaurants. Likewise, metaverses can be found for specific educational purposes, such as visits to libraries, museums [13] and university classrooms [14], text games [15] and archeology [16], among others.

One of the most important metaverse projects worldwide has been Second Life, developed by the company Linden Lab, in which globalization is tacitly promoted in all systems of goods and services, coupled with leisure and education, with millions of users to date. A different aspect of this virtual world compared to traditional ICTs is that they take students to an environment outside the conventional classroom, where the video game environment is no stranger to them, so their approach to this type of digital tool it motivates to investigate and with this it takes advantage to bring it closer to learning [17] and knowledge in a more fun, entertaining, interactive and immersive way. In addition, there are advantages of simulation in a virtual world contributing to the knowledge and learning of cyberculture, as [18] points out, where the visual aspect and the possibility of real-time change through the action of avatars, it is a great help for short-term memory by amplifying the imagination, individual and collective intelligence.

Projects are constantly being developed to improve the environments of virtual reality (VR), adaptive reality (AR) and mixed reality (RM) that converge to metaverses with a high degree of immersion without precedent. An example of this is the Viveport, Daydream and Oculus Rift system [19]. As a particular case of Oculus Rift, it uses stereoscopic vision in a device designed specifically for virtual worlds, offering the user 3D images for each eye with slightly different perspectives. The worlds and applications that are created for this type of device are quite wide for all tastes and ages [20, 21, 22]. The metaverses created under this type of technology present immersion and high contrast image developments, so that their application in research in multiple fields of science and engineering is growing day by day.

Another development that will give much to talk about in the coming years is the Firefox Reality project; which is a specific browser in virtual reality and augmented reality, available for standard RV viewers since 2018 [23, 24]. The interesting thing about this project is that it promotes the participation of any developer interested in this platform, as well as content creators and geeks to improve this system permanently, so that their entertainment level projections exceed it, to accommodate to industrial, educational, scientific and health applications, among others.

3 Method

For the development of the metaverse software project, the agile methodology SCRUM [25] was used, characterized in that the work team can tackle problems in an adaptive way, committing to the delivery of products with a maximum possible value under an incremental iterative approach, which It facilitates optimizing the predictability and control of risk in each phase. In this sense, four roles were defined: Project Manager, Scrum Master, Product Owner and Scrum Team. In each cycle of development or iteration (sprint) it ended with the delivery of an operative part of the product (increase). [26] The project manager assumed the role of software architect who represented those interested in the final product. The Scrum Master had the responsibility of maintaining harmony within the research group, ensuring that technical and administrative impediments did not make a difference in the project. The product owner, was the person who assumed the role of functional analyst, whose task was to capture and make agile the idea of the project. As for the Scrum Team, he played the role of making the client's project proposal a reality, which in this case was the University of Cundinamarca by developing the product in a self-managed, self-organized and multifunctional way.

Based on the proposed methodology, information was collected regarding the digital tools that could be implemented and managed in the metaverse, as well as the technological platform. Once the procedures were verified, the functional requirements of the program in terms of records, navigability, output data, control and security, among others, began. This in order to guarantee a quality, reliability and confidence product to the users.

To explore the degree of acceptance of the metaverse of students and teachers, a mixed research approach was used, which allows for a quantitative analysis of the project participants. In this sense, the teacher's experience with the virtual world and use of mobile devices in class [27] was considered in the study.

Regarding the design of the research, it was of a quasi-experimental nature carried out on a group of 32 students belonging to the first academic semester 2019 of the Faculty of Systems Engineering, who were taught the virtual world in terms of its navigability and available ICT resources. for study in the area of mathematics. Consequently, the sample was of a non-probabilistic or directed type, since for the purposes of the research, the selection of students was made based on the premise of establishing whether the system used would contribute to improving the perception that this has regarding the subject of Calculation I, based on the fact that they have a computer and internet connectivity from their homes, using the inverted class as a pedagogical framework, and hybrid learning and mobile learning as a methodological framework, a model that [28] calls hybrid mobile learning invested. Regarding the population, it was determined based on the students admitted in the first academic semester 2019-1 of the Systems Engineering degree, which was 90.

Once the experiment was completed, a questionnaire was applied to these groups to establish the degree of satisfaction with the use of the virtual world in their studies, based on specific topics given by the teacher of the subject of the Calculus I pilot course, such as: hyperlinks represented in images from specific MOOC (Massive Open Courses) web pages and information alluding to topics such as algebra and introduction to multivariate calculus. Also, QR codes were embedded that directed the Google Play Store to download mobile math applications such as Geogebra, Algeo and Mathematics; which were taken into account based on their score and popularity on this platform. Other hyperlinks represented in metaverse murals were: WebApps such as Desmos, Wiris, Algebra Calculator and Symbolab. In the same way, resources related to programming and own systems engineering topics were implemented, distributed by different walls and rooms of the virtual world. As for the evaluations, these were arranged on the virtual platform of Moodle, where the student could enter through the virtual world in which a pop-up window was created, thereby facilitating access and consultation.

To verify the viability of the metaverse, a non-experimental design was applied, the objective of which was focused on observing and analyzing the behavioral and interactive variables of the student and teacher with the virtual world from a natural context inside and outside the classroom, through from the query to the server or directly to the virtual world evidencing the number of students who surfed it in academic as well as non-academic hours. Likewise, it was proposed to extract information concerning the potentialities and implications of the use of the virtual world in the teaching-learning process at the University of Cundinamarca, through the integration of certain digital tools and emerging technologies such as M-Learning and B-Learning. and emerging pedagogical models such as the Inverted Class, combined with collaborative and meaningful learning, among others. Under this approach, the questionnaire and the interview were chosen as the data collection instrument, framed within the context of data triangulation.

4 Results

The ICT and emerging technologies offer to the service of education diverse digital tools that tend to change the traditional paradigm of the teaching-learning process. Thus, the development of virtual worlds integrated with other teaching tools such as Blended-Learning, Mobile-Learning, Flipped Classroom and social networks, among others, It opens a myriad of possibilities for face-to-face, virtual and distance teaching, thus enabling a greater approach to the student and teacher to new educational proposals, approaching what has come to be called dynamic and interactive education [29, 30, 31] and an extensive dissertation on its implications in higher education [32, 33].

One aspect to consider regarding the management of virtual worlds for education, is that it facilitates the student a new study tool in which mobile technology and Blended-

Learning, platforms are integrated, enabling the teacher new means and teaching methods, which for the particular case of study was the subject of Calculus. This study was part of the research project entitled "Development of pedagogical strategies through emerging technologies for the teaching of mathematics at the University of Cundinamarca", whose overall objective is framed in addressing higher education from the perspective of ICT and emerging technologies, which act as support for the teaching-learning process, thereby minimizing the low academic performance of students in the area of mathematics.

Based on the need to propose a striking digital resource for the student, which motivated him to consult and interact with academic information and at the same time was fun, he opted for the design and development of a virtual world, taking as his own navigability model college. For this, it was designed in the Blender program, which allows modeling, creation of three-dimensional graphics, rendering, lighting and animation of the physical structure of the facilities, in order to familiarize the student as the teacher in a known environment, such as it is observed in figure 1, in which several ICT resources were distributed in key points, in order to make the navigability of the avatar more dynamic throughout the university.

Fig. 1. Virtual world from part of the facilities of the University of Cundinamarca.

It is important to point out the importance of the avatar in the virtual world, since it contributes, as [34] affirms, for students to acquire skills on technological and virtual tools, which promotes the inclusion of the student in the society of the information. Under this concept, the avatar design was restricted to being a humanoid animation and not mythological entities, animals, metahumans, etc., to give some sobriety to the system, whose purposes are strictly academic.

Regarding the development of the virtual world project, it was based on the OpenSimulator [35] multiplatform; on which several commercial metaverses have been developed such as: Osgrid, FrancoGrid and 3RD Rock Grid. This platform is characterized by free software under a BSD license, which does not imply any cost for the developer. OpenSimulator offers a unique and flexible environment for the teaching staff interested in distance and classroom teaching, cooperative work through computers, simulation and business training. [36] OpenSimulator allows those who browse it, develop and practice skills based on the exploration of new experiences and ideas. This is because it facilitates multi-user 3D environments online, supporting physical simulations and creating 3D content in real time. Supports multiple clients and protocols: access the same world at the same time through multiple protocols, just as it supports inworld scripts using several different languages, including LSL/OSSL, C # and VB.NET. [37]

As for the OpenSimulator server, it is divided into two components according to [48]:

- Back-end data services: which consist of user accounts, login service, assets and inventory;
- Server simulator: which can host unlimited virtual environments called regions. There are two modes available, which are independent and grid. In standalone mode, these two components are combined in a single OpenSimulator process.

Based on the above characteristics, the basic skills that an avatar can perform in the virtual world of the project called MVudec are: walking, changing appearance, flying and interacting with certain metaverse objects, such as chairs and boards, as observed in figure 2. In addition, it allows communication via social chat with other nearby avatars, among other resources and teleport from one point to another of the university's facilities.

Fig. 2. Image showing the avatar of a student in a classroom, consulted an HTML 5 learning resource.

The educational platform of MVudec based on its design structure, facilitates distance or virtual classes, where the teacher can upload various pedagogical resources that can be consulted by the student via the web in the first instance or by a mobile device having at hand the virtual world on your computer. Now the mobile learning is combined with hybrid learning whose pedagogical resource is the inverted class [39]. This implies that the user to perform any query and/or practice with the virtual world must follow the following steps:

- The student and/or teacher must create an account under a specific URL, and then be directed to the registration page.
- Software installation. To connect to the virtual world of the University, it is necessary to use a viewer, which in this case is Singularity, which must be downloaded, installed and configured on each user's computer.
- Avatar settings. For being the first time, the user enters Mvudec, the avatar must be created and personalized his wardrobe and appearance.
- To navigate the virtual world, a process of using specific keys such as W, A, S and D or the arrow keys was established. It also has the option to fly (Key E) and stop flight (Key C).

In order for the metaverse to be fully exploited, a previous training was required, where the user knew the resources available to a certain class, thus procuring that the teaching-learning process would be much more dynamic and interactive than the traditional one. In this sense, once acquired the ability to manipulate the avatar, the user apart from moving around the university facilities, can interact with other colleagues through the internal social network to share academic information, thereby promoting collaborative learning, or to surf the internet through hyperlinks arranged in the system that direct it to certain topics, as well as enter the virtual platform of the University as seen in figure 3.

Fig. 3. The first image shows the Avatar of a student consulted bibliographic resources in the virtual world.

As a particular aspect of the system, the virtual world was initially left active for consultation and navigation, restricting the possibility of object construction or movement programming. Once the activity left by the teacher was finished, it was observed that it was important to create an alternative space for the student to enjoy, so that an island adjacent to the university was created, so that whoever frequented it could create their own objects, where creativity and inventiveness had no restrictions whatsoever.

Regarding the technological infrastructure of the system, there are certain requirements to take into account, such as:

- Have a good bandwidth, since the system becomes slow otherwise.
- Computers must have good processing capacity and graphics card, since otherwise the system generally slows down and normally collapses, causing Singularity to restart.
- The requirements of the server where the metaverse is installed must be of high performance to avoid connection drops and/or navigability.

5 Discussion

There are certain peculiarities of metaverses that make them attractive to students and teachers, as they are seen as an ideal space for the ubiquitous teaching-learning process, in which it is combined with other forms of digital learning such as mobile, hybrid and micro-learning, where the traditional pedagogical model changes from being static to dynamic represented in the inverted class [40] and collaborative being the center of this process the student. With this in mind, the paradigm of traditional education is broken, adopting a methodological and pedagogical model that fits into the so-called emerging technologies and pedagogies, where ICTs are the support or means of access to knowledge, removing physical barriers for all those students who wants to learn from anywhere.

A peculiarity of the developed virtual world is that you can implement various ICT resources raised specifically by the teacher, where the student has them at hand facilitating their learning. Similarly, QR codes can be incorporated to access the university's virtual classroom and applications available in the Google Play Store to be installed on students' mobile devices. In general, the virtual world is summarized in figure 4; which acts as an integrating element of the inverted and collaborative class, hybrid learning and mobile learning, where workshops and evaluations formulated on the virtual platform could be consulted either by means of a mobile device or computer, using the communication bridge metaverse, in which the student can use various informative web resources, MOOCs and mobile applications as a complement.

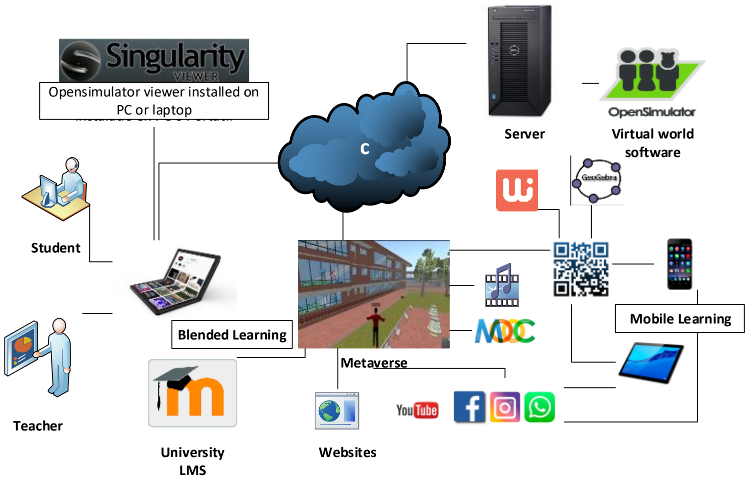

Fig. 4. General outline of the virtual world that integrates hybrid inverted mobile learning.

It is worth mentioning that a drawback when developing the metaverse with Opensimulator, is that a connection to Moodle is required through an application called Sloodle, the problem found is that the mentioned application is only updated for lower versions of Moodle 3.0, so that the decision was made not to create the Moodle database on Opensimulator, but to address it through a hyperlink within the same metaverse. This decision optimized the navigability and use of server resources, since when browsing the metaverse the connection through the hyperlink allows you to link to another server where Moodle is installed with its respective database, which for this particular case was the University and another test server where the pilot course was.

After applying the questionnaire to a sample of 32 students, it was obtained as a general result that the level of interest in navigating and interacting with the virtual world is high. In addition, with the digital resources that the virtual world has to study, either through the metaverse's own platform or the university's Moodle virtual platform, it facilitates learning not only through the use of a computer, but also through mobile device that the student has, facilitating the training process in and out of the classroom synchronously and asynchronously. With this result, a contribution is made to the change in the paradigm of traditional education, which converges to a flexible, dynamic, participatory and collaborative model [41, 42] mediated by ICT and emerging technologies, in this particular case from the perspective of virtual worlds.

The basic science areas form a fundamental pillar, since they allow the development of disciplinary skills and competences through observation, inference, verification, comparison, consolidation, among others, to achieve access to knowledge. [43] Having said this, in the process of training engineers, mathematics is fundamental and it is no mystery that any methodological and/or pedagogical contribution related to ICT and emerging technologies that allows improving academic performance in this area you will be welcome. In this sense, there are some technological and pedagogical challenges [44] that must be taken into account when implementing a virtual world either in a mathematics course or in any other subject, such as:

- It is required to have a server to mount the metaverse, added to an administrator dedicated exclusively to manage the registration of students and teachers in the system, as well as the digital resources in it.
- The digital resources to be implemented in the metaverse should be designed, raised and/or provided by the teacher to the administrator; which will assign a respective space for its location within the virtual world, which should later be socialized with the teacher(s).
- You must have good internet connectivity so that the virtual world does not slow down or disconnect. Similarly, it is required to have good hardware both in processing capacity and graphics card by the teams of users who wish to make use of the virtual world.
- In pedagogical terms, learning in a virtual world is based on the student, in which self-learning and collaborative learning [45] are encouraged, among others, which act as an essential component to the pedagogical model of the inverted class. Therefore, it is up to the teacher to design the digital resources of the case (podcast, multimedia, hyperlinks, MOOC, etc.), which are attractive for the student to interact with them.
- Regarding evaluations, the process is equivalent to that developed for hybrid learning, so the teacher can create the evaluations directly on the virtual platform, or on another digital resource that can be added to the virtual world directly as an image and hyperlink label.
- In the case of mobile learning, the use of applications installed on smartphones makes it possible to manage various resources for the development of specific tasks inside or outside the classroom [46-50], which can eventually be combined with the metaverse. Therefore, it is up to the teacher to design the activities to be carried out using these resources in a rational way.
- The teacher can create various digital resources under the model of learning by doing, in which he can take advantage of the social network integrated to the metaverse to promote different types of participatory exercises.
- The teacher must motivate the student to interact with the various digital resources implemented in the virtual world, acting actively through his avatar.
- The integration of the teaching-learning process of the traditional classroom with technology should be gradual and methodical by the teacher, in which the teacher must act as a facilitator, a guide and tutor to accompany the student in their training.
- A virtual world allows incorporating various digital learning contents in different formats, such as: video, text, images, web platforms, etc., that the teacher must appropriate, adopting a different position in terms of management and interaction with ICT and Emerging technologies.
- The virtual world is characterized by its persistence, understood in the sense that the environment where the student interacts will continue to exist and develop even when not connected, resuming it whenever you want. Therefore, rules of digital coexistence or netiquettes [51, 52] must be established, where the use of the lexicon and respect for the other must be applied from the first moment of interaction of the participants.

- Multiple digital learning resources can be implemented in the virtual world to be much richer in terms of interactivity and immersion, so it requires the commitment of the teacher and students to take advantage of this technological tool.

To finish this section, a difference of the metaverse developed compared to similar projects, is that it was custom designed under specifications and needs of the University of Cundinamarca. Although some aspects need to be polished in terms of the technical part, giving the personalization of virtual classrooms and digital resources to the teacher so that he can manage them directly, he is on the right track, thus making it possible to continue the metaverse project to bring it to a new phase of development.

6 Conclusion

With virtual worlds, new educational practices are explored based on consolidated digital pedagogical models, or that are in the process of being so. This type of tool contributes its own in pedagogical and methodological terms, providing both teacher and student with an alternative way of teaching and learning, and at the same time complementary to learning models such as hybrid and mobile. In addition, it facilitates the teacher the use of pedagogies such as inverted class and collaborative learning, among others, thereby promoting flexibility and class dynamics. Another aspect to take into account is that, due to the structure of programming and creation of metaverses, these are scalable, which allows incorporating various ICT resources, as well as more interactive elements or expanding the created region, thus diversifying its spectrum of applications according to academic, research or leisure needs.

An aspect to take into account when interacting with a virtual world by a neophyte teacher, is that this can be adapted quickly, it only requires expanding your knowledge of ICT tools and their management. As for the student, he adapts faster, since being a digital native, his interaction with this type of resource is more intuitive, since he has internet connectivity at hand by different technological means. In this sense, you can take advantage of this digital resource, which, as pointed out [53], with adequate knowledge of the platform, students and teachers can carry out a single study plan, a curricular and methodological adaptation for all. Therefore, the creation of virtual spaces to host training activities must follow similar design criteria in terms of rigor and quality as the design of training spaces for the real world. [54]

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