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Review Article

Application of Metaverse and virtual reality in education

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ABSTRACT

The objective of this article is to develop a literature review on the use of Metaverse and virtual reality focused on education. Taking into account that education lives a continuous process of change in search of quality, the use of new tools favors this process, therefore, the use of virtual platforms focused on virtual reality and Metaverse are in essence tools that energize the teaching and learning processes, contribute to organize and update the contents, and allow the student and learner to interact within the virtual environment. In this context, the present work was developed based on an exploratory, descriptive methodology; using the categories Metaverse, virtual reality and teaching, a search was carried out in the Science, Scopus and web Science databases, obtaining one hundred reference articles, from which the above categories are analyzed.

Keywords: multimedia teaching; teaching and communication; educational informatics; didactic material; educational technology; information technology

1. Introduction

The world of teaching is evolving, education methodologies are revolving around computer technology, day by day the use of software has become common in classrooms. Virtual reality plays an important role and offers didactic tools that contribute to improve education. Metaverse are presented as virtual environments in charge of providing entertainment to the users of these platforms. These worlds were not designed with the purpose of being applied to teaching. However, they managed to attract the attention of educators and could be adapted to mediate teaching and learning processes. One such example is the one developed in the Master's thesis project in Information and Communication Technologies, whose purpose is to develop a 3D virtual environment to mediate the learning process of level a1 in English at the language center of the Universidad de la Amazonia. This article contributes with the studies carried out for the execution of the project, with the review of literature related to Metaverse and virtual reality focused on teaching.

The search for articles focused on the databases "Science Direct", "Web of Science" and "Scopus", where topics related to the themes of the object of study were found. The search yielded a universe of 100 articles, which were

analyzed by answering four guiding questions that are formulated below, emphasizing the gaps in the subject, the development of the topics over the years, current discussions and relevant issues.

The purpose of the article is linked to the analysis of the themes that have emerged in the last five years, highlighting the issues of virtual reality as a scenario of interactive communication, behavior, affection and belief in a scenario that promotes worlds of efficiency for all students. Several educators choose to use this technology to strengthen the learning of their students, ensuring autonomous and effective learning[1]. The knowledge acquired in a meaningful way will serve the student to be used in real life situations, gaining experience and knowledge in the virtual world[2].

2. Methodology

The present study was conducted with an exploratory method of descriptive approach, with which a search was formalized in the databases of "Science Direct", "Web of Science" and "Scopus", of significant experiences related to the use of Metaverse, virtual reality and teaching. To carry out the searches, the categories of Metaverse, virtual reality and teaching were approached, in addition to an emerging topic, E-Learning, obtaining a universe of 100 articles related to the different categories.

After the search, the contents were analyzed based on the following research questions: What are the gaps in the topic? How has the topic developed over the years? What is the current discussion focusing on? What are the relevant topics in these investigations? Based on these four questions, the answers were systematized and the articles were classified into the previously established categories, and possible emerging categories, in order to obtain

the analysis of each article.

3. Literature review

In the teaching processes carried out in education, new tools such as virtual reality are being used. Thanks to technological advances, these can be used to improve learning capacity and knowledge acquisition. These tools have been adapted to didactics, methods and contents, and it is recognized that thanks to it there is a feedback process between users (students / teachers).

The people in charge of the design have as a result an improvement in the applicability of technological tools in virtual classrooms, where the environments are a fundamental part. These attract the attention of users and motivate them to learn in a dynamic way. In addition, ease of use is rooted in virtual environments, a relevant factor to access the applicability of virtual reality in the learning process[3].

3.1. Virtual reality

For many, the participation of people in virtual reality platforms is fundamental to obtain detailed information about a topic, to interact with content, users and communities in any latitude of the planet being one of the greatest achievements in this branch, increasing the abstract from the physical world to the virtual[4].

Cutting-edge technology allows virtual reality to transcend over the years, becoming an everyday thing among people. Its use is magnified to the point of reaching different areas such as education, maximizing teaching and learning. By transcending this technology, it forces people to manage new virtual worlds, in line with the present and ensuring a long traceability of this use[5].

These virtual worlds are catalogued as a tool that helps student users of these worlds to

improve their learning. However, an inadequate presentation of these media gives room for the fact of not taking into account the context of the students and, therefore, their use could become boring, bringing with it a disaffection on the part of the students towards this type of virtual reality[6].

Education is looking for strategies to employ this technique and achieve the purpose of interacting in an easy and effective way during learning. Thus, the contexts managed in the past manage to evolve, forging a change in the everyday, strengthening the acceptance of augmented reality as a means of teaching. But the sophistication of online learning does not mean leaving aside the teaching of pencil and paper. It is about teachers applying the most appropriate tool to achieve their main task of imparting knowledge in the various branches of education[7].

Similarly, virtual reality has been applied to mobile devices, such as cell phones, where it also contributes to education, since they can also be used to obtain information and interact with knowledge.

On the other hand, four stages are followed to achieve the development of a virtual tool, emphasizing the current needs of education. The initial stage consists of the design and development of new facilitating components of this work; then the analysis of information searching and consulting with the aim of creating an efficient application, which meets all the required expectations; then comes the time of implementation of the interactive design, a fundamental part that seeks that users of the application are attracted and learning through this tool. Finally, the evaluation is carried out where the final result is contemplated, thus giving feedback to detect the positive and negative aspects of the design.

These virtual reality applications seek a way to address various problems in education, looking for an attractive and dynamic way to carry out the teaching process, as well as to reduce the deficiency of current tools to access learning[8]. A clear example is the use of virtual reality in medicine, focusing on central topics and managing to guarantee and enrich the knowledge and advances in this field of science. As mentioned before, virtual reality tools can be used in, and from, anywhere in the world. It is a versatile tool that allows users, such as students and educational institutions, to access it and interact from anywhere and at any time[9].

Within the world of virtual reality focused on academic purposes, there are architectures based on virtual reality, which are mainly characterized by an easy handling compared to large platforms, such as Learn 9.1, Moodle 2.0 and Sakai 2.7. These architectures strengthen the way to incorporate them day by day in the different educational spaces, making the use easy and understandable for students, as a way to take advantage of technological advances and generate at the same time, a supply and demand in this sector of educational entrepreneurship[10].

Education has reached an investigative state in an exhaustive way, contemplating a qualitative-interpretative paradigm focused on the pedagogical research carried out as a model for the elaboration of virtual learning environments granted in the way of validation of the products resulting from these practices. It is possible to identify characteristics where the learning in a face-to-face and virtual way is compared, making the use by the students where it is reflected in the acquisition of knowledge. It can be recognized that these models are efficient at the time of being raised in the world of education, thus confronting what is proposed by society against what is contemplated in the way of teaching these new technologies[11].

Thanks to the innovation in technologies

and communications, virtual reality is given an applicability in a moldable way, allowing the growth of teaching on the web or so-called online teaching. Education from a distance will be a fundamental pillar for the growth of this tool, increasing knowledge in virtual learning communities. This form of virtual reality learning will encourage a way of communication with other people in the world where they are interested in the same topic making dialogues between the communities of another country interacting in a search for improving knowledge and contributing in the social field[12], these knowledge societies can compare the means of learning either face-to-face or virtual, the use by students is greater thanks to the good use of time reflected in the acquisition of knowledge. Efficient models can be recognized at the time of being raised in the world of education, thus confronting the paradigm proposed by the society contemplated in the way of teaching these new technologies[13].

The emphasis of virtual reality applied to teaching is adapting technologies such as the inverted classroom where it has a high quality of pedagogical potential strengthening the way educators educate their students. One of the relevant aspects of this innovation of the inverted classroom is based on the traditional way of teaching, where formerly the number of face-to-face classes occupied all of them, but thanks to this form of learning is not affected this traditional teaching, because the education process is not affected. On the contrary, it benefits learning, making the themes used in these realities a way to strengthen the intellect and academic performance of students[14]. A clear example of this is presented in virtual reality models based on geographic information, where they get to know 3D modeled terrains, these models prove to be very attractive to users, running main themes associated with

geographic virtual reality can identify the reality times of each of the surfaces, the predictable consequences, various and large scales of the same[15]. Another clear example is proposed in the virtual reality based on human simulators where students can do their practices safely without any real risk and achieve maneuvers for medical use. The clinical environment is another topic of relevance to virtual reality where the implementation of procedures, decision making and critical thinking about how to use these media to simulate treatments is a priority[16]. Finally, virtual reality manages to encompass interactive communication scenarios, behaviors, affects and beliefs. These scenarios promote worlds of efficiency for all those learners emphasized towards language learning. Several educators choose to use these scenarios to strengthen their students' learning by guaranteeing autonomous and effective learning[1].

3.2. Teaching

The use of generic tools for learning does not always meet all the evaluation criteria chosen by the teacher to run in their classes, where these do not fill a high percentage of the topics required to teach their students. So the work of customization of teaching systems will be an essential component when using these tools, where thanks to this, you can make regulations, changes and adaptations according to the needs of users (students) in which the work of learning is effective and increase teaching[17], for this should take into account the digital spaces. These are entertaining platforms where they provide certain types of information, education makes the comparison between educational software against these so-called social networks, currently most people are captivated by these platforms consuming long time compared to a purely educational platform,

an important gap is based on the use of Metaverse for education, these platforms allow users to have a bit of two worlds. On the part of the virtual world, they will have different types of avatar at their disposal being complemented by the educational platforms applying the necessary topics for teaching[18]. The education given in the Metaverse has been directed towards educational learning, over the years has been evolving the way of seeing these virtual worlds its initial purpose was not to educate but to entertain, these Metaverse have been strengthened with the theme of education providing new tools carrying out factors of reliability and validity of learning under a changing model, giving a way of readjustment over the years according to their need[19]. A clear example was based on the use of structured applications implemented to primary school students, where favorable results were found for the acceptance of these forms of teaching, the use of these teaching applications are not traditional in primary education sectors but are focused on high school education and higher education, where infants do not handle ICT (Information and Communication Technologies) making educational environments for children achieving their good use and easy understanding. A fundamental part of these applications must be the relativity of the understanding of the application for the children since these will call their attention[20]. A fundamental part of these educational techniques is based on the games where they make the work entertaining, in which while the children playing, they are learning. This way of learning is not only aimed at children, on the contrary, all these tools oriented to learning games are designed for people of any age making use of this, it is worth mentioning the different software where the scenarios are applied according to the corresponding theme and for the topic being worked on. Several of

these games today are applied to education, but its main function is entertainment, these types of games are adapted to the time of education and thus forming a guarantee of learning through new generations of modern teaching applications[21].

The current teaching is based on a modern mechanism where new people innovate making use of new technologies for their teaching work, this applies to virtual reality, giving students the knowledge in a non-traditional way as it was used in the past. The 3D education make this work in an entertaining way because while observing three-dimensional illustrations are learning, without leaving aside the use of pencil and paper, it manages to highlight different worlds of virtual reality where scenarios of three-dimensional figures are applied according to the subject used for the training process of students[22]. The 3D games used in teaching make an entertaining work, these tools oriented to learning games are elaborated towards people of any age can make use of this, it is worth emphasizing different virtual reality worlds where the scenarios are applied according to the corresponding theme and for the thematic worked. This type of tool is going through a stage of acceptance in society where there are still people who are old-fashioned and do not support this way of acquiring knowledge, which determines a population in the process of acceptance of this type of applications[23].

The world of education is implementing new tools, these contribute to the teaching of their students, therefore the use of virtual reality is implemented to achieve an effective and easy way of teaching. The branch of physics has implemented an application based on virtual reality, in this you can perform different prototypes of experiments based on physics where the laboratory will allow students to achieve and perform the practices without any

risk or simply test them before executing them in the physical world. In the past, the search for information was somewhat tedious, but thanks to these virtual reality applications, there are virtual tutors in charge of guiding the students as if they were an assistant in class, thus contributing to the students by analyzing the topics and quickly understanding the activities carried out during the classes[24]. In the past, the applications were made with specific functionalities, the rise of social networks as a means of education was something changing, with them a suitable approach to society was achieved, these social networks are taken as a means of distraction, but if you manage to focus these issues to teaching materials, users would learn in these social environments educating in a different way[25].

To talk about teaching is to take into account several aspects, but its general use today is adopted to education where an alternative way of learning is implemented, in this it is necessary to take into account subtopics related to the quality of information, quality of service and satisfactory use as the main subtopics to achieve a successful product. These will help students to learn with better fundamentals applied to teaching environments[26]. In this teaching, a series of factors are taken into account in order to determine the quality of these tools, thus assessing their use and effectiveness when applied by students at the time of learning. The important factors to take into account are based on the quality of the information, which is important to deliver true data, the system is a factor responsible for maintaining the correlation between all the subsystems of applicability for the user. Finally, the human talent factor is made up of both teachers and students, the teacher must be ready to use this tool of diversity of evaluation, managing to apply it to the interaction with students.

Focusing on the results, it is possible to determine that their use is not directly dependent on user satisfaction, achieving a great impact on the learning process individually[27].

3.3. Metaverse

Metaverse are virtual worlds to let the users' imagination fly, within this experience the avatars are a crucial part when it comes to take their imagination to another world. A problem present in technology are virtual traumas where users, not having access to these worlds, go into states of depression, loneliness and a lost world, their attachment is so great that it causes chaos among Internet users[28]. These second worlds are full of users where day by day they seek to satisfy their communication needs or just hang out. However, it must be considered the interdependence towards this type of Metaverse where there are discrepancies between developers and users. The representative gap occurs when entering these worlds where users feel that their way of thinking is often inhibited, which causes dissatisfaction in people[29].

The technology of education is evolving, day by day we find different ways of doing everyday things, but in a sophisticated way, time ago for education the use of paper and pencil was common, books gave a great knowledge between its pages, but this knowledge was captured for readers only. As time went by, education was optimized, opening the way to the digital era. This era helped in the development of virtual reality, and in turn led to virtual worlds (Metaverse), these worlds managed to allow users to have the ability to grow, create and appropriate knowledge using these tools[30]. Metaverse is important for practices in virtual reality. They allow a better development and development in this field. For example, formerly the teaching of English was based only on the teacher's guide in the classroom, after the arrival

of virtual reality established in Metaverse such as *Second Life*, an unimaginable world for teaching, the way students communicate with other people, their knowledge grows and the teaching of languages is facilitated, whether English or other languages. By using *Second Life* to interact with native speakers of these languages, students can listen to these people and practice their grammar and lexicon, thus enriching and stimulating their knowledge[31].

Education is making use of new pedagogies seeking results for their students, which is why tools such as virtual reality accompanied by Metaverse are implemented. These complements are a fundamental part attracting the attention of students. These are the beneficiaries acquiring participation didactic spaces practicing new ways to focus their attention to a specific topic. The initiative and critical thinking are processes rooted in the learning experience socializing participation, collaboration, interaction and communication at the time of learning[32]. The implementation of software for education is opening the doors to a great tool to educate, this is how virtual reality is directed to the *Second Life* as are the Metaverse making a difference in the learning process. Over time, different ways of providing education have been used. The branch of medicine has put into operation the new ways of learning using *Second Life* as a platform for teaching and learning under the themes of medicine, in the past unfortunately could not have the complete clinical environments for the training of medical personnel, but thanks to these new technologies were able to show positive results at the time of learning[33].

Within the different platforms there are relevant topics, but it is worth mentioning the use of these Metaverse for creative teaching and motivation focused on youth, where the use of realities focused on the subjects used either in primary, secondary or basic high school is taken. Virtual classrooms are of great importance in Metaverse being one of the meeting points within these worlds, where work guidelines, short, medium and long term activities will be given with the purpose of teaching in an autonomous and innovative way[34]. A clear example is the incorporation of Metaverse within a museum, where technological resources were used, achieving to direct users to a different learning. A crucial point is related to the services contemplated within the contents of the exhibitions where such contents tend to be as realistic as possible. Augmented realities are crucial when taking users to navigate through the worlds where the simulations must be in accordance with the themes presented[35].

3.4. E-Learning

Within education it is possible to implement E-Learning, this is a modern approach where standard learning topics are put into consideration. Currently this type of education includes technological branches. However, it presents gaps related to the solution of doubts focused on the problems, where such platforms do not have the necessary resources to clear doubts of users, these doubts result in the abandonment of these platforms achieving an imbalance between the proposed topics[36]. Current education is implementing an environment of combined work between the traditional method and the methodology of electronic teaching, the traditional way consists in the use of pencil and paper while the electronic teaching takes into account the use of technological artifacts to teach. It is taken into account the evolution of education in time has been very successful, currently two environments are used but it is foreseen for the future the maximum use of electronic methodology applied to schools, colleges and

universities[37]. These education tools have great support as is the use of the internet and 5G communication, thus achieving to reach various places where knowledge is not so wide referring to living standards. The information is a few clicks away and not miles away. These experiences significantly improve how students look at the way of teaching getting a taste for learning. Using the tools in a dynamic and autonomous way, they can be accessed from anywhere, there is no need for a teacher, with ease of execution where any common person interested in studying or acquiring this knowledge can be without any setback[38].

The E-Learning learning system is one of the current tools capable of strengthening the learning areas. Currently an important factor is being implemented based on the adaptation and versatility of the applications, where the same evolution guarantees the learning methodology will always be up to date in order to meet the expectations of those who manipulate this type of tool. Thanks to this factor of evolution of the environment, metadata will be able to keep track of how it contributes to self-regulation tasks focused on teaching[39]. Currently, the use of literature for learning is taking up again those practices of strengthening knowledge through reading, but there are areas where the use of online tools complements the processes of education and contributes to the construction of a citizen with moral and social rules set by the interaction with electronic media. Therefore, it is important to recognize the existence of another way of teaching, a lively way where students can improve with an integrated learning space under digital platforms, example: GitHub[40]. Books have been used for the guidance of generations through the ages, it is these books worked in ancient times carrying knowledge in their leaves, making these a very useful tool for society. Nowadays, the use of

books has decreased in a high percentage, so computer technology is in charge of carrying the learning information. The teaching of E-Learning is being strengthened every day, using technological resources to achieve this task, in this case the use of traditional readings is tested against digital readings achieving favorable results for this discipline[41]. In this case, a series of factors have been implemented to determine the quality of this tool, assessing its use and effectiveness when applied by students at the time of learning, this evaluation task is difficult to measure. It must take into account two points of view to evaluate the task, the factors taken into account such as pedagogy and software development. Numerous applications have low applicability of pedagogy for teaching, a content indicator is managed to make an analysis to the E-Learning systems, this is applied to software already implemented thus managing to obtain a collection of information to restructure the second stages of the same[42].

The Unity platform provides powerful tools associated with virtual reality and augmented reality, this time the themes for the design of these applications is oriented to the construction of housing sectors (farms) where students and teachers will have the development of their own sectors, taking into account the allocation of a limited amount of resources and construction areas. This application draws attention because apart from contributing to the teaching methodology it also refers to an ethic implemented to care for the environment. One of the fundamental requirements of games is as an initial parameter to take into account the pollution of the water sources assigned to each user, where it must manage and take into account if their sector pollutes it with waste as it affects both the water source itself and all users (neighbors) found in the same sector. This tool will apply several aspects to improve students

intellectually, morally and ethically, the virtual reality aimed at forging skilled people from all points of view[43]. A clear example is the analysis of the behavior of the human body to different stereotypes of current problems. Students were analyzed under the criteria of eye blink reaction and face temperature. The video platform called YouTube was used as an educational tool, in which two videos were projected where the environments changed for their respective analysis. This analysis helps to achieve feedback and analysis of how students behave under pressure and what are their ways of attacking the problems present[44].

Collaborative work is being strengthened day by day in educational environments, implementing E-Learning allows active learning in cooperative groups looking for learning and communication among them, making research models using common media frequently used and giving invention and learning in a structural way. This is allowed through a LAN connection, nowadays the use of internet is something basic where anyone has access to it. Therefore, the use of the network becomes a collaborative tool, both for research and for the time to carry out groups reflected on issues leading to basic education and implemented to virtual reality[45]. An analysis focused on the emotions of the users of these online tools, describes in detail the physical responses of nonverbal users focusing on their facial features, with these studies obtained results of how users respond to an environment where doubt or motivation are part of performing an action, changing their physical features mainly showing a pattern of blinking symbolizing the way to face the activities[46].

The tools based on E-Learning are mainly related by two aspects: man and machine. On the one hand the man who is the manipulator of all these tools aimed at learning, there is a relationship between different types of tools,

while some are used for the social part where it is educated in an informal way. Others can change their applicability as a whole that form a cognitive computing managing to cope with practical cases in the processes of computer education[47]. Since the late ninth century and early twentieth century the impact generated by online education has been fundamental for future generations, thanks to these technologies it has been possible to advance in the branches of education motivating students to be interested in acquiring knowledge in different ways, either reading, watching videos, listening to documents in short all the different ways offered by these tools. The online communication of these technologies has led to the control of learning with a self-directed center by the users putting these learning motivation mechanisms to the test[48]. Three types of spaces have been implemented to provide different fields to be applied to teaching, each of them directly linked to the fundamentals of virtual reality. One of these is based on the interactive 3D model which is the basis of virtual reality, in this same is formed by understanding and the way of retention of the subjects. Then we have the role scene which is responsible for opening the interaction between the virtual world to achieve the activities, these conform the analysis and applicability. Finally, there is the creation of the 3D space where the user has total control over the space, being able to execute as he/she pleases the creation and evaluation tools given to it[49].

E-Learning is frequently used for modern education, to this tool is added the use of gamification applying this technique to achieve better results adapting to the needs of users, gamification brings up the mechanics of other tools not specifically designed for the task of educating, strengthening areas and user experience against the way to acquire knowledge[50]. Within the E-Learning is valid to

evaluate a WEB 3.0 environment which offers new tools for the learning process, the topics of greater impact associated with education are being implemented by software as a didactic alternative at the time of teaching are accepted by students obtaining the perception of the applicability of these same, this use highlights a didactic and alternative way of learning, where you can learn in a fun way enjoying WEB learning[51].

The use of platforms such as OpenSim and Sloodle allow a systemic approach given to the way of learning using E-Learning on foreign languages. It is possible to highlight 3 important aspects such as the support of these platforms as a modern teaching method using WEB applications. The conduction of the use of these platforms under a virtual reality environment having as a major factor the adaptation to the topics where they can be seen in different degrees and finally an approach to promote these online platforms to develop the interest of students and teachers creating virtual learning environments oriented to the current topics[52]. An example of these platforms is Moodle, these are used for business or educational purposes based on E-Learning, in this case it was done for the collection of data mining where the comments of the users were evaluated obtaining as a result three important aspects: The use for learning yielded satisfactory results, it is possible to identify the term "Mono Click" where there is a common practice treated on the user clicks to do so without taking into account the topics and finally the user interfaces are related where these are responsible for giving the text presentations to the user and if these are not consistent the ability to attract the user will be lost[53].

4. Conclusions

The science of education is evolving, so it is innovating its teaching techniques, technology is a fundamental part in this transition process acting as an important complement where the use of virtual platforms focused on virtual reality and Metaverse are the tools for modern education. These platforms provide a social impact with respect to the means by which information is provided, where anyone with internet access can make use of these platforms to acquire knowledge. One of the methodologies used by these tools consists of playing while learning, where didactic games strengthen the way of learning. These are the reasons why the use of educational software is cataloged either in second worlds as Metaverse and virtual realities as essential factors where the usefulness of these is demonstrated when it comes to providing education.

Conflict of interest

The authors declare no conflict of interest.

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