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From broad reality to the Metaverse: Critical reflection on the contribution of education

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ABSTARCT

Augmented reality is a concept that includes virtual reality, augmented reality and hybrid reality. It has made remarkable progress in recent years and has a great impact on understanding education. Based on two key concepts: immersion and existence, the study of extended reality is helpful to improve teaching. However, these contributions need to be reviewed on a key theoretical basis to avoid falling into technophobia without scientific evidence. The purpose of this article is to understand and evaluate the contribution of a wide range of realities to education and the educational challenges faced before the development of Metaverse. To the end, RST defines each type of reality and critically evaluates their application in the field of education. Second, it puts forward critical arguments on the advantages and disadvantages of these technologies in educational practice. Third, it describes the challenges faced by Metaverse in education. This analysis shows that augmented reality contributes to the innovative development and improvement of the teaching process, despite the lack of teacher training to design the learning experience according to augmented reality, and the lack of interdisciplinary cooperation in technology and education. These results have affected the development of Metaverse, which is another step in expanding the evolution of reality and will have a significant impact on the field of education. The survey results show that it is necessary to design an ethics code, develop a culture and protect the identity of users.

Keywords: extended reality; Metaverse; virtual reality; augmented reality; mixed reality; educational theory; information and communication technology; study

1. Introduction

The educational community is learning how developments in the field of information and communication technologies (ICT) can provide students with new learning tools that enable them to improve their knowledge beyond time and geographical barriers[1,2]. Research shows that the impact of ICT on the inaccuracy of educational practice is embodied in the small-scale educational innovation of teachers' methodology, which depends on their educational background and attitude towards teaching and learning[3,4]. Emerging technologies are changing traditional teaching models, which are close to online scenarios[5,6]. Despite the progress made in infrastructure, telematics resources, training and teachers' digital capabilities, the existence of ICT represents a major change in teaching practice[7].

In the past decade, online learning has

expanded to the field of education, so research has focused on understanding the potential of emerging technologies in virtual environments[8,9]. Schroeder[10] defines a virtual environment as "a computer-generated screen that allows users to feel that they are in and interact with an environment different from the actual environment". Among the most widely used trends in virtual environments, mobile learning is a method centered on learning knowledge using mobile phones[11]. This approach contributes to the development of four types of learning: personalized learning, which allows students to learn at their own speed; situational learning, including learning in a real environment using mobile devices; collaborative learning, which allows easy interaction and communication with other students and informal learning, which occurs when students learn outside the classroom at their own speed[12]. In recent years, more and more attention has been paid to using mobile phones with educational functions[13]. The scientific literature "CA" focuses on the impact of mobile learning on students' academic performance[14].

The epidemic caused by Covid-19 highlights the role of emerging technologies in education. Virtual reality (VR), which is considered as the learning tool of the 21st century[15], Augmented Reality (AR) [16] and Hybrid Reality (HR) [17], is used most with mobile phones, and they constitute Extended Reality (ER) [18]. This is a concept involving virtual and real environments and interaction with users[19]. Progress in a wide range of realities has enabled people to validate tools to measure the degree of presence provided by virtual environments, opening up new possibilities for education[20].

Theoretically, it is necessary to understand the input provided by a wide range of realities, which may be a remedy to help disseminate information, or something harmful that can replace teachers[21]. In addition, it is necessary to critically re-examine the contribution of extensive reality to education, because the development of Metaverse is a challenge that educational theory must face.

The overall goal of this paper is to understand and evaluate the contribution of extended reality (virtual reality, augmented reality and hybrid reality) to education and the educational challenges brought by the development of Metaverse. Starting from a well-founded critical methodology, we must first understand the concept of each technology and its potential in the field of education from a critical perspective, to avoid falling into the so-called technical field or lack of enthusiasm for the possibility of new technology. Secondly, the advantages and disadvantages of these technologies in educational practice are discussed. Thirdly, it describes the challenges faced by Metaverse in future education, which opens a new research field.

2. Methodology

This work is carried out within the framework of a critical methodology, which comes from the social critical paradigm and is based on a critical analysis of reality to change educational practice[22]. This approach enables us to re-examine the application, advantages and disadvantages of each reality in order to provide knowledge for educational researchers and professionals and apply it to the field of education[23]. The contents of the bibliography were analyzed using atlas software. It allows the identification of four categories: Each realistic concept, its application in the field of education, advantages and disadvantages.

3. Result

3.1. The concept of virtual reality and its contribution to education

Virtual Reality (VR) is an analog environment built in digital form. It has visual and sound effects to make users believe that their environment is real. It can be used in the field of education to immerse students in a created space and make them feel

different emotions, such as walking in ancient Egyptian cities[24]. It includes two key concepts: immersion and presence. The first describes the experience generated by using technology, which introduces us to an imaginary field and exchanges realistic information generated with another number, such as images and sounds[25]. The second is the subjective response of users immersed in the virtual environment, so the behavior of the brain is similar to that in the real world[26].

It emphasizes the possibility of virtual liteARture in the process of science teaching. The virtual reality laboARtory used to teach stem (Science, *technology, engineering and* Mathematics) allows experimental simulation using 3D created objects[27]. Few studies have designed virtual reality applications based on specific learning theories and studied how to integARte them into the curriculum[28].

Different studies have shown that virtual reality scenes can produce mild insecurity and other more important dizziness[29], which highlights the importance of designing scenes that minimize physical discomfort. Study by Krokos *et al* [30] shows that after participating in the virtual reality education experience, students can retain more information and better apply what they have learned.

Advantages and disadvantages of virtual reality

The advantage of RV is that it can witness a situation. When students immerse themselves in a virtual reality environment with a helmet mounted display (HMD) or a helmet like display device, they feel a greater sense of presence, but they learn less than another low immersion computer environment[31]. The disadvantages of RV are the technical defects of using RV and the high cost of equipment required for high-level immersion experience[32], which contribute to the implementation of RV in educational practice. In this sense, the professional knowledge related to virtual reality has not been consolidated in education in terms of students' feelings, because the equipment required to implement virtual reality in the classroom requires a lot of training and investment.

3.2. The concept of augmented reality and its contribution to education

Thomas P. Caudell, a researcher and scientist, coined the term "Aumen Tada reality" (AR) for de fi NIR in 1992, which is a technology to increase vision through frontal visualization[33,34]. Augmented reality is a technology that allows users to see Supplementary reality through virtual objects superimposed on the real world[35]. It is an environment that contains two world elements (real and virtual), maintains real-time inteARction and can be displayed in three dimensions[36]. Since 2010, the number of research on the application of AR in education has increased significantly due to the integration of AR system into smartphones and tablets, which stands out among emerging technologies[37].

The application of AR in education enables teachers and students to annotate in the real world, interact with real and virtual objects, and safely use virtual objects for practice in the real environment, such as animal anatomy[36]. In this regard, one of the areas most affected by AR is stem, where AR based exploARtion tools are used together with research and simulation activities[38]. In the field of mathematics, the use of AR in educational practice has a significant impact on concept understanding[39], problem-solving ability[40] and academic achievement[41]. One of the most common AR models in the field of education is GPS geolocation, which is a technology that can understand geographical location anywhere in the world and obtain maps and real-time information through geolocation[42]. Geolocation and augmented reality facilitate autonomous environmental exploration activities and geogARphical concepts[43,44].

Advantages and disadvantages of augmented reality

The advantage of AR in education lies in its ability to help students participate in immersive technical activities and improve the learning experience[45]. The use of AR in educational practice has a moderate impact on students' academic performance[46]. The disadvantages of AR are related to its complexity, which translates the need for special training for teachers into creating content to improve the teaching process[47]. AR challenges educational practice to improve the teaching and learning process: lack of teacher training and experience, need for more classroom time to improve its use, and deficiencies in high rate classrooms[48]. AR is another step in the combination of RV and the physical world, which helps to stimulate students' enthusiasm, although there is insufficient training in the implementation of university courses in educational practice.

3.3. The concept of mixed reality and its contribution to education

Milgram and Kishino[49], two groundbreaking technical researchers, explained the possibility of RM improving learning anywhere "at both ends of the virtual continuum". In this case, the virtual environment extends from the real environment to the virtual environment through a technology that can "increase" the user experience. In this sense, they created a "reality virtual continuum" (see **Figure 1**) to describe the evolution of RM.
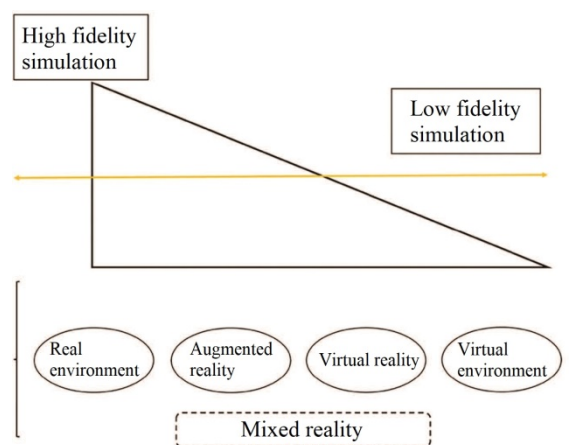
Figure 1. Evolution of mixed reality

Source: Translated from Pellas et al. (2019)[50]

RM is a combination of AR and RV, which provides the possibility of physical inteARction with virtual objects in the real world[51]. It can be used to develop "enhanced" environments in other real worlds where users can add or integARte virtual information[52]. In an RM environment, data is processed through a variety of different input devices, such as smart glasses, tablets, sensors, or personal computers (PCS), which are combined with output devices, such as projectors, interactive walls, or PC monitors that display processing results. All input and output devices must be integrated into a physical environment to improve the user's sense of "presence" [53]. The main difference between AR and RM is that the former allows virtual objects to overlap in the real world, while the latter is a means to integARte a set of virtual and real elements through the continuity of reality[54]. Studies have shown that the use of RM in teaching can produce[55,56].

The main challenges posed by VR, AR and RM are personalized learning and educational intelligence. Learning personalization means creating and implementing a learning experience based on students' educational needs and characteristics (previous understanding, interest and learning style of a subject). Educational intelligence is the application of new technologies and intelligent methods to improve students' learning[57].

The application of RM in education has been the subject of in-depth research in many studies[58,59]. The application of mixed reality in education has produced a learning environment called mrle (mixed reality learning environment) or mixed reality based learning environment[60]. One of the mrle applications that have the greatest impact on learning is the use of mobile devices in the field of science. By designing a hybrid Reality Laboratory, users are allowed to focus on laboratory testing, add graphics, modify Carlos and conduct experiments[61]. It is also used in the field of astronomy to teach knowledge about outer space[62].

Students' motivation is an important factor in academic achievement[63]. The use of RV and RM has a greater impact on students' motivation than traditional methods, which plays an important role in improving academic performance[64,65]. The use of magnetic resonance imaging in educational parctice can improve students' academic performance, especially those with low spatial ability[66].

Advantages and disadvantages of mixed reality

The advantages of RM are related to its various methodological applications, because it combines the possibilities of VR and AR in one method, to design and develop learning experience and make students' learning relevant, interesting and important. One approach emphasized by RM is serious play, which is a digital game designed to entertain and achieve at least one educational goal by promoting problem-solving[67]. In this regard, RM based serious games help students solve an important problem in a cooperative way, while taking advantage of the possibilities provided by these two realities[68]. The disadvantages brought by the application of RM in education are related to the lack of interdisciplinary cooperation between the technical research of stents (such as smart glasses) used in RM and the application of pedagogy in educational practice. Only by consolidating and accepting the development of

different disciplines such as technology and education through interdisciplinary cooperation can meaningful RM-based experience is created. Therefore, separate discipline development may make one-way assumptions about the use of technology[69]. In this regard, advances in the understanding of these new technologies have promoted interdisciplinary approaches with great potential, making various methods and applications possible[70].

The literature review shows that there is a lack of research on the use of AR and RV for education due to the following three factors. First, these technologies are obtained through smart phones, and their use in teaching has not been consolidated There is a lack of content on the use of these technologies in educational institutions. The digital divide between countries and schools[71]. RM's experience in Metaverse will require oARl inteARction with virtual objects and obtain feedback or feedback. Therefore, voice inteARction is the main challenge in the development of RM to educational Metaverse[72]. To this end, it is necessary to improve the development of glasses used in RM, which use static and preset voice commands[73], and include other retractable glasses to adapt to user feedback.

3.4. Concept and contributions of the Metaverse to education

Mark Zuckerberg announced in October 2021 that Metaverse would appear in five to ten years, denying that it was another digital reality for people to work, play and socialize[74]. Since then, comments on the potential impact of Metaverse on society and its impact on e-learning have emerged one after another, emphasizing the importance and importance of this theme. In order to understand the challenges faced by Metaverse in the future digital scene, we start with concepts and experiences close to this new reality published in scientific journals. The concept mentioned in Metaverse is "mirror world" or "spatial Internet", so it can be understood as "virtual enhanced

physical reality"[75].

Metaverse is an abbreviation, which is composed of the prefix "meta" (transcendence) and the contraction of the term "verse". It is an immersive, interactive and collaborative three-dimensional virtual world[76]. It is a new dimension on the Internet and has a significant impact on future education. It is the American novelist Neal Stephenson[77] who first used the word to refer to the new version of the Internet in his novel avalanche. This allows different members of the team to work together in virtual space through avatars, which interact face-to-face and create three-dimensional objects representing ideas, values or feelings[78].

Metaverse brings together a series of features that go beyond broad reality[79,80]:

It is lasting. It does not restart or pause, but continues independently.

It contributes to the initiative of users, who control, make decisions and predict possible events.

It is synchronous and real-time.

There is no limit to the concurrency of users in the activity.

It provides an experience that covers the relationship between the digital world and the real world, private and public networks.

It provides interoperability between data and digital elements. For example, virtual objects of video games can be given to friends through Facebook.

One of Metaverse's educational potential is to establish museums, hold special exhibitions and provide experiential content for tourists[81]. Others are related to the design of learning experience based on Metaverse, which requires the creation of an avatar, another self of a user, which can interact with other avatars in the virtual world[82]. Horizon

report 2021 emphasizes the use of avatar practice language in virtual environment. Avatar is connected to a chat robot that provides answers to alum nado's questions[83]. A groundbreaking study assessed people's social perception by creating two avatars, one with the same facial appearance as the user and the other with the same gesture expression. The results showed that participants did not agree with the appearance of their avatars, but recognized themselves in avatars that made the same gestures as them. Therefore, this behavioral realism plays an important role in designing and realizing the embodiment of Metaverse[84].

The challenge of Metaverse in Education

In 2013, dionio et al. Emphasized that the transition from virtual world to virtual world is a powerful challenge, but dionio et al[85]. Realism (make users feel they are immersed in another dimension). Universality (establish access to the system through digital devices and maintain the virtual identity of users in the system). Interoperability (allowing the creation and movement of 3D objects outside the system). Scalability (allowing many users to connect two systems at the same time). From a practical point of view, the experience of approaching Metaverse for the first time focuses on the written and oral understanding of language[86].

Metaverse offers many educational possibilities related to acquiring cultural knowledge[87]. In this sense, a key concept in the development of Metaverse is culture, which reflects the background and experience of people as part of this dimension[88], including two related concepts: who we are and how we live[89]. Castells[90] "RMA" requires the establishment of a culture in a knowledge society, starting with the formulation of certain rules. The author points out that this culture is a part of a real virtual system, in which the same reality (human existence) is submerged in a virtual image scene, in which the image not only appears on the screen of exchanging experience, but also becomes experience. In this regard, it is necessary to

establish a culture or a set of basic norms and values in order to communicate, work and exist in the meta universe. In this alternative reality, the boundary between physics and virtual is still blurred and needs to be accurately defined in order to maintain the identity of users. In this regard, Smithson[91] proposed the necessity of developing the ethical norms of Metaverse culture, which has five aspects:

Metaverse based transparency of knowledge and views between consumers and product creators helps to improve its functionality.

Values scale conducive to coexistence and relationship between users.

The principle of inclusiveness is essential. Metaverse should be accessible and easy for everyone to use.

The avatar (or another self) is a real person, so bullying and cheating attitudes will be punished and users in this space will be temporarily deleted.

Ethics is the cornerstone, which translates into designing courses and learning experiences to ensure consumer consistency.

4. Conclusions

The epidemic caused by Covid-19 leads to the transfer of teaching to digital platform, which marks an entry point for the implementation of emerging technologies in future education. In future education, external reality and meta universe are prominent because of their relevance, interest and impact on the teaching process. Therefore, the main purpose of this study is to understand and evaluate the scientific contribution of extended reality (virtual reality, augmented reality and hybrid reality) to the field of education and the challenges of metauniverse to future education.

About the concept of three types of reality that constitute extended reality, VR combines visual and sound effects to make users believe that they exist in the environment of reality. The basic goal of this reality is to solve the problem of immersing in the virtual field without giving up the existence or subjective reaction of users. These two concepts, immersion and existence, guide the further research of augmented reality, which provides the possibility of physical interaction with virtual objects in the real world. Smart phones and tablets have promoted the development of AR. In order to increase the sense of immersion and existence, hybrid reality came into being. It integrates virtual and real elements through a continuous reality, and provides an important background for the development of the meta universe. The meta universe is a three-dimensional virtual world, which needs to create an avatar to interact with other avatars in the virtual world.

Regarding the application in the field of education, VR focuses on designing laboratories in the field of stem to carry out experimental simulation without risk. The application of AR has been extended to the fields of mathematics, concept interpretation and geography to explore the geographical environment through geographical location. The implementation of hybrid reality means improving laboratory testing in the field of science by modifying and adding graphics and teaching the concept of outer space in the field of astronomy. It also marks significant progress in developing new methodological proposals, such as serious games.

About the advantages and disadvantages of augmented reality, virtual reality provides a greater sense of immersion and presence than traditional methods, but the equipment cost required to develop high-quality experience in educational institutions is very high. Although it is not necessary for teachers to apply practical education to stimulate students' learning motivation. On the other hand, mixed reality promotes the development of various methodological strategies. Although the development of technology and pedagogy is carried out through parallel channels, there is no interdisciplinary cooperation to improve

the understanding of the educational possibility of RM in education.

Fourth, the main challenges faced by education in developing a wide ARnge of educational realities[92-94]:

The significant investments made by centers to implement RV and AR enable them to create new learning experiences in digital laboratories.

Personalized training takes students as the starting point and organizes learning rhythm and teaching methods according to the needs of each student.

Combining positive methodologies with emerging technologies means developing methodologies, such as reverse classes, where students prepare a syllabus before class and devote classroom time to implementing them.

The search for meaningful learning sees emerging technologies not only as a tool in themselves, but also as a tool for teachers and students to improve the teaching process.

These challenges have affected the development of Metaverse, which is known as a revolution in new technology, communication and education. In this new reality, we need to design an avatar to represent users and inteARct with other avatars in order to communicate, work and collaborate, which opens many possibilities for e-learning beyond time and geographical barriers. In the future research, three aspects are very important:

The development of Metaverse may blur the boundary between the real world and the virtual world, which indicates the need to design and develop an ethics code as a guide to safe development. This is not to say that this "alternative" reality replaces the reality itself, but is regarded as a new and improving reality, which opens new possibilities for the teaching process.

This code of ethics contributes to the development of culture, which includes design and implementation norms, which are meaningful in Metaverse and consolidated through experience. The two fundamental aspects of this code of ethics are the principle of inclusiveness and values conducive to the development of user relations.

Protect user identity. The creation of an avatar involves another self, which brings together a series of physical and or personality characteristics that make us individuals in the meta universe and distinguish us from other avatars. This situation requires ensuring the consistency of personal data.

To sum up, it can be said that in e-learning, the transformation from external reality to Metaverse needs a different method, and immersion and presence are a means to improve the teaching process. In Metaverse, they themselves represent a virtual reality. Interdisciplinary cooperation needs to be strengthened between the fields of educational technology and research, so that the introduction of Metaverse into e-learning will lead to better teaching.

Conflict of interest

The author declares no conflict of interest.

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