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Higher Education in the Face of the Push of New Technologies. Virtual, Augmented and Mixed Reality in the Teaching Environment

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Abstract

Almost by magic, due to the Covid-19 pandemic, schools and universities around the world closed their doors, affecting some 1.5 billion students worldwide. This new situation has cascading consequences in the lives of students, whether they are studying abroad or at home. The closures, as a measure to contain the Covid-19 pandemic, have led to an accelerated deployment of distance education solutions to ensure educational continuity.

The obstacles are manifold, from low connectivity and lack of online content aligned with national curricula to a faculty unprepared for this "new normal. Regardless of the level of education, the fundamental danger is that inequalities in learning will widen, marginalization will increase and the most disadvantaged students will be unable to continue their studies.

Higher education is not an exception, although at this level digital technology has had the greatest impact in recent decades, which is why this article has focused on the influence that virtual, augmented and mixed reality could have on the Higher Education environment, aimed at improving student academic performance and boosting their motivation.

It is concluded that although this new technology has been very well received by students, it is necessary to increase the number of studies on the incorporation of

new technology in the educational field, because most of the studies are very specific and it would be advisable to implement longitudinal studies.

Keywords: higher education, virtual reality, augment reality, multimedia material, teaching innovation

1. Introduction

The new coronavirus SARS-CoV-2, which causes COVID-19 disease, continues to spread around the planet and has already infected more than 34.3 million people, while the global number of deaths is above one million and those recovered exceed 23.8 million people (35).

The most affected country is the United States, with more than 7.2 million infections and more than 207,000 deaths, followed by India, which already exceeds 6.3 million cases and 98,000 deaths, and Brazil, which exceeds 4.8 million cases and accumulates more than 143,000 deaths. Russia has also exceeded 1.1 million infections, while Colombia and Peru exceed 800,000, while Mexico and Argentina exceed 700,000. Spain, for its part, has accumulated more than 778,000 cases and almost 32,000 deaths, and is the European Union country most affected by the pandemic (36).

As a result of the spread of the virus, more than half of the world's population has been subjected to some form of confinement, social alienation has been imposed, and movement has been paralyzed, as has economic activity, causing a severe recession across the globe.

Not only the economy and people's lives have changed immediately, the coronavirus crisis is drastically changing Higher Education, universities have closed, classes have been suspended or are being held online as well as academic conferences (34). Students who were participating in programs abroad may not be able to be evaluated and some of them may not be able to return to their home countries yet. Study abroad programs have been cancelled until further notice. Teachers have been asked not to travel to countries affected by the pandemic or to avoid international travel altogether. The immediate implications and inconvenience will increase as the coronavirus spreads to more countries and affects more people.

Most higher education institutions are teaching their students to use multiple online resources since virtually all universities are closed. It is impressive how quickly many of these institutions have adapted to make the transition from face-to-face to online mode in record time, however, there are gaps in the quality offered and the extent to which students are satisfied with this new education.

The crisis has forced an immediate and abrupt migration of educational systems to the online mode, resulting in "emergency remote teaching" (10). The current crisis leaves no time or space for planning and designing the learning experiences that characterize a true online education.

There are many aspects and modalities that should be considered, for example: asynchrony or synchrony of teaching, how to manage group discussions effectively, or how to organize tasks or evaluations at a distance. These are just some of the issues that must be resolved. Of course, the effectiveness of online teaching and learning is possible, but this will take time and support will be needed, especially financial support. Trying to make these changes quickly can have an impact on the quality of teaching as indicated above. And quality also decreases if students lack adequate computer equipment at home, poor internet connections, or few physical spaces available to work at home. For all this, adaptation to the 'new online teaching' must be taken calmly and not idealized, otherwise it could fall into a serious error, only time will give or take away reasons.

The continuous technological advances clearly influence the ways of teaching and learning, so that current technology has become an indispensable aid for teachers and students: mobile devices, tablets or smartphones, digital blackboards, 3D printers, avatars, virtual, augmented and mixed reality, etc. (38).

2. Methods and Materials

Education, in general, and therefore, Higher Education, is one of the social areas that has been less developed in the last decades. Technology has anticipated the forms and ways of teaching. We think this is something that should be changed. The master class where the teacher is the one who speaks and the student is the one who listens, and very occasionally asks, must turn the page. Education in a general context, must bet on other types of teaching methodologies where the student assumes another role, is more involved, type class invested, for example. For this, technology and education do not need to be on opposite sides, the good thing would be that they would work together with the same objective.

Studies have been carried out (3) where it is indicated that the University should be interconnected with several ecosystems, being these the knowledge, the social institutions, the people, the economy, the learning, the culture and the social environment (22). It describes the evolution of the University in different phases: the first one, is the University 1.0, it would be the metaphysical university developed in the medieval period with a strong presence in religious and spiritual beliefs; the second one is the University 2.0 that would correspond with the universities created from the XV century, it arises in the scope of the

post-industrial societies with a more marked deployment of the investigation; the University 3. 0 would be the third phase and could be defined as the entrepreneurial and advanced University concerned with optimizing its strategies in an increasingly competitive world, it is the University that develops in Europe in the nineteenth century; and finally, the University 4.0 where learning is provided on demand in multiple formats, with more fluid collaboration between universities and industry in a digitized environment (13).

The adaptation of technologies as incipient as those proposed in this work (virtual, augmented and mixed reality) would perfectly comply with that common objective that education should seek together with technology.

In the case of Spain, all educational centers closed in mid-March of this year, and Higher Education centers have been forced to work generally on-line due to the pandemic, moving teaching activity to homes, which has revealed the existence of three gaps (18, 32) in the Spanish educational system: the access gap (having or not having access to connection and technological devices); the use gap (time of use and quality of use); and the school gap (teachers' skills, availability of resources and adequacy of online platforms to support teaching).

The results show, on the one hand, that as a result of the closure of schools and online work in higher education centers, there will be a negative impact on the learning of all students. On the other hand, this impact will be much higher for students from vulnerable disadvantaged environments, which suggests a significant increase in the educational gap.

Statistical studies show that the reality in Spain is very different for some students than for others due to the different 'gaps'. Their influence on the learning process could marginalize some students with respect to others in terms of the gaps indicated above.

Within these statistical studies, the Conference of Rectors of Spanish Universities (CRUE) has prepared the report Universitic, Analysis of ICTs in Spanish Universities, and this has been done since 2006 (21). In this report, the state of the Spanish university system in relation to the implanted ICT is gathered and evaluated according to a set of quantitative indicators. These indicators are divided into information technology (IT) indicators and IT management indicators. The budget that Spanish universities allocated to the promotion and use of Information and Communication Technologies (ICT) grew by 3.62% in 2016, reaching 3.44% of the total, although Spain is still far from the 5% of the investment recommended by the OECD.

In summary, the report points out that the funds that universities devote to the implementation of these technologies have experienced "a slight increase", although it is still "insufficient". The report highlights that 81% of the teaching rooms have a multimedia projector and Internet access and stresses that in total

there are 75,000 computers (fixed, loan or mobile classrooms) available to students. In addition, the number of wireless connections has increased significantly (30 million per center).
On the other hand, it highlights the effort made for the creation of multimedia content and the adaptation of existing materials. According to the study, almost all teachers use more or less frequently the digital teaching platform and 89% of students have used ICTs throughout their academic process. In addition, 75% of universities have considered the implementation of 'MOOC' (Massive Open Online Courses) and the degrees 'online' account for 7% of the total.

As a negative figure, the report highlights a slight decline in ICT training for students and teachers. Also, the research calls for more human resources specifically for ICT and regrets that although it is normal to share infrastructure between centers, collaboration between the heads of this area and research groups dependent on the same university is "virtually nil. Finally, he points out that only one in ten of the services provided by universities are offered "from the cloud", which means "a slow introduction" of this technology.

Students, in general, learn in the same proportion during the classroom course regardless of their socioeconomic status, thus achieving an effect of equality. If the classroom course is reduced for a period of time, classroom learning is reduced for everyone in that time.According to certain studies (11, 28), for middle and high income students it is assumed that the home-based learning situation has a slight learning loss of 20% with respect to a classroom-based learning situation. For lower income students, due to the digital and socio-cultural gap between families, it is assumed that students will unlearn during this process.

The following graph (Figure 1) represents the number of computers per socioeconomic quartile in Spain. The access gap (having or not having access to connection and technological devices) suggests that the vast majority of homes have an internet connection but the devices do not reach all homes.

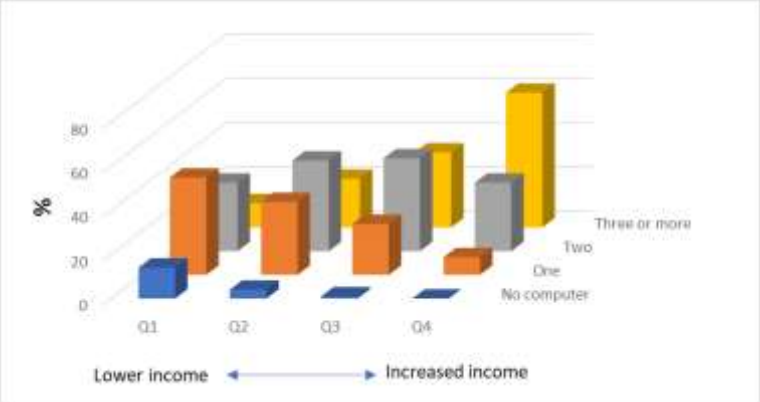

Figure 1. Number of computers per socio-economic quartile (source: Cotec from PISA 2018 data).

Once the access gap is overcome, not all students are equally familiar with the use of the new technology and the question arises as to what learning can be achieved from the experiences with the digital device. The gap in the use of technologies, measured mainly by the socio-cultural capital of the families) shows differences by socioeconomic level with respect to the use of ICT devices in the homes (4.30).

The graph in figure 2 represents and compares the time of internet use in Spain by students against the European Union and the OECD (Organization for Economic Cooperation and Development). From the graph it can be deduced that practically the time of internet use in the three analyzed bands is very similar in Spain, European Union and OECD.

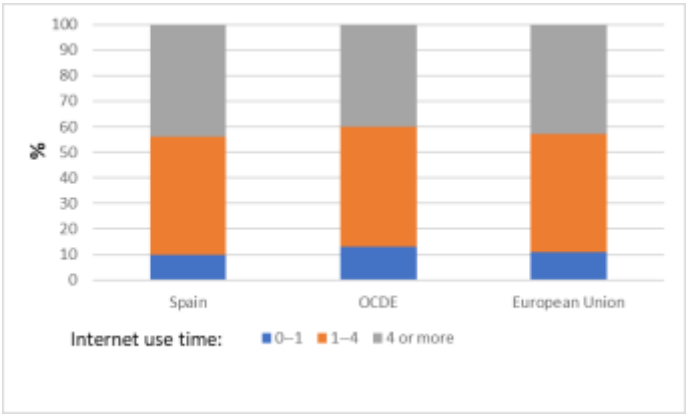

Figure 2. Internet usage time in homes (source: Cotec from PISA 2018 data).

Figure 3 indicates the use of ICT devices in the home (tablets, smarthphones, computers, etc.) according to the normalized value of ICT use. It can be seen that Spain is below the values of the European Union and the OECD in the use of these devices(25).

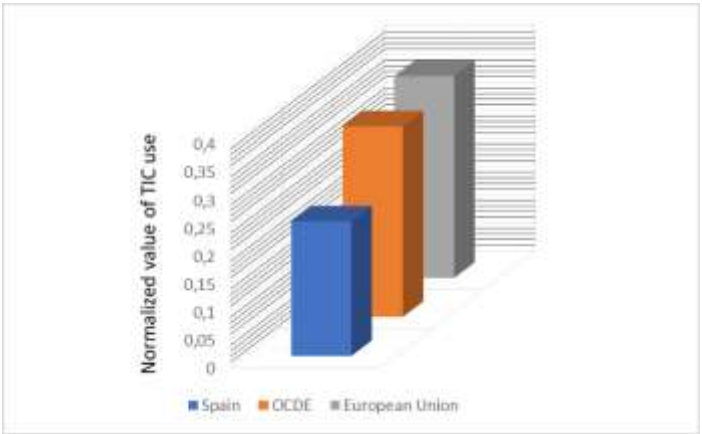

Figure 3. Index of ICT device use in households (source: Cotec from PISA 2018 data).

Virtual reality (VR) has existed since the eighties as a technology that has been in constant evolution, and although it has always been given attributes related to the world of video games and entertainment, the rebirth of these gadgets has migrated to other applications such as education, allowing the integration of technology in the classroom (1, 5..7).

The technology of virtual reality is developed through a special viewer equipped with gyroscopes that allows emulating the movement of the head in the video that is emitted in the screens that go in front of the eyes, transforming it into an immersive experience for the student. Virtual reality allows the creation of realities that do not exist but can be visualized thanks to devices such as VR glasses. Without having to leave the classroom, this technology places the student in simulated conditions and scenarios in feasible conditions. The creativity of this technology, and its capacity to provoke new experiences, leads us to a new way of learning.

Figure 4. Applied Virtual Reality 3D model creation (https://arvr.google.com/blocks/).

This technology is not only applied to entertainment, it has been introduced in fields such as tourism, marketing and also education, where educators from all over the world are implementing it in their classes to make the student feel more involved and what as a consequence of that involvement, have a better learning and performance (12, 20).

Students who have direct experience within their learning process are 90% more likely to remember what they are studying, and although this theory is debated to this day, educators believe that the implementation of virtual reality is a useful complement in the classroom, but that the guidance of a teacher or monitor is necessary to add context to what is being seen.

The implementation of didactic methods of learning has been tested according to a large number of works. According to a study by Bloxham and Wileman published in the Journal of Virtual Studies, students who experienced a practical education using augmented reality increased their retention rates to 18.1% in the area of

Mathematics, followed by 13.1% in Mechanics and 2.9% in Engineering (2,15,19,24).

Augmented reality (AR) consists of integrating or overlaying digital content in a real environment. Due to the already widespread use of cell phones and tablets worldwide, this technology is increasingly popular with students and their educational environments as it allows them to deepen their knowledge and make them more attractive (31).

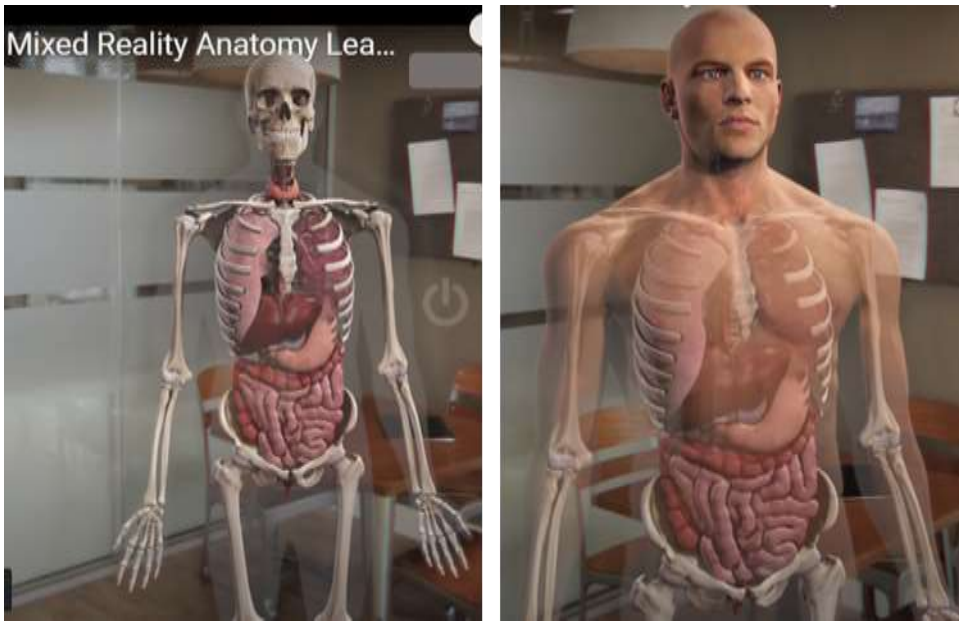

Figure 5. 3D Augmented Reality applied to Anatomy (Project Esper: https://www.neosentec.com/ejemplos-aplicaciones-realidad-aumentada/).

It has been estimated that the increase in student retention rates in didactic classes where this new technology has been used has been the following:

- 18.1% Mathematics and Language Arts
- 13.1% Mechanics and Conduction
- 7.7% Beauty and Hairdressing
- 2.9% Engineering

One of the advantages of using virtual and augmented reality methodologies is that it is possible in the digital world, which is impossible in the real world. This is why the United Nations Industrial Development Organization (UNIDO), in collaboration with VR technology developers, has taken training in these technologies to countries where the materials needed to apply them are not always available. An example of this was created by Eon Reality to see the operation of a diesel engine and all the necessary steps to perform its maintenance without the

need to have the tools or the engine itself, all visible in an interactive and digital interface (2,8,9).

The immersive application of this and other companies are giving the learning experience to meet the educational needs of the entire process, from medical simulators, to digital classes that will have a reduced cost compared to the alternatives or traditional classes.
The sum of these factors, experience plus context, is what allows virtual and augmented reality to become the tools of the future in the learning experience process.

On the other hand, mixed reality (MR), a mixture of RA and VR will also contribute to the potential development of student learning. This technology allows interacting with real objects within a virtual world, or reproducing virtual elements by seeing the real world. Closed headphones are also necessary, but these have a camera so that the user can see the reality and combine it with virtual environments.

The University must have the ability to adapt to the future era so it must be in continuous reflection and alert, this implies vision of a digital world to which the University has opened its doors, but where there is still a way to explore and assimilate.

3. Conclusion

Changing the teacher for a hologram is still not easy, but technological advances are coming at a fast pace, many times we are unable to process so much technology and it is difficult to catch up with it (27). As teachers, great opportunities are presented to both professors and students in the coming years, but we must analyze them carefully before incorporating them into the world of Higher Education.

Research has provided very significant arguments for the incorporation of these technologies into teaching due to an increase in academic performance and the enhancement of motivation due to a better interactive/participatory context, levels of satisfaction and the motivation and acceptance of these methodologies in students.

Both virtual reality and augmented reality in university education are presented as very versatile tools. Both lead to a more immersive education and greater student participation (34). For example, virtual reality is presented as a very varied tool, since it can go from the simplest (Google Cardboard) to the most sophisticated (Oculus Rift / HTC Vive).

These methodologies are presented as very interesting to be applied in the medical careers that would allow to create photorealistic experiences in 3D

models with 360º rotation for the human body, for example; in Architecture where the plans and designs created in CAD could be exported as files to be used in virtual reality, the Revit type programs, could join plans of the whole building including the plans of heating, electricity, ventilation installations, etc. In Engineering, using engines, decomposition of pieces, installations, etc (26,31). As a joint tool it would also serve to view virtual simulations of the buildings and facilities made by the students in their Final Projects (FCP) and help in their qualification. They could be used to generate empathy and inculcate values. Being able to transport us to a different reality can allow us another type of perception of what they want us to believe in the news worldwide, for example, in the news offered about the refugee crisis. The presence in the same crisis thanks to the virtual reality could be necessary to look for and adapt new solutions in the search of a more just society.

Living new experiences can improve the learning of any student and fix its content. For students who finish their careers, applying in practice everything they have learned during their university journey can be complicated, but if they have already experienced these sensations and situations with the new tools, it can help a lot. The simulation also improves the student's skills by allowing them to visualize them again, see the precision with which they have performed, the time, etc. Many times people with some kind of disability are excluded from the traditional educational system, however, with these tools, they can learn along with any other student with full abilities.

We believe that it is still early to see the results of the immersion of these new technologies in higher education, studies predict a great support to education and learning, but we must be cautious.

It should be considered that the real challenge of the University of the future is to enhance the ability to solve real problems, generating the necessary knowledge and critical spirit to achieve solutions to the world in the different challenges it faces.

4. Discussion

As a general rule, whenever something is experienced or implemented there are advantages and disadvantages, so far the advantages have been discussed, and also a certain amount of mistrust has been expressed, about these new tools to help the student's education.

There are certain disadvantages that should be noted in this part of the study.

The great diversity of students in the world with its different economic situations, make some students can go to certain universities (with more technical means) and

others to others (with less means). This could lead to a two-speed education for the same degree and would have repercussions on society in the long term, where only the best could get a job.

The disproportionate increase in the production of these resources, to work the different learning units, as well as to cover a greater number of disciplines, could lead to the collapse of teaching, and the student, due to an over-saturation of resources and methodologies involved in their learning.

Studies should be carried out on the immersion of these techniques in the different fields and degrees in order to adapt them in the best possible way and in those techniques and disciplines where a better suitability for the student's development is seen.

Studies of psychological variables should be applied to see the immersion of these tools in teaching methodologies according to different learning styles and approaches, as well as to analyze the interaction of students with the objects made and involved in learning due to RV and RA.

The creation of production and development centers of these new methodologies should be considered to carry out and enhance them in the same universities.

There are other limitations that should be reflected on them as the lack of theoretical reflection by teachers, the existence of more developments than educational practices, lack of educational materials, lack of experience of interaction of students with virtual objects, slow internet in schools, teacher training, research still very limited, etc.

There is a very changing and challenging environment, in which universities should be up to the task. The university must reinvent itself so as not to become an obsolete institution in a world in continuous movement and change. It is a question of fully assuming the transition that the digital transformation implies and of promoting digital innovation in each institution (17,33). It is also about ensuring the best possible experience and training for students, optimizing the development of learning processes and the use of facilities more efficiently and productively.

The University of the Future report. Bringing Education 4.0 to life (16,23) redefines education by redefining the educational landscape by placing the student at the center of the ecosystem and changing the approach from teaching to learning.

New and better adapted indicators must be designed to measure the activity carried out in the technological maturity of universities according to the strategies defined by them in the renewal and modernization of the university in general, in order to take advantage of the digital transformation in the design of a more effective, efficient and efficient model in the so-called University 4.0. This new University is

proposed as an open academic system, where the local community and society in general will become an integral part of the university ecosystem. The interaction between industry, society and the University has to become a living platform with dissemination of ideas, knowledge and needs of each one of them attended by the others (14,37).

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