Augmented Virtual Reality: How to Improve Education Systems

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Abstract: This essay presents and discusses the developing role of virtual and augmented reality technologies in education. Addressing the challenges in adapting such technologies to focus on improving students' learning outcomes, the author discusses the inclusion of experiential modes as a vehicle for improving students' knowledge acquisition. Stakeholders in the educational role of technology include students, faculty members, institutions, and manufacturers. While the benefits of such technologies are still under investigation, the technology landscape offers opportunities to enhance face-to-face and online teaching, including contributions in the understanding of abstract concepts and training in real environments and situations. Barriers to technology use involve limited adoption of augmented and virtual reality technologies, and, more directly, necessary training of teachers in using such technologies within meaningful educational contexts. The author proposes a six-step methodology to aid adoption of these technologies as basic elements within the regular education: training teachers; developing conceptual prototypes; teamwork involving the teacher, a technical programmer, and an educational architect; and producing the experience, which then provides results in the subsequent two phases wherein teachers are trained to apply augmented- and virtual-reality solutions within their teaching methodology using an available subject-specific experience and then finally implementing the use of the experience in a regular subject with students. The essay concludes with discussion of the business opportunities facing virtual reality in face-to-face education as well as augmented and virtual reality in online education.

Keywords: higher education; new technologies; augmented reality; virtual reality

Introduction

Virtual and augmented reality technologies have made their appearance within the education sector. The challenges to be addressed are mainly focused on improving students' learning outcomes. The educational element they have put in motion has been experience as a vehicle to get the student to acquire specific knowledge. Many are the stakeholders who will be part of this process, all with equal importance to the success of the initiatives. First are students as recipients and digital natives—individuals that embrace the use of new technologies, influenced by the technological progress of society; customers, and as such, very demanding in their requests, thinking that technologies like these should be readily available in the existing portfolio. Second are the faculty members: academic professionals who have to be trained to introduce these innovations into their teaching methodologies. Success will require involving them as participants in the creation of such solutions. There is no one better than faculty members to know in what areas a student will need more help, and therefore, what parts of the subject will be best suited to and best complemented by these educational experiences. Third are the institutions. They have to bet on these types of technologies, conceiving them within their models of educational innovation. It is not enough to have some trial devices available for users; instead, the greatest effort of institutions will focus on providing products and training that will raise their

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educational quality to the highest level. Last but not least, are the manufacturers, influencing through their devices, applications, and events; all of which are fundamental elements and, obviously, pillars to the expansion of these new tools.

Without a doubt, the most important element to highlight around virtual and augmented reality is neither the potential nor the devices, nor even the existing applications. The most important concept to understand is that these are tools. The ultimate goal focuses on the improvement of student outcomes throughout the educational process in which they are involved. Increasing the number of students who manage to acquire the minimum knowledge demanded by an expanding competitive market is the only mission of these tools. Millions of professionals in thousands of institutions work every day to achieve this goal. Today people speak of virtual and augmented reality, but tomorrow they may talk about holography or any other outstanding technology. In the end, these are tools, and the increase of student knowledge will continue to be the common and constant goal in this sector throughout all time.

Augmented and Virtual Reality Definitions

Virtual Reality Definition

Taking a common definition per the American Heritage Dictionary, virtual (n.d.) means "existing or resulting in essence or effect though not in actual fact, form, or name." Also, it can mean "created, simulated, or carried on by means of a computer or computer network" (“virtual,” 2005) Other definitions can be found in the scientific literature to complement the dictionary, such as “the action to induce a targeted behavior in an organism by using artificial sensory stimulation, while the organism has little or no awareness of the interference” (LaValle, 2017). Another interesting definition for virtual reality is an interactive computer simulation which transfers sensory information to a user who perceives it as substituted or augmented (Abari, Bharadia, Duffield, & Katabi, 2017). Therefore, virtual reality could be defined as an environment created by a computer system that simulates a real situation.

Starting with the resulting description, it can be said that this technology provides the user with the opportunity to be immersed in a programmed environment that simulates a reality. Currently individuals can be immersed within these realities through the sense of sight, by using visualization goggles; through touch, by wearing haptic gloves; and finally, through hearing by using headphones. The technology that makes it possible is based on software developments that use peripherals to interact with them. There are two types of applications. On the one hand, those that need powerful processors to use. On the other hand and in parallel, the complete offerings available on the market via a multitude of applications that can run with the processor of a smartphone in order to increase the channels of access to this technology.

The video game industry has been the main sponsor for the development of this technology (Prieto, 2017). This sector has a critical mass of users willing to invest capital in order to improve the quality of ludic experiences. Once their capabilities have been proven, other sectors, such as communication, advertising, and marketing, have discovered that such technology can be a differential element within their business.

Augmented Reality Definition

Many people think that augmented reality is the evolution of virtual reality. Today it is clear that they are two technologies with different R&D paths and usages. Augmented reality technology integrates digital information with real environments in which people live. Everything is processed and produced in real time. This is one of the main differences with virtual reality, which uses artificial environments. Augmented reality uses the real world and completes it with digital information. Basically, it increases the amount of information that a human can take from the environment (Curcio, Dipace, & Norlund, 2016). Additionally and previously, Azuma (1997) defined augmented reality by three main characteristics. Firstly, the combination between real and virtual, secondly, the interaction in real time, and thirdly, the registration in 3D. All systems that develop an activity under these three characteristics are considered augmented reality systems. Other authors have gone deeper and have introduced into the definition some clarifications, such as “an augmented reality system does not consider necessarily a headset for viewing images” (Schmalstieg & Höllerer, 2016).

This technology is less developed largely due to the fact that it needs even more processing power. It must interpret the real world and adhere to it all the digital information available to the system in question. This means processing a reality with infinite variables that change without a closed argument. While in virtual reality the environment is completely programmed, in this technology the environment is alive and behaves unpredictably. Narrowing the potential values of the multiple variables becomes the main challenge.

Initially the main applications that have shown the technology’s potential have been interior designs, videoconferences, visits to malls, browsers, etc. All of these possess a low level of development when taking into account the forecasts made about what one could get in the system. Many of the major technology multinationals have already presented their first prototypes, placing augmented reality as the tangible element that can achieve products only seen in fiction so far. In any case, this technology is just a visualization tool. Adjacent technologies, such as artificial intelligence or the interpretation and extraction of value of big data, will be the ones that give content and meaning to a type of technology like this (Olshannikova, Ometov, & Koucheryavy, 2014).

Virtual Reality Versus. Augmented Reality

Following the previous deep definitions, some comparisons are exposed:

- Virtual reality runs over new environments completely computer generated. All that user can take, touch, or interact with is virtual. Augmented reality uses virtual elements only to enhance the real world and the user’s experience. Virtual reality replaces the physical world. However, augmented reality does not do so.
- The level of immersion of virtual reality is 100%. Users are fully detached from the real/physical world. Users are fully connected with the physical world through augmented reality. Users are fully aware of their surroundings and can perceive, touch, and interact with the real world helped by all the digital information the application provides.
- Virtual reality needs a very powerful processor. New applications are being launched using mobile phone processors, but they are very limited. Quality is substantively different from dedicated devices such as Oculus Rift or HTC Vive. Augmented reality is able to offer interesting services through tablets or mobile phones. It is necessary to take into account that augmented reality is not only Microsoft HoloLens or Meta 2, dedicated devices which are highly demanding. Other augmented reality applications run over mobile phones with a full range of features.
- Finally, virtual reality is 10% real and 90% virtual. Augmented reality is 75% real and 25% virtual. Obviously, the percentages depend on the application. They are general estimations based on current market applications.

Virtual Reality in Education

Virtual reality has found in education a new area in which to display its full potential. Education has all the elements in which this technology cannot only bring value, but it also becomes an extreme differential value (Kumar, 2017). The learning methodologies with the greatest impact in current educational systems are those that confront students with a real situation that they have to solve using acquired theoretical knowledge, or by making the students enhance capacities that until that moment are nonexistent or underdeveloped. Until now, the situation was described through text or, in exceptional cases, an audio with or without video. Through virtual reality technology, the particular situation can be programmed with several variables and environments on which the student can act. Applications can be completely customized for each subject, area of knowledge, population segment, or geography. It will be possible to transfer the message to all students, matching messages to the case described (Falloon, 2010). Thanks to these kinds of technologies, access to knowledge will be more democratic. Students who struggle to achieve some learning goals with a low rate of success will now be able to achieve the goals successfully. There is a rationale behind this claim. These technologies will contribute to making tangible many abstract concepts that these students should build within their minds. Since not all students have these kinds of skills, these technologies will support this exercise, thus increasing the rate of success.

Another major area where virtual reality is providing a more than significant value is in the representation of abstract concepts (Curcio, Dipace, & Norlund, 2016), such as applications that are able to represent complex mathematical functions in space: solutions that allow the use of digital resources to represent artistic works in any of the branches that can define them (painting, music, or sculpting), and products that allow walking across architectural structures facilitating access to all the layers that compose the structure (wiring, conduits, and any type of existing material).

Virtual reality also offers significant opportunity in the area of simulation. Laboratories completely simulated through this technology allow interaction between the student and the devices (Hoffmann, Meisen, & Jeschke, 2014). Obvious direct benefits include that measuring devices would be updated with only a new version of the environment. Students would have the opportunity to work with the latest technology without having to have the physical elements that would clearly represent a higher investment for the institutions. Taking this analysis further, the cost savings in spaces would be huge. The underutilized spaces within the centers would be significantly reduced and would be replaced by "multi-laboratory" rooms in which, according to the subject, one laboratory or another could be accessed (Lindgren, Tscholl, Wang, & Johnson, 2016). These products are already becoming available on the market. The development of these products, as it cannot be otherwise, will depend on the commitment that the traditional education sector makes for them.

The number of applications with potential in the education sector extends as much as imagination or ability to adapt materials in traditional format allows. Today, many examples can be found on the market such as ThingLink (www.thinglink.com/), a collection of interactive images and videos on a variety of topics including science, language, and arts. Another choice is Unimersiv (unimersiv.com), a bundle of educational virtual reality apps, including three educational experiences at launch: (1) the discovery of the International Space Station, (2) human anatomy, and (3) travel to Stonehenge in Wiltshire, England, as it was 5000 years ago. Yet another choice from Unimersiv, MoleculE VR, is a virtual reality app introducing some basic concepts about cell communication. One more is InMind (luden.io/inmind/), a scientific game for virtual reality. InMind allows the player to experience a journey into the patient's brain in search of the neurons that cause mental disorder. Many and many applications can be found around educational area.

The main problem lies in the education sector itself. It is a segment in which it is common to have individual institutions that cover a small geography. On the other hand, the manufacturers that are dedicated to these technologies have a global geographic scope of business. They need global partners in the education sector with which to test solutions before launching products into an international market. Unfortunately, there are very few options. This undoubtedly hurts development, although it does not eliminate it; it simply slows it down. Given this opportunity, a multitude of small companies are being born that are able to integrate technological solutions from major manufacturers and sign agreements with a relevant number of small institutions to have the flexibility that a large multinational lacks. The results are already beginning to stand out. It is important to emphasize the fact that the agreement between a large manufacturer and a global educational partner, without a doubt, is a great opportunity to explore.

Augmented Reality in Education

Augmented reality, in a degree of development still smaller than virtual reality, has been working in the education sector since the beginning. Start-ups such as MetaVisión, which have raised a lot of investment capital, have launched applications pending verification around education on different areas of knowledge such as health or engineering (Villarán, Ibañez, & Delgado Kloos, 2015). In other areas, such as design, augmented reality is presented as the fundamental tool that will establish prototypes generated digitally based on the reality in which the physical elements will be manufactured. Within educational processes, augmented reality will allow students to work by increasing their creativity without fear of manufacturing risks and costs (Di Serio, Ibáñez, & Delgado Kloos, 2013). The inexperience risk that significantly increased the difficulty of carrying out projects with all kinds of implications could be reduced substantially. Through this technology, a student can display an image of a final result over a real space, without the need to complete a physical manufacturing process.

Similarly, sessions around health and engineering areas (Boletsis & McCallum, 2013) will enable the teacher to share knowledge with students using images superimposed on the reality of their classrooms. Through the model of a digital human body shown in the three dimensions of space, the teacher can access any type of information about its elements, separate each of its parts to show details, or even have students interacting with the model at will to develop any type of activity. Moving this initiative to engineering, teachers would have a digital model of an engine, printed circuits, or even an architectural structure. All of these models would allow interaction from the students, but would also take into account the social factor of sharing the experience in real time with real individuals: their classmates (Ibáñez, Di Serio, Villarán, & Delgado Kloos, 2014).

Many examples on the market show the power of this technology. For instance, Amikasa (www.amikasa.com), which helps users to style one room and figure out their desired layout before ever buying a piece of furniture. Imagine this opportunity for students of design. Another interesting example is AR Liver Viewer from ISO-FORM (www.iso-form.com/apps/ARLiver/). This is a real-time, 3D medical education and patient communication tool, featuring incredibly detailed anatomical models. 4D Anatomy (www.4danatomy.com/) is another very good solution using augmented reality in the health area. More examples are found in other interesting educational areas, such as aeronautical engineering. HoloFlight (http://www.valorem.com/) allows users to visualize real flight data in 3D as holograms. Finally, one more example is HoloStudy (www.holo.study/), which offers a series of geology, physics, chemistry, and biology lessons. Undoubtedly these applications are created to disrupt the paradigm of education.

There are great possibilities. The current challenge is to identify which technology is most appropriate for each subject area. This is a developing process and is not yet fully defined or contrasted. With certainty, the availability of applications on the market will refine the balance in these first moments, but it is essential to expose empirical results that support the different proposals of the developers.

Benefits and Risks

The benefits of virtual reality are still under investigation. They should undoubtedly focus on improving students' learning outcomes. Not many years have passed since the first experiments, introducing the first virtual experiences in regular teaching. There are important contributions in the understanding of abstract concepts, as well as in training in real environments and situations. The immersion in made-to-measure environments allows students to face learning experiences that maximize the use of all their senses. This may seem insignificant but such experience becomes indispensable in the understanding of concepts unknown to the individual in question (Huang, Rauch, & Liaw, 2010). The spatial representation of a complex mathematical function or navigating the depths of the human body are just some of the more successful applications in the early stages of applying virtual reality to the education sector. Going back to the origins of virtual reality, the saying “a picture is worth a thousand words” evolves to another level, becoming an experience beyond an image. It could be rephrased as "an experience is worth more than a thousand images". Thus, the main benefit of virtual reality is its use as a tool to improve the understanding of abstract or complex concepts (Hwang & Hu, 2013).

Conversely, there are also risks and negative aspects in the use of this technology within the education sector. The abusive use of this type of applications can entail the personal isolation of individuals from their peers. There are collaborative environments that use virtual reality, but it is no less true that they are currently less common than those in which participation is individual. Personal interaction is embedded in human DNA and with such interaction comes learning through imitation, collaboration, and exchange of experiences.

In particular, the main risk of virtual reality within education focuses on misunderstanding technology as the end rather than a means to the end: improving student outcomes in their learning process.

Current Technology Landscape

Currently the state of the art of both virtual reality and augmented reality technologies is clearly divided between the prototypes announced through major advertising campaigns and those devices launched by major manufacturers that seek to capture the first prescribers.

With regard to virtual reality, there has been progress from devices that only allowed the transfer of information in one sense, that is, those that only served for observation. Currently the technology is already in a more advanced version where there has been intense work in increasing the interaction of the user with the environments. This provides an added value that is more than significant, since it empowers the person to feel like the actor in the situation, going beyond being a mere spectator. The packages created for the use of this technology are formed mainly by a visualization and audio device, to which elements have been added to enable the use of hands thus allowing interactions with the surroundings. Two types of visualization devices can be found. Those dedicated exclusively to this end, among which the main exponents are the trademarks Oculus Rift and HTC Vive. These are devices that significantly exceed $600 and also require a computer with high processing capacity, which brings the complete set of devices necessary to enjoy an experience through virtual reality to exceed $3,500. However, it cannot be forgotten that the device offered by Sony for exclusive use on its PlayStation platform sold out in the 2016 Christmas campaign for less than $400 per device.

On the other hand, there are low cost devices that have used the processing capacity of smartphones. These are mere housing with different features, depending on their price, that are usually moving widely below $100 per device. They provide glasses and headphones in most cases. Some manufacturers, like Samsung, have added a small track-pad that allows increased interaction of the user with the environment. Others have added headphones with high sound quality. So far these manufacturers have not provided supplementary devices that increase the interaction as in the case of dedicated devices. But soon, and with the increase of the processing capacity of smartphones, supplementary devices will be available.

The most common assemblies are made up of elements supplied by the same manufacturer and also lacking compatibility with other suppliers. About a year ago, smaller companies began launching peripherals offering compatibility with different packages marketed by the big brands. This expands the possibilities for developers and lowers prices with increased competition. This offers users increased options, and also, the capabilities have developed. A clear case of this type of element is the haptic gloves (Arnab, Petridis, Dunwell, & de Freitas, 2011) created by a start-up during 2015.

Another important feature in immersive experiences through virtual reality is the physical mobility of the actors. Until very recently, the display and sound devices needed to be connected to the processor via cables. This limited the interaction by subtracting comfort from the experience. Currently, the aforementioned manufacturers have already publicly presented the main prototypes that eliminate this wiring, making use of wireless connections. The user gains in mobility and with it, in comfort to be able to interact with the programmed environment.

In relation to augmented reality, two very clear states of technology can be described. Initially the first applications that made use of this technology focused their value contribution on the interpretation of symbols or codes and the substitution in the system of visualization by previously programmed elements. A clear example of this is the applications that allow the user to superimpose on furniture spaces of a catalog to approximate how they would fit if they were bought and installed. Another example that has supposed an enormous amount of income for the company that put it on the market, is the game based on Pokémon animations. Using the camera that the vast majority of smartphones have, it superimposes animated characters above the surrounding reality. The impact on the market has surpassed any optimistic expectations on the part of its producers. They are therefore simple applications that overlay digitally created images on images taken from the real environment with both images exposed on a mobile screen, tablet, or any similar device.

In another order of possibilities are augmented reality glasses. Although the offerings increase every year, the Microsoft HoloLens device has certainly opened the market, making real and tangible applications that until now were just cinematic fictions. This gadget is able to map the real environment around it and superimpose information on its viewer, getting the human eye to perceive the real images and those digitally added as elements of the same reality. Some of the most striking examples shown in the promotion have been the design and re-creation of interiors, and calls between individuals, placing both partners in the same room. The effect achieved is that each interlocutor has a digital image with size and movements fully synchronized with the other end of the communication, simulating a hologram of the other person.

Facilitators and Barriers to Adoption

The main facilitators for the adoption of this technology within the education sector are the students themselves. It is a trend that is technically reaching its maturity. The multichannel promotion is massive. The entire technology sector has already presented its credentials by launching pilot projects, applications, and even development platforms. The access possibilities have been diversified through dedicated computers or common mobile devices. This, without a doubt, has been one of the great successes in its conception. Following the trend of technological democratization, manufacturers have proposed the opportunity not to have to make additional investments. Any smartphone already offers the possibility of acting as a display device. This achieves forecasts of universal access from the technical point of view in a short space of time (Kerawalla, Luckin, Seljeflot, & Woolard, 2006).

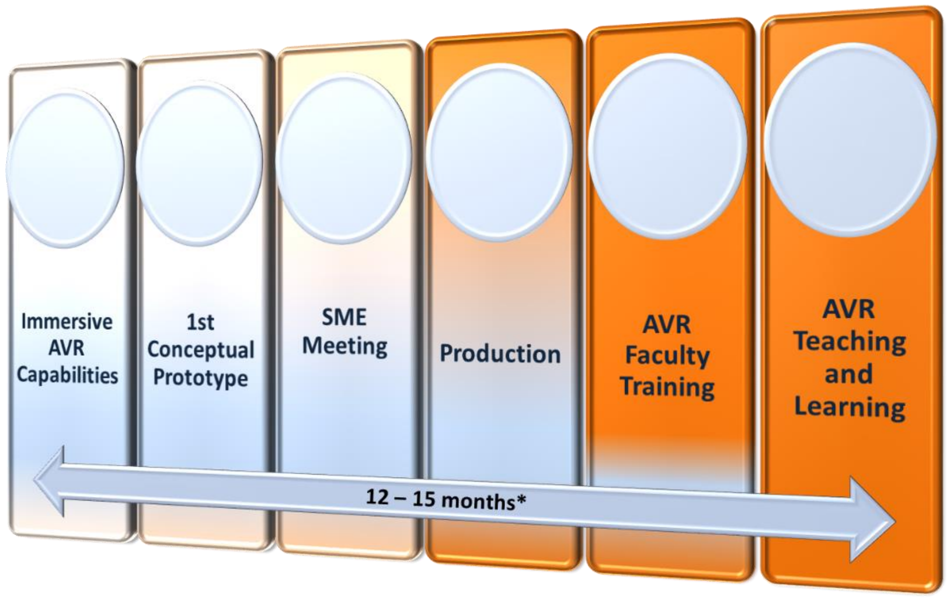
The big players of the market have bet, without doubt, on a business focused on services and not devices. The bulk of the benefits are expected to focus on software, with hardware being a small part reserved for users with advanced needs, whether professional or for gaming. This transfer to the education sector is undoubtedly a substrate of high quality. The institution's population segments are already digital natives with last-generation devices used as utensils on a daily basis. The investment by educational centers is minimal in the future, since users will already have their own devices, both dedicated and smartphones (De Souza e Silva, 2006).

The next facilitator in the chain will undoubtedly be the institution and, with it, the faculty. They will be the protagonists and, at the same time, the main barrier. Teachers have not yet been trained to use this technology within their teaching functions. This is, without a doubt, one of the main barriers. The next, but not least, is the content.

In relation to the first barrier, the training of teachers must have two indispensable points. First is technological training: what virtual-augmented reality is and what its possibilities and potential are. Secondly, but with as much importance as the above, is how to use this technology within a teaching itinerary. This barrier is relevant, since the use of virtual-augmented reality as a tool for teaching is not obvious if teachers want to get the most out of it. There is also the human factor of reluctance to change. Teachers should always continue to learn, introducing new tools and methodologies. Virtual reality, although conceived for intuitive use and providing it with accessories that allow interaction, presents a significant complexity in terms of not only adapting existing curricula, but also improving curricula by taking advantage of the immense opportunities that are made available for professionals (Cheng & Tsi, 2013). The demand exists; the barrier is placed on the bidders in this case.

Second, and as a reference for another significant barrier, is the content available under this technology. There are many training proposals offered by companies with expertise in development. The main problem is that the training content is not adapted to the curriculum but is based on experiences that are presumed interesting for the students. Given this, two options are presented: compatible and nonexclusive. On the one hand, these developments could be used for existing parts in the current subject. Use them as teaching elements, adapting the material committed to these experiences. On the other hand and in parallel, experiences could be developed adjusted to the subject accredited with regulators. Both roads are passable. In fact, one must feed the other and vice versa.

Methodology



* This timing should be consolidated after first developments.

Figure 1. Six steps for adopting virtual and augmented reality within education.

The methodology proposed to adopt these technologies as basic elements within the regular education consists of six steps (Figure 1).

The first phase includes training teachers on these new technologies. Due to their novelty, the vast majority of faculty do not have enough knowledge about the technologies, and, therefore, they do not know the potential use associated with teaching. This process will comprise two distinct parts. On the one hand is describing the main concepts that form the elements of technology: devices, mobility, environments, types of interaction, existing platforms, and the trends that will define the technological evolution in the coming years. On the other hand, it is essential to complete the first phase of the training using existing examples of applications that can reflect everything shown in the first part of the block. Solutions will be needed depending on different types of environments, real and fictional. An additional need will be different ways of interacting on the part of the main stakeholders with the mentioned environments: tools; their own hands; actions that they can perform like painting, running, catching objects, throwing, etc. Also needed are solutions on different areas of knowledge: anatomical atlases, mathematical representations, mechanical workshops, etc.

After completing this first phase, the teachers will be able to understand and to know the potential of both technologies as applied to the sector. This knowledge will give way to an individual period of design in which the teachers must imagine the first applications they would need to include within their courses. These should reinforce areas that would improve students' understanding of the subject with the help of these types of techniques. The production would focus on building concrete experiences covering parts of the subject matter of the courses. Teachers must not forget that these technologies are tools to develop experiences, not channels of communication such as face-to-face or online.

The second phase will be the first conceptual prototype of the experience that the teacher wants to use in a course. This prototype may well need new development, an adaptation of an existing solution, or the direct use of a commercial application. The result will consist not only of the functional needs of the experience from a software point of view, but also of the methodology to be used for the introduction within the course, the learning objectives to be achieved, and even the rubric that allows the evaluation of the learning achieved through this experience.

For this, teachers should study in detail the composition of their subject. The most important elements will be contents, activities, and using these new technologies at their disposal (the scenarios, interactions, concepts to include in the solution, time frames, necessary number of stakeholders within the experience, and other essentials that should be taken into account).

Finally, for the development time of this work, it is advisable not to exceed 20 days in order to keep very present everything learned in the training sessions of the first block. In another case, and because it is a technology that today is not available to everyone in their homes, there is a risk of forgetting important concepts and thereby losing potential in the development of the experience.

The third phase passes through the activity that involves the joint work of a team. This group will be formed by the subject-matter-expert teacher, a technical programmer expert in the development and adaptation of solutions that make use of the technology in question, and finally an educational architect. Beginning the description by the last profile proposed, the architect will be responsible for recommending to the teacher all the good practices for the improvement of the proposed experience. Additionally, the individual will have technical knowledge that will make the prototype, presented by the academic staff, have real potential to be developed under the most appropriate technology.

This group of professionals will bring, as a result, a set of functional requirements that will form the input for the production and/or adaptation phase if necessary. These types of processes may be carried out internally within the institution or externally through a provider. In any case, and taking into account the novelty of the technology in question, the quality control processes must be rigorous, because the first impression of a newly implemented methodology can mark the success in the adoption by both the faculty and the students.

The production of the experience (the fourth block) will provide results in two phases. First, a version of tests to be evaluated by a small set of students within a controlled environment. In this first phase, it is necessary to debug possible programming errors, as well as details that allow the adjustment of the technical interpretation of the functional requirements with the conceptual design proposed by the teacher. In a second phase, a fully functional version will be presented that can be used as an experience within the subject for which it was designed. This version should be reviewed and updated based on results and feedback from the stakeholders.

The fifth phase starts from an experience already created for use within a subject. Teachers should be trained to use these types of solutions within their teaching methodology. To this end customized courses will be created based on active methodologies that make use of new technologies. The faculty will receive this type of training through face-to-face and/or online sessions. This training will consist of the description of the basic elements that technology makes available as an introduction. Once a minimum knowledge base is established, training will be completed with pedagogical elements, such as the definition of learning objectives, tasks based on experience, creation of rubrics, examples of group problems, and construction of real problems to be solved through this kind of virtual situations.

Finally, after going through the first five phases, the use of the experience is implemented in a regular subject with students (the sixth phase). It is important to explain to the students the improvement objective brought through the use of these new technologies. It is also basic to have feedback for the adjustment and improvement of the experiences in question. The technical and pedagogical support for both teachers and students in the introduction phase of these experiences must be intense and carefully planned. The success of the introduction of these techniques will have a very important component in the first applications. Regardless of the quality of the solutions to be used, everything that surrounds the student experience must be almost perfect. Also note that the measure of improvement of student outcomes will significantly support the continued use of these innovations in the education sector.

Business Opportunities

What´s Next in Augmented-Virtual Reality in Face-to-Face Education

The development of technologies linked to virtual and augmented reality will undoubtedly be driven by the entertainment world. More efficient engines of development and processing will be developed—new devices of interaction amplifying the potential use of human senses. Touch already has products on the market (Inoue, Makino, & Shinoda, 2015). Perhaps taste and smell are fields to explore (Gatto, 2011). In short, the technological potential will always be ahead of the potential of the application.

In relation to the education sector, two channels with very different characteristics are clearly defined to focus on and make the most of the technologies in question. In the first place, the opportunities for face-to-face teaching will be presented. From the conceptual point of view, it focuses on the development of simulators that offer the opportunity to replicate real situations within specific environments. The objective will be to place the student in conditions as real as possible. The future surrounds the creation of platforms that allow these environments to be configured quickly and without having to follow-up with a new development from scratch whenever a new solution should be launched. This, taken to a practical arena, should achieve as mentioned above, that the laboratories should be mostly virtual. Thus leading to greater updates, lower costs and a better experience for the student.

In parallel, and related to augmented reality, the future lies in the sharing of digital images within a face-to-face session in a class, such as tailored models applicable to areas such as health, mechanics, or architecture (Scholz & Smith, 2016). Students will be able to interact with these models in real time, and all the students inside a classroom can not only see but also act on these models. A very obvious example is the exploration of a motor or a human body within a theoretical explanation giving the user the ability to pick and move each element of the model at will. Students will not only see the model but will also receive all the information around each part of the model.

In the technological field, the future will run through the introduction of more senses within the experience. Currently the sense of touch is developing with intensity. In addition to this, the latest experimental developments are focusing on getting the display device to detect the point at which the user is visually fixed, using this as a pointer to interact with the environment. In addition, another of the main pillars of advancement will be the increase of subject mobility within the surroundings. Increased mobility arises from elimination of connection cables when possible; creation of platforms that allow the user to run, jump, and move without moving from a controlled physical environment; and creation of interaction peripherals more adjusted to human biomechanics to facilitate the performances. All these lines of work are currently being developed in real time (Soo, 2016).

These innovations, focused on expanding the capabilities offered to the student, will need a more powerful processing engine. The educational centers will have an investment capacity, in some cases, greater than a domestic user, and therefore, it seems more convenient to think that they will be available to students in universities and colleges. A greater need for processing, implies the need for more powerful equipment and, with that, more investment.

Augmented and Virtual Reality in Online Education

The online area is undoubtedly the educational segment that can grow the most using these technologies. Market trends indicate how the segment of distance learning through the Internet grows in double-digit all the markets. This leads to an increase in the number of users and thus to an increase in the supply for all of them in light of the existing potential business. Increased competition, following the logic of business, will increase suppliers' quality of products to capture a greater share of the market, since price reduction has a lower limit that lies in the transition from prestige to disrepute of the title to be obtained. When products are too cheap in the education sector, they no longer fulfill their role in the professional market when using them as a claim to obtain a job.

That said, traditional online teaching is at the limit of the exploitation of services through current platforms (Meggs, Greer, & Collins, 2011): inclusion in social networks, collaborative learning through conversations, video and audio, virtual tutorials using videoconferencing systems, links to forums, multichannel access to information databases around the globe, etc. The platforms do not have more capacity. Perhaps it is time to focus on improving the experience within the teaching field itself, namely, what is currently available to the student: texts, videos, and problems to be solved individually or in a group (but always dependent on the imagination and the creative capacity of the end user). This, no doubt, will change with the integration of educational experiences through the use of virtual and augmented reality.

From the technical point of view, the major breakthrough has been focused on creating a technology that is capable of operating using an element with a social penetration higher than 95%: the smartphone. The progress of smartphone processors, as well as the quality of their screens, has increased exponentially. With this, individuals currently carry in a pocket the processing power that they previously had in a PC device of great performance. The outlook is obvious in the absence of a partner with resources that is willing to bet on being the first. The problem is that it is not just a question of money and investment, but, to make this a profitable reality, the different participants in the process must assimilate a multitude of concepts and methodologies that are far from being immediate, as shown above.

Technologically speaking, the forecasts of the main manufacturers of dedicated devices, predict that in less than 5 years, individuals will all have a high-performance display device (Oculus Rift, HTC Vive, PlayStation VR, etc.) in their homes as they already have a laptop or a mobile phone. The prices are equal to these elements already considered common. In any case, without having to reach such sophisticated devices, as mentioned above, any user will be able to access the content just by using a housing for an approximate price of between $20 and $70.

From the conceptual point of view or the point of view of service, the future for virtual and augmented reality through online channels will happen because the educational programs introduce real experiences making use of these technologies. This will equalize distance learning even more with face-to-face teaching, making use of the flexibility that by definition distance learning already entails. The new virtual reality systems applied to collaborative social systems will allow students to attend a class and perceive that they are sitting in the classroom surrounded by their classmates and seeing the teacher in front of them teaching the subject (Merry, 2016). There are already simple applications that envision that the concept can be made tangible very soon. The classrooms will move to any point on the planet, leaving behind the feeling of solitude that a web page or an online learning platform confers. The goal, and with it the future, of online education will be to get the best of both worlds: the benefits offered by the flexibility of access without preset hours, adding the convenience of doing it from home, along with the advantages of having experiences, equipment, companions, and professors that give students the same value as face-to-face teaching.

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