18

Experiential learning with Augmented Reality

Giovanni Arduini, Diletta Chiusaroli
University of Cassino and Southern Lazio, Italy

Introduction

Augmented Reality (AR) represents an area still almost completely unexplored in all fields of technology and knowledge that only in recent years has seen a widespread diffusion, thanks to the development of new technologies in the digital world such as smartphones, webcams and GPS. While virtual reality is entirely built on the computer, augmented reality consists in adding to the real environment, through a software, content and information with which the user can interact via IT devices.

According to Lara Jongedijk's definition "Augmented Reality is an environment in which real life is enhanced by virtual elements in real time" (Jongedijk & Moorman, 2008). The purpose of AR is to improve the information we naturally receive through our five senses, with the addition of overlapping virtual elements, built to bring complementary information and meaning that may not be possible with natural means. This technology was born in the early nineties in the military, thanks to the pioneering "Virtual Fixtures" platform, developed in 1992 by Louis Rosenberg at the Air Force Research Laboratory. In the field of the air force we can also find Augmented Reality applications in the form of head-up display (HUD) - superimposed viewer on fighter planes, enabled to show pilots flight data (speed, altitude, target distance) without taking the eyes off the focus to check all the instruments on board.

One of the first applications that dealt with Augmented Reality is Layar, a reality browser that, thanks to the arrival data on the device's GPS and with the accelerometer allowed to frame a particular building or monument with the camera, to receive information such as its history or name.

From Layar we witness the passage to Google Glass. The Mountain View colossus captures the potential of Augmented Reality, bringing it to a more advanced dimension. The user, wearing glasses and simply using his voice or the integrated touchpad, searches on Google, surfs the web, checks social networks or Google Glass are also in constant communication with the Smartphone and therefore able to call, view and send text messages, take photos, record videos, get help from Google translator or from Google Maps when you are in difficulty with a foreign language or a destination to reach. A technology that, gradually evolving, changes the way we look at the world.

Cita sugerida:
Arduini, G., Chiusaroli, D. (2020). Experiential learning with Augmented Reality. En REDINE (Coord.), *Contribuciones de la tecnología digital en el desarrollo educativo y social.* (pp. 178-187). Eindhoven, NL: Adaya Press.

In recent years, augmented reality is becoming a growing sector and is rapidly catching on in the everyday life of all of us. Many of us will have experienced the game that has literally conquered everyone: Pokémon Go, based on augmented reality geolocalized with GPS, created by Niantic and marketed starting from 2016. The great success and popularity of this video game show us how much 'AR is easily accessible by anyone and above all does not require large costs in terms of purchasing specific devices, since often what is needed is simply the use of a smartphone. According to an article in Forbes magazine, the reason why major companies are investing so much in this technology is that applications go far beyond the field of social media, video games and special effects: augmented reality has practical applications in areas ranging from geolocation, to e-commerce, to medicine.

In fact, there are already in the pipeline many applications capable of changing everyday life. For example, in the medical sector, surgeons can consult the medical records of their patients without interrupting an ongoing operation. Or the firefighters can view the location of a fire, to know in advance where the hydrants are located or study the plans of a building, even before intervening to put out the flames. Augmented Reality is about to "invest" even the automotive sector by completely changing our habits behind the wheel; the windshield showing real-time directions, traffic information, signs and speed limits. These are many examples in which imagination and creativity represent the only limit.

Augmented reality in the educational context[1]

Augmented reality can also offer significant contributions in the educational context. Augmented Reality, if used in the right measure, can be an optimal educational tool that not only allows to improve the cognitive activity of the individual, but also acts as a relational tool to improve the communication activity of the user.

It is precisely its use in didactics that interests us particularly: AR offers countless advantages from an educational point of view and represents a tool that is proving to be very valuable for facilitating learning and offering new stimuli and educational ideas. First, as the Bricks magazine suggests, AR favors the transition to a more active and engaging study method, in which students are not passive observers any more, but participate personally in learning, fully immersing themselves in the study process (Gabbari *et al.*, 2017). The teaching method is nothing short of revolutionary: the use of augmented reality undoubtedly promotes greater creativity in pupils, facilitates communication and allows for a much more involving study experience (Billinghurst & Duenser, 2012). The students, learning through pleasure and fun, will be facilitated in the memorization of information and the achievement of objectives and will see their interest and curiosity reawaken. In the "2010 Horizon Report", Johnson (2010) states that augmented reality offers strong potential for the learning process and for exploring and discovering the real world. It also

1 This work is a development of the abstract published in the Book of Abstracts of the EDUNOVATIC Conference 2019.

gives a powerful contextual view that teachers can use in their educational environments and the content is very attractive not only to sight, but to all five senses. The AR indeed combines reality with synthetic information (3D images, sounds, videos, texts ...) and consequently allows direct interaction with virtual objects; students, having the opportunity to deal with these models, develop a holistic approach to learning and are stimulated by a new and exciting reality. Thanks to augmented reality, in the classroom it is possible to explore scenarios that otherwise could only be studied theoretically and some abstract concepts can be touched by hand and become much more accessible and exciting; imagine a history lesson during which students have the opportunity to walk the streets of ancient Rome or London from the Victorian period, or the opportunity while visiting a museum or archaeological site to view additional information, educational videos or even reconstruct through augmented reality parts of buildings or scenarios that would otherwise be impossible to build or visit. During a science lesson, you could look at the Earth walking on the Moon or even travel within the solar system. The possible applications are endless. All this is possible, for example, thanks to *Google Expeditions*: an app for immersive teaching that, in collaboration with museums, universities and laboratories, literally allows you to explore the world through various virtual and augmented reality tutorials. In this way, without leaving the classroom, teachers can create virtual trips for their pupils: explore an art gallery, the underwater world or the outer space. Allowing students to view information in a new way can have a big impact on their ability to store it.

A very common example occurs in museums, with the use of a latest generation smartphone (equipped with GPS, compass and camera): with a specific augmented reality application installed, pointing the smartphone camera on the object concerned, you can access a multitude of information regarding the object observed (its history, its current physical location in the museum, etc.) allowing the visitor to fully know the work of art.

As we have seen, one of the characteristics of Augmented Reality lies precisely in interactivity, that is, the ability to respond to user input which confers great potential for learning and its evaluation.

Derrick de Kerckhove (2010) said: “We are taking the first steps in Augmented Reality, a real magic possible thanks to the Air Tag. Existing softwares allow users, with suitable devices, to connect to sites that provide information services on the place you are visiting”.

With the use of virtual content in the real environment, it is possible to immerse yourself and interact with other users in real time.

The rendering systems, which allow to take raw geospatial data and create a viewable map, also allow to make a three-dimensional rendering (‘’3D rendering‘’) still using geospatial data as input. These are able to recognize a support, an environment or a person, and to add multimedia contents (two-dimensional or three-dimensional graphics and video, audio) in real time.

With the characteristics of Augmented Reality we can adhere to the interaction with virtual objects and to the variety of its use in relation to the objectives to be achieved: communicative, educational, marketing (Arduini, 2012).

Users can both see and touch real objects and at the same time have interactive guided support to allow them to work at their own pace. According to Azuma (1997, p. 356) to avoid limiting Augmented Reality to a specific technology, the system should have the following characteristics:

- Combination of real and virtual.
- Interactivity on real time.
- 3D recording.

In other words, the technology is able to improve the efficiency of the teaching-learning process, it constitutes different thinking styles, creates real-life scenarios in the classroom, going beyond the theoretical nature, gives creative solutions regarding the problems of contemporary life.

With the spread of tagging it is possible to classify everything, improving the level of information that that source is able to give. Thanks to an image tag for example, one can trace back to the place or the people related to that image. With this information enrichment, the individual's knowledge expands.

Labels and tags allow to share knowledge through connections which are visual, and therefore understandable to anyone who seeks a global sharing of knowledge, where the virtual level comes into contact with the real one.

Virtual Reality allows to add 3D virtual content to a physical environment in real time. Unlike Virtual Reality, Augmented Reality does not replace physical reality, but superimposes computer data on reality itself, giving the possibility to the subject to feel physically present within the landscape reflected on the screen and consequently the reality perceived by the subject is "increased" from virtual objects with additional information to the real environment. This technology can access different environments such as that of medicine, defense, architecture, museography, advertising as well as educational technologies.

Thanks to a greater ability to offer authentic experiences, marketing sees interesting opportunities in Augmented Reality. In fact, through Augmented Reality, brands can offer a more valuable system to their customers thanks to the creation of much more incisive and effective interactions.

The way in which marketing can use augmented reality consists of a form of marketing that can be defined as experiential as it not only focuses on a product but also on an entire experience created for customers, also introducing elements of fun. For example, with the help of augmented reality, a buyer can compare products by superimposing virtual images in the real world. We can mention some applications of Augmented Reality that allow you to try the jewels directly on the hands, or the creation of digital fitting rooms, or virtual fitting rooms that offer a 360 ° dynamic vision and allow you to adapt clothes to human forms, making the process of purchase faster and more fun. Sephora, thanks to a collaboration with ModiFace, has designed a latest generation mirror that allows you to try different types of make-up, seeing the final result on the screen even from different angles simply by moving the head.

With the launch of the first experiential marketing campaigns in which AR technology elements were included, companies have ventured into exploring the possibilities of augmented reality in an attempt to capture the attention of consumers.

Several economics experts say that the contemporary world is in the experience economy, where customers focus not only on the products themselves, but on their experiential consumption. In this way, marketing considers consumption as a holistic experience and recognizes both the emotional and rational aspects of consumption. The importance of experiential marketing can be recognized as a means of creating added value for the consumer, which in turn becomes a competitive advantage for companies.

Experiential learning

Augmented reality also finds interesting applications in business and professional training. We know that this type of training should not be limited to transferring notions or providing standardized manuals, but allowing to share knowledge, practices and experiences that can help human resources to perform new tasks or to modify and innovate old ones, and also to allow to make adequate decisions regarding new and specific contexts and situations. Each training intervention, whether it takes place in the classroom or in the field, should give space to interaction and experience in order to allow each participant to actively contribute to the sharing process, also in relation to the real training needs of each, with practical exercises and with continuous feedback. The challenge becomes even more interesting when the training is administered remotely as it becomes more complicated to create the necessary connection between theory and practice.

It is in this context that augmented reality applications can really make a difference: images, words and instructions merge with action, guide the exploration of environments and tasks, correct and perfect gestures through a pleasant and intuitive interface, they also enable gamification processes that stimulate attention and allow to measure the progress of the learner. For example, let's consider the training activity linked to the introduction of a new procedure for the maintenance of a machine. An ordinary training course would include a one-to-many approach in which the trainer explains to a group (present on site or connected remotely) which steps must be performed to correctly complete the operation. Once the procedure is learned, learners should try their hand at the practice. Thanks to an augmented reality application, however, the course participants can receive instructions directly on their smartphone or tablet and explore the machinery by framing it and view it on the display, as they receive instructions on the intervention from the teacher, tips on how interact with the object. Recognizing the machinery, in fact, the application generates pop-ups and contextualized notifications that guide the operator, highlighting the various elements that compose it and explaining step by step the actions to be taken. Of course, each session can be interrupted at any time to ask for advice or clarifications from the trainer or even from the application itself, which may offer the possibility of linking to in-depth information sheets and complementary content.

Augmented reality is also very useful for providing safety courses. Placing dangerous situations on the screen means allowing collaborators to visualize how the work environment could appear, for example, attacked by a fire: the application can build escape routes and indicate behaviors and precautions to be taken in case of emergencies. Once more in this case, gamification represents a formidable tool to engage users and transmit content and experiences more effectively.

Implementing these technologies is much simpler than you can imagine. Both for the ease of access to hardware equipment, due to their spread and increasingly low costs, and for the increased availability of specific apps in the most varied sectors. A critical aspect can be identified in the lack of awareness of the opportunities that augmented reality offers which in many cases are still considered too futuristic.

Another area in which to consider the developments of Augmented Reality concerns that of publishing and in particular that of books. The book, although it is not subject to discussion about its validity, it could be a far less effective learning tool than an augmented reality device. The latter contains at least the same information as the book, with, in addition, a spatial availability and a relationship with objects of sure efficacy.

A recent innovation in the printing sector is represented by the Augmented Books where the typical paper book is proposed as an interface for Augmented Reality. Where there is the possibility of associating interactive multimedia elements to the printed text that can be used through specific Augmented Reality devices. These types of books can also be multi-user since they can be used simultaneously by several students who can interact and communicate with each other. Many scholars agree that paper books will continue to have a privileged place in the classrooms for the near future even if the evolution of the textbook will be accompanied by the contribution of Augmented Reality which will be able to integrate the flat page with images, videos and 3D interactivity. In addition, Augmented Reality will allow you to update content over time and enrich it with interactive features. For example, you could imagine a high school anatomy book that uses a photo of an arm to start an Augmented Reality experience in which a 3D model of the arm bones is shown above the book page or on the same physical arm as the student and where you can use the movements to rotate in any direction or from any angle. Ultimately, all the various media related to printing could be “increased”, thus giving rise to immersive experiences that can attract users and make them more sensitive and more involved with respect to the message or information that you want to communicate (Rivoltella, 2010).

With regard to the educational sphere, the spread of these new technologies allows students to be fully involved, and also to immerse them in more likely interactive spaces, to allow more effective learning (Rossi, 2013).

As for the teachers, the introduction of Augmented Reality in the classroom should not produce feelings of inadequacy because today many easy and useful applications are available for each discipline and do not require complex knowledge and skills in the field. When a teacher feels ready, he can also try to create and implement his own educational paths that involve the use of augmented reality, this certainly constitutes an opportunity for schools to bring real-life experiences to classrooms.

Furthermore, the effectiveness of this technology as a self-learning tool should be analyzed, because it allows you to “learn by doing”, allowing a more autonomous and independent knowledge giving priority to experimentation rather than to traditional knowledge, promoting experiential learning.

The main characteristic that distinguishes experiential learning lies in its cyclical dynamics: in this process there is the mobilization of important basic skills which in turn, through observation and reflection, are transformed into new concrete experiences.

The first to define an experiential learning theory was the American educator David Kolb. In the Experiential Learning model, the author is inspired by the studies of John Dewey, Jean Piaget and Kurt Lewin. Within this model, a significant role for learning is attributed to concrete experience and reflective observation. Kolb’s model (1984) is characterized by the circularity of the process and the author divides the learning cycle into four phases:

- a. concrete experience: meant as the moment in which the subject is immersed in doing and experimenting;
- b. reflective observation: the experience produces sensations and behaviors on which the subject starts a reflection examining the problem from multiple points of view;
- c. abstract conceptualization: understanding through reflective observation leads the subject to conceptualize the functioning relationships and to elaborate concepts that integrate observations in reference theories;
- d. active experimentation: theories and concepts are tested through action with intentionality and awareness.

The learning cycle begins and ends with the phase of concrete experience as the knowledge generated by each new experience can produce new ways of doing and thinking. Kolb therefore defines learning as a process whereby knowledge is created through the transformation of experience. Furthermore, each of the four phases described by Kolb identifies a different learning style.

Even Jarvis’ reflection which, like the Kolb model, finds space above all in studies on adult learning, has as its main theme the concept of experience which can represent a valid point of reference for directing the didactic action to building transversal skills in a lifelong learning perspective. Jarvis’ thought (1987) identifies the study of human learning as fundamental, not in artificial laboratory or classroom situations, but in space, time and social relationships. The author highlights how “every learning begins with experience”. Therefore, learning is configured as a purely individual action that makes each subject unique by virtue of the relationship between his biography and the present experience, which takes place in a social context which can enhance or limit personal development: the author refers to this process as paradoxes of learning (Jarvis, 1992). In addition, the author highlights a plurality of ways of learning that can be followed and an equally multiplicity of answers that the subject provides to the experiences lived.

For these reasons, an educational design that takes into account the student's entire experience is essential, where Augmented Reality applications can find a significant space. After considering the role assumed by experience in learning processes, it is legitimate to ask ourselves what influence past learning has on future ones as forms of lived experience. Compared to this Ausubel (1978) has highlighted how:

> Past experience influences, or has positive or negative effects, on new meaningful learning and its retention, by virtue of its impact on the relevant properties of the cognitive structure. If this is true, any significant learning necessarily involves a transfer, because no case can be conceived where such learning is not influenced in any way by the existing cognitive structure; this learning experience, in turn, gives rise to a new transfer, modifying the cognitive structure.

Past learning, therefore, is nothing more than a basis to which any future learning can be anchored. However, this aspect is not without problems, as each learning experience can have a positive or negative value for the subject by virtue of the double emotional and cognitive component inherent in the experience itself and this highlights the importance of taking into consideration the affective and motivational factors in the design of learning paths.

For the educational sciences, this innovation is of fundamental importance, which requires continuous research. In fact, faced with these innovations, it is necessary for teaching to develop new research programs regarding the introduction of Augmented Reality, on how they influence the cognitive processes and the teaching-learning processes starting from the assumption that these should be more effective thanks to the lower mnemonic load thanks to the possibility of associating theoretical information with practical-experimental activities. In this way, the learning processes should be facilitated, thanks to the dual dimension of physical and virtual reality, transforming the learning process also into an activity with playful aspects.

We then come to talk about "augmented learning" which, according to Professor Erik Klopfer's definition, constitutes an "on-demand learning technique, where the context adapts to the needs and inputs of the students" (Klopfer, 2008).

Conclusions

Augmented reality devices allow us to move from a teaching method that is mere transmission of concepts and information, to a completely new procedure, in the name of reasoning and multidisciplinarity. In this way the figure of the teacher also evolves, he is no longer a transmitter, but a facilitator of learning, that is, one who knows how to exploit the tools available not to impose his own teaching, but to direct students towards the acquisition of an autonomous method, integrating organizational and relational skills. Teaching through augmented reality is certainly an inclusive form of teaching, as the student immerses himself completely in the experience. This also represents a great strength for pupils with Specific Learning Disorders and Special Educational Needs who, thanks to this

new form of learning, are greatly facilitated in the approach to teaching content. Augmented reality is particularly effective in overcoming the various difficulties that students with disabilities may encounter, in fact it favors the ability to concentrate and the assimilation and storage of information through the use of multimedia content. This aspect certainly needs further research programs also considering interesting applications for educational interventions on specific situations of disability or disorders such as in the case of sensory or cognitive-behavioral disabilities and in autism spectrum disorders.

References

Arduini, G. (2012). La realtà aumentata e nuove prospettive educative. *Education Sciences & Society, 3*(2), 209-216.

Ausubel D. (1978). *Educazione e processi cognitive*. Franco Angeli.

Azuma, R. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments*, *6*(4), 355-85.

Billinghurst, M., & Duenser, A. (2012). Augmented reality in the classroom. *Computer, 45*(7), 56-63.

De Kerckhove, D. (2010). Realtà aumentata: Grande Mutazione di oggi. *Media Duemila, 270,* 13-15

Gabbari, M., Gagliardi, R., Gaetano, A., Sacchi, D. (2017). Comunicazione e apprendimento “aumentati” in classe – Fare lezione a scuola con la realtà aumentata. *BRICKS, 7*(1), 8-30.

Jarvis, P. (1987). *Adult Learning in the Social Context*. Cromm Helm.

Jarvis, P. (1992). *Paradoxes of Learning*. Jossey-Bass.

Johnson, L., Levine, A., Smith, R., Stone, S. (2010). *The 2010 Horizon Report*. The New Media Consortium.

Jongedijk L., Moorman, L. (2008). *Wiki: Trends In Educational Technology: Augmented Reality*. Graduate Division of Educational Research. University of Calgary. Retrieved from: http://augreality.pbwiki.com

Klopfer, E. (2008). *Augmented Learning: Research and design of mobile educational games*. MIT Press.

Kolb, D. (1984). *Experiential Learning: experience as the source of learning and development.* Prentice Hall.

Rivoltella, P.C. (2010). Oltre il virtuale: la nostra è una “realtà aumentata”. *Vita e Pensiero, 5,* 102-108.

Rossi P.G. (2013). Realtà aumentata e mediazione didattica. In D. Persico, V. Midoro (Cur.), *Pedagogia nell’era digitale* (pp. 73-76). Menabò.

Giovanni Arduini. PhD in Training Models, Theoretical Analysis and Comparison. Researcher and Aggregate Professor of Experimental Pedagogy at the University of Cassino and Southern Lazio with positions of: President of the Study Programs in Educational Sciences (L-19 and LM-85); Didactic Coordinator of the Specialization Course for Didactic Support; University Enabling Teaching Coordinator; Scientific manager of the Educational, Didactic and Inclusion Research Laboratory at the Department of Human, Social and Health Sciences. He teaches Experimental pedagogy, Evaluation of educational systems and Theories and techniques of pedagogical research.

Diletta Chiusaroli. PhD in Educational and Anthropological Sciences. Contract teacher of General Didactics and inclusion in the degree course in Education and Training Sciences, and of Social and Family Pedagogy in the master's degree in Pedagogical Sciences. Coordinator of the CA.S.P.I. Special career for inclusion activated at the Educational, Didactic and Inclusion Research Laboratory at the Department of Human, Social and Health Sciences of the University of Cassino and Southern Lazio. The research field to which his scientific production is addressed concerns the themes of inclusion with reference to Special Educational Needs.

ISBN 978-84-09-22968-0