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# From Desire to Necessity – the Use of AR as Innovative Teaching and Learning Method in Higher Education

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**Abstract:** The subject of innovation in education is not a new one, but the ever faster technological changes and the succession of crises with a direct impact on the educational sector amplify the need for debates and analyzes on this topic. The application of innovation in education, regardless of the form in which it manifests itself, is a guarantee of a competitive and dynamic educational system. An educational system open to innovation is a promoter of sustainable economic growth, which then translates into increased employment and social cohesion. The present work aims to briefly present the importance of using innovative technologies as teaching and learning methods, as it results from the literature, with emphasis on the use of Augmented Reality (hereafter AR), as well as the requested competences a professor should have to apply the AR in teaching-learning process.

**Keywords:** innovation; knowledge society; socio-economic progress; skills for future society

**JEL Classification:** D83

## 1. Introduction

The development of digital technologies has imposed and continues to impose substantial changes in education systems around the world, whether we refer to teaching-learning methods or whether we consider the structure of courses, skills and abilities of teachers and students. It is therefore necessary to continuously innovate teaching methods, in accordance with the nowadays fast technological innovation.

Innovation in education is a particularly important and complex process that needs to be followed closely. Studies and analyses on measuring innovation in education are frequently conducted by both international organizations and scientific researchers.

At the level of European Union, it is considered that the innovation applied to education systems is the main way to get more competitive and dynamic education, that can ensure sustainable economic growth and can increase employment and social cohesion.

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The European Commission clearly recommends innovation in education systems: "Educational institutions, such as schools and universities, need to evolve and adapt to achieve their core mission: educating students to succeed in a complex and interconnected world facing rapid technological, cultural, economic and demographic change"

Starting from the generally accepted fact that an educational system open to innovation offers positive impact on economic and social development, this work illustrates both the necessity and the consequences of applying innovative teaching and learning methods, with a special emphasis on using the AR in education and on the professors' requested skills and competences to obtain positive results.

## 2. Literature Review on Innovation of Teaching-Learning Processes

A unique, well-established, concrete definition of what innovation in education means is hard to find. Moreover, there are studies that argue that the two concepts must be well delimited, namely the concept of innovation in education and the concept of educational innovation.

In the context of the modern educational act, traditional lectures no longer have their place in the classrooms of education institutions of any level. If traditional teaching focused on learning based on lectures given by teachers during classes, innovative teaching methods focus on the ability of students to learn using other methods, innovative methods, to the detriment of teacher lectures.

An overview on the literature regarding innovative methods in education highlights the presence of these methods in various fields of specialization[1] and at very different levels of education, starting from preschool training institutions to higher education institutions.

The literature exposes different innovative didactic/pedagogical methods used in higher education, which may or may not include modern technologies.

In this regard, Branch et al. (2017) presents the innovative teaching methods in a very broad way, highlighting that innovation in teaching and learning at the level of higher education can be done using: role, role-play and game, student partnership, modern technologies, case-based teaching and learning, authentic learning-environments and experiences and field work, e-learning.

All these methods are innovative, even if the use of modern technology is not requested, from the perspective of defining innovation as any improvement of the classical procedures used in the training activity. Many of these methods are combinations of teaching and learning methods.

Other methods of innovation of the teaching-learning process treated at the level of scientific articles refer mainly to innovation achieved exclusively through the use of modern technologies, such methods being: blogs (Garcia et al., 2019), flipped and micro-flipped classroom (Fidalgo-Blanco et al., 2017), methods specific to the online learning environment - OLE Online Learning Environment, such as virtual laboratories, online simulations and interactive activities, educational videos (Estriegana et al., 2019), virtual reality and augmented reality (Scaravetti & Doroszewski, 2019; McCarthy & Uppot, 2019). Another innovative method whose usefulness has been analyzed by experts in teaching and learning activities is the use of the graphic novel (Rocamora-Pereza et al., 2017).

[1] However, there is a preponderance of technical and medical fields.

Other studies indicate that the innovation of teaching process using technological tools offers new opportunities to increase student interaction and pleasure learning, making the teaching-learning process more active, efficient, meaningful, and motivating. One of these technological tools, the use of which has become increasingly widespread in recent years is the AR.

## 3. The Use of AR in Education and Its Impact

### 3.1. The Use of AR in Education

Augmented reality can be defined, in the simplest way, as "technology that acts as a bridge in the real world and the virtual world, the connection being ensured through synchronous interactions" (Yilmaz, 2018), offering a multitude of advantages and gains when used in education due to its ability to allow interaction with virtual and real objects, to learn by applying and to increase attention and motivation (Singhal et. al, 2013).

The use of AR in education can take various forms, from use in the traditional classroom to the creation of AR laboratories.

One of the simplest uses of AR in education is its introduction in the traditional classroom. Supporting materials in textbooks with examples of AR adds another dimension to the learning process - a process that thus becomes a hybrid between the traditional (textbook) and the digital approach (innovative practical illustrations in AR of complicated concepts). Augmented reality can make the educational experience fun for a young and restless group of pupils or students who have become accustomed to visual stimulation and interactivity. AR applications and resources are already used in the classroom (successfully), and the chances are that the scope will expand even more as more AR developers get involved in such activities.

Another use of AR is to create worksheets in AR for students or pupils to continue the educational process individually, at home. The benefit of this use is given by the fact that it would help to better manage homework and tasks at home, without direct interaction with the teacher. Teachers could begin to provide their students with worksheets activated in AR, to encourage students to explore the educational content at their chosen times.

AR can make images and information "extend" from a textbook or worksheet, emphasize the most important concepts, and break down the boundaries of learning in classical textbooks, which are perceived by many students as tiring. Once the materials and applications in the textbook are designed for this purpose, implementing AR technology in the learning process will become simple and easy.

This is one of the reasons why this technology is preferred over another similar technological tool, namely virtual reality (VR). While VR requires the use of a headset, AR only needs an application and a smartphone to bring educational concepts to life.

Laboratory experiments and demonstrations are, without a doubt, one of the most effective practical options for bringing challenging concepts to reality. Due to budgetary constraints, available equipment, or the dangers of conducting experiments, many schools limit the scope of practical demonstrations to which students are exposed. This is another fact that is beginning to change with the adoption of AR technology. The number of experiments and demonstrations that students can witness will increase.

When using AR, the control over the educational process is held by both teachers and students. The goal of the technology introduced in the classroom is personalization. Students can explore the lessons and concepts they need to review and go through the AR demonstration at their own pace. The next step would be to create personalized learning materials for students and teachers.

### 3.2. The Impact of Using the AR in Education

The impact of the use of AR in formal and informal education has been analysed in various studies in the profile literature. Among the results of the use of AR in formal and informal education were found:

✓ *increasing student involvement, interactivity, and the pleasure of learning*; (Moro et. al., 2017);

✓ *improving students' ability to solve space problems and interpret maps*; (Carrera & Asensio, 2017);

✓ *development of critical thinking*; (Bronack, 2011; Cai et. al., 2014; Facione et. al., 2000; Ho et. al., 2012; Kim et. al., 2013; Wu et. al., 2013);

✓ *positive impact on motivation*; (Serio et. al., 2013);

✓ *a better understanding and memorization of the content on certain topics*; (Lingren & Moshell, 2011; Macchiarella et al., 2005; Macchiarcela & Vincenyi, 2004; Valimont et al., 2002; Vincenyi et al., 2003; Hedley's, 2003);

✓ *increasing performance in performing physical tasks*; (Henderson and Feiner, 2009, 2011; Pathomaree and Charoenseang, 2005; Tang et al., 2002, 2003).

✓ *stimulates collaboration between students*. (Morrison et al., 2009; Billinghurs et al., 2003).

More recent studies (Ibáñez & Delgado-Kloos, 2018; Kucuk et al., 2016; Chang et al., 2013) show that, overall, students' perceptions of RA experiences are positive, learning scientific concepts is enhanced by using augmented reality in teaching activities.

### 3.3. Advantages and Limitations of Using the AR in Education

AR in education helps students to acquire, process and easily remember information. In addition, AR makes learning more engaging and fun.

Moreover, not being limited to a single age group or level of education, AR can be used equally in all levels of education, from pre-school to college or even to the workplace.

A summary of the advantages offered by the use of AR in the educational process is given below:

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|---|---|
| Learning materials available: anytime & anywhere | • AR has the potential to replace paper textbooks, physical models, posters, printed textbooks, offering portable and less expensive learning materials. As a result, education is becoming more accessible and mobile. |
| No special equipment is required | • Unlike virtual reality, AR does not require expensive hardware. Since 73% of teenagers now own a smartphone, AR technologies are immediately available for use, for the majority of the target audience. |
| Higher student commitment and interest | • Interactive and gamified AR learning can have a significant positive impact on students. It keeps them active throughout the lesson and makes learning fun and effortless. |
| Improved collaboration skills | • AR applications offer vast opportunities to diversify and enliven boring courses. Interactive lessons, in which all students are involved in the learning process, at the same time, help to improve teamwork skills. |
| A faster and more efficient learning process | • AR in education helps students to achieve better results through visualization and full immersion in the subject. |
| Practical learning | • In addition to education, vocational training can also benefit greatly from the use of AR. For example, the exact reproduction of the conditions in the field can help mastering practical skills needed for a particular job. |
| Safe and effective training at work | • Through AR, the dangerous situations that can be encountered in real life are simulated and allow the training of staff in safe conditions. |
| Universally applicable to any level of education and training | • Whether we learn games for kindergarten or training at the job, AR is not limited to a single application or a scope. |

Despite these recognized advantages, there are certain limitations in the use of RA in the educational activity, as are mentioned below:

| | |
|---|---|
| Lack of proper training | • Some teachers may struggle with the use of these new technologies because their background training does not provide the necessary skills. Only the most "open" teachers and innovative educational institutions are ready to use AR applications in education. |
| Dependence on hardware | • Using augmented reality in the classroom requires a certain resource base. For example, not all students have smartphones capable of supporting AR applications. |
| Content portability issues | • AR application created should work equally well on all platforms and devices. However, it is practically impossible to provide the same quality of AR content on any device. |

### 3.4. Requested Competences to Use the AR in Education

The use of new IC and learning technologies is necessary for the effective training of today's students, and studies argue that the integration of new technologies into the educational process, based on the cloud and AR, creates the conditions for the development of 9 out of 10 key skills at the student level. (Merzlykin et. al., 2018)

Teachers are the common element of every educational system and they play a key role in integrating and accepting technology in education. While the AR research and development community becomes stronger, teaching competence and the exchange of good practices in this field are still very little analyzed, with few studies focusing on didactic aspects. However, experts agree that understanding learning methods, learning objectives, assessment criteria and the knowledge, skills and competences needed to use AR in teaching and learning activities will help to identify trends, perspectives and opportunities for development of teaching and learning methods that use this form of technology. (Klimova et. al., 2018)

The introduction of ICT and distance learning in universities has grown exponentially, both in terms of quantity and quality (Carril et. al., 2013)

At the same time, the design, development and evaluation of digital education introduce certain characteristics and require specific teaching tasks for teachers, so it is necessary to evaluate all the changes involved in teaching using AR applications, both institutionally and academically, from a double perspective: clarifying the teacher's profile, which involves defining the teacher's roles and competencies, and establishing the necessary training. Teachers who use digital innovation in education need to take on a multidimensional role. They need to integrate a number of different and numerous skills, a combination of traditional teaching skills and skills specific to the digital tools used. Also, the required teaching skills derive from the context in which the teaching takes place: the characteristics of the training program, the specific role of the teacher and the financial, functional and human resources available (e.g. necessary and existing equipment, designers, IT technicians, etc.).

According to UNESCO (2018) "Effective integration of ICT in schools and classrooms can transform pedagogy, providing students with improved skills. In this context, it is essential that teachers have the skills to integrate ICT into their professional practice in order to ensure equity and quality of learning. Teachers must also be able to use ICT to guide students in developing the skills of the knowledge society, such as critical and innovative thinking, complex problem solving, the ability to collaborate and socio-emotional skills. Teacher training and further professional development relevant to teachers are essential in order to benefit from investments in ICT. Ongoing training and support must enable teachers to develop the necessary ICT skills so that, in turn, they ensure that their students develop relevant skills, including digital skills for life and work".

The teaching-learning process through the use of AR applications is a complex process, which consumes time and usually require more than one instructor for its proper implementation, especially in locations and place-dependent applications. The technical challenges involved should not be neglected: qualified instructors, the involvement of computer specialists and the use of software programs for image and video editing and computer graphics creation (Tzima et. al., 2019).

Considering the above, it can be concluded that the main specific competencies necessary for teachers to implement AR applications in the teaching process belong to the category of general competencies that refer to information and communication technology (ICT).

There are many studies on the development of AR applications for education and their role in improving the educational process, but very few have been analyzed and presented the competencies that teachers should have.

The AR technique has known and is experiencing rapid developments, and if in its beginnings teaching using AR applications required only user skills from teachers, the applications being developed entirely by specialists, now there are AR creation tools that offer the teacher the opportunity to create, adapt and develop the application according to the specifics of the courses they teach. These creative tools require users (teachers) to have more technical skills, which go beyond the minimum ICT skills (for example, computer programming, the ability to develop a digital 3D model and a few other skills that allow the development of an AR application). Most AR applications created are developed by researchers or programmers. Although there are efforts for this technology to be used by others along with programming specialists, there are currently no easy-to-use and suitable AR authoring tools for teachers. Therefore, it is very important to identify the level of training of teachers on the ICT skills needed to enable them to develop the AR application using the creative tools currently available. In addition, it is essential that teachers get all the benefits of AR technology to improve the teaching and learning process.

It thus goes from the minimum ICT skills considered mandatory at the level of a teacher, namely: word processor usage, spreadsheet usage, database management, presentation programs use, internet browsing knowledge, email management, skills related to computer networks, to complex ICT skills, intended for use, creation and development of AR applications, respectively: programming knowledge; operating skills in 3D modeling software; knowledge of using graphics software; knowledge of using animation software (Saforrudin, 2015). Of these, the first two are fundamental. Therefore, an early specialized training of teachers who want to use AR applications in teaching and learning processes becomes necessary.

Continuous and rapid changes in technology, limited longevity and changes in software platforms generate the need for continuous training in the field of AR. Also, the need for continuous training may arise when teachers have been improperly trained, have negative attitudes or the necessary technical expertise (ICT and programming skills) for the development of AR applications has not reached an appropriate level (Tzima et al., 2019).

## 4. Conclusions

The topic of innovation in education is not a new one, but the pandemic crisis and the rapid pace of technological change have amplified the need for debate on this issue, as a natural answer to society's problems. The application of innovation in education is seen by the European Union as the way in which European education can become more competitive and dynamic. The present study shows that the University can be an inspiring space to develop solutions, innovative proposals and out-of-the-box initiatives, it can be the promoter of sustainable economic growth, which will ultimately ensure the increase of employment and implicitly will lead to social cohesion.

Sustainable economic development based on innovation can be achieved through close collaboration between the University and the business community, technology pioneers, experts and local community representatives, who together will address the topic of innovation in the community and in companies to develop solutions, innovative proposals and out-of-the-box initiatives.

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