DIGITAL REALITIES IN EDUCATION: PROJECTS IMPLEMENTED USING AUGMENTED REALITY IN PORTUGAL

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Abstract

The use of mobile devices by students and teachers in the classroom has been widely discussed in the literature. In addition to the traditional access to specific web pages, there are reports about the use of applications that allow access to complex information like animations, videos, and three-dimensional objects. That, in some cases, can be previously planned by the educator, or the educator uses specific applications that already exist on the market. To help educators in this process, they have tools at their disposal to use augmented reality in classroom contexts. The use of this technology has another advantage that has already been identified in the literature: it is an appealing way to focus the attention and interest of its users.

An open repository in Portugal (RCAAP) allows access to a wide range of publications (articles, theses, and other scientific documents) that were written or that had the collaboration of professors or researchers from higher education institutions or belonging to an investigation. Despite the limitations of this repository, it is possible to access a set of documents that reveal the state of the art of what has been produced at the scientific level in Portugal.

In the research that we carried out through the RCAAP on May 31, it was possible to verify that there are cases of educators who make use of applications that exist in the market to implement the use of digital realities in the classroom context and in these cases, there is no need to program applications.

It was also possible to verify the possibility of adapting existing applications to different educational contexts and levels of education. These and other information are important and help to reflect on the topic of digital realities.

This investigation uses a systematic review work that aims to understand: the contexts in which applications have been used, answer the question about which applications have been used, what are their characteristics, and then obtain a data reference that will serve as a basis for the design, development, and implementation of an application based on the use of augmented reality.

Keywords: digital realities, augmented reality, Education Context, educators, Implementation

1 INTRODUCTION

The number of applications for mobile devices that have been installed by users has grown steadily in recent years, with these numbers reaching billions annually [1].

In the first quarter of 2022, the five main categories of applications downloaded and installed by users are related to: video games; business applications; education; utilities and other lifestyle related [2]. Some of these applications make use of AR technology, and there is also a forecast that by the end of 2024 there will be more than 1.73 billion devices that will have AR applications, largely with the help of hardware that, however, will appear on the market by the end of 2022 and is related to different types of headsets that will expand the use of this technology [3].

A study carried out identified that one of the nine technological trends for 2021 was the use of AR. For consumers, this technology enables experiences to help them purchase products, such as the choice of styles, colors and materials used in the products they intend to purchase [4].

But it's not just the consumer market that makes use of AR and Virtual Reality (VR). Industry, government services and defense have also resorted to these technologies to encourage collaborative work, namely through more immersive learning experiences, to promote greater consumer involvement with their brands, and more internally, to enable employees have access to shared knowledge and carry out the respective analyses themselves, that is, so that they can, for example, detect flaws during the development process, to suggest new methodologies and even to facilitate the creation of their own perceptions about the work they develop [5] [6].

For the authors Saxena and Verma [7] VR refers to the one that is generated by computer and that allows a complete immersion in a world that was artificially created. Through physical devices, such as VR headsets or even Google Cardboard, it is possible through these technologies to simulate environments equivalent to those that are real, but in the digital world. Augmented reality is characterized as an attempt to create an artificial environment from elements of the real world, adding details to complement/increase the experience of its users. The experience in this case is semi-immersive, having as its most important attribute this real-time integration of virtual objects with the real world [8] (see Figure 1).

Figure 1 - Smash Tanks app for iOS, Smash Tanks font

Mixed reality is a type of hybrid reality between virtual reality and augmented reality. It is similar to augmented reality, complementing external reality with elements, but at the same time adding virtual reality elements. Thus, unlike the others, mixed reality allows interactivity with existing objects in reality and virtual reality. It makes use of voice and recognition through the use of devices forming an integrative experience (an example of use is that made through the devices of Microsoft HoloLens (see Figure 2) or Samsung Odyssey (see Figure 3)) [7] .

Figure 2 - Microsoft HoloLens 2, Microsoft font

Figure 3 - Samsung Odyssey, Samsung font

AR is a technology that has been around for some time, for example the RA SDK has been evolving since 1999 [9], and large companies such as Google or Apple have developed their own SDKs: ARKit [10] and the ARCore [11] respectively, so that applications with this technology are developed.

In 1994 Paul Milgram and Fumio Kishino's presented the book "A Taxonomy of Mixed Reality Visual Displays". In this book, they mention spatial computation in which they describe the various modes of virtual continum, where they indicate the positioning of terminology related to the four themes addressed in the previous section and in this way they position: virtual reality; augmented reality, mixed reality and extended reality. This graphic element (see Figure 5) also allows describing the spectrum of various realities, from virtual to physical, among others [12]. For these Milgram et al, it is through the use and evolution of "computer vision" technology that AR and other realities are possible to be implemented.

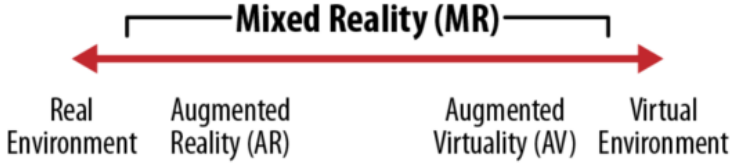

Figura 4 - Virtual contimum modes [12]

These positions are also reinforced by other authors, that AR is something that is evolving, as is the case of Marr [13], who indicates that the future is the fusion of AR, VR and RM to create more immersive environments/experiences. for users, where he can, with a single device, move to a deeper experience, that is, move from a real world experience to a virtual world experience. This mix of technologies will allow the user to transform his world into what he wants. Marr says that there are already devices that make use of this type of technology, such as the LiDAR scanner, which uses pulses of laser beams to help map environments; or lighter, higher resolution VR devices with devices capable of detecting hands or eye positioning; or accessories for VR systems that allow the transmission of sensations in the user's body, such as, for example, that of a Zombie in a video game that catches the player, or that of a mother who hugs her child, I embrace that sense for both of them, even though they are both in distant geographic locations.

AR has allowed the development of a diverse set of applications for different areas such as education [9], art [14], simulation [15], industry [16], among others.

Also in the world of board games and video games, some experiments have been carried out, some of them with very important commercial results, as is the case of Pokémon Go, which was made available on the market in 2016 and which makes use of geographical points in which it is possible to access different creatures. This application makes use of the map of a certain physical space, which is generated by the GPS and "encourages" the application's user to exercise while playing. For some authors [17] this reality takes the name of active AR games, since its purpose is to make available in real world objects, attributes that allow the user to interact with them through physical exercise or because they can be moved.

2 METHODOLOGY

The RCAPP platform allows you to search and have access to various documents that are made available in various institutional repositories and in scientific journals. This set of repositories includes several Portuguese Higher Education institutions that, through these platforms, make available what has been produced by their researchers in different areas. From this portal, and with reference to the last five calendar years, the year 2017 (inclusive) to the year 2021 (inclusive), we sought to obtain information about what has been built or explored with AR, trying to obtain data from these sources on what is being done with this technology in Portugal. From the results we obtain, resources related to references to non-Portuguese institutions were removed.

Therefore, on May 31, 2022, an advanced search was carried out on RCAPP using the reference time period, from 2017 to 2021, and two sets of words were used to carry out the search and collection. The first was used the expression "augmented reality" and the second with "*realidade aumentada*". The justification for using the two expressions was related to the fact that Portuguese researchers were encouraged to write their research works in English to allow other communities to read their work.

With these searches in Portuguese and English, a very similar number was obtained, in terms of quantity, with one hundred and seven references being collected in Portuguese and one hundred and fourteen references in English. Subsequently, all documents were collected, which resulted in obtaining one hundred and eighty-nine files.

The total number of results was not equal to the total number of collections that were carried out, because there are several documents that are of restricted access and that imply that: either the registration is made on the platform, after which it is necessary to proceed with the formal request to the authors and wait for an answer, or just request via form with the repository manager. We thought that at this stage it would not be necessary to carry out this contact, since, by principle of use of the RCAPP, the referenced documents should only be those of public access and without the need for other formalisms and also because these blocked documents represent approximately, and only, 14% of the total of the final sample. Despite this situation, and because they may be necessary, all references to blocked documents have been saved.

Despite a high number of documents that were collected, it was clear that not all discussed the use of AR in education. Thus, in the next section, only these cases will be presented.

3 RESULTS AND FURTHER WORK

Since 2017, there has been evidence that AR is part of everyday teaching in Portugal. Although only ten documents were collected this year, all of them describe work carried out in primary or secondary education, and only one document appears about work carried out in higher education. This amount of documents collected was also identical in 2018, but it was only from 2019 onwards that documents appear where AR is explored in the context of training. From this year until 2021, there were publications related to the three teaching activities: Support for training; Support for basic and secondary education and support for higher education (see Table 1). In the context of basic education, there are also works related to preschool.

Table 1. Caption for the table.

	Source				
Summary analysis of contexts	**2017**	**2018**	**2019**	**2020**	**2021**
Training support	-	-	[18]–[20]	[21]	[22], [23]
Support for primary and secondary education	[24]–[29]	[30]–[35]	[36]–[42]	[43]–[50]	[51]–[56]
Support for higher education	[57]	[58]	[59]	[60]	[61]

Some of the applications that were used have video game dynamics [20], [24], [27], [35], [39], [43], [49], [52], [53], [57] or of board games [26] being mentioned that these aspects pleased the students and

teachers. The motivation factor for the use of AR was also highlighted by students [29], [45], [46], [51], [54], [60].

A large number of applications that appeared in the documents, portray different stages in the development of different applications using AR, and in these stages, studies were carried out on the impact of these applications with students and teachers. But there are also cases of using applications that exist in the market [44].

The use of these applications also encouraged the exploration of outdoor spaces [24], [30], [45], [51], [58] or interior spaces but outside the traditional context of a classroom, or in the traditional room [28], [37], [39], [44].

There were special cases of use of this type of application with children with SEND [32] or in which there are eferencias that they can be adapted to these children [34] with the inclusion of sound effects, either by means of previous recording an audible narration, or with the use of certain sounds. In these cases, the evaluation made by the educators and the students was also positive.

Although AR has had a very positive acceptance by those who used it, it is necessary to highlight that it is not only the technologies that create “memorable” experiences, it is necessary that the context in which they occur, the strategies and dynamics that are used help to to build “knowledge spaces” [33, p. 465]. And despite the many positive descriptions that emerge, there is also a report where the lack of time, or the fear on the part of the teacher of “losing” the focus of his students does not motivate him to use these technologies in the classroom [43], or because there may be problems with the behavior that these applications may have on different student devices and that this may be a problem that the teacher may not be able to solve [23].

The vast majority of the documents that were analyzed, with the aim of identifying that they were used in formal or informal training contexts, do not identify which technologies they used, that is, what technological resources were used for the development of applications using AR. In the cases where this was identified, it was clear that the Unity video game engine and the Vuforia tool were used for the use and development of AR.

Thus, and based on the little information that was obtained, it will be necessary to develop a broader research outside the scope of education and to look for other references that help obtain complementary information by alternative resources.

Even so, this work was important to confirm that it is possible to use AR applications in the current teaching context to expand the use of technologies inside and outside the classroom.

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