

The possibilities of using augmented reality (AR) in education through interactive applications

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Abstract— The authors have focused on the implementation of augmented reality into different levels of the education process through the use of interactive mobile applications. The possibilities are presented primarily through good practices, tested applications and the methodological ideas associated with them.

Keywords—augmented reality, mobile applications, education

I. INTRODUCTION

Bridging virtual and real worlds, augmented reality (AR) creates a reality that is enhanced and augmented [4] [9]. New possibilities for teaching and learning provided by AR have been increasingly recognized by educational researchers. The coexistence of virtual objects and real environments allows learners to visualize complex spatial relationships and abstract concepts [1], experience phenomena that is not possible in the real world [9], interact with two- and three-dimensional synthetic objects in the mixed reality [8], and develop important practices and literacies that cannot be developed and enacted in other technology-enhanced learning environments [12] [13]. These educational benefits have made AR one of the key emerging technologies for education over the next five years [6] [7] [10].

With mobile devices, wireless connection, and location-registered technology, the pervasive or mobile-AR system could enable ubiquitous, collaborative and situated learning enhanced by computer simulations, games, models, and virtual objects in real environments [3] [5].

Augmented reality (AR) has the potential to engage and motivate learners to explore material from a variety of differing perspectives, and has been shown to be particularly useful for teaching subject matter that students could not possibly experience first hand in the real world (e.g. Shelton and Hedley 2002). It also affords the demonstration of

spatial relationships and the interactions of elements within a 3D space (e.g. Shelton and Hedley 2003) whilst providing the potential for seamless interaction between the real and virtual worlds (e.g. Billinghurst 2003; Shelton 2003).

There are also pedagogical issues that need to be taken into consideration when AR systems are implemented in classrooms. First, like many educational innovations in the past, the use of AR in classrooms could encounter constraints from schools and resistances among teachers. The learning activities associated with AR usually involve innovative approaches such as participatory simulations and studio-based pedagogy. The nature of these instructional approaches however is quite different from the teacher-centered, delivery-based focus in conventional teaching methods [8] [11] [12]. There are also challenges related to learners and their learning processes. In an AR learning environment, students could be cognitively overloaded by the large amount of information they encounter, the multiple technological devices they are required to use, and the complex tasks they have to accomplish. That is, students need to be multitasking in AR environments [16].

II. GOOD PRACTICES OF IMPLEMENTING AR AND APPLICATIONS IN ELEMENTARY SCHOOL EDUCATION

In the following, we present some applications that are excellent for use in education.

A. Quiver

The Quiver app is an interactive coloring tool that achieves its full effectiveness with augmented reality. The application is free to download and is available on Google Play (no age limitation) and on the App Store (Age Rating 4+). The application, with proper preparation, is excellent for use in education, supplemented by experiential pedagogical elements, such as the stages of the eruption of a volcano or

the description of the parts of DNA. This application is excellent for both fun and learning, and all this can be enjoyed in 3D as well.

Using the application consists of the following steps:

- Print out some Coloring Packs from the website: <https://quivervision.com/coloring-packs>. There is some free content, while some of it is only available for subscribers and there are some paid pictures as well. Coloring Packs can be divided into the following categories: Quiver and Quiver Education.
- Color the printed pictures using any color, or one's favourites.
- Scan the colored picture using the previously downloaded and installed Quiver application.
- Play and bring your pictures to life with the selected colors, and play some unique games with the available characters.

B. *Animal 4D*

The app brings animals to life with augmented reality technology, and displays the animals in 3D. The animals can be displayed using the trigger cards assigned to them, which also depict the animals themselves. A description of the animals can also be displayed, which, in addition, can be fit into different lessons and subjects in various ways. If a card containing the animals and their appropriate food (herbivore - grass or bee - flower) is started, further animation will start to play. For example, a bee lands on a flower.

The application is free and available for Android and iOS. A number of cards are also available on the website of the application, but there are some premium cards as well. The company that created the app (Octagon Studio) has developed other applications as well that can be used well in further education. For example: Dinosaur 4D+, Space 4D+, Ocean 4D+, Cars 4D+.

C. *Curiscope*

The application called Curiscope allows your child to get to know their internal organs in an immersive way. The application presents circulatory, respiratory and digestive systems. Using augmented reality, specific internal organs appear on a t-shirt, and are interactive and animated.

The above mentioned internal organ systems come with descriptions and additional animations that are 360 degrees and 3D.

Curiscope itself is free to download, however, the t-shirt on which you can project your internal organs must be purchased.

D. *Counting with Paula*

Math made fun for kids. Children can learn addition and subtraction with the Numbers from the popular TV series, Counting with Paula. Coupled with the physical flash cards, the Numbers come to live onscreen to challenge and guide kids through basic mathematics equations. Counting with Paula Augmented Reality is the latest app to help kids and parents have fun together while learning all about addition

and subtraction. Line an equation up with the flashcards, for example, $4 + 5 =$, wait for the numbers to pop up and contemplate the answer together. Then tap on the = sign and the answer will pop right up [17]. The presented 3D and augmented reality based programs and platforms can be used in the teaching-learning process, as well as others like Wallame, Metaverse and ROAR.

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