Chapter 2
Educational Augmented Reality (AR) Applications and Development Process

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ABSTRACT

In recent years, presenting the useful information in an effective way has become a great necessity for educators. The opportunities provided by the AR technologies offer practical ways to meet this need of educators. By integrating the digital objects with real-world assets simultaneously, AR helps to concretize abstract concepts, and enhances the sense of reality, which in turn is a huge contribution to learning. In this chapter, it was presented the various limitations and advantages of AR revealed by some empirical studies in the literature. In addition, it was given information about AR development tools/ programs, add-on packages and presented development stages for an exemplary AR book page. The use of the Unity and Vuforia was explained as the development tools. It is believed that this information would be useful for those who will develop AR application which can be easily displayed by mobile or desktop PCs.

INTRODUCTION

Various information and communication technologies (ICT) including interactive technologies like online sharing of information, mobile technologies, and Augmented Reality (AR) have accomplished to come to our classrooms to facilitate traditional teaching (Chen & Wang, 2015). In this sense, it has been a great necessity to understand how that technology would be beneficial for learning in what context and with what kind of content use (Richards & Taylor, 2015). Especially, a competitive market has emerged with the rapid spread of mobile phones, and wireless network communications have largely facilitated the accessibility of these technologies. This has created important advantages for people in terms of technology-assisted learning. In recent years, research on learning technologies has focused on emerging technologies (e.g., adaptable learning, digital badges, mobile learning, open content, virtual and remote laboratories, learning analytics, augmented reality, volumetric and holographic displays,

virtual assistants, serious games, etc.) in terms of impact on learning (Johnson, Adams Becker, Estrada, & Freeman, 2015). These studies have contributed to the development of personalization processes placing students at the center of learning activities. AR technologies have taken important steps recently to prove the value of these options among these research trends. It can be said that AR technology, which can be used with mobile or non-mobile devices, represents an indispensable technology for educational environments in the near future.

Augmented Reality

AR is a technology blending context-based digital information and real-world environments dynamically (Sommerauer & Müller, 2014). A more formal definition is: "AR is a variation of Virtual Environments (VE), or Virtual Reality (VR) as it is more commonly called" (Azuma, 1997, p.355). "An AR system supplements the real world with virtual objects that appear to coexist in the same space as the real World." (Azuma et al., 2001, p.34). AR integrates 3D virtual objects with real environments in real time.
    In these contexts, AR systems have the following features (Azuma et al., 2001):

1.   Combine real and virtual objects in a real environment;
2.   Run interactively, and in real time; and
3.   Register (align) real and virtual objects with each other.

AR increases the sense of reality by adding virtual information into the user's real environment (Bokyung, 2009). We cannot restrict AR only to visualization technologies like head-mounted display or with our sense of sight (Azuma, 1997), because AR is a technology that has the capacity to affect all our senses. The AR applications of today have been improved with integrated cameras, GPS sensors, and mobile internet access that enable to overlay the real-world environments with dynamic, context-based, and interactive digital content (Sommerauer & Müller, 2014). AR systems employed in certain professional fields such as the military for 50 years have also become available to the general public with the spread of mobile technologies (Sommerauer & Müller, 2014). 3D models can also be used in addition to texts, images, videos, and animations in AR applications. AR applications, having such rich content support, have brought an innovative approach to multimedia-assisted learning environments, which are widely used at present. In particular, the use of 3D virtual worlds in learning environments offers interesting, attractive, and original learning experiences (Richards & Taylor, 2015).

The Use of AR in Education and Its Potential Benefits

Besides having several inspiring features for education environments, AR provides various opportunities for teaching designers and academicians to think more deeply about students' context and status (Haag, 2013). AR could enable (1) learning content in 3D perspectives; (2) ubiquitous, collaborative, and situated learning; (3) learners' senses of presence, immediacy, and immersion; (4) visualizing the invisible; and (5) bridging formal and informal learning (Wu, Lee, Chang, & Liang, 2013). In several studies, it has been found that elements of AR can increase the motivation, participation, and satisfaction of students while performing learning activities (Ibáñez, Di-Serio, Villarán-Molina, & Delgado-Kloos, 2016). AR technologies can take any situation, location, environment, or experience to a whole new level of meaning and understanding (Haag, 2013). In case AR is designed in conjunction with several

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