Augmented Reality and Education

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Introduction

Augmented Reality, or AR in short, is a real-time and interactive experience created by enriching real-world environmental elements using data from computer-based graphics, video, and GPS. Virtually generated images and graphics are added to real world images with the help of various software and hardware used, and a new type of experience is created by enriching the existing reality without leaving the reality.

Augmented reality involves strengthening and supporting reality by providing information that is not detectable by people's senses and cognitive processes under normal conditions (Azuma, 1999). Augmented reality basically gives the individual a virtual experience as if it were real in the physical environment and in real time. A new environment is created by placing various virtual objects on the snapshot of the individual's environment. The real environment is supported by digitally generated images, sound, graphics and GPS data. In this way, people in the given environment can even talk with objects (Aslan, 2017).

The image created with augmented reality has basically 3 features. These features; combination of the real world and the virtual image, the real-time interaction of virtual objects and the resulting image being located in three-dimensional environment (Azuma, 1997; Wu, Lee, Chang, & Liang, 2013). Augmented reality is not environments where reality is created from the beginning, but where existing reality is supported (Erbaş & Demirer, 2015).

Milgram and Kishino showed the concept of augmented reality on the diagram of real-virtual continuity (As cited in: Özarslan, 2011). This continuity is moving from the real environment to the virtual environment (Kesim and Ozarslan, 2012). When real-virtual continuity is examined, augmented reality and augmented virtuality are positioned in the middle of the generated diagram; augmented virtuality being closer to the virtual world and augmented reality to the real world.

Real-Virtual Continuity

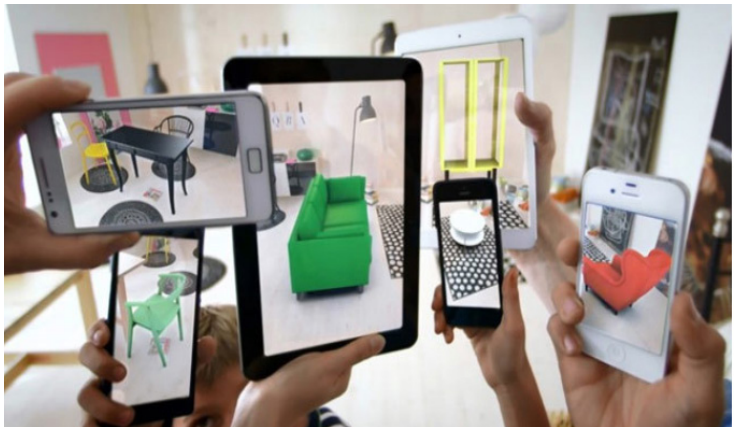
Azuma (1997) described augmented reality as a type of virtual reality in his study. Although virtual reality and Augmented reality applications have similar basic elements such as virtual objects, real-time response and having visual equipment, there have some differences, too (Sin and Zaman, 2010).

While the user is in an artificial environment created in virtual reality technologies (Sin and Zaman, 2010), he cannot see the real world around him, but AR applications allow the user to see the real world placed on virtual objects (Azuma, 1997). Unlike virtual reality, AR creates real-world perception by enabling users to see a real-world environment enriched with 3D images produced, and also realizes user interaction with virtual objects (Devkan, Demircioğlu and Akkuş 2016).

Historical Process of Augmented Reality

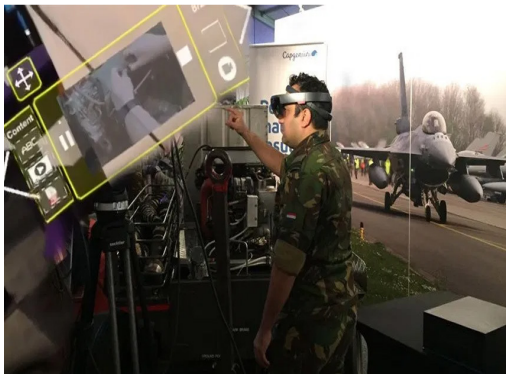
The concept of Augmented Reality was first introduced in the early 1990s, but on the other hand, various studies have been carried out on the first wearable device with AR features since the late 1960s. Even though completely mechanical, the first product to create a feeling of augmented reality is Sensorama, developed by Morton Heilig in 1962. Sensorama is built on a system that emits smells in accordance with the images and sounds seen in a film and transmits vibrations to the user. However, the concept of AR was first introduced into the literature through the study of Caudell and Mizell (1992), which indicated that it was more appropriate to virtualize and process the required amount of images in their research (As cited in: Bozyer, 2015).

In particular, improvements in processor (GPU and CPU) capacities and the development of camera lenses of mobile devices, have enabled the rapid deployment of applications with AR technologies.



Today, Augmented Reality (AR) application range extends to dozens of different fields from real-time camera filters used for entertainment purposes, to new generation educational applications, from furniture shopping applications that enable products to be displayed in real environments before purchase, to tourism, military, health, museum, advertising and Industry 4.0 solutions.

In particular, the widespread use of mobile devices (desktop and laptop computers, tablets, smartphones, etc.) has increased the use of AR in educational settings (Wu, Lee, Chang and Liang, 2013, Uluyol and Eryılmaz, 2014).



Today, as a result of many researches on the applications of educational technologies, there is an increasing interest in emerging technologies. The content of these studies is generally related to the development of student-centered learning and adaptive learning environments (Bacca, Baldiris, Fabregat and Graf, 2014).

Use of Augmented Reality in Education

The new generation, which is called the digital generation or generation Z, is predicted to be different from the previous generations due to the fact that they were born and raised in a digital age (Oblinger & Oblinger, 2005). This new generation is intertwined with internet technologies and digital equipment in their daily lives. For this reason, it can be said that the traditional learning methods and environments used in the upbringing of previous generations cannot be sufficient to attract the Z generation.

A true learning experience is always necessary for individuals, and the involvement of more senses in the learning process makes learning more efficient. This is why augmented reality applications can be described as a new and developing technology in education (Lai & Hsu, 2011; Luckin & Fraser, 2011).

According to Özarslan (2013), effective learning takes place as long as the learner has fun in the learning process and actively participates in the learning process. On the other hand, it is said that integration of augmented reality applications into the education process allows experiences with real or near-realistic interactions between the learner, teacher, environment and content to be lived and learners to freely discover, design their own learning experiences and learn real life elements by doing or living. In addition, it is possible to embody abstract concepts with augmented reality technology, to enable different learning styles, and to develop support materials that provide a learner-centered approach in the flexible learning process with virtual elements to be placed in the real world.

Augmented reality allows students to apply knowledge and skills that are seamlessly learned by combination of real-world and learning environments. Since learning students can share their knowledge and experiences among themselves, the augmented

reality environments created allows face-to-face interaction with the aim of transfer of information (Lave & Wenger, 1991).

Augmented reality is used not only in interactive applications, but also in books, as in the case of the Magic Books. In addition to being able to be read as regular books, when the images and objects in the book are observed, a three dimensional image is obtained through the necessary enrichment made by mobile devices in advance (Lee, 2012).

The rapid change and development in technology has transformed AR not only to be a technology that requires special hardware, but also as a technology that can be easily used on computers, tablets or mobile devices.

Especially the increase in the use of mobile devices has increased the use of AR in educational environments (Wu, Lee, Chang and Liang, 2013). Thus, the use of AR in education has become an important research topic in recent years and some of these studies are shown in Table 1.

Table 1. Some Studies on the Use of Augmented Reality in Education

Author	**Date**	**Field**
Freitas, Campos	2008	Comparison of augmented reality and traditional classroom applications.
Abdüsselam, Karal	2012	The effect of the use of augmented reality in the learning of physics on academic achievement.
Cuendet, Bonnard, Do-Lenh, Dillenbourg	2013	A study showing that augmented reality studies can be carried out in the classroom
Çetinkaya, Akçay	2013	Use of augmented reality in education environment
Tülü, Yılmaz	2013	Using augmented reality in education with an iPhone
Erbaş, Demirer	2014	Augmented reality applications in education: Google Glass, Example 1
Yılmaz, Batdı	2016	Meta-Analytical and Thematic Comparative Analysis of Integration of Augmented Reality Applications into Education
Atasoy,Tosik-Gün, Kocaman-Karoğlu	2017	Determination of Primary School Students' Attitudes and Motivation Situations Against Augmented Reality Applications
Buluş Kırıkkaya, Şentürk	2018	The Effect of Using Augmented Reality Technology in the Unit of "Solar System and Beyond" on Academic Achievement of Students
Yalçın Çelik	2019	Experience of Augmented Reality Materials of Prospective Biology and Chemistry Teacher Candidates

Researchers' studies show that augmented reality (AR) applications contribute positively to educational environments. It can be said that the use of AR applications increases students' academic achievement (Buluş Kırıkkaya and Şentürk, 2018; Chen and Wang, 2015; Hwang, Wu, Chen and Tu, 2016; Sırakaya, 2015). Research also shows that AR supports learning by doing (Singhal, Bagga, Goyal and Saxena, 2012).

Augmented Reality in Science Education

Even though the content of science courses is very much in the daily life of students, it is among the most difficult courses for students. The reasons for this undesirable situation are the lack of lecture hours, excessiveness of the concepts they need to learn, the abstractness of the concepts to be taught, mathematical expressions and calculations, and the inadequate graphic and table interpretation skills of the students. In order to improve this situation, some solution suggestions such as using laboratory applications and increasing the science class hours have been presented. (Timur, Timur, Özdemir ve Şen, 2016). There may also be teacher-related reasons for students' difficulties in science classes. Reasons such as teachers mostly using traditional methods, their lack of assessment techniques cause students to experience misconceptions.

Looking at the recent studies in the literature, we can say that augmented reality applications are a tool preferred by researchers in science education (Table 2). According to the results of these studies, it can be said that augmented reality applications make a significant contribution to science education. Some of these studies are presented in Table 2.

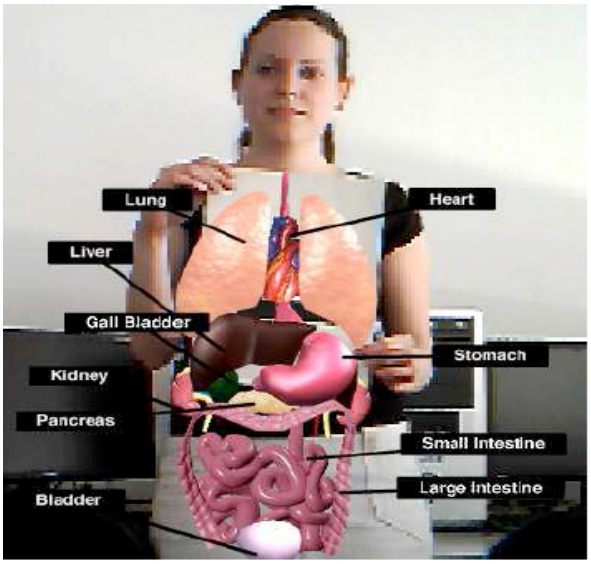
Table 2. Augmented Reality Studies in Science Education

Researcher(s)	Subject of Study	Study Results
Abdüsselam (2014)	Magnetism	Provided a better understanding of the subjects.
Akçayır, Akçayır, Pektaş and Ocak (2016)	Laboratory training	Helped improve students' laboratory skills and attitudes.
Avcı and Taşdemir (2019)	Periodic Table	More effective understanding processes for the subjects.
Buluş Kırıkkaya and Şentürk	Astronomy	An positive effect on academic achievement is observed.
Chen and Wang (2015)	Astronomy	Increased students' success
Yalçın Çelik (2019)	Biology and Chemistry course materials	Students found augmented reality materials more impressive and remarkable than other course materials.
Delello (2014)	Astronomy	Increased student participation and motivation
Furio et al. (2015)	Water cycle	Increased students' motivation
Hwang, Chen and Chou (2016)	Ecology	Class participation has increased and positive learning outcomes achieved.
Lin, Duh, Li, Wang and Tsai (2013)	Momentum	Learning level has improved.
Matcha and Rambli (2013)	Electric	Contributed to cooperative learning
Vilkoniene (2009)	Digestive system	Increased students' success
Zhang et al, (2014)	Astronomy	Increased the permanence of learning.

Augmented reality applications make teaching of the subjects possible by combining real and virtual and enabling the observation of situations that cannot be observed in the classroom environment (Kerawalla et al., 2006).

When Table 2 is examined, it is seen that applications prepared with augmented reality technology are used in teaching many different science education subjects and effective results are obtained as a result of these applications.

In particular, science subjects such as astronomical events that cannot be observed in a classroom environment, or chemical experiments that cannot be conducted in classroom environments where the learning is happenings, can be taught to the learners by doing and living thanks to augmented reality.



On the other hand, many research results show that augmented reality (AR) technology makes learners learn abstract concepts that are difficult to learn easier (Abdülsselam, 2014; Kamarainen et al., 2013; Wu et al., 2013) by objectifying them (Shelton and Stevens, 2004). When augmented reality is evaluated in this respect, it provides an opportunity to teach abstract subjects such as magnetism and electricity by objectification.

Attitude causes the individual to behave biased in the decision-making process and directs the individual's behavior (Nuhoğlu, 2008). Accordingly, students' positive attitude

towards learning science will determine their level in learning science subjects. In this context, it can be said that augmented reality technology applications will contribute to students' positive attitudes and motivation towards learning science. Also in this context, it is possible to come across many studies examining the effect of augmented reality (AR) technology on students' attitudes and motivation in the literature (Delello, 2014; Furió et al., 2015; Perez-Lopez and Contero, 2013).

Conclusion and Discussion

Nowadays, augmented reality (AR) applications can be standardized in the coming period, and with the increase of use of smartphones and tablet computers, it will be widely used in all areas of our lives. It is very difficult to limit the uses of augmented reality in our daily lives. This situation attracts the attention of developers, because AR is a new technology. As a result of this interest, augmented reality technology is emerging in different fields with each passing day. AR's fields of application are a very wide area such as advertising, design, health, military, and education, and a new field joins the range of AR every day.

Augmented reality technology has attracted attention in the field of education with its ability to interact with virtual and real objects, increase learners' attention and motivation, and enable them to learn by living (Singhal, Bagga, Goyal and Saxena, 2012). The applications of this technology are observed in many disciplines and different levels of education and it can be said that it is effective in teaching the events that cannot be followed with the naked eye, showing the situations that may be dangerous and concretizing abstract concepts (Walczak, Wojciechowski and Cellary, 2006).

Constructivist approach of augmented reality and it allowing learning by doing - living experiences and new generations, called generation Z, that are intertwined with new technologies using digital technologies effectively have helped it become more and more common everyday in the field of education. Today, it is seen that various studies have been carried out in many different fields, especially in the fields of health

education, science education, mathematics education, foreign language education and teacher education with augmented reality technology.

As a result of the studies, it has been concluded that augmented reality technology has many benefits such as providing contextual support to learners, providing spatial skills, creating a more attractive learning environment, and visualizing and concretizing concepts (Majoros & Neumann, 2001; Kaufmann & Schmalstieg, 2003; Shelton, & Hedley, 2002; Dori & Belcher, 2005; Klopfer & Squire, 2008; Sumadio & Rambli, 2010).

In the light of these studies, as a result of AR's contribution to students' attitudes and motivation towards science learning, more comprehensive studies can be conducted for the creation of AR-based learning materials and the development of existing ones for use in science education. Efforts can be made to successfully integrate AR technology into the education process. Considering the reflections of technology on our daily lives, the applications of augmented reality technology will continue to appear in every aspect of our lives in the coming years.

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