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# Augmented Reality Research and Applications in Education

*Ezgi Pelin Yildiz*

## Abstract

Augmented reality is defined as the technology in which virtual objects are blended with the real world and also interact with each other. Although augmented reality applications are used in many areas, the most important of these areas is the field of education. AR technology allows the combination of real objects and virtual information in order to increase students' interaction with physical environments and facilitate their learning. Developing technology enables students to learn complex topics in a fun and easy way through virtual reality devices. Students interact with objects in the virtual environment and can learn more about it. For example; by organizing digital tours to a museum or zoo in a completely different country, lessons can be taught in the company of a teacher as if they were there at that moment. In the light of all these, this study is a compilation study. In this context, augmented reality technologies were introduced and attention was drawn to their use in different fields of education with their examples. As a suggestion at the end of the study, it was emphasized that the prepared sections should be carefully read by the educators and put into practice in their lessons. In addition it was also pointed out that it should be preferred in order to communicate effectively with students by interacting in real time, especially during the pandemic process.

**Keywords:** augmented reality research and applications, field of education, pandemic process, digital transformation, virtual environment

## 1. Introduction

Today, rapid changes and advances in science and technology affect and change the lifestyle of individuals. Apart from individuals, it is not possible for the education process and educational environments not to be affected by this change [1]. When the technologies used in educational environments from the past to the present are examined, it is seen that there is a transformation from blackboard and chalk to the computer and internet world, even to smart technologies with artificial intelligence. Especially in recent years, computer and internet technologies have had such a wide area of use in our lives that it was unthinkable for education services to be left out of the field [2].

The definition of today's learners as Z generation and/or digital generation and their characteristics require educators to follow technological developments and use the most appropriate technological tools in learning environments. One of these new technologies is augmented reality applications in education. When the literature is examined, there are many definitions of the concept of augmented reality made by researchers. Some of these definitions:

Augmented reality according to Milgram and Kishino [3]; “it is a reality environment where digital media products are used instead of real world objects” appears to be the most general definition. According to Azuma [4], augmented reality is a derivative of virtual reality. According to this definition, augmented reality is virtual environments in which existing reality is supported, not created from scratch. In this context virtual and real objects in augmented reality environments offered to users in harmony. Augmented reality creates the interactive environment between the virtual and real world. Augmented reality is used to achieve this [5, 6]. When the definitions in the literature are examined, as a common definition; augmented reality can be defined as real worlds enriched using virtual objects.

When the important areas where Augmented Reality (AR) Technology is used are examined;

- Education
- Health
- Marketing
- Game and Video
- Tourism
- Build
- Cinema
- Food
- Art and Museums
- Automotive
- Device Maintenance/Support

With the rapid development of Augmented Reality applications day by day, usage areas in many sectors are starting to increase. Major brands have started to give importance to providing a more realistic and embodied experience to their customers by using Augmented Reality (AR). This technology, which appears in many fields such as cosmetics, automobiles, construction, food, combines the virtual world with real life. Identifying target audiences, tracking and using technology in brand awareness and sustainable marketing is now vital for companies. The most importantly, companies from the public or private sector invest on enhanced technology in order to better promote or market their services/products and need talented people/firms in this field. In this context, augmented reality applications offer these services to businesses with technology support.

Although augmented reality applications are used in many areas, the most important of these areas is the field of education. New opportunities offered by AR technology for education have started to attract the attention of educators over time [7]. When these new opportunities and advantages are evaluated [8–11]:

- to provide students with more flexible and interesting learning environments,

- to experience an excitement they have never experienced before,
- to increase their willingness and motivation to learn,
- to help students make active observations during their learning processes and to form hypotheses as a result of these observations,
- to increasing students' learning performance and helping them establish social interactions within the group,
- to bridging formal and informal learning and encouraging students to learn collaboratively,
- AR technology; it gives a feeling of independence from the place, freedom and personal,
- to creating new opportunities in education by promoting learning.
- it is possible to rank as.

When the augmented reality technologies, which are frequently used in the field of education, are examined, **wearable technologies** draw attention. Wearables are loaded with smart sensors that track body movements. Usually these products use bluetooth, Wi-Fi and mobile internet connection to sync with smartphone wirelessly. Users are connected to wearable devices with the help of sensors. Wearable technology products that are always with the user; it provides important services in many areas, especially in entertainment, health, work, information, education, socialization and security.

Wearable technologies in the field of education are used in learning-teaching environments. Modern visualization techniques help students explore existing educational resources and new knowledge (**Figure 1**) [12].

Wearable technologies frequently used in education:

- Internet of things
- Smart watches
- Google – Glass Project



**Figure 1.**  
*Wearable technologies the past and present and future.*

- HoloLens – Microsoft:
- Oculus Rift – Facebook
- Bracelets, Rings and Necklaces
- Smart Clothing and Tattoos

These tools, which can also be named as wearable computers in the literature, reveal a commensalistic relationship between human and computer however, the daily life of the individual has a structure that enriches their experience [13]. From smart watches to wristbands, sensor accessories such as rings and necklaces, virtual reality glasses, Google Glass project and derivative smart glasses, as well as smart optical lenses and headphones, many things can be shown among wearable technologies [14].

When the programs that enable the use of AR technologies in education are considered:

- Augment – 3B
- Google Translate
- SketchAR
- Wikitude
- LifePrint Photos
- Smartify
- Spyglass
- Blippar
- Aurasma

In the light of all this information, the purpose of this chapter; the use of augmented reality environments and applications in the field of education, the programs and technologies used in this context, and the researches are discussed in detail.

The new normal situation, especially with the pandemic process, also creates an opportunity for more educators to try new generation technologies (VR and AR technologies) beyond video and teleconferencing applications. It is predicted that such research studies will be important so that educators realize the benefits of these technologies and use them actively in learning environments.

## **2. Conceptual framework**

Augmented reality (AR) has been slowly but surely following its predecessor virtual reality in changing the education sector—digitizing classroom learning, and making training more diverse and interactive. In this section, current studies in the literature in recent years on the integration of augmented reality applications into education are given. When these studies are examined;

Çetin [15], investigated the effect of augmented reality-based stories on reading skills in his research. In the research, augmented reality based story text samples were presented to primary school 3rd grade students (**Figure 2**).

A scoring key was developed for the answers given to the questions prepared by the researcher to measure the skills of expressing what they read in writing. As a result of the research, it was observed that the augmented reality-based stories did not have a significant effect on the reading motivation and reading comprehension skill levels of the students, but they created a positive significant difference on their ability to tell what they read in written and verbal form. In addition, as a result of the research, it was observed that the reactions of the students towards the texts increased.

As a similar study Baysan and Uluyol [16], the effect of the use of augmented reality books (AR-books) on the academic success of the students and the students' opinions about the environment were investigated in his study. The AR-based teaching material developed by the HITLibHZ-BuildAR program was used in the laboratory environment for the experimental group of 22 people and the course was taught by the researcher. As a result; according to the qualitative data obtained from the students, AR is a promising technology. Educational AR applications should be used in areas that require 3D spatial visualization such as Geometry and Geography rather than technology education. Participants support the use of AR in Computer Hardware training, with better developed platforms and more professional designs (**Figure 3**).

Almusawi et al. [17], in their study, they discussed innovation in physical education: teachers' perspectives on readiness for wearable technology integration. The study is a case study and includes semi-structured interviews with 38 public school physical education teachers. The following scheme was used in the study (**Figure 4**).



**Figure 2.**  
*Augmented reality based story text samples.*



**Figure 3.**  
*Augmented reality application book sample.*

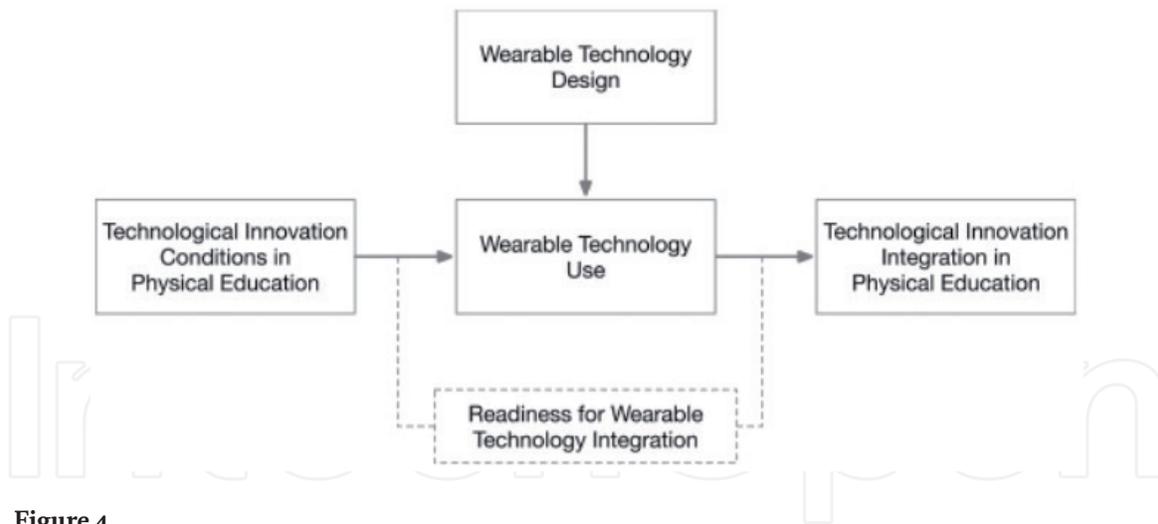


Figure 4. Augmented reality application book sample.

The findings show that physical education teachers have concerns about the design aspects of wearable technologies in terms of material design and device suitability for physical education. To eliminate these concerns, it is proposed to provide innovative learning environments that impact technology through collaborative, competitive, engaging and evidence-based learning experiences through wearable technologies that provide comfort, enhanced wearability and injury prevention in physical education.

It is understood from the existence of studies in the literature that augmented reality technologies have been used frequently in medical education recently. When the relevant studies in the literature are examined (Figure 5).

Kucuk et al. [18], a new perspective in medical education multimedia applications: augmented reality has been studied in their research. As a result, it is difficult to understand the subjects including the structure of the brain and vessels such as neuroanatomy in medical courses, in this direction, it was emphasized that AR applications could be developed to facilitate the learning processes of students in such subjects. Considering the characteristics of today's students in the digital citizen group, it has been suggested in the study that students should be supported

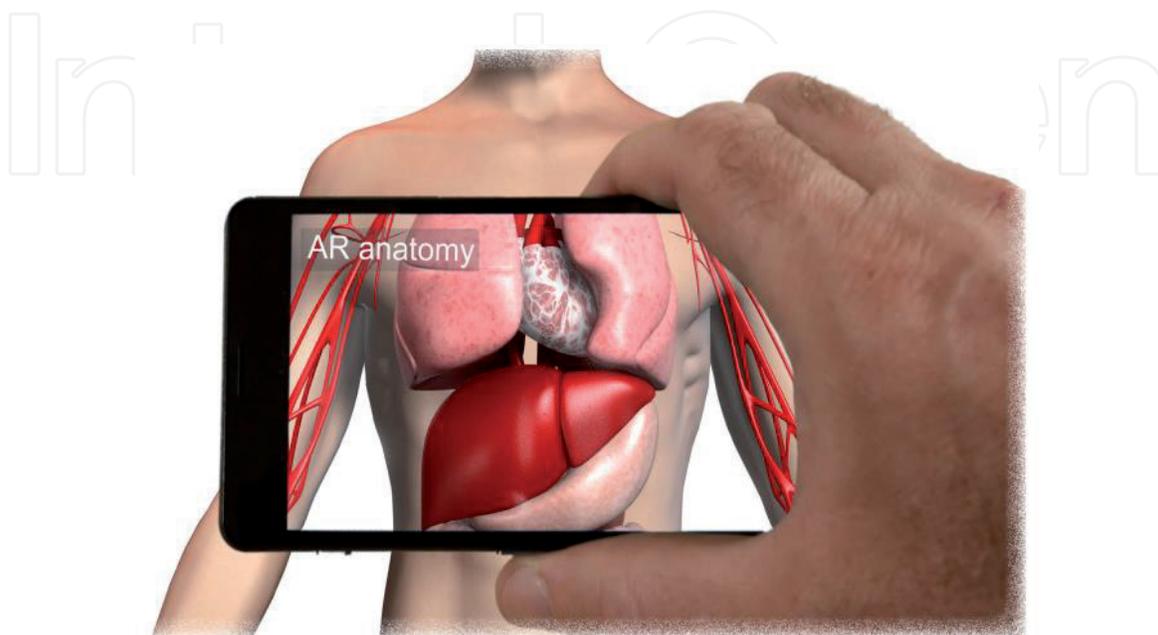


Figure 5. Use of augmented reality technologies in medical education.

with various technological solutions in this process, at this point, the dissemination of medical augmented reality applications that are based on the learning approach anytime and anywhere and support individual learning.

### 3. Augmented reality applications used in education

Augmented reality, a concept that has been frequently encountered recently, promises a future where we can get away from the world we live in, create a new worlds and enter 'inside' our imagination. By adding this technology with which we can 'beautify' the world we live in, make brand new additions to our world and bring our imagination to the place we live in, we started to manipulate our real world at the same time, while constructing mixed reality virtual worlds that we use together. It has become compulsory to benefit from these privileges and advantages that augmented reality offers to our lives, especially in terms of education, on behalf of the Z generation youth.

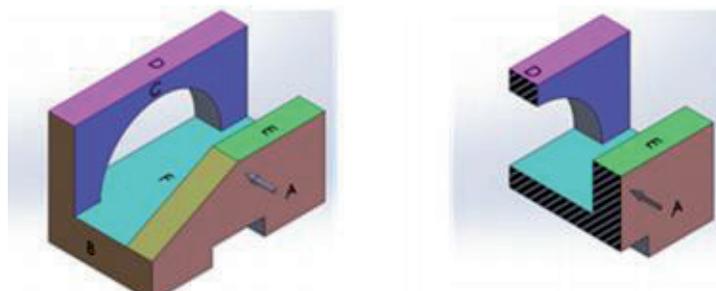
It is now possible to use these technologies in learning and teaching environments by making use of the ready-made programs of augmented reality. When the literature is examined, the frequently used programs and application areas are below:

#### 3.1 Augment: 3B

Augment is an ARCore-based mobile app to visualize 3D models in Augmented Reality, integrated in real time in their actual size and environment. Balak and Kisa [19] investigated the effects of this application on technical drawing education in their studies. The data obtained as a result of the use of Augmented Reality technology in the technical drawing course of the 2015–2016 period were examined. As a result; the result of the survey made with the pre- and post-tests applied; it has been determined that the students understand and adopt the Augmented Reality technology, which is a modern education tool, and this technology increases their interest in the lesson (**Figure 6**).

#### 3.2 Google translate

According to Google, the Translate app currently supports text translations between 103 languages, offline translations for 52 languages and Word Lens-based augmented reality translations for 30 languages. Aiming to make life easier for users with its mobile translation application, Google offers Instant camera translation; It started to support a total of 88 languages with the addition of 60 new languages such as Arabic, Hindi, Malaysian, Thai and Vietnamese etc. (**Figure 7**).



**Figure 6.**  
*Technical drawing with 3D modeling with AR technologies.*



**Figure 7.**  
*Augmented reality-based Google translate app.*

### 3.3 SketchAR

SketchAR, which is an application that combines augmented reality and drawing, is among the applications frequently preferred by artists recently. SketchAR, which is basically a drawing application made available to artists, confirms that digital works created by artists are unique and original, making them accepted as NFT (data unit). SketchAR, an initiative founded in 2017 by Aleksandr Danilin, Alexander Danilin and Andrey Drobitko in Lithuania, offers its users a different drawing experience by combining augmented reality technology with drawing, together with artificial intelligence support (**Figure 8**).

### 3.4 Wikitude

Wikitude initially focused on providing location-based augmented reality experiences through the Wikitude World Browser App. In 2012, the company restructured its proposition by launching the Wikitude SDK, a development framework utilizing image recognition and tracking, and geolocation technologies. Wikitude initially entered the market with its geo location AR app. The Wikitude



**Figure 8.**  
*Drawing courses with SketchAR.*



**Figure 9.**  
*Wikitude world browser app.*

app was the first publicly available application that used a location-based approach to augmented reality (**Figure 9**).

It is supported by studies in the literature that this application is also used in geography education. Wikitude; it is a complete AR development platform used by major brands, travel catalogs, retailers and publishers to deliver a variety of engaging solutions.

### 3.5 LifePrint photos

Life Print is an Android and iPhone photo and video printer. The Life Print program uses augmented reality to magically bring photos to life (**Figure 10**).

### 3.6 Smartify

The application starts with permission from users to access camera and location. With camera access, the artwork is scanned, and according to the location, it provides the opportunity to get information about which museums are and how far, how many artworks of art they are, open and closed hours, and to see some of the artworks in the museum. The application has three basic directions; *scan*, *profile* and *explore* (**Figure 11**).



**Figure 10.**  
*Augmented reality app: LifePrint photos.*



**Figure 11.**  
*Augmented reality app: Smartify.*

### 3.7 Spyglass

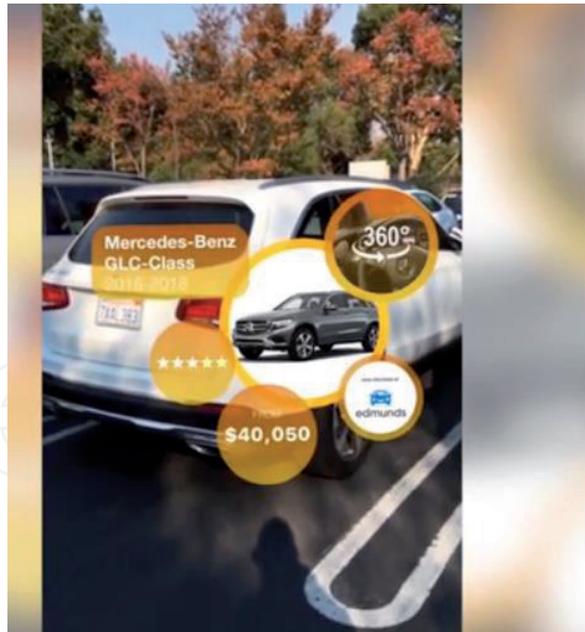
Spyglass app is a program that allows users to turn their smartphones into a compass, gyroscope, star tracker and more (**Figure 12**).

### 3.8 Blippar

Blippar uses augmented reality, artificial intelligence and computer vision to provide you with information about what you find around you. It is quite successful with its advanced image recognition algorithms that find out what the objects are and bring the relevant information. Blippar will introduce the feature that will allow its users to create their own profiles very soon, but it will be possible to get detailed information about a person with the innovation called Augmented Reality Face Profiles (**Figure 13**).



**Figure 12.**  
*Locating with spyglass technologies.*



**Figure 13.**  
*Unlock augmented reality of everyday objects and places with the Blippar app.*

### 3.9 Aurasma

One of the web 2.0 tools using Augmented Reality technology is the Aurasma application. Interactive virtual reality materials can be created free of charge with the Aurasma web 2.0 tool. With these materials, students can be taught more efficiently, and very effective information can be provided outside the classroom [20].  
*How to Use Aurasma Web 2.0 Tool in Education:*

- by creating animated and interactive boards
- prepare interactive lecture notes or handouts
- interactive presentation of albums or details about activities such as observation projects, experiments (**Figure 14**).

According to Onder [21], the Aurasma application draws attention with its ability to provide AR environments and opportunities to teachers and students, ease of



**Figure 14.**  
*Educational use of Aurasma app.*

use, support for distance education, creating individualized learning environments and being used as an evaluation tool.

#### **4. Method**

This research is an example of a literature review. A literature review is a search and evaluation of the available literature in your given subject or chosen topic area [22]. At the end of the study, it was emphasized that the prepared sections should be carefully read by the educators and put into practice in their lessons. In addition it was also pointed out that it should be preferred in order to communicate effectively with students by interacting in real time, especially during the pandemic process.

#### **5. Conclusion and suggestions**

In this research, a detailed analysis of the augmented reality environments and applications that are frequently used in the design of learning and teaching environments in the education sector with the digitalization process is included. As the general results of the research; today, with the introduction of technologies into educational environments, different tools and materials have begun to be used in teaching methods. In this context, it is seen that the inclusion of mobile tools and mobile applications in learning environments has become widespread recently. With this rapid development in mobile technologies, new media environments, in which interactivity increases, offer an increasing number of services to the user. One of the environments where this interaction is provided and which can integrate objects in virtual environments with real objects is technologies that offer “Augmented Reality (AR)”. These technologies allow virtual objects to be superimposed on real images. AR tools consist of camera, computer infrastructure, a marker and tangible objects.

One of the most important sectors in which augmented reality technologies are used is the education area. Augmented reality applications help students understand abstract concepts in the learning and teaching process; it provides environments where students can share information within the group. In addition, it has been supported by studies in the literature that these environments significantly increase students’ learning. In addition, it was emphasized that augmented reality increases the interests, motivations and experiences of students in the field of education and plays a role in transferring the knowledge and skills gained in the virtual environment to real environments.

In all this context; increasing the use of learning environments of augmented reality environments and applications, where the effectiveness of its use in education has been determined to this degree, in different levels and course contents is the most important suggestions of this research.

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