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## Interdisciplinary Take on Augmented Reality

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### Abstract

This publication attempts to show the interdisciplinary nature of augmented reality. With the development of technology and the widespread use of smartphones, there has been a great development of AR technology. This technology, due to its universal nature, is used in various spheres of everyday life. Discussing the interdisciplinary nature of this technology within the scope of this publication, the author focused on the possibilities of its use in education, medicine and marketing. By pointing out practical examples of the use of AR, the author will show how this technology is entering everyday life. The choice of the areas indicated is intended to show that AR technology will be used by the majority of society in the future. This is due to the fact that this technology has great prospects for development with particular emphasis on the areas mentioned.

**Keywords:** augmented reality, education, technology, AR in medicine, AR in marketing

### Introduction

With the development of technology, particularly telecommunications technology, which uses increasingly modern devices no longer referred to as phones but as “smartphones”, the use of augmented reality (AR) has entered everyday life with a “bang”. The rise of AR and its practical use has certainly also been influenced by the popularity of the game *Pokemon Go*, which in 2016 became a global hit in the games market in less than a few weeks (Siwak, 2016, p. 365). The opportunity to use AR in this case is contained within the broader realm of entertainment. It is just one way of using this form of information sharing. For, in fact, AR technology has its applications in various areas of life. With this in mind, the main purpose of this publication is to review the possibilities of using AR technology in relation to education, medicine and marketing. These areas have been chosen because of the wide range of their impact on society.

### **The subject matter of the study**

In the first part of the paper, the issue of augmented reality will be analysed, followed by the author's review of the possibilities of its use in order to emphasise the interdisciplinary nature of the technology in question. Particular emphasis will be placed on the role of AR in education, where the possibilities of using this technology are numerous. Whether we are dealing with primary or tertiary education, AR can be an interesting way to make the traditional learning process more attractive and quality enhancing. Next, the author discusses the possibilities of using HR in medicine, pointing out the possibility of using this technology in both theoretical and practical terms. In the last part of the paper, the author will characterise the possibilities of using AR in marketing.

### **Research methodologies and tools. Selection and characterisation of the research method or literature**

The author will base his research in the context of reviewing the possibilities of using augmented reality technology on a literature search, during which he will focus on analysing available scientific publications and online sources.

Issues related to the use of AR are of interest to researchers all over the world, so the author will base his analysis on both Polish and foreign literature. Particularly important in the analyses conducted on the interdisciplinary nature of AR is the use of foreign literature. This is due to the fact that the use of AR technology in practical terms is definitely more developed in the USA. A corollary of this, is that there is a far more extensive literature that describes the use of AR.

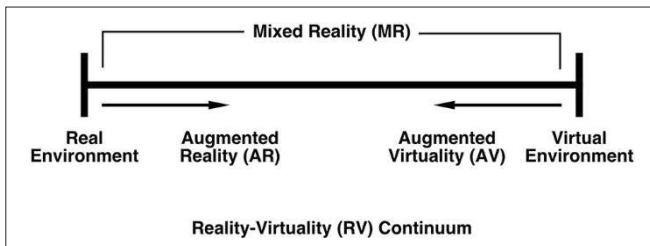
The combination of foreign and Polish literature will allow the topic to be treated comprehensively, which will give the author a good overview of how AR is used in the areas discussed. It will also contribute to a better identification of the directions of development of the discussed technology in the future.

### **Results of analyses of the possibilities of interdisciplinary use of augmented reality**

When considering the possibilities of using AR in an interdisciplinary manner, it is important to start by defining what the technology actually is. In the literature on virtual reality, the most commonly cited definition is the one developed by Pardel (2009, p. 35), who believes that AR is "an area of scientific research in computer science that deals with combining images of the real world with elements created using information technology. Augmented Reality does not create a virtual, complete, new 3D world (like virtual reality, Virtual Reality, VR), but extends and supplements the one we know".

From an analysis of the definition cited above, we can conclude that augmented reality is intended to complement the image of the real world around us

by a so-called information layer. This layer is superimposed on physically existing objects in the real world. These objects form the background for the message generated using virtual reality. It is worth emphasising at this point that the role of this background is crucial, as AR cannot exist without reference points in the real world. Also noteworthy is the fact that the literature emphasises that the information presented using this technology is close to the real world view of the presented world. This is undoubtedly a great advantage in that we do not treat AR as a “virtual world”, but as a complement to reality, aimed at stimulating interest and curiosity. This advantage is very often emphasised in the literature on the subject; many authors, when attempting to define AR, refer to the “Mixed reality” diagram developed by Miligram and Kishino (1994, p. 1323).



**Figure 1. Milgram and Kishino’s reality-virtuality continuum**  
(adapted from Milgram et al., 1994).

In this chart, physical reality is placed at one end of the scale, while virtual reality is placed at the opposite end, with AR and augmented virtuality marked in the middle of the chart. The positioning of the technology of interest in this article shows that it is definitely closer to the real world than virtual reality. Another aspect that distinguishes AR is the generation of an information layer in real time, a feature that distinguishes this technology from others. This approach can be found, among others, in the work of Carmigniani, according to whom AR is “a real-time direct or indirect view of a physical real-world environment that has been enhanced/augmented by adding virtual computergenerated information to it” (Carmigniani et al., 2011, p. 342). Another feature of augmented reality worth pointing out in the context of this publication is that, as discussed in Warchol’s publication, defining AR as primarily the visualisation of objects is too narrow. This author points out that this technology is also the ability to perform activities previously designed by the designer (Warchol, 2016, p. 185).

### **AR in education**

With the development of AR, more and more new application solutions are being created and used in various areas of human existence. The use of this technology in education is particularly interesting. According to Keşy (2017,

p. 127), the increased interest in augmented reality as a supplement to the traditional educational process is due to its great visualisation possibilities. These possibilities can be used, among other things, in the study of human anatomy, the design of complex technical devices or even in spatial geometry. The learning process at each level should involve the use of a variety of teaching methods and resources. With help in this case comes AR, which can make education at each level more attractive by illustrating something that is not easily presented on the pages of a textbook. Such textbooks can contain “markers” that, when scanned by, for example, a smartphone with the appropriate software, will give us complementary multimedia information (Postawa, 2018, p. 114).

There are two forms of AR in education, one is information-locative and the other is vision-based. The former offers learners digital multimedia to navigate through a physical area using a smartphone equipped with GPS. Graphics, text, audio or 3D models are used to extend the physical area in order to narrate or provide scientific information about a location. Vision-based AR, on the other hand, presents learners with digital media only when the camera of their smartphone is pointed at an object with, for example, a QR code (Postawa, 2018, p. 114). The forms described take advantage of the several possibilities available through the use of a smartphone (camera, GPS, traceability) to supplement the real world with an additional layer of information, which creates a very attractive opportunity to provide content to support teaching and learning.

The use of AR in education, due to its unique nature, has interdisciplinary potential. The technology is already being used in teaching subjects such as mathematics, biology, physics, chemistry and astronomy as part of primary education (LEE, 2012, p. 14). Also in history education AR finds its application, in this case it can be used as a technology to develop content in a textbook and as a guide to historical cities and museums (Dejanka, 2012, p. 31). In addition, the mentioned technology can be used during field history lessons. An example of the aforementioned didactic intentions is the project “Warsaw 44 – tracing the Warsaw Uprising by mobile phone”, which can link selected places in Warsaw to the events of that period. The project Guide. Lublin 2.0, which also plays an educational role (Laskowski, 2013, p. 39).

The use of AR technology is also finding its way into higher education, where students can improve their skills in complex theories or mechanisms thanks to this highly efficient technology. Liarokapis, for example, has shown that complex mechanisms and theory can be taught to students using AR technology by making them more understandable. He used AR technology when discussing the construction of a valve train, where, thanks to a contextually enriched presentation, he discussed a 3D model of the valve train using real engine components (Liarokapis, 2004, p. 13). Another translation of the use of AR in higher education is the teaching of human anatomy in medical science. An exam-

ple of a solution dedicated to medical science, among other things, is the augmented reality-based iSkull app. This application offers the possibility to study the structure of the human brain thanks to a so-called 360 view.

The use of AR technology in higher education is particularly evident in areas where it is important to combine both theoretical and practical knowledge. Technical and medical sciences are prime examples of this, and it is significant that AR technology can support both the learning process and the real world. This dual use of AR technology is particularly evident in the medical sciences, where it can also be used to guide surgical procedures or operations. The possibilities for the use of AR in medicine are extensive and therefore worth analysing in more depth.

### **AR in medicine**

AR-based technology support in the medical professions is a very popular activity. Already at the level of medical studies, this technology for presenting content is being used, which is really only an introduction to the extensive use of AR in medicine. In addition to the education process and, later on, the training process of medical personnel, AR can have many important applications. The technology can be used to support or replace the senses of its users through the use of sensory substances. With its use, it is possible to assist visually impaired users or those with low vision based on the use of auditory cues. Similarly, it is possible to assist the deaf-blind, who can perceive the external world in a wider range thanks to visual cues (Carmigniani et al., 2010, 342).

AR technologies, due to the wide range of applications they offer, are also playing an increasingly important role in diagnostics and in supporting the healing process. According to Pereira (2019, p. 760), healthcare solutions that make use of AR have made significant advances in the context of providing high-quality diagnosis or treatment support. In addition, AR supports the development of preventive medicine, through the use of online consultations, the doctor is able to conduct real-time surveillance of the patient which, among other things, increases the possibility of detecting tumours (Omarov, 2022, p. 9854). The development of the use of AR in Poland is definitely still in its infancy and is definitely only gaining momentum. It is true that the Polish medical market and technology are catching up with solutions adopted in the West, although the prevalence of AR use is much lower. While Polish centres are tentatively starting to make use of AR, more than 200 hip and knee replacement surgeries have already been performed in the United States, using the ARVIS augmented reality-based orthopaedic navigation platform. This platform uses information that is collected by tracking cameras and presents it on a 3D display combined with a hands-free interface. This tool was recently approved for commercial use by the US Food and Drug Administration (Medicalpress, 2022). In addition, the

development of AR-based m-health services also supports the medication dosing process through greater supervision and supports rehabilitation processes, which has been improved through the use of this technology (Ara, 2021, p. 845).

Such a wide range of possibilities for the use of AR technology in medicine will certainly influence its use in the future, not only in the operating theatre but also in doctors' offices supporting the process of diagnosis or teleoperation. Market Research Future analysts predict that the augmented reality market in healthcare will reach a value of more than \$11.6 billion by 2030. The average annual growth rate in the coming years will remain at over 28 per cent (Medicalpress, 2022).

### **AR in marketing**

The use of augmented reality also has significant business potential in the context of marketing activities. Companies using augmented reality in the promotion of their products can improve the quality of sales, both in relation to traditional sales channels and in e-Commerce. The increased interest in using AR technology to promote products is linked to the development of mobile marketing and the popularisation of the use of smartphones. This situation has created an environment in which AR applications can be freely created and developed (Gabajova, 2021, p. 42). The use of AR provides the opportunity to obtain more complete information about a product by using additional layers of data that can contain any useful information that can be read when viewing the product with a smartphone or other mobile device with an embedded camera. For e-Commerce, augmented reality can become a tool for detailed examination of goods by the potential buyer in terms of their usability (Vilikna, 2022, p. 58). A popular example of the use of augmented reality in e-commerce is IKEA's "IKEA Place" app. Using the camera on a smartphone to scan an area in a room, this app provides the opportunity to place the furniture offered by IKEA in the room. The user of this app will be able to see, free of charge, how the products offered by the aforementioned company fit into the layout of the flat (Delante, 2022).

### **Conclusions**

In conclusion, the use of virtual reality in the areas of life cited in this publication has a great deal of potential for use. The use of AR in education is a solution that is increasingly boldly entering the teaching of various subjects at every level of education. There is great potential in the development of this technology in the context of education, which will influence its greater use in the teaching process. In the opinion of the author of this publication, the prospects for the development of AR in education are very high and this technology should be used more and more boldly in the teaching of more subjects.

Augmented reality in medicine is actually already a thriving industry, the development prospects of which are described in this publication. This technology will certainly become more popular in Poland in the future in line with trends in the United States. These trends in the use of AR accelerated during the COVID-19 outbreak, when there was a surge in demand for this technology in North America. As a result, the author predicts that the level of interest in the technology in question in the broader medical field will also increase significantly in the coming years.

In a highly competitive market, companies wishing to increase their sales and thus their profits must use ever more modern methods of reaching the customer's imagination. The answer to these needs is definitely the popularisation of the use of AR technology in marketing activities. Therefore, in the opinion of the author of this publication, the potential for the development of AR technology in marketing activities is also high, especially at a time when market saturation with this technology is not yet so high, and the need to stand out from competitors is constantly growing.

In conclusion, this publication presents the interdisciplinary nature of augmented reality technology, demonstrating that the technology has very high development potential. The projected development of AR technology in the sectors discussed will make the technology an indispensable element of human life in the future. This prediction is supported by the fact that the Augmented Reality (AR) Industry is already being talked about globally. And the interdisciplinary nature of this technology will be an advantage that will give AR the opportunity to grow in other fields.

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