

Augmented and Virtual Reality in Education

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Abstract: *Technological advances have enabled the sustainability and desirability of augmented and virtual reality in many domains. When it comes to their application in education, it should be noted that they provide new models of learning that better meet the needs of modern society. The paper presents an overview of previous research on augmented and virtual reality in education. By reviewing and analyzing related works, relevant results were obtained on the application, benefits, and impact of augmented and virtual reality on the educational process. The paper aims to examine the importance of introducing augmented and virtual reality in education based on the analysis of the results of previous research and to present the reasons for the justification of their application, which will become a reality shortly.*

Keywords: *augmented reality; virtual reality; education*

1. INTRODUCTION

Augmented reality and virtual reality are modern technologies that are developing rapidly. While augmented reality is a technology that offers reality modified by computer-generated data, virtual reality is designed to replace reality with simulated data of various kinds. Their educational potential should be used to transform teaching methods and learning styles.

Virtual reality is defined as a set of technologies used to synthesize an authentic set of visual, auditory, tactile, and other sensory experiences, to provide the illusion that virtually non-existent things defined and stored only in computer memory can be seen, heard, touched, and felt some other way. This creates an interactive interface between man and virtual worlds. On the other hand, augmented reality means the real world that is expanded by computer-generated data and objects. This technology allows computer virtual images to accurately capture real-world physical objects [1].

Public interest in virtual and augmented reality is growing in both the business and social worlds. Although the concept of these technologies is not up to date, they have not yet become something that is known to everyone and has mass use. In many more developed countries, the benefits of these technologies are used in various fields such as tourism, industry, architecture, construction, military, and medicine. However, the existence of a large number of papers suggests that education is one of the most promising areas for the use of augmented and virtual reality technologies, which is one of the motives for writing the paper.

2. LITERATURE REVIEW

Although the interest in augmented and virtual reality in education has been current for many years, not much research is available that combines these two technologies. Based on the review and detailed analysis of the available literature, several relevant recent papers in this field have been singled out.

In the paper entitled "Application of virtual and augmented reality technology in education", the authors Mitrović K., Jakšić A., Čuričić J., Bogojević B., and Gračanin D. analyze the potentials of virtual and augmented reality in education. As a result of their research, the authors cite the growing application of virtual and augmented reality technologies in education and recommend measures to improve the educational process using these technologies [1]. Elmqaddem N. author of "Augmented Reality and Virtual Reality in Education. Myth or Reality?" talks about the reasons for the increase in the use of augmented and virtual reality in education. He also states why the application of augmented and virtual reality in education is one of the ways to improve teaching and learning, as well as why they are more suitable for 21st-century students [2]. In the paper entitled "Virtual and Augmented Reality in Education", the authors Gudoniene D. and Rutkauskiene D. present a model for the development of integrated learning objects, based on the approach of virtual and augmented reality that can be integrated into other educational content. The paper presents a review of the literature on virtual and augmented reality and provides an analysis of integrated models for the implementation of the educational process [3].

Authors Daniela L. and Lytras M. talk about the transformations in the learning process that occur due to the application of augmented and virtual reality technologies in education in the paper entitled "Editorial: themed issue on enhanced educational experience in virtual and augmented reality" [4]. The author Siegle D. in his paper entitled "Seeing Is Believing: Using Virtual and Augmented Reality to Enhance Student Learning" presents the results of the application of virtual and augmented reality and highlights the many benefits of creating interesting and interactive content that enhances the learning process [5]. Empirical research comparing virtual and augmented reality technologies depending on their impact on learning outcomes is presented in the paper "Augmented Versus Virtual Reality in Education: An Exploratory Study Examining Science Knowledge Retention When Using Augmented Reality / Virtual Reality Mobile Applications". The authors of this paper, Huang K. T., Ball C., Francis J., Ratan R., Boumis J., and Fordham J., conducted research using a mobile application through which digital content was presented to students using both technologies, and then an analysis of the technology provided better results in terms of the adoption of the presented content [6]. The possibilities of applying augmented and virtual reality in collaborative learning is presented in the paper "A Review on Collaborative Learning Environment across Virtual and Augmented Reality Technology" by Wanis I. A. and Nur Affendy N. M. [7].

When it comes to the application of virtual and augmented reality in primary education, works with significant research results can be singled out: "Comparative evaluation of virtual and augmented reality for teaching mathematics in primary education" by Demitriadou E., Stavroulia, KE. and Lanitis, A. [8] and "Challenges and Prospects of Virtual Reality and Augmented Reality Utilization among Primary School Teachers: A Developing Country Perspective" by Alalwan N., Cheng L.K., Al-Samarraie H., Yousef R., Ibrahim Alzahrani A and Sarsam S.M. [9].

Most related research relates to the application of augmented and virtual reality in higher education. Some of them that will be the subject of analysis in the part of the paper related to results and discussion are: "Experiential learning through Virtual and Augmented Reality in Higher Education" by Jantjies M., Moodley T. and Maart R. [10], "Use of Augmented and Virtual Reality in Remote Higher education: A Systematic Umbrella Review" by Nesenbergs K., Abolins V., Orman is J. and Mednis A. [11], "Virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first-century skills "by Papanastasiou G., Drigas A., Skianis C., Lytras M., Papanastasiou E. [12], and "Augment reality and virtual reality for the improvement of spatial competencies in Physical Education "by Gómez-García M., Trujillo-

Torres J., Aznar-Díaz I., and Cáceres-Reche M. [13].

3. RESEARCH METHODOLOGY

3.1. Subject and goal of the research

A review and analysis of existing research on augmented and virtual reality in education is the subject of research. The systematic search of the e-repository aims to obtain as much published research literature relevant to the field of research, and then perform their analysis and present the research results.

The research aims to systematically review and analyze the published relevant literature to examine the application of augmented and virtual reality in education, point out the importance of introducing these technologies and present the reasons for their justification. By the set goal of the research, it is possible to single out the following research questions:

- What is the time distribution of published papers dealing with the research of the application of augmented and virtual reality in education?
- What do previous studies on the application of augmented and virtual reality in education show?
- What are the advantages of augmented and virtual reality in education based on the relevant literature included in the research?

3.2 Search process and selection of relevant literature

The paper uses the method of a systematic search of electronic databases. Namely, three e-repositories "ScienceDirect", "Google Scholar" and "ResearchGate" were selected and the relevant literature was searched. During the search, the criteria were set for the works to be published in the period from 2017 to 2021, while the query used for the search was formed by entering the keywords "Augmented Reality and Virtual Reality", "AR and VR", and "augmented and virtual reality". By reviewing the obtained search results, the selection of those papers related to education was made.

The primary search of the e-repository yielded 42 results. After excluding duplicates, there were 36 left. To answer the research questions, the suitability of the obtained results was examined according to the following criteria:

- availability of work in full in English or Serbian,
- review papers on augmented and virtual reality in education,
- works on the application of augmented and virtual reality in education.

During the examination of the suitability of the obtained results according to the given criteria, 29 papers were excluded.

4. RESULTS AND DISCUSSION

The process of searching and selecting relevant literature shows that a lot of research has been done on augmented and virtual reality in education. Although the earliest research on the introduction of the mentioned technologies in education was divided, the newer ones testify to the numerous advantages of their application. Also, what can be concluded based on a systematic review and analysis of previous research is that augmented and virtual reality are technologies that reach maturity, as evidenced by the growing number of areas in which they are applied. Based on the review and analysis of previous research, the answers to the research questions will be explained through the results and discussion.

In response to the first research question "What is the time distribution of published papers examining the application of augmented and virtual reality in education?", A tabular overview of papers included in the research classified according to the year of publication was created (Table 1).

Table 1. Papers included in the research by years of publication

Year of publication	Review of papers
2017.	[17] [21] [22] [28]
2018.	[10] [13] [19]
2019.	[2] [3] [4] [5] [6] [7] [12] [15] [20] [24] [26] [27]
2020.	[1] [8] [9] [11] [14] [16] [18] [25]
2021.	[23]

The obtained search results from the previously mentioned e-repositories show that most of the papers were published during 2019, and it can be concluded that at that time there was the greatest interest in the field of research. The number of published papers is decreasing in 2020, while in the current 2021 only one paper was published. During the process of searching and selecting relevant literature, following the selected selection criteria, it was noticed that in several recent works there is a separation of augmented and virtual reality technologies, ie, authors prefer to research the application of one of these technologies. Consistent with this observation, future research should be limited to research on one of these technologies.

The answer to the second research question: "What do previous researches on the application of augmented and virtual reality in education show?", required a review and detailed analysis of works based on which they were categorized depending on the degree and field of education. The categorization includes only those words that describe the application of augmented and virtual reality in education in whole or in part. Figure 1 presents the percentage of selected works by the

level of education, while Figure 2 presents the share of selected works by field of education.

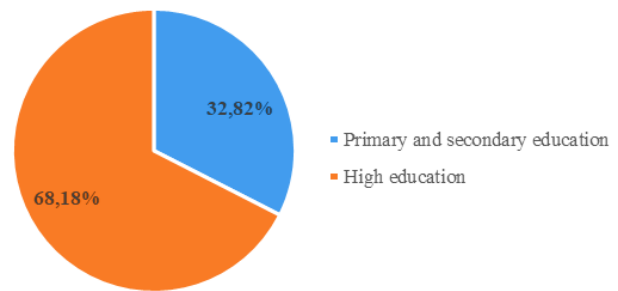


Figure 1. Share of selected references by the level of education

The categorization of papers according to the level of education shows that there is a much larger number of published papers on the application of augmented and virtual reality in higher education, compared to primary and secondary. As the papers mainly present the real results of research conducted in various higher education institutions around the world, it can be concluded that the application of augmented and virtual reality technologies is more prevalent in higher education.

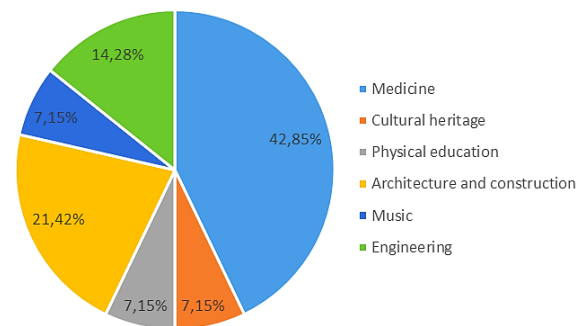


Figure 2. Share of selected references by field of education

The categorization of works according to the field of education shows that in terms of the application of augmented and virtual reality in education, the field of medicine is the most researched. As for other areas of education, the results show that there is a much smaller number of published papers, however, as the papers are mostly more recent, an increase in interest in research in other areas of education can be expected.

The third research question: "What advantages of augmented and virtual reality in education can be distinguished based on relevant literature included in the research?", requires a synthesis of the advantages presented in the works covered by the research. Based on the relevant literature included in the research, the most significant advantages of augmented and virtual reality are:

- The ability of virtual reality technology to offer immersive alternative reality, while augmented reality technology can upgrade existing reality so that the physical world and all accompanying

real and virtual objects are perceived as existing in the same place [27];

- Improving literacy in the digital age, creative thinking, communication, collaboration, and problem-solving [11];
- Improving traditional curricula to meet different learning needs of students [11];
- Enabling new types of learning through practical experience in different educational fields, using augmented and virtual reality technologies to simulate such learning environments [17];
- Promoting decision-making when interacting in a virtual environment, providing independence in researching and understanding complex concepts [1];
- Ability to adopt a system of collaboration in different applications that allow multiple users to work together in one common space and task [7].

5. CONCLUSION

The purpose of the review paper is to present the author's approach and examples of the application of augmented and virtual reality in education. A brief, representative overview of published papers is given, to examine the possibility, advantages, and impact of the application of virtual and augmented reality technologies in education. Examining and analyzing papers published in this field, it is concluded that there are promising results that indicate that the application of augmented and virtual reality technology improves learning outcomes and brings many benefits to various fields of education. Also, it was noticed that in future research it is necessary to separate these technologies and investigate their individual potentials in education.

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