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Augmented Educational Reality: Integrating AR Technologies into the Future Learning Process

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Abstract: In today's educational landscape, augmented reality opens up new perspectives for transforming learning approaches. The integration of augmented reality through AR technologies into the future educational process is defined not only as a technological step forward but also as a step towards innovative, more effective learning adapted to the needs of the modern world. The integration of augmented reality technologies into the educational process contributes to the improvement of

teaching methods, providing interactive and immersive learning environments. This, first and foremost, enhances the motivation of education seekers, fosters creativity, and improves the quality of education in educational institutions. The purpose of this study is to analyse and systematise the features of integrating AR technologies into the future educational process and identify trends in their further development. The following research methods were used: analysis, synthesis, and systematisation of literary sources; inductive method. Data from various sources were summarised, classified, and analysed to identify trends in the further integration of AR technologies in education. The results of the study confirmed the wide range of opportunities that open up as a result of the use and integration of AR technologies into the future educational process. The analysis showed both the advantages and disadvantages of using AR technologies, highlighting the potential of these technologies. The study revealed the current state of integration of AR technologies into educational processes. The current trends that determine the directions of further integration of AR technologies in the future educational process are highlighted, paying attention to the key aspects of the development of these technologies in the modern educational environment. The conclusions emphasise the importance of integrating AR technologies into the future educational process, which opens up a wide range of opportunities for improving the quality of education. The need for further research and improvement of these technologies to ensure their effectiveness and accessibility in the educational sphere is emphasised. In further research, it is important to investigate in more depth the impact of AR technologies on the learning process of different age and educational groups. Also, studying the optimal methods of implementing AR technologies and their impact on the formation of the learning environment is a key area for future research.

Keywords: AR technologies, artificial intelligence, augmented reality, educational process, innovations, integration into the educational process, immersive technologies, trends, features

Introduction

In today's society, the development of information technology actively affects all spheres of life, including the educational process. Augmented reality is defined as a technological approach that allows you to interact with the real environment, supplementing it with virtual objects and information. The integration of AR technologies into the educational process opens up new prospects for improving the effectiveness of education and ensuring a deeper learning experience (Abad-Segura et al., 2020).

The relevance of the topic of augmented reality and its integration into the educational process is determined by the rapid development of information technology and the ever-growing demand for modern, innovative methods in education. The use of AR in education allows solving important tasks of modern learning, such as individualisation of learning approaches, activation of cognitive activity of students, and increasing the efficiency of knowledge acquisition by creating immersive learning environments (Alexov & Didyk, 2023). The ability of AR to transform the traditional learning process by providing students with the opportunity to interact with virtual objects and scenarios determines its importance as a tool for achieving a high level of pedagogical success and meeting the requirements of the modern educational environment (Belda-Medina, 2022). Such technological integration also meets modern socio-cultural and economic challenges, creating the preconditions for the formation of flexible and adaptive educational systems that promote the deep and balanced development of the cognitive, creative, and intellectual potentials of students (Calabuig et al., 2020).

Many authors and researchers have studied the theoretical and practical aspects of integrating AR technologies into the educational process. In particular, the study by Amores-Valencia et al. (2023) aims

to analyse the impact of augmented reality on the academic performance of secondary school students, taking into account gender characteristics and students' attitudes towards this technology. Using a mixed-methods study involving 321 students, they found that the use of augmented reality led to improved academic performance. The results indicate the potential benefits of integrating this technology into the educational process, with no significant differences between the genders of students.

Alexov and Didyk (2023) focuses on virtual and augmented reality technologies, tracking their potential in the educational process for training future professionals. This study is based on a review of the development of virtual technologies and game simulators, identifying the main virtual reality technologies in the field of information technology. The analysis of virtual reality programmes, together with a remote survey via Google Forms in the Khmelnytskyi region, aimed to determine the readiness of society to introduce these systems into the educational process.

In their study, Perifanou et al. (2023) analyse the views of teachers on the use of augmented reality in education by interviewing 93 teachers from different countries. The acquisition of digital skills to support pedagogy in an appropriate infrastructure is identified as an important condition for successful teaching using AR.

A study conducted by Marrahi-Gomez and Belda-Medina (2023) defines the role of augmented reality applications in foreign language learning, enabling learners to learn languages in a more engaging way using modern electronic devices.

The study by Kirikkaya and Başgöl (2019) examined the impact of using augmented reality on students' academic performance, motivation, and attitudes towards studying natural sciences in a science course. The "Solomon's Four Groups Model" was used, which included two experimental and two control groups. The experimental groups used mobile AR applications during their studies, while the control groups used traditional methods.

Iatsyshyn et al. (2019b) highlighted the advantages and disadvantages of augmented reality in education, emphasising its importance in shaping the creative self-development and self-realisation of students, as well as in developing various life competences. The authors' study notes that the use of augmented reality technology for educational projects can help increase students' interest in the material, develop new competencies, increase motivation for independent learning and cognitive activity, and create conditions for personal and professional growth.

A study by Belda-Medina (2021; 2022) analysed the possibilities and limitations of using augmented reality (AR) in second-language teaching, highlighting its potential as a transformative technology, not just a delivery tool in teacher education programmes. The study involved 229 students from the Faculty of Education at the University of Alicante who developed 47 AR projects for teaching English to children. The results showed that while teachers may lack practical training in creating and implementing AR content, their attitudes towards AR integration were very positive, particularly in terms of attention to learners, collaboration, and enjoyment of collaborative learning.

Wen et al. (2023) conducted an experiment in an elementary school that showed that while academic performance did not differ statistically significantly when using AR, students' independent learning and creative thinking skills improved after participating in QIMS-based research activities. The integration of QIMS and AR proved to be particularly beneficial for students with low academic performance, while the study results did not indicate a significant impact on critical thinking and effective knowledge creation skills.

In their research paper, Kamińska et al. (2023) revealed the basic concepts related to augmented reality and focused on current trends and challenges that arise when integrating it into the educational context in the fields of life sciences, engineering, and healthcare. All sections of the article are devoted to discussing the relevance of using the best features of augmented reality and their potential contribution to achieving positive educational outcomes.

Thus, the study of the integration of AR technologies into the future educational process was conducted by various authors and proved to be quite complete and informative.

Despite the achieved results in researching the integration of AR technologies into education, trends related to adapting to the technology's own development, innovative changes in educational programs, and the interaction between educators and learners in the field of virtual learning remain insufficiently explored. Further research in this direction can contribute to understanding and considering these aspects to achieve maximum pedagogical effectiveness.

The results of this study have practical significance for educators, policymakers, and educational technology developers, as they provide information that identifies key aspects for developing strategies to improve the learning process and enhance the quality of education using AR technology.

Research Problem

The research problem lies in the necessity of clearly defining the possibilities, advantages, and current trends of integrating augmented reality technology into the educational process. Unveiling these aspects is crucial for the effective implementation of innovative techniques in the educational process, ensuring increased motivation of learners, and optimizing pedagogical interaction, which, in turn, will contribute to the further development of quality education.

Research Focus

Artificial intelligence is having a significant impact on the paradigm of modern education, work processes, and methods of exploring the world (Kencevski & Zhang, 2019). It is especially important to consider the role it plays in the implementation of augmented reality in the educational process of the future. Due to the growth of data and computing capabilities, this technology has become an important tool in solving complex problems facing education and science. With the development of digital tools, they are becoming more accessible for use in various fields, including education, medicine, and engineering. It is important to know how to make the most of such opportunities to achieve the best results. Thus, the focus of this research problem is to reveal the potential and effectiveness of integrating augmented reality into the future educational process.

Research Aim and Research Question

The aim of the study is to assess the features of integrating AR technologies into the future educational process. The realisation of this goal involves the disclosure of additional tasks:

1. Identify opportunities for the use and integration of AR technologies in the educational process, analyse the advantages and disadvantages of AR technology;
2. To reveal the current state of integration of AR technologies into educational processes;
3. Identify current trends for further integration of AR technologies into the future educational process.

Research Methodology

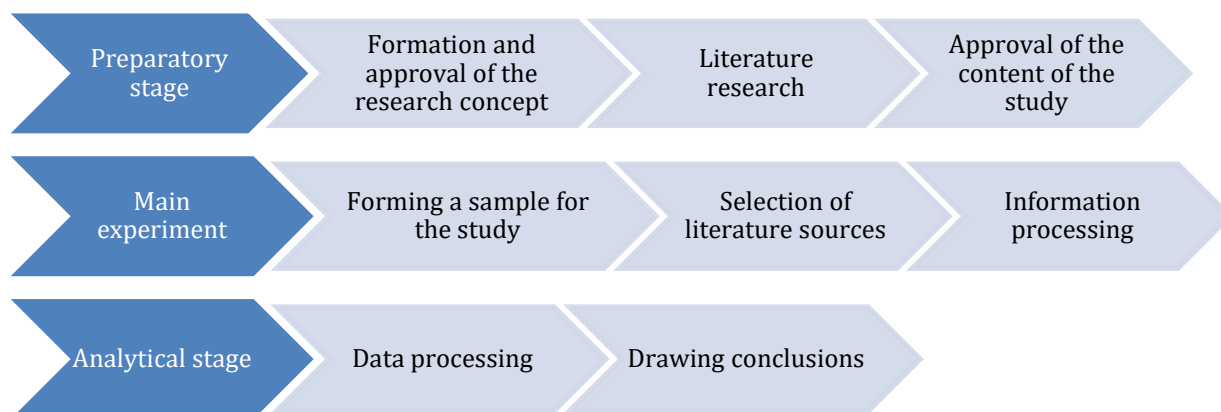
General Background

The content analysis method was used to analyse the scientific literature covering research on AR integration. Content analysis is the systematic analysis of textual scientific information to identify patterns, trends, and models in a large volume of texts.

The research scheme is summarised in Fig. 1.

Figure 1

Abstract design of the study



Thus, this approach proved to be extremely useful for summarising and extracting important insights from the large number of academic sources found during the literature search.

Data Analysis

The study used general scientific methods of cognition, such as methods of empirical analysis, synthesis, generalisation, analogy, classification, and systematisation. Critical analysis allowed us to identify authoritative sources and researchers in this area, which is an important point to include in the study's justification and increase its credibility. During the research on the impact of Augmented Reality (AR) on the educational process, it was essential to select works that provide a detailed and comprehensive overview of the topic. The choice of these works is justified by their high scientific status and relevance in the context of information technology development. The selected works cover various aspects, including the analysis of academic performance, teacher-student interactions, and the role of AR in foreign language learning. This approach allows for a comprehensive review of the contemporary scientific approach to the topic and highlights the diversity of perspectives on the use of AR in education. The systematic method facilitated the identification of application areas for AR in education, the recognition of important aspects, and the determination of general trends. The classification method helped pinpoint specific areas where AR can make a significant contribution, such as individualizing learning, creating immersive educational environments, and enhancing the motivation and activity of learners. The method of generalisation made it possible to formulate reasonable and generalised conclusions from the study and emphasise them in the context of the topic. In this study, a schematic approach was employed, which, through the use of tables, provided an overview of the advantages and disadvantages of integrating Augmented Reality (AR) into the educational process. Additionally, this method proved useful for graphically representing the global AR technology market in education at the present stage, in 2022, and a forecast for the year 2030. This visualization helped capture the growth dynamics of interest in these technologies within educational institutions. The result of the analysis and

synthesis was the identification of trends in the further integration of AR technologies into the future educational process. The comparison method was important: it allowed us to compare the data obtained with the results of other researchers. The typological method was used for qualitative processing and grouping of the information obtained.

Research Results

One of the major challenges facing modern education is the transformation of pedagogical methods. Traditional teaching strategies are proving to be increasingly inadequate to the demands of the digital society. The classical model of the lesson, where the teacher uses a textbook and gives lectures that students have to memorise for an exam, is gradually losing its relevance (Kaliraj & Devi, 2022). This approach is ineffective and inappropriate in the context of the challenges of the 21st century, especially given the widespread access to information. In the modern world, one of the most important skills is not mechanical memorisation, but the ability to quickly find, analyse and apply information in practical situations.

The constant integration of augmented reality into the educational process is becoming a key factor in improving teaching methods and engaging students.

Table 1 shows examples of how AR technologies are being integrated into the modern learning process. The information in Table 1 demonstrates the various areas of the learning process that use AR to improve the learning experience.

Table 1

Examples of integrating AR technologies into the modern educational process

Nº	Scope of the educational process	Description.
1	Healthcare	Today, it is possible to participate in virtual surgeries and other medical procedures to gain valuable experience without harming any party. Thanks to the use of augmented reality technologies, healthcare training is gradually evolving to provide a higher level of safety and efficiency.
2	Chemistry	When studying chemistry, students are given the opportunity to use augmented and virtual methods, which leads to significant changes in the way they learn. Students are able to conduct experiments, interact with substances, and learn about chemical processes based on their own experience. This not only ensures a higher level of safety but also proves to be more cost-effective than traditional laboratory experiments, as schools no longer need to pay for various chemical reagents.
3	History and geography	In the context of studying history and geography, students often show interest in stories about ancient Greece, Egypt, or Mesopotamia, but have difficulty remembering a lot of information about various aspects of life, objects, and events that are significantly different from the present. The use of augmented reality (AR) in history and geography lessons can make this process interesting and creative. Virtual tours require less time compared to traditional ones, usually from 30 minutes to an hour.
4	Physics	Physics lessons based on the study of classical mechanics and Newton's laws of motion are essential for students to develop a fundamental understanding of physical principles. However, modern augmented reality (AR) technologies can provide a unique opportunity to put these theories into practice. For example, teaching astronomy can become much more engaging by allowing students to take virtual interstellar journeys, exploring light years and distant galaxies.
5	Arts and culture	The Prisma mobile app illustrates the possibilities of augmented reality by transforming images and videos into works of art based on the styles of famous artists. This example demonstrates how AR encourages play and at the same time stimulates the study of art and cultural history. The use of virtual reality through glasses also

		allows you to remotely attend cultural events, including ballet, opera performances, and concerts, as well as virtually go back in time to watch original events.
6	Languages	The traditional method of learning a language by travelling abroad and communicating with native speakers has been out of reach for most people due to financial constraints. However, thanks to new technologies, in the future, everyone will be able to virtually “visit” countries, thus learning foreign languages and local culture on the spot.

Source: Compiled by the authors based on Al-Ansi et al. (2023); Garzón et al. (2020); Iatsyshyn et al. (2019a).

Thus, the information in Table 1 shows the peculiarities of using augmented reality (AR) technologies in various areas of the educational process. It is worth noting that AR can transform teaching methods and help improve the quality of education in various disciplines, ranging from healthcare and chemistry to art and language learning. Each field is marked by a unique approach to AR, enabling virtual transactions, chemical experiments, storytelling, and cultural events to be experienced in a virtual format. This analysis demonstrates the wide range of possibilities of AR in education and its potential benefits in enriching the educational process.

AR content can be viewed through a variety of devices, such as screens, special glasses, portable gadgets, mobile phones and various headsets. AR technology tools will eventually function similarly to mini-computers - modern smartphones. They are equipped with a processor, GPS, flash memory, RAM, Bluetooth/Wi-Fi to measure speed, angle, direction, spatial orientation, etc. The information collected by the sensors is projected in the form of digital content on the surface or displayed on an AR headset that displays the processing results. Some AR devices help the human eye to perceive virtual images, and their mirrors are designed to align the image correctly (Kaliraj & Devi, 2022). The main components required to set up an environment and create augmented reality applications can be divided into two categories: software and hardware (Table 2).

Table 2

Augmented reality hardware devices that are most often used in the educational process

№	Device	Looks like
1	Mobile devices	
2	Holographic displays	

3	Smart glasses	
4	Immersive head-up displays	

Source: Compiled by the authors based on Kaliraj and Devi (2022).

With the introduction of the latest technologies in the learning process, augmented reality (AR) has significant potential to improve the quality of education. The presentation of information in the form of virtual objects and scenarios allows for an immersive learning environment that promotes student engagement and learning more effectively. However, along with the undoubted advantages, the use of AR in education also comes with certain challenges and limitations that should be carefully considered (Table 3).

Table 3

Advantages and disadvantages of using augmented reality in the educational process

Nº	Advantages	Disadvantages
1	<i>Immersive learning - AR allows you to create interactive scenarios that immerse learners in immersive environments where they can interact with virtual objects and receive learning material in a more natural way.</i>	<i>Technical issues - poor connection quality, equipment limitations, and unstable AR applications can affect the usability and accessibility of this technology for all students.</i>
2	<i>Visualising complex concepts - AR helps to visualise abstract or complex concepts. For example, in maths, it can help to visualise three-dimensional objects or graphs of functions, making them easier to understand.</i>	<i>Cost - AR infrastructure can be expensive, including specialised devices, software, and support, which can limit the technology's accessibility to a wide range of learners and educational institutions.</i>
3	<i>Individualised learning - AR can adapt to the needs of each learner by creating personalised learning scenarios, enabling learners to learn at their own pace and according to their unique needs.</i>	<i>Distraction and dependence on technology - too much use of AR can lead to distraction from the main material and turn learning into an entertainment process rather than a learning experience.</i>
4	<i>Stimulating interest in learning - using AR lessons makes learning more interesting and engaging, as it arouses interest and activates students' attention through an innovative approach.</i>	<i>Heterogeneity of content - the quality of AR content can vary, sometimes not even meet educational needs or be of poor quality, which can affect the effectiveness of learning.</i>
5	<i>Practical applications - AR can recreate real-life situations, allowing learners to gain hands-on</i>	<i>Privacy and security issues - the use of AR may raise questions about privacy and the protection of</i>

	<i>experience in a safe environment, such as in medical or engineering education.</i>	<i>students' personal data, especially when using an internet connection.</i>
6	<i>Developing critical thinking - AR promotes the development of analytical and critical thinking skills as it requires learners to solve problems and make decisions in an interactive environment.</i>	

Source: Compiled by the authors based on AlGerafi et al. (2023); Avila-Garzon et al. (2021); Cabero-Almenara et al. (2019); Shen and Ho (2020); Takrouri et al. (2022).

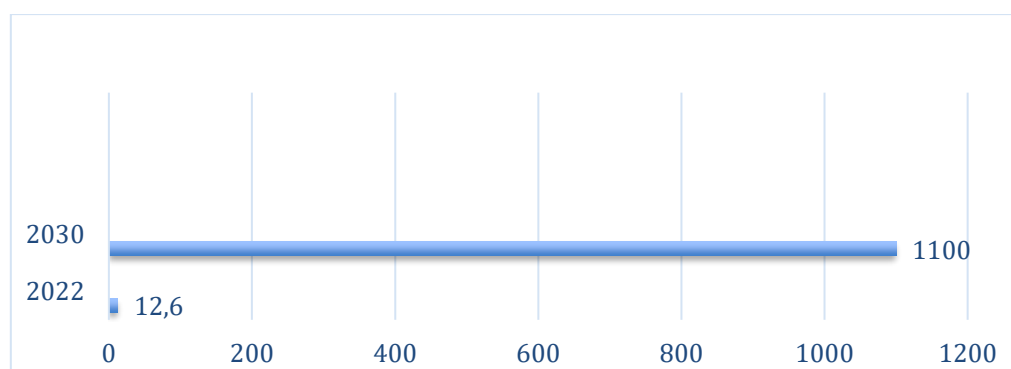
Thus, the use of AR technologies in the educational process has a number of advantages, such as immersive learning, visualisation of complex concepts, individualisation of learning, and stimulation of interest in learning. However, it is accompanied by technical challenges, cost constraints, distraction from the main material, heterogeneity of content, as well as privacy and security issues that need to be carefully considered and addressed.

To fully understand the impact of augmented reality on education, it is important to look at the global market for this technology. AR is transforming the way learners perceive knowledge, bringing innovation and interactivity to the learning process ([Calabuig et al., 2020](#)). Considering the state of AR in the global market allows us to trace and evaluate its powerful impact on the educational sphere, identify trends in the integration into learning and the development of this technology in school and university environments.

In 2022, the global market for augmented reality in education was worth USD 12.6 billion. This market is expected to reach USD 1.1 trillion by 2030, representing a CAGR of 75.7% between 2022 and 2030 (Fig. 2).

Figure 2

Global market of AR technologies in education in 2022 and forecast 2030, USD bn. US DOLLARS



Source: Research and Markets (2023).

The augmented reality market in education in the US was worth \$4.3 billion in 2022. China is projected to reach \$156.7 billion by 2030, which means a 70.7% annual growth rate from 2022 to 2030. Japan and Canada are also expected to grow by 67.2% and 63.1% respectively over this period. And Germany is forecast to grow by about 50% annually (Research and Markets, 2023).

The augmented reality (AR) market in education is thus actively developing, demonstrating impressive growth rates in terms of both volume and geographic distribution. These high growth rates confirm the importance and opportunities that AR will bring to the education sector in the near future.

The integration of augmented reality (AR) into the educational process opens up great opportunities for the future development of education.

1. Individualised learning is becoming an important trend thanks to the development of augmented reality. AR technologies allow you to create unique learning interactions, paying attention to the needs of each student. Thanks to AR, learning content can be adapted to the individual characteristics, learning style, and pace of information assimilation of each student. This technology makes it possible to create personalised scenarios where each learner can study the material according to their needs, goals, and individual level of learning (Cao & Yu, 2023; Gurevych et al., 2022). This approach creates a favourable environment for effective learning, contributing to the development of each student's skills and knowledge in the most optimal way.

2. Active development of interaction between the virtual and real worlds to enrich the learning experience. AR technologies allow creating learning scenarios in which students can interact with real objects or scenarios using virtual applications or devices (Iatsyshyn et al., 2019a). Such technologies provide unique opportunities to deepen understanding of concepts by engaging with materials or objects that were previously difficult to access or unavailable for learning in a classroom context.

3. The trend of AR technologies spreading across different platforms and devices is creating new opportunities for education. The growing availability of these technologies on various devices, from smartphones to tablets and even virtual realities, creates the possibility of their widespread use in educational institutions (Volynets, 2021; Yang et al., 2021). This allows teachers and students to use AR for educational purposes without significant technical limitations. Increasing the availability of AR on various platforms makes it more flexible and easy to use, which facilitates the integration of these technologies into the learning process and the development of innovative teaching methods while improving the learning process and the quality of education. achievements.

4. Increased cooperation between educational institutions and AR technology developers. Such cooperation is aimed at creating and improving innovative teaching methods. Educational institutions establish partnerships with AR solution developers to create visual, interesting, and effective curricula, which facilitates the introduction of advanced technologies into the learning process, allows teachers to create more meaningful lessons, and increases students' interest in learning. Such cooperation contributes to the creation of learning tools that meet the needs of the modern educational environment and contribute to improving the quality of education in general (Calabuig et al., 2020; Kaliraj & Devi, 2022).

Thus, the trends in the integration of augmented reality (AR) into the educational process reflect the great potential of these technologies in the field of education. Individualisation of learning, enrichment of the learning experience through interaction with real objects, increasing availability of AR on various devices, and cooperation between educational institutions and AR solution developers create prospects for changes in educational approaches. These trends point to a paradigm shift in education, where AR technologies contribute to a more efficient, interactive, and individualised learning process that can improve the quality of education and prepare students for the challenges of the modern world. This direction of AR development in education opens up new horizons for innovation and transformation of educational practices in the future.

Discussion

As part of the development of research in the field of AR integration into the educational process, determining the possibilities of this technology in education is a key issue. The need for a detailed analysis of the current state of AR technology integration into educational processes requires a thorough

identification and evaluation of existing approaches and their effectiveness. The growing importance of revealing current trends in the use of AR in education lies in analysing modern innovations and ideas to improve the educational process and identifying ways to optimise AR technologies to achieve maximum learning outcomes and meet future educational requirements.

The analysis of the possibilities of using AR technologies in the educational process has revealed their powerful advantages and disadvantages that require attention for effective integration. Further study of the current state of AR in education indicates the active development of this technology and the opening of new opportunities for improving the educational process. Current trends in the development of AR in education show an increase in interest and expansion of its use, in particular in the individualisation of learning and cooperation with technology developers.

Alexov and Didyk's (2023) study of existing virtual environments and game simulators revealed the interest of participants in implementing these technologies in the educational process, which indicates the growing popularity of VR and AR technologies in various fields, including education. The authors concluded that users are interested in using virtual technologies and gaming environments in education, and this can contribute to their integration into various spheres of life, including education, culture, business, and many others. It is worth agreeing with the authors' conclusions because their research was based on a thorough analysis of available technologies and their potential for implementation in the educational process. Their observations on the possibilities of integrating virtual and augmented reality into the educational process have a significant basis in scientific sources. However, it can be pointed out that the rapid pace of technology development may pose challenges to the relevance of the findings in the future. Also, limited research or insufficient generalisability of findings across different areas of education may be an obstacle to fully understanding the potential of these technologies in their full range of applications. This study, on the contrary, reveals the presence and potential of augmented reality in modern education, pointing to a wide range of possibilities for integrating these technologies into the educational process and developing innovative teaching methods.

The study by Perifanou et al. (2023) confirms that teachers' opinions and views are key to the successful integration of augmented reality into the educational process. The most important skills for this are identified as technical, pedagogical, and soft skills that teachers are willing to develop. However, some questions about the cost, safety, and ethics of augmented reality remain open. To agree with the authors, the really high cost of AR technologies is a significant obstacle to their widespread adoption in educational institutions, limiting the availability of these innovations in many educational environments. In addition, the issues of security and ethics of using augmented reality are relevant and require careful consideration before the widespread introduction of these technologies in the educational sphere. This study also emphasises the following shortcomings.

The authors Perifanou et al. (2023); Kirikkaya and Başgöl (2019) believe that integrating AR into the educational process will help to engage students, increase their interest and involvement, and promote interaction and understanding of the material. To successfully integrate AR into education, teachers need to acquire the relevant knowledge and skills, receive support and training courses, and school administrators need to promote these technologies among teachers, students, and parents and facilitate their implementation. In this context, it is worth considering that the effectiveness of Augmented Reality (AR) largely depends on the quality of the hardware. Modern sensors, cameras, and virtual reality (VR) ensure impressive visual and auditory experiences. Advancements in data processing speed, graphic quality, and adaptability to different devices are crucial aspects to provide learners with a maximally realistic and immersive experience. It is also important to note that specific

software requirements include the need to develop high-quality AR applications that align with contemporary educational approaches. Additionally, ensuring manageability and monitoring are achieved through analytics, allowing educators to track progress and adapt their teaching accordingly. It is worth agreeing with the authors, as the integration of AR into the educational process can really make learning more attractive for students, increase their engagement, and promote greater interaction and understanding of the material. However, it is important to note that successful AR integration requires not only the technical knowledge of teachers but also support, training, and adaptation of the pedagogical approach to new technologies.

The authors of Iatsyshyn et al. (2019b) emphasise that the main difficulties in using AR technologies in the educational environment are financial, professional, and methodological. Thus, it is worth agreeing with the authors that various factors are needed to introduce augmented reality technologies into the educational process. Government support and orders for the development of AR technologies contribute to their development and accessibility for educational institutions. This study also points to this need.

The results of this study contribute to a new understanding of current trends in the integration of AR technologies into the future educational process. By analysing the views and opinions of various authors on the use of AR in education, the key aspects necessary for the successful implementation of these technologies have been identified. This study contributes not only to the identification of key aspects of successful integration but also reveals strategic directions for further improvement of strategies for implementing AR technologies in the educational sphere, which forms the basis for further development and optimisation of educational processes in the future.

Conclusions and Implications

The results of the analysis of the possibilities and integration of augmented reality (AR) into the learning process demonstrate the significant potential of this technology to transform the educational environment. Identification of the advantages and disadvantages of AR technologies has revealed a wide range of opportunities that they bring to the learning process. It has been shown that AR provides interactivity, facilitates the visualisation of complex concepts, and stimulates the active participation of students in the learning process. However, the analysis also reveals certain limitations, such as technical difficulties, the availability of appropriate hardware and software, which require further development and improvement.

The current state of augmented reality (AR) integration in education reflects the impressive development of this segment. Based on data from 2022, the global AR in the education market was worth USD 12.6 billion and is forecast to grow to USD 1.1 trillion by 2030. This data indicates the strong and rapid development of AR in education, reflecting the great prospects and opportunities this technology has for the future educational environment.

A look at current trends for the further integration of augmented reality (AR) into the future learning process reveals several important aspects that are shaping new perspectives and approaches in education. Firstly, the shift towards individualised learning is becoming a major trend due to the expanding possibilities offered by AR technologies. In addition, the expansion of AR technologies across different platforms and devices is becoming another major trend. The increased availability of AR on various devices provides a wide range of opportunities for its application in educational institutions, allowing AR to be used without significant technical limitations. Finally, the growing cooperation between educational institutions and AR technology developers indicates a trend towards the creation and improvement of innovative teaching methods. This cooperation is aimed at creating effective

curricula that take into account the needs of the modern educational environment and contribute to improving the quality of education in general. These trends identify important areas for further development of AR technologies in educational processes, emphasising their importance and potential contribution to the future of education.

Suggestions for Future Research

The prospects for further research in the field of augmented reality (AR) integration into educational processes offer great opportunities for development.

In this context, there are unexplored aspects of the scientific problem that have the potential for further research.

1. Long-term impacts - a deeper study of the long-term impacts of using AR in the educational process and the development of students' skills, which may include not only academic performance but also the ability to apply the acquired knowledge in real-life situations, the ability to think creatively, etc.
2. Adaptation of teachers and students - the study of the process of adapting teachers and students to the use of AR in the educational process, which may include their readiness to use technology, the problems they face during implementation, and perception of innovations.
3. Individuality and accessibility - considering the possibilities of personalised learning through AR, as well as addressing the accessibility of these technologies for different groups of learners (including people with disabilities or learners from remote regions).
4. Evaluation of effectiveness - development of more objective methods for assessing the effectiveness of AR in the educational process, which would take into account more aspects than just academic performance.

Thus, paying attention to these aspects can help researchers gain a more complete picture of the role of AR in the learning process and its impact on students' learning and development.

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