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TEACHERS' PERSPECTIVES ON THE USE OF ARTIFICIAL INTELLIGENCE AND IMMERSIVE TECHNOLOGY IN THE PROCESS OF TEACHING GEOGRAPHY

Abstract: Artificial intelligence (AI) and immersive technologies (VR, AR) are deeply embedded in modern education and are becoming an integral part of it. The main feature of these technologies is that they allow you to make lessons interactive, making teaching methods more interesting and effective. One of the most important factors influencing the future of education at high institutions is the attitude and acceptance of teachers towards the use of these technologies in their educational practice. In this article, we will examine how successfully teachers' attitudes can be implemented in this process. While some teachers are ready to use new technologies, others may be skeptical. In this regard, the relevance of the study is to identify the possibilities of using new technologies in the process of teaching geography by analyzing teachers' opinions. To achieve the research goal, an 8-question survey was developed and conducted based on the analysis of scientific articles and Google Forms. The survey was conducted among 116 university teachers, 77 of whom were women and 39 were men. The data obtained during the study were processed and analyzed using the SPSS Base software package. The survey results highlighted the key research questions and demonstrated the potential and challenges of AI, VR, and AR technologies in improving the quality of education. In the final section, the effectiveness and difficulties of introducing these technologies into the process of teaching geography are systematically analyzed, and scientifically based conclusions are drawn on their integration.

Keywords: Immersive technology, artificial intelligence, geographic knowledge, innovation, VR, AR.

Introduction

In modern times, the prosperity of any state, the level of socio-economic development of society, and the well-being of its citizens are directly related to the quality of education in that country. As the share of qualified, professionally competent citizens in society increases, the state's global competitiveness increases and the country's economic potential strengthens. As the share of qualified, professionally competent citizens in society increases, the state's global competitiveness increases and the country's economic potential strengthens (Bógdał - Brzezińska, 2023).

Education policy is a set of comprehensive measures aimed at improving the quality of education and ensuring access to education at the national and global levels (Saulembekov A. R., 2023). Modern education policy aims to modernize the education system, supporting innovations and prioritizing their integration. The main priorities in education policy are the introduction of innovative technologies and the digitalization of the education system. The interrelationship of innovation and digitalization is aimed at increasing the efficiency and accessibility of the education system. Digitization makes the education system accessible to all participants, providing a wide range of educational resources and platforms. Innovative technology plays an important role in improving the quality of education. New teaching

methods, including artificial intelligence and virtual and augmented reality, increase student engagement by making the learning process interactive. Technological progress brings about significant changes in every era. In the era of Industry 4.0, the use of technological tools by people in various industries and environments is constantly increasing (Asmiatun et al., 2020; Bécue et al., 2021; Wendt, 2023).

The rapid development of technology requires teachers to master new technologies and teach modern lessons. One of such technologies is artificial intelligence (AI) and immersive technologies (VR, AR). Such educational technology refers to the integration of digital tools, resources and pedagogical practices to enhance teaching and learning (Gocen & Aydemir, 2020; Dignum, 2021). It includes interactive whiteboards, e-learning systems, mobile learning programs and, more recently, various platforms and devices such as artificial intelligence (AI) and augmented reality (AR) (Korinth et al., 2019*).*

The combination of virtual reality and augmented reality with AI is revolutionizing education around the world. VR and AR are not artificial intelligence in themselves, but AI has played an important role in their use in the learning process (Russell & Norvig, 1995; Tahiru, 2021; Zhang & Aslan, 2021). These technologies become more powerful and flexible when used in conjunction with artificial intelligence. These technologies can work more effectively by integrating artificial intelligence tools (Jasim Sharki et al., 2024).

Artificial intelligence (AI) stands out as an effective and accessible tool that adapts educational content to the individual needs of learners, provides visual presentation, and provides instant access to information. The term artificial intelligence is derived from the combination of the words "artificial" and "intelligence". Here, "artificial" means made by humans, and "intelligence" means the ability to think. Thus, the concept of artificial intelligence means "the ability to think made by humans" (Rangel-de & Duart 2023). In addition, the ability to flexibly restructure content and systematically track student progress allows educators to adapt teaching strategies and provide additional resources during the learning process, taking into account individual needs (Baker, T., et al., 2019). Artificial intelligence can mimic human abilities to know, reason, understand, make sense of, generalize, infer, learn and effectively multitask. There is no reason to doubt the technologies that have developed today. Augmented reality (AR) and virtual reality (VR) stand out as technologies that offer new experiences to users in the field of education (Christou, 2010; Kavanagh et al., 2017; Jagdish Deshmukh et al., 2023). However, both of these technologies have their own advantages and limitations. Understanding the differences between augmented reality (AR) and virtual reality (VR) allows to better understand their impact on the field of education. (Tira Nur Fitria 2023).

Virtual reality is a computer-generated environment that simulates reality. The definition of the word "virtual" means not physically present, while "reality" is something that you experience as a human. Thus, the term "virtual reality" basically means "close to reality" and is basically an illusion that allows them to be in a computer environment, so people can feel like they are actually there, even though they are not actually in it. VR applications aim to engage users by interacting with different senses (vision, hearing, touch, etc.) and blocking out external stimuli (Daniel Egunjobi & Oladele J Adeyeye 2024). Virtual reality technology is being used effectively in the field of education. It increases students' interest in learning by presenting knowledge in a game format and ensures their active participation in the lesson (Freina & Ott, 2015). In short, virtual reality is emerging as a new tool to make learning more effective, interesting and engaging.

Augmented reality is a current field of research for using objects such as computer models, text, and video in the real world. Augmented Reality (AR) is a technology that creates a virtual environment by integrating virtual information into the physical real world. AR not only adds virtual information to the real environment, but also to streaming videos and games, providing the user with a more immersive experience (Sutopo, 2022).

Mobile devices for students and teachers are an immediately available tool for using AR technologies. This technology has great potential and advantages in education. Its exercises enhance the learning process by clarifying the topic, increasing memory, increasing interest and satisfaction, providing the opportunity for repetition, and providing multimedia support (Yapici & Karakoyun, 2021).

Augmented Reality (AR) is a technology that combines real and virtual objects interactively through 3D elements displayed on the screen. Augmented Reality is widely used in various fields, including education. In the field of education, AR technology is used as a teaching tool to make the learning process more interesting and effective (Adami & Budihartanti, 2016). Augmented reality can serve a variety of purposes in education: from helping students to better acquire, process, and remember information, to making learning more engaging and engaging. Therefore, it needs to be engaging to achieve its goals (Demirezen, B. 2019). Augmented reality helps students master abstract and complex subjects like geography because it adds a new dimension to classroom learning (Emiola, A. G.2022).

In general, VR and AR technologies contribute to creating an interactive and realistic learning environment (Sunder Kala Negi 2024). For example, VR offers students the opportunity to directly experience and experience geographical phenomena, while AR focuses on enriching real-world geographical concepts with digital information. These two technologies can be considered two sides of the same coin. This is because with AR, people can interact with 3D objects in the real world, while with VR, they are completely immersed in a virtual world (Sidiq, M., Lanker T. & Makhdoomi K., 2017). These technologies, in turn, pave the way for the development of interactive educational materials in geographical education, the organization of virtual trips, the modeling of natural phenomena, and the increase of students' learning activity. VR and AR technologies help to create an interactive and realistic learning environment (Saduakasova**.**A., 2024). As technology continues to advance, the future of immersive learning environments holds exciting prospects (Luan et al. 2020; Ng et al., 2023; Kumar S 2023).

The purpose of the study is to comprehensively study the scientific and pedagogical possibilities of introducing artificial intelligence (AI) and immersive technologies (virtual reality - VR and augmented reality - AR) into the process of geographical education. This goal is defined by the following component areas:

- Determining teachers' perspectives: An empirical study of geography teachers' professional and psychological readiness to use AI, VR and AR technologies, their level of acceptance and attitude towards innovative technologies

- Pedagogical impact analysis: Determine the impact of the mentioned technologies on the content and quality of education, including their contribution to the mastery of geographical concepts, the development of spatial thinking, and increasing the effectiveness of teaching.

- Evaluate the impact on students' interest in the subject: Analyze the impact of immersive environments and personalized AI tools on students' enthusiasm for the subject of geography and active cognitive activity.

- Propose solutions to difficulties encountered during application: Identify technical, methodological, and organizational obstacles and provide specific methodological recommendations and practical solutions aimed at overcoming them.

Research methods and materials

This study was conducted using analytical and survey methods. In order to comprehensively describe the scientific and pedagogical potential of introducing artificial intelligence (AI) and immersive technologies (virtual and augmented reality - VR and AR) into the process of geographical education, the article is structured in two main stages.

The first stage of the study involved a comprehensive analysis of the scientific literature and previous studies on the topic, and the theoretical foundations of the research direction were identified (Wendt & Bógdał-Brzezińska, 2018; Bógdał-Brzezińska et al., 2023). Analysis of scientific articles is an important stage in studying the current state of the research field, as well as identifying the main issues and research objectives related to the research topic. Using this approach allows the researcher to form a comprehensive understanding of the established theories in this area, the methods used, and the results of previous research.

In the second stage of the study, an electronic survey was conducted among teachers of geography at higher educational institutions in order to comprehensively study the scientific and pedagogical potential of introducing artificial intelligence (AI) and immersive technologies (virtual and augmented reality - VR and AR) into the process of geographical education. The survey was prepared on the basis of the Google Forms platform and consisted of 8 questions. This platform allows you to develop a survey for free and distribute it widely through social networks and web resources, as a result of which it was possible to quickly and effectively receive feedback from a wide range of respondents.

The collected data were processed and analyzed quantitatively using SPSS Base software. This method allowed us to systematize and structure the survey results and interpret the information obtained in a clear and reliable way. In addition, based on the respondents' answers, the main directions and common trends in their views were identified. This approach allowed for a deeper understanding of the research problem in terms of content and structure, and strengthened the scientific basis of the study.

To ensure the development and effective use of these technologies and teaching practices, it is important to address the following key issues.

1.Advantages and opportunities of AI, VR, and AR technologies in geographical education. Success criterion: To systematically describe the effective aspects and functional capabilities of AI, VR, and AR technologies in the field of education based on scientific literature and previous research.

Currently, the question of what impact artificial intelligence and immersive technologies can have on geography lessons is becoming increasingly relevant. If we focus on practical examples of the use of artificial intelligence in geographical education, some universities are introducing machine learning algorithms for analyzing geographic data. For example, such programs can process satellite images and provide students with data on the state of ecosystems and climate change. And they can predict the risk of various natural disasters, such as avalanches, earthquakes, and floods. This means creating conditions for students to learn through real examples, not just learning theory, thereby making lessons more visual and interesting (https://chatgpt.com).

Another notable example is the combined use of virtual reality (VR) and artificial intelligence. With the help of these technologies, students can “travel” to different regions of the world and explore their geographical location and features, climatic conditions, and cultural geography. Such experiences not only broaden students’ worldview, but also contribute to a deeper understanding of the material. For example, in lessons on the topic of climate zones, students can see how nature changes depending on geographical conditions, which is impossible to do with traditional teaching methods. These technologies increase students' memory skills and allow them to understand the topic more deeply. In short, virtual reality is emerging as a new tool to improve learning, make it more interesting and engaging (Gizéh & Josep, 2023).

The collaboration between AR and AI is transforming the educational experience by creating immersive learning environments that engage learners more deeply than traditional methods. AR adds digital information to the real world, enhancing the learning context, while

AI analyzes data and personalizes content according to the individual needs of learners (Jasim Sharki et al., 2024).

They can provide a personalized learning experience that responds to real-time student interaction. This is where artificial intelligence and immersive technologies can take advantage of traditional teaching methods. These technologies can create a unique learning experience and increase student engagement by providing an unparalleled learning environment for students (Suchitra Labhane., 2024). AI, VR, and AR have also played a significant role in accommodating diverse learning styles and abilities. The future of these technologies in education is based on technological advancements, expanding content options, and a greater focus on inclusiveness and ethical considerations. As these technologies continue to evolve, they have the potential to revolutionize the way students learn, teachers teach, and educational institutions operate globally. These technologies are making the educational process accessible and engaging across challenging subjects, creating immersive learning environments. AI-powered gamification helps make learning more interactive and engaging (Deeksha Saraswat., 2024).

2.Applications of AI, VR, and AR technologies in geography teaching. Success Criterion: To identify specific platforms and tools that can be used in geography lessons.

When considering ways to incorporate these technologies into geography education, it is clear that the types of applications used will increase the interest and activity of teachers and students in the lesson, as well as the possibilities for its use. Therefore, Table 1 below provides a summary of the types and content of the most accessible applications and platforms in the process of geography education (Emiola, A. G. (2022)., Anubis G. de Moraes Rossetto et al.,2023., Jie Geng.,2019., Open AI. (2025). *ChatGPT* (May 2025 version).

Table 1

AI and VR and AR applications for geography teaching.

Application types	Application content
Artificial Intelligence (AI)	
Google Maps AI	Analyzing map data and exploring geographic information
Knew ton	Adapting geography materials to the student's level of knowledge
Quizlet	AI capabilities for memorizing geographical terms
Planet AI	Satellite image processing and analysis of natural phenomena
Google Maps AI	Analyzing map data and exploring geographic information
Open Street Map AI	Research of urban infrastructure. Processing of cartographic data.
Climate AI	Predicting natural disasters and analyzing climate change.
Magic School. AI platform	Helps make geography lessons interactive, data-driven, and tailored to individual needs.
Socratic by Google	Finds geographic resources and provides students with information when it is most needed.
Edmentum platform	Offers automated geography tests and quizzes, maps, charts, and climate data.
Virtual reality (VR)	
Google Earth VR	Explore anywhere in the world in VR
Google Cardboard	Virtually view geographical locations
zSpace	Interactive work with geographic models
Ocean Rift	A virtual app for exploring ocean ecosystems

National Geographic Explore	A tool for teaching geography in a fun and interactive way
	Augmented reality (AR)
Merge Cube	Display geographical 3D models (earth's crust, volcanoes).
AR Flashcards	Designed to explain geographical terms and landforms.
Augment Education	An app designed to improve students' visual perception and explain complex concepts in an easy way.
POPAR planets Smart book	An app to be used in conjunction with a special interactive book to learn about space and the solar system. This app often uses Augmented Reality (AR) technology.
Night Sky	A mobile application designed for astronomy enthusiasts and people interested in the stars, allowing you to explore the sky and get information about astronomical objects in real time.

While the artificial intelligence technology applications and platforms presented in this table help to improve the skills of geography teachers and create lessons tailored to the individual needs of students, virtual and augmented reality technologies help to create interactive and realistic learning environments. That is, in geography lessons, virtual tours using AR/VR, working with 3D models, and exploring various data using AI make the lesson more interesting and engaging. Visual materials make it easier to understand abstract and complex geographical phenomena. For example, studying the movement of tectonic plates, atmospheric processes, and the formation of relief through VR has become more understandable and interesting for students. In modern society, the introduction of artificial intelligence and immersive technologies into the educational process in secondary schools teaches students to use these tools from the very beginning of school. This experience, in turn, significantly contributes to the development of skills that are in demand in the future labor market and marketing (Vlačić et al., 2021).

3. To examine the challenges of fully integrating AI and VR/AR technologies into the educational process and explore ways to overcome them.

The success criterion for this task includes identifying the most common challenges based on survey results. The introduction of artificial intelligence and immersive technologies into the process of geographical education is a modern way to ensure high-quality and effective learning. However, there are significant challenges that prevent their full use in geographical education. Since geography is a constantly evolving science, some of the data provided by new technology applications may become outdated and inaccurate. Table 2 below presents the challenges of fully integrating AI, VR and AR technologies into the process of geographical education (Suchitra Labhane et al., 2024., Emiola, A. G.2022.,Enitan Shukurat Animashaun et al.,2024).

Table 2

Challenges of implementing AR, VR AR technologies into the process of geographical education

N	Types of difficulties	Reasons
1	Financial issues	High cost of equipment and insufficient financial support.
2	Pedagogical difficulties	Inability to use AI, VR and AR technologies or lack of experience.
3	Limited technical infrastructure	Low internet speed and lack of devices.

4	Possibility of mental problems	Prolonged use of AI, VR, and AR devices can cause eye strain, dizziness, and nervous exhaustion in some students.
5	Challenges in adapting the curriculum	Content limitation, i.e. the lack or insufficiency of ready-made content for the subject of geography.
6	The risk of people losing touch with each other	Failure to maintain a balance of use, i.e., increasing dependence on the virtual world.

To effectively implement AI, VR, and AR technologies in the educational process, we need to consider ways to overcome the challenges presented in Table 2:

- Continuously improve the skills of teachers through various interactive trainings.
- Provide financial support from the state to provide schools with modern equipment:
- Increase access to the Internet and equip classrooms with the necessary devices and equipment.
- Ensure data security and confidentiality when using AI technologies.
- Solving these challenges will allow for the effective use of new technologies in teaching geography and will direct the educational process towards innovation.

To study teachers' attitudes towards the use of artificial intelligence and immersive technologies in their teaching practices and provide effective recommendations.

We will consider conducting a survey to determine teachers' attitudes towards technology as a measure of success for this task and providing methodological recommendations or practical guidance based on the survey results.

A) Develop a teacher community and professional experience exchange network

The goal is to ensure mutual exchange of experiences, dissemination of best practices and professional support mechanisms among teachers on the effective use of artificial intelligence (AI), virtual (VR) and augmented reality (AR) technologies in geography teaching. Implementation mechanisms include creating a professional community for geography teachers, for example, establishing regular online communication by opening special groups on Telegram or WhatsApp messengers under the name “AI + Geography Teachers KZ”; and organizing monthly online meetings on the topic of “Digital Geography”. At these meetings, teachers will present their experience, introduce new methods, and exchange views on the use of digital technologies in the educational process.

B) Formation of a database of digital platforms

The goal is to develop a structured and systematic list of educational platforms based on artificial intelligence, virtual and augmented reality technologies adapted to the subject of geography. Implementation mechanisms include development of an online catalog of platforms based on AI/VR/AR technologies. This catalog should indicate the description of each platform, its methodology of use, level of accessibility (free/paid), language support capabilities and thematic areas.

This study was conducted among geography teachers in the form of an online survey based on the Google Forms platform. The data obtained were processed and analyzed using the SPSS Base software package.

Summary of the literature review

As a result of the literature review, it was found that the number of scientific publications devoted to the use of virtual reality technology in higher education institutions is quite large. In recent years, the number of scientific studies aimed at the use of artificial intelligence (AI), virtual reality (VR) and augmented reality (AR) technologies in the educational process has increased significantly. This trend clearly demonstrates not only the relevance of this direction, but also its scientific and practical value. Many studies currently

underway comprehensively analyze the impact of AI, VR and AR technologies on the educational process of students, demonstrating a number of advantages in improving the quality of their education, developing cognitive activity and increasing motivation for learning. However, there are still few works that study the advantages and effectiveness of introducing AI, VR and AR technologies in the process of teaching geography. This situation indicates that the topic has not been fully studied scientifically and is an urgent issue that requires further study (Sadvakasova, A. K., et al., 2024). Table 3 below provides a list of studies that have been specifically reviewed within the framework of the topic of using AI, VR and AR technologies in the educational process.

Table 3

Main results of the scientific works included in the review

No.	Researchers	Concepts
1	Bogusevschi D., Muntean C. & Muntean G. M.	The experiment conducted among young students showed that the use of VR makes the learning process more interesting .
2	Kornılov Iy.V., Mykasheva M.Y., Sarsımbaeva S.M.	The issues of optimal student learning using virtual reality technologies have been studied.
3	Hodgson P., et al.	They showed that VR enhances students' understanding of subjects and increases satisfaction with learning .
4.	Hamilton, D., et al.	Systematic literature review concluded that VR is generally beneficial, though a few studies reported negligible effects. One of the greatest advantages of virtual reality in education and learning is that it allows students to perform complex and dangerous tasks in a safe environment.
5.	Al-haimi B. et al.	Artificial intelligence helps students adapt to new paradigmatic learning systems, namely blended learning, location-independent and time-independent learning, and flexible learning. Thus, artificial intelligence tools optimize the responsibilities of the teacher.
6.	Serik M, et al.	In the works of researchers, it was noted that the level of creative thinking and practical skills of students increases during practical work with the help of artificial intelligence and neural networks. This study demonstrates that the use of artificial intelligence by children enhances their interest and activity in the classroom.
7.	Mukhamediyeva K.M., et al.	During the study, the authors concluded that the use of elements of artificial intelligence in STEM teachers training field provides effective opportunities. Overall, researchers explained that the use of artificial intelligence technologies, especially in STEM subjects, will open up new opportunities and change traditional teaching methods.

While the vast majority of current research focuses on assessing students' experiences with VR and AR technologies, there are few studies that directly analyze the impact of these technologies on academic achievement. In particular, it is clear that the theoretical and methodological aspects of introducing artificial intelligence (AI), virtual reality (VR), and augmented reality (AR) technologies into the teaching of geography have not been fully explored. The peculiarity of the proposed study is that it is not limited to assessing the current level of development of the research area by analyzing scientific articles, but also focuses on identifying relevant scientific and practical problems and specific tasks that need to be solved within the framework of the topic. This approach allows the researcher to form a comprehensive and systematic understanding of the theoretical foundations of the field, the applied methodological principles, and the results of previous studies.

In the second stage of the research, an electronic survey was conducted among teachers of geography at higher education institutions to comprehensively study the scientific and pedagogical potential of introducing artificial intelligence (AI) and immersive technologies (virtual and augmented reality - VR and AR) into the process of geographical education.
The survey was developed on the Google Forms platform and consisted of a total of 8 questions. It assessed teachers' access to these technologies and their level of readiness to use them in their professional activities. The effective use of AI and VR technologies in the classroom is directly related not only to technical capabilities, but also to the level of teachers' mastery of these technologies. In this regard, the survey allowed us to identify the main methodological and organizational obstacles encountered in the process of teaching geography and develop recommendations aimed at overcoming them.

116 geography teachers working in higher education institutions of Kazakhstan participated in the survey (Table 4). Of these, 77 participants were women and 39 were men (Figure 1). The collected data was processed using SPSS Base software, and the respondents' answers were subjected to quantitative analysis. This method allowed for a systematic structuring of the obtained data and a high-level interpretation of the results.

Table 4
Number of survey participants

		Statistics	
		Gender Distribution	Pedagogical qualification
N	Valid	116	116
	Missing	0	0

Figure 1
Gender of participants

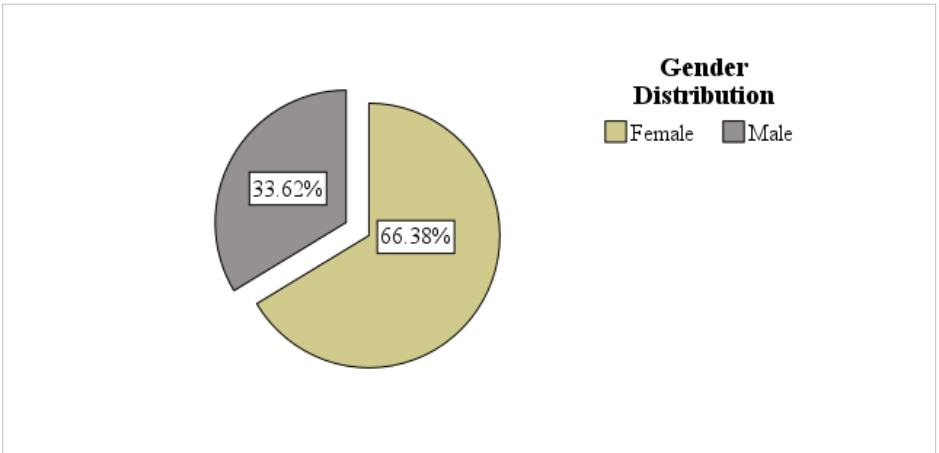
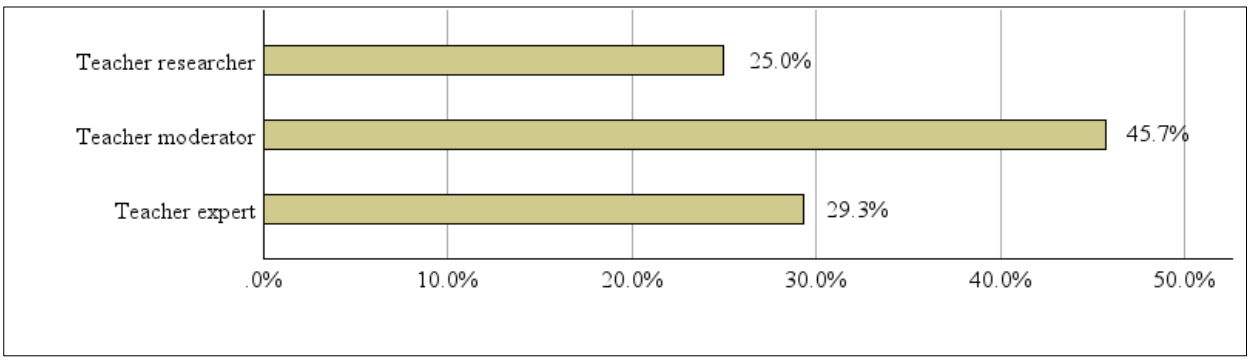


Figure 2

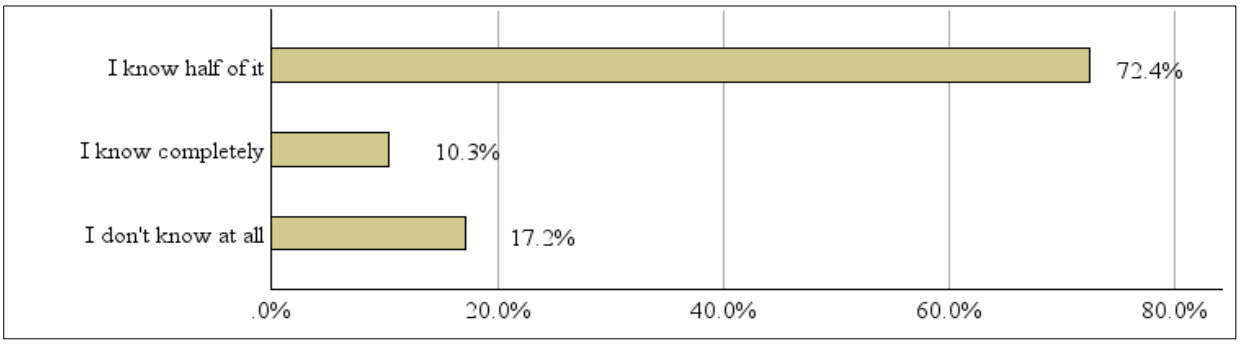
Data on the pedagogical qualifications of teachers participating in the survey «Pedagogical qualification»



The main questions and results of the survey were developed by the authors based on online surveys in the Google format.

Figure 3

How would you rate your knowledge of AI and AR/VR technologies?



As indicated in the first question above, the data indicate that teachers are not sufficiently knowledgeable about AR/VR technologies. Specifically: The majority (over 72%) are aware of these technologies to some extent, but not fully mastered, indicating that additional training is needed to effectively use them in the classroom, while 17.2% are completely unaware, indicating that AR/VR has not yet been widely introduced into geography education in high educational institutions in Kazakhstan, or its importance has not been sufficiently explained to teachers. Only 10.3% are fully aware, which indicates that very few teachers actively use these technologies in the educational process. In general, such indicators indicate the need to strengthen the education and training of teachers in the use of AR/VR technologies.

Table 3

Have you used AR/VR or AI technologies in Geography?

	Frequency	Percent	Valid Percent	Cumulative Percent
I refuse to use it	1	9	9	9
No, but I plan to use it	47	40.5	40.5	41.4
No, I have not used it	29	25.0	25.0	66.4
Yes, I used it	39	33.6	33.6	100.0
Total	116	100.0	100.0	

The results of the second question showed that the level of use of AR/VR and AI technologies in geography is still low, but there is a generally positive attitude. More specifically: more than 40.5% plan to use them, which means that teachers are interested in this technology, but have not yet introduced it into the teaching process. This, in turn, may be due to their level of preparation or lack of necessary tools, while the fact that 25% did not use these technologies at all indicates that these technologies are not widely used in geography lessons. Meanwhile, 33.6% used them, that is, every third teacher has tried to implement AR/VR or AI technologies in their practice. Only 0.9% refused to use them. These results indicate that teachers are interested in these technologies. However, additional training and methodological support are needed for their widespread implementation.

Table 4

*How much do you value the use of AR/VR or AI technologies in geography lessons***?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Average	20	17.2	17.2	17.2
Effective	62	53.4	53.4	70.7
Inefficient	1	9	9	71.6
Very effective	33	28.4	28.4	100.0
Total	116	100.0	100.0	

The answers to the third question showed opinions on the overall effectiveness of using AR/VR or AI technologies in geography lessons: 53.4% (62 people) rated them "Effective", meaning that more than half of the respondents considered these technologies useful, while 28.4% (33 people) rated them "Very Effective", indicating that they are confident in their high effectiveness. 17.2% (20 people) answered "Average", meaning that they recognize the benefits of the technologies, but believe that the effectiveness effect is not significant. 0.9% (1 person) considered it "Ineffective", which means that they did not see the benefits of AR/VR and AI or thought that there were difficulties in using them. Summing up this question, a small number of respondents considered their impact to be weak and were skeptical about the need to use them in the learning process, while the majority admitted that these technologies are effective in geography lessons.

Table 5

In which geography topics will the use of AI or augmented/virtual reality tools be effective?

	Frequency	Percent	Valid Percent	Cumulative Percent
Climate change	16	13.8	13.8	13.8
Land resources and environment	19	16.4	16.4	30.2
Natural disasters and geographical processes	28	24.1	24.1	54.3
World maps and topography	53	45.7	45.7	100.0
Total	116	100.0	100.0	

In the fourth question, the responses showed that the effectiveness of using AI or AR/VR technologies in geography lessons varies depending on the topic. According to the survey results, the highest percentage (45.7%) considered it effective when teaching world maps and topography. From this, we can see that AR/VR tools are very effective and useful in teaching spatial thinking and cartography. Students can better understand the terrain, elevation differences, and geographical features through interactive maps. The topic of Natural Disasters and Geographical Processes was chosen by (24.1%) of respondents.

This, in turn, led to the opinion that virtual simulations would help them see the effects of earthquakes, tsunamis, volcanic eruptions, and other phenomena. In this regard, AI could teach students to analyze data and predict natural disasters. 16.4% of respondents considered it appropriate to use it in the topic of Land Resources and Environment. In this area, AI can be used for monitoring, remote sensing of the earth, and resource management. The lowest indicator was the topic of "Climate Change" (13.8%). The use of AI and AR/VR in this topic is also useful (for example, in modeling climate change and analyzing weather trends), but we can see that respondents considered this topic less important than others. Summing up this question, these technologies allow us to teach cartography in a more transparent and experience-based way than traditional methods. Therefore, it can be confidently said that AR/VR is one of the most effective tools in cartography and topography.

Table 6

What do you think about the impact of AR/VR or AI technologies on student learning outcomes in geography?

	Frequency	Percent	Valid Percent	Cumulative Percent
Increases students' interest	41	35.3	35.3	35.3
Increases understanding	27	23.3	23.3	58.6
Reduces the difficulty level of the topics	17	14.7	14.7	73.3
The learning process will be very interesting and interactive	31	26.7	26.7	100.0
Total	116	100.0	100.0	

The fifth question showed that the use of AR/VR and AI technologies in geography lessons has a positive impact on student learning outcomes. 41 respondents (35.3%) said that it increases student interest, 27 (23.3%) said that it improves understanding, and 17 (14.7%) said that it reduces the level of difficulty of topics. There is certainly a reason for this, because some geographical topics (for example, geodesy, climate change, cartography) are difficult for students. However, with the help of AI, data processing and interactive tasks make it easier to master the topic. The remaining 31 (26.7%) answered that the learning process using these technologies will be very interesting and interactive. This is because geography lessons, enriched with active learning methods, allow students to gain experience-based knowledge. Experiences such as climbing mountains, exploring the ocean floor, and seeing the terrain in three dimensions through VR, clearly make the learning process more interesting.

Table 7

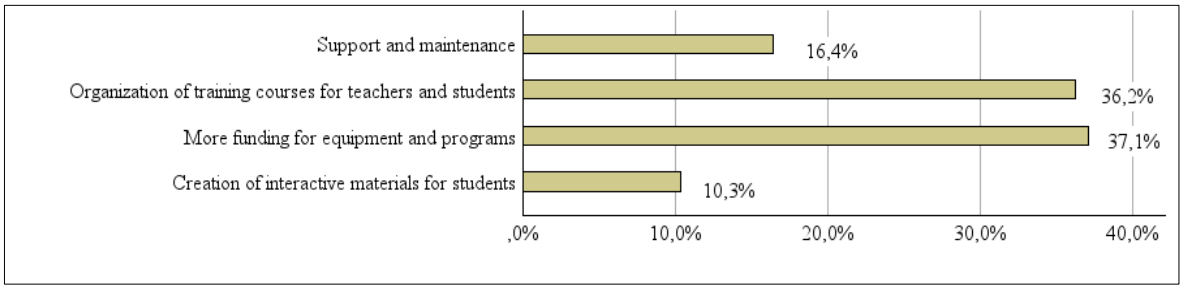
What do you think are the advantages of using AR/VR or AI technologies in teaching geography?

	Frequency	Percent	Valid Percent	Cumulative Percent
Allows you to adapt training to individual needs	7	6.0	6.0	6.0
Facilitates interpretation of topics	12	10.3	10.3	16.4
Increases students' interest in the subject	55	47.4	47.4	63.8
It shows geographical phenomena and processes in a clear visual way	42	36.2	36.2	100.0
Total	116	100.0	100.0	

The results of the sixth question show that AR/VR and AI technologies play an important role in teaching geography. Most respondents noted that these technologies increase students' interest in the subject (47.4%) and allow for a more realistic and visual representation of geographical phenomena (36.2%). In addition, facilitating the explanation of topics (10.3%) and tailoring teaching to individual needs (6.0%) were also considered important factors. These data indicate that the effective use of AR/VR and AI technologies in geography lessons can increase students' cognitive interest and improve their mastery of educational materials.

Figure 4

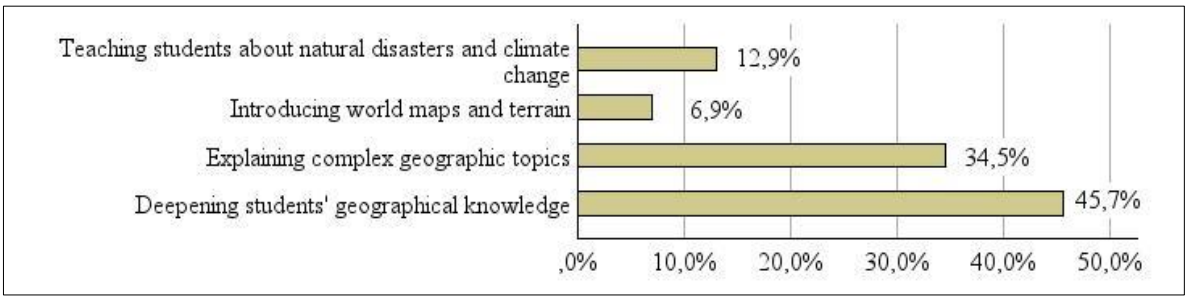
In your opinion, what measures are needed for the widespread use of AR/VR or AI technologies in geography lessons?



Based on the results of the seventh question, it was found that for the widespread use of AR/VR and AI technologies in geography lessons, it is necessary, first of all, to train teachers and students (37.1%) and strengthen the material and technical base (36.2%). In addition, the organization of technical support (16.4%) and the development of interactive educational materials (10.3%) are important factors. By implementing these measures, the process of teaching geography will be based on modern technologies, students' interest in the subject will increase, and the quality of education will improve.

Figure 5

What do you think AR/VR or AI technologies can improve in teaching geography?



As a result of the eighth question, respondents noted that these technologies could improve the following aspects:

- Deepening students' geographical knowledge - 45.7%
- Explaining complex geographical topics - 34.5%
- Introducing world maps and landforms - 12.9%
- Educating students about natural disasters and climate change - 6.9%

These results show that AR/VR and AI technologies are primarily used to deepen students' geographical knowledge (45.7%) and explain complex geographical topics (34.5%). In addition, introducing world maps and landforms (12.9%) and teaching about natural disasters and climate change (6.9%) were also considered important areas. The widespread use of these technologies in geography lessons has allowed students to better master the material, understand the topics in a clear and visual way, and develop practical skills.

Conclusion

The survey results highlighted the key research questions and demonstrated the potential of AI, VR, and AR technologies to enhance the quality of education. Studies have shown that immersive technologies have increased awareness of environmental issues and contributed to the formation of beneficial behaviors (Demirezen, B. 2019).

The respondents' answers showed a generally positive view of the effectiveness of these technologies in developing geographical knowledge in line with modern requirements. While the results of the study prove the potential of VR and AI technologies to improve learning outcomes, it also shows that teachers' ability to fully utilize these tools is still insufficient in some areas. Therefore, there is a need to effectively integrate these technologies into current educational methodologies and learning materials. Overall, the research results show that although AI and VR technologies are still in their early stages of development, they have great potential for education.

However, the issue of providing teachers with the necessary tools and resources to effectively implement these technologies in their lesson plans remains relevant. In this regard, there is a need to conduct additional research and ensure their practical application in order to fully realize the potential of the technologies considered in the education system. In the course of studying this topic, we analyzed a large number of materials and scientific articles. We also examined the advantages and disadvantages of modern educational methods compared to traditional teaching methods and summarized teachers' views on the introduction of these technologies into the learning process based on the conducted research.

Conflict of Interest Statement

The authors declare no potential conflicts of interest regarding the research, authorship, or publication of this article.

Author Contributions

Aizharkyn Nurgazina: Data curation, Writing - Original draft preparation,Investigation; Jan A. Wendt & Erkin Tokpanov: Validation, Formal analysis, Visualization; Sholpan Karbayeva: Conceptualization, Methodology, Resources

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