

## Artificial Intelligence in Virtual Reality (VR): Prospects, Practice and Challenges in Teaching Geography and Environmental Education

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### Abstract

The integration of Artificial Intelligence (AI) in Virtual Reality (VR) is crucial for creating immersive and personalized experiences. The advanced technology has the potential to revolutionize the teaching of geography and environmental education through adaptive learning, realistic simulations, and intelligent interactions. This paper explores the prospects, practice, and challenges of using AI-powered VR in fields such as marine fisheries and water pollution, geological exploration and geotechnical engineering, smart meteorology, smart agriculture, urban planning, and tourism geography. Its impacts are already felt in Geographic information system (GIS) and remote sensing techniques. The study sought to examine the current state of AI in VR, highlighting its applications in geography and environmental education through immersive learning experiences. When adequately utilized, AI-powered VR could enhance students' interest, improve knowledge retention, and foster deeper understanding of complex geography and environmental education concepts. However, the study equally identified some challenges related to accessibility to technology because not all schools have the required resources to implement AI tools effectively, and the absence of this technology can create disparities in educational opportunities. The paper concludes by discussing future directions for research and development, including the potentials for AI-powered VR to address environmental issues and to promote sustainable development.

**Keywords:** Education. Environment, Artificial Intelligence, Virtual Reality, Environmental Education, Geography.

### Introduction

The integration of Artificial Intelligence (AI) and Virtual Reality (VR) is transforming a variety of fields, including education. This paper investigates the potential and practices of using AI-powered VR to teach geography and environmental education. Using immersive VR experiences and AI-driven adaptive learning, educators can create engaging, interactive, and personalized learning environments that improve students' comprehension and retention. This topic delves into the potential benefits, challenges, and applications of artificial intelligence in virtual reality for geography and environmental education, offering a forum for educators, researchers, and industry experts to share insights and shape the future of geography and environmental education.

Artificial intelligence refers to the development of computer systems capable of performing tasks that normally require human intelligence (Chorley 2019). These tasks may include problem solving, learning, perception, and decision-making. AI systems are intended to analyze data, identify patterns, and make informed predictions or decisions based on the information provided. It is embedded in a type of ICT-enhanced pedagogy known as virtual reality (VR), which Ayodele (2023) defines as a simulated experience of a three-dimensional environment. Its use enables students to look around, move, and interact with their environment. Virtual reality has the potential for an infinite number of applications, such as virtual museum visits or

historical travel while physically present. Applying AI in school geography has its challenges, but students can gain a deeper understanding.

One area where AI is having a significant impact is school geography. Geography is a science that studies the earth and its inhabitants, focusing on the description of land, sea, and atmosphere, the distribution of animals and plants, as well as humans, and the labor that humans perform in accordance with the interrelationship of natural forces. Similarly, environmental education focuses on aspects of human behavior that are more directly related to man's interaction with the biophysical environment and his ability to comprehend this interaction. In essence, education and public participation have the potential to influence and improve environmental quality. Environmental Education is not a distinct branch of science, but rather a lifelong interdisciplinary field of study. According to UNESCO-UNEP, environmental education is concerned with the study of the environment, including its physical, biophysical, and process aspects. It refers to educating for the environment or environmental health in order to promote sustainable development. According to Ezeudu (2003), environmental education entails education aimed at protecting and enhancing the environment, as well as education as a development tool for improving human communities' quality of life. Quality education helps to protect, preserve, and conserve environmental resources for future use.

Traditional manual research and learning in geography and environmental education are simple, but the workload is enormous, and data processing efficiency may be low. However, computer technology has the potential to mimic human intelligence in reasoning and can easily summarize natural efforts. AI has simplified the learning process, giving students a better understanding of themes, concepts, places, and cultures. In geography and environmental education, artificial intelligence (AI) plays an important role in expanding traditional learning methods. It enables students to grasp detailed insights and analyses in a more immersive and interactive setting. Using AI technologies, geography educators can create engaging learning experiences that go beyond textbooks and traditional classroom resources.

In support of the relevance of AI in geography and environmental education, Abdul Muin (2023) discovered that artificial intelligence in geography and environmental education is strategic to replace traditional methods of learning that rely heavily on

rigorous operations and manual labor, which over time is surrounded by many defects such as thinking and reasoning limitations. Similarly, Huan (2021) believes that AI facilitates the mapping relationship between image neural network training and a variety of deep learning remote sensing image retrieval methods that have been developed and can perform tasks such as land use monitoring, automatic lithology classification, water pollution modeling, ecological index calculation, and compensate for many deficiencies in previous manual retrieval and interpretation methods. Furthermore, Alam (2022) found that artificial intelligence technology is primarily used in traffic monitoring, urban layout, cartography, and other aspects of human geography and urban and rural planning.

### **Artificial Intelligence in Geography and Environmental Education**

The use of artificial intelligence in geography and environmental education to replace the traditional method, which is heavily reliant on artificial operation and expert work, can overcome many flaws such as computer storage capacity, speed, and cognitive reasoning limitations. Hehanussa (2023) reported that geography is evolving into geographic information science, with information, automation, and intelligence as key points, and that artificial intelligence is an important tool in achieving this goal. According to Demers (2021), artificial intelligence was the first and most widely used technology for compiling, extracting, and analyzing systems. Now, the neural network-based algorithm is maturing and redefining traditional geographic concepts.

Lavallin (2021) discovered that artificial intelligence technology can compensate for the shortcomings of artificial rescue operations in five areas: disaster analysis and judgment, tracking and searching for targets, engaging in high-risk rescue work, disaster disposal assistant decision-making, and disaster disposal effect evaluation. In terms of urban layout, multidimensional perception and urban dynamic modeling are carried out by combining urban streetscape with the activities of urban residents, questionnaires, and other data sources. Chan et al (2023). Meanwhile, the impact of environmental visual variables and people's mental states can be identified, which is useful for urban layout management. Chang and Kidman (2023) explain how the reinforcement of deep learning methods in cartography can precisely mark the spatial position of

modern geographical elements on historical scanned maps. The integration of artificial intelligence and map design may partially realize the automated workflow of cartographic generalization, such as building polygon simplification and aggregation, road network line simplification and integration based on connectivity, and so on. Some areas where AI is visible in geographic knowledge include:

### **Marine fishery resources and water pollution**

Geography encompasses location, climate, topography, hydrology, soil, vegetation, and natural disasters. Artificial intelligence technology is now widely used in the management of marine fisheries and water pollution, as well as the detection of topography, atmospheric movement, and disaster prediction. Alam (2022) reported that using machine learning-provided parameters for the marine ecological environment and fishery integration data, useful information can be inferred, such as the size of fish spawning sites and the location of migration channels at different spatial and temporal scales, which can be used to monitor marine fishery resources.

Human activities are causing an increase in water scarcity and pollution. As a result, monitoring and reducing water pollution has become a popular topic in recent years. Artificial intelligence research on water pollution currently focuses on water supply, sewage treatment, and water quality simulation (Chang and Kidman 2023).

### **Atmospheric Science and Smart Meteorology**

In atmospheric science, neural networks and random forest algorithms can be used to create mathematical models for analyzing complex weather systems and large databases. The rise of intelligent meteorology in recent years has been used to combine the high application, accuracy, and coverage of artificial intelligence technology with atmospheric science research, allowing the meteorological system to accurately perceive, judge, make decisions, analyze, and adapt itself, resulting in the intelligent development of atmospheric science. According to Rakuasa (2022), the primary problems addressed by artificial intelligence technology are big data, high complexity, and uncertainty, which correspond to long-term accumulated materials, data, and cases in specific fields. Meteorological data are not only big data with multiple observation elements that are closely related to people's production and life, but also random and uncertain.

The combination of two data sets casts artificial intelligence technology in the shadow of front-end observation, data processing, forecast analysis, and product provision, thus advancing atmospheric science Rakuasa (2022). Based on its current use in meteorological science, artificial intelligence technology's future development trajectory will be brighter and more positive. Artificial intelligence technology will be used in meteorological observation, data analysis, meteorological forecasting, industry service, and other areas to encourage in-depth meteorological research and the meteorological industry's growth.

### **Urban planning and Construction**

The rapid advancement of artificial intelligence and machine learning technology has resulted in a more optimized model for urban planning and layout, industrial transfer and agglomeration, man-land relationships, traffic trunk line planning, and other applications, indicating a clear path for ecological, economic, and cultural development. AI technology has the potential for widespread use in urban big data construction. Susan et al (2023). In urban construction, an artificial intelligence system can effectively synthesize data, fit and collect it, and present a visual urban construction model based on many factors and massive data. At the same time, it can significantly reduce planners' operating time and workload. AI can make necessary upgrades to the GSM system at the corresponding time nodes, such as adding new mobile stations, signaling, and connecting with the backbone network, to improve the efficiency and timeliness of urban construction. Among them, artificial intelligence technology is widely used in traffic construction and modern logistics, which play an important role in the development of a smart city.

### **Smart Agriculture**

In recent years, Internet of Things and artificial intelligence technology have also greatly improved agriculture's economic benefits and sustainability, reduced the environmental burden, and contributed significantly to the harmonious development of human-land relationships. Yield prediction, real-time crop growth monitoring, agricultural expert systems, and agrometeorological analysis are currently the most pressing concerns in the development of smart agriculture. Artificial intelligence technology was among the first and most widely adopted in agricultural water irrigation. It

collects various data, such as plant height, air humidity, soil fertility, and so on, in an all-around and three-dimensional manner using neural network deep learning to make accurate predictions. Following a thorough analysis, the system was found to have high intelligence, high precision, low construction and maintenance costs, and so on. The use of artificial intelligence technology in agricultural production has greatly improved water use efficiency, and it has become an important measure to promote the sustainable use of water resources, which contributes to ensuring national food security.

To harness the power of AI in geography and environmental education, various technologies and tools have been developed. These tools according to Li (2022) facilitate the processing, analysis, and visualization of geographic data, enabling students to explore places in new and innovative ways. Key technologies and tools include the following:

**Geographic Information Systems (GIS):** Geographic data can be captured, managed, analyzed, and visualized by users using GIS software. In order to comprehend locations more thoroughly, it allows students to make maps, superimpose various informational layers, and conduct spatial analysis.

**Remote Sensing:** In order to obtain information about the Earth's surface, remote sensing entails gathering data from satellites, airplanes, or drones. Through the analysis of remote sensing data, artificial intelligence (AI) algorithms can derive important information about vegetation, land use, urban development, and other geographic features.

**Machine Learning:** It is possible to train machine learning algorithms to evaluate geographic data and generate classifications or predictions. AI can, for instance, classify various cultural features based on image analysis, identify different types of land cover, and forecast changes in climate patterns.

**Natural Language Processing (NLP):** NLP technologies enable computers to understand and process human language. In the context of geography and environmental education, NLP can be used to analyze textual data, such as historical documents or travel narratives, to extract information about places and cultures.

### **Artificial intelligence (AI) and Virtual Reality (VR) in the Context of Geography and Environmental Education**

Virtual reality is an off shoot of Artificial intelligence. It is a simulation of a three-dimensional

environment, Ayodele (2023). The most common way to access VR is through a virtual reality headset, such as the Meta Quest, the Sony PlayStation VR, or the Apple Vision Pro. In geography and environmental education, VR may allow students to experience previously impossible scenarios, such as visiting distant cultural sites or traveling back in time from the comfort of the classroom. Virtual reality enables users to look around, move, and interact with their surroundings. Virtual reality has potentially limitless applications, such as virtual museum visits. Its advantages include: immersive learning experiences; increased engagement and motivation; improved retention and comprehension; and accessibility for students with disabilities.

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### **History and Geographical Expedition**

Both educational experiences and time-traveling video games allow students to experience the world in the past or in an imagined future. Few geography students can afford to travel to another continent, but virtual reality can provide this opportunity for the majority. Geography students can use a headset to visit historical sites or monuments from the comfort of their own classroom. It can also simulate different geographic regions, allowing students to experience what it's like to live in a different climate or continent entirely.

### **Virtual Field trips and Lab Simulations**

A critical application of virtual reality is allowing geography students to go on virtual field trips for a fraction of the cost. Virtual field trips are applicable to a variety of subjects and pedagogical areas, ranging from history and geography to a fully simulated chemistry laboratory where students can conduct exciting experiments. Students with physical disabilities can also use VR to visit places that would otherwise be impossible or difficult. Geography students with social disabilities may benefit from using VR because they can pause the experience whenever they feel uncomfortable.

### **Challenges in Integrating AI in Geography and Environmental Education Curriculum**



The process of implementing AI in a geography classroom is costly. The initial expenses of buying the devices as well as the continuing costs of training educators and other school staff must be considered. Because of this, educational institutions with tight budgets might not prioritize AI tools. Because of these drawbacks, AI technology needs to advance before it can be widely used in educational institutions. Here are some challenges highlighted:

1. **Access to Technology:** Making sure all students have fair access to AI technologies is one of the main obstacles. It's possible that some schools lack the resources or infrastructure needed to successfully use AI tools. Inequalities in educational opportunities may result from this digital divide.
2. **Training and Professional Development:** For educators to successfully incorporate AI into the curriculum, they might need professional development and training. They must acquire the abilities and know-how to effectively use AI tools and technologies to improve geography and environmental education.
3. **Curriculum Integration:** It can be difficult to smoothly incorporate AI into the current geography curriculum. AI-powered activities must be carefully planned and matched with learning objectives to ensure that they enhance and supplement current teaching strategies.
4. **Ethical Considerations:** It is essential that AI be used in geography and environmental education in a responsible and moral manner. Concerns about privacy, data security, bias in AI algorithms, and the possibility of perpetuating cultural or stereotyped biases must all be addressed by educators. To guarantee that AI is applied in a way that values inclusivity and diversity, ethical standards and regulations should be created.

### **Innovative Techniques to Overcoming Environmental Challenges**

1. **Infrastructure and Access:** Efforts should be made to close the digital divide by providing schools with the necessary infrastructure, such as computers, internet access, and artificial intelligence tools. Collaborations between technology companies, governments, and non-profit organizations can help ensure equal access to AI technologies.

2. **Professional Development Programs:** Training programs and professional development initiatives should be designed to provide educators with the necessary skills and knowledge to effectively incorporate AI into geography education. These programs may include workshops, online courses, and collaborations with AI experts.
3. **Curriculum Redesign:** The curriculum should be revised to include AI-powered activities and projects that correspond to the learning objectives of geography and environmental education. This can include developing interdisciplinary projects that combine AI with other subjects like history, social studies, and environmental science.
4. **Ethical Guidelines and Policies:** The responsible use of AI in geography education should be addressed by clear ethical standards and regulations. To guarantee that AI is applied in a way that fosters inclusivity, accuracy, and cultural sensitivity, educators should receive training on privacy, data security, and the potential biases associated with AI algorithms.

By addressing these challenges and implementing innovative solutions, educators can effectively integrate AI into geography and environmental education, providing students with enhanced learning experiences and a deeper understanding of the world around them.

### **Conclusion**

Artificial intelligence and machine learning have played significant roles in numerous unlisted branches of geography. It has significantly reduced the difficulty of analyzing big data in geography and environmental education, improving data accuracy while reducing the uncertainty and randomness of traditional geography, truly elevating geographical studies to a new level. However, the application of artificial intelligence technology in geography and environmental education is unbalanced, with it now being used primarily in a few fields such as GIS, RS, and urban construction. Other branches of geography's application scope should be expanded in the future to promote the research process of "intelligent geography" from all angles. The future of both disciplines is expected to be brighter and more positive because of the irreversible

## Recommendations

The following recommendations are made:

1. Learning institutions should develop AI-powered VR modules which will create interactive and immersive VR modules that utilize AI to adapt to individual students' learning styles and pace, enhancing their understanding of geography and environmental concepts.
2. Geography curriculum should incorporate real-world datasets and scenarios into AI-powered VR experiences, to allow students to explore and analyze complex geographical and environmental phenomena in a realistic and engaging manner.
3. Conduct rigorous studies to evaluate the effectiveness of AI-powered VR in geography and environmental education, identifying best practices and areas for improvement to inform educators and policymakers.

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