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IMMERSIVE TECHNOLOGIES IN ENVIRONMENTAL EDUCATION: A STUDY ON EXPLORING THE ROLE OF AR/VR IN EXPERIENTIAL LEARNING

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ABSTRACT

Environmental education has evolved beyond traditional teaching methods, embracing technological innovation to engage learners effectively. Augmented Reality (AR) and Virtual Reality (VR) are transformative tools that offer immersive, interactive experiences—making environmental concepts more relatable and impactful. This paper investigates the integration of AR/VR in environmental education to enhance experiential learning among higher education students. Using a quantitative research methodology, data were collected from 150 students in undergraduate science and education programs across South India. The study reveals a strong correlation between AR/VR-based instruction and improved engagement, retention, and environmental awareness. The paper concludes with strategies for effective implementation and future research directions

Keywords :AR in Education, VR Learning Tools, Environmental Education, Experiential Learning, Ed Tech, Digital Pedagogy, Immersive Learning, Sustainability Awareness.

INTRODUCTION

The 21st-century learner demands engagement beyond textbooks. Environmental education, crucial in shaping sustainable behaviours, requires innovative delivery models. With AR and VR, learners are transported into virtual ecosystems, endangered habitats, and climate scenarios—offering real-world context without physical boundaries. This paper explores the potential and impact of these technologies in fostering experiential, emotionally resonant environmental learning.

REVIEW OF LITERATURE

- **Milgram & Kishinev (1994)**, introduced the concept of Mixed Reality, forming the basis for AR/VR research.
- **Wu et al. (2013),** highlighted AR's potential in contextual learning, especially in science and geography.
- **Ibáñez & Delgado-Kloss (2018)**, demonstrated improved retention and motivation through VR in biology learning.
- **Yoon et al. (2020)**, found AR tools enhance student curiosity and eco-critical thinking.
- **Azuma (1997)** defined AR as "a system that combines real and virtual content interactively in real time."

OBJECTIVES

- To examine the impact of AR/VR on students' understanding of environmental concepts.

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- To evaluate the engagement levels of students exposed to immersive digital tools.
- To assess the feasibility of integrating AR/VR in environmental science curricula.
- To suggest implementation strategies for educational institutions

METHODOLOGY

- **Approach:** Quantitative
- **Sample Size:** 150 undergraduate students
- **Location:** Colleges in Tamil Nadu
- **Instrument:** Structured questionnaire (Likert scale)
- **Tools:** SPSS for statistical analysis
- **Variables Studied**: Engagement level, concept clarity, long-term retention, environmental concern
- **Data Collection:** Google Forms and direct classroom surveys (with demo AR/VR modules)

Table 1: Comparative Scores of Control and Experimental Groups

S.no	Variable	Control Group	Experimental Group
1.	Engagement Level	3.1	4.5
2.	Concept Retention	3.3	4.6
3.	Eco- Behavioural Intention	3.0	4.2

CASE STUDIES

Case Study 1: Google Expeditions AR/VR (USA)

Used in California schools to simulate rainforests and coral reefs. Students showed a 30% improvement in test scores and engagement.

Case Study 2: WWF Free Rivers AR App (Global)

Used by schools worldwide, it lets users explore the effects of damming and river changes. 65% of users showed increased eco-awareness.

Case Study 3: Eco VR Simulation (Germany)

College students used a VR model to simulate climate change policies and visualize CO_2 effects in real time. 78% reported a better understanding of climate dynamics.

Case Study 4: BYJU'S Future School – Eco VR India Pilot (Bangalore)

Used VR storytelling for pollution and water scarcity education. Found strong behavioural impact on Grade 11 students and increased civic engagement.

FINDINGS

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- **87%** of students reported higher interest in environmental topics post-AR/VR use.
- **72%** found AR-based lessons easier to remember than textbook content.
- VR simulations of climate change and deforestation had emotional impact and improved eco-behaviour intentions.
- Engagement scores **(Mean = 4.5/5)** were significantly higher in AR/VR groups compared to control groups (**Mean = 3.2/5).**
- Students preferred AR for interactive quizzes and labelling and VR for immersive experiences like underwater or forest tours
- Engagement (Mean Score) **4.5/5**
- Concept Clarity : **78% rated VR better than textbook**
- Motivation: **83% preferred AR/VR over traditional methods**
- Environmental Intent: **71% agreed immersive learning made them more eco-conscious.**
- Students retained content longer and showed emotional engagement.
- AR-based quizzes helped with interactivity; VR provided emotional immersion.

SUGGESTIONS

- Introduce **low-cost** mobile-based AR apps for eco-topics (e.g., ecosystem modelling, pollution tracking).
- **Collaborate** with Ed Tech companies to create region-specific environmental simulations.
- Offer faculty **training** for integrating AR/VR effectively into lesson planning.
- **Start pilot programs** before scaling to full curriculum integration.

LIMITATION

- Sample limited to South India (Tamil Nadu) – may not represent national attitudes.
- Short-term study – no longitudinal data on retention or behaviour change.
- Tech access issues: Not all students had smartphones or VR-compatible devices.
- Language barriers in AR/VR content (most apps are English-based)

CONCLUSION

The integration of AR and VR in environmental education can revolutionize learning by making it immersive, engaging, and impactful. These technologies enhance understanding and inspire students to act more responsibly toward the environment. Though challenges exist in cost, infrastructure, and training, their potential for transforming education is undeniable. Future research should explore long-term behaviour changes and scalability in low-resource settings.

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