

Effect of an AR-based Gamified Environmental Education Platform on the Environmental Consciousness of Grade 5 Students: a Case Study

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Abstract: *Traditional environmental education often emphasizes cognitive knowledge acquisition while providing limited support for affective engagement, behavioral intention, and pro-environmental action. This case study explored the effects of an AR-based gamified platform on elementary school students' environmental consciousness. Following a six-week classroom intervention, semi-structured interviews with nine students were thematically analyzed across four dimensions: affective, cognitive, conative, and active. The findings indicate that the platform was particularly effective in strengthening the conative and active dimensions, as students demonstrated greater willingness to engage in environmental actions and observable pro-environmental behaviors. Improvements in the affective and cognitive dimensions were more modest, mainly reflected in short-term emotional engagement and initial knowledge acquisition.*

Keywords: Environmental consciousness, AR-based Learning, Gamified learning

1. Introduction

Cultivating environmental consciousness (EC) is widely recognized as a prerequisite for environmental protection and sustainable development (Su et al., 2021). However, environmental education often faces a persistent “knowledge–action” gap, where greater environmental knowledge does not necessarily lead to behavioral change (Rueda et al., 2023). Emerging technologies offer potential solutions: Augmented Reality (AR) can create immersive learning environments, while gamification can enhance learners' motivation and engagement (Hung et al., 2017; Sailer et al., 2020). However, learner-centered research on AR-based gamified environmental education in elementary contexts remains limited. Guided by Jiménez and Lafuente's (2010) framework, this study explores how an AR-based gamified platform supports Grade 5 students' EC across affective, cognitive, conative, and active dimensions.

2. Methodology

This study reports the second phase of a mixed-methods investigation examining the effects of an AR-based gamified environmental education platform on Grade 5 students' EC. In the first phase, 72 students from two classes at a public elementary school in Shenzhen, China, participated in a six-week intervention, with one class using the AR platform and the other receiving traditional instruction. Nine students from the experimental group was selected in the qualitative phase, representing students with high, medium, and low post-test scores, for semi-structured interviews. Conducted after the intervention, the interviews explored students' learning experiences and were analyzed using thematic analysis across the cognitive, affective, conative, and active dimensions of EC.

3. Results and findings

The **affective dimension** of EC refers to learners' level of concern for environmental issues and their attitudes toward environmental protection (Jiménez & Lafuente, 2010). Thematic analysis indicates that the AR-based gamified platform enhanced students' affective engagement, particularly by stimulating short-term interest and curiosity. For example, Student 5 noted, “When I used to watch videos, I would guess if it was rehearsed or not, but the 3D modeling made it feel real and more appealing to me.” However, evidence of sustained emotional change was limited, with only a few students demonstrating deeper emotional responses to environmental issues. For instance, Student 7 reflected, “Seeing people cut down the forest in the 3D model made me feel sad for the animals.”

The **cognitive dimension** of EC refers to learners' level and sources of environmental knowledge, as well as the importance they assign to environmental news and their understanding of related issues (Jiménez & Lafuente, 2010). The findings suggest that the AR-based gamified environmental education platform supported early-stage cognitive development of EC, while evidence of deeper cognitive restructuring remained limited. For example, Student 1 explained, "The AR little turtle model introduced us to many marine creatures," indicating that cognitive gains are primarily concerned with the acquisition of knowledge rather than complex conceptual changes.

The **conative dimension** of EC refers to learners' willingness to engage in pro-environmental actions and their sense of being part of the solution (Jiménez & Lafuente, 2010). Thematic analysis indicates that the AR-based gamified platform provided immersive, socially contextualized learning experiences with moral reflection. These experiences enabled learners to recognize they could be part of the solution, strengthening their readiness to act and enhancing the conative dimension of EC. For example, Student 2 remarked, "When my classmates and I played games and shared ways to protect the environment, it made me want to do more."

The **active dimension** of EC refers to learners' environmentally related behaviors in both home and educational settings (Jiménez & Lafuente, 2010). The results show that the AR-based gamified environmental education platform effectively motivated learners to adopt pro-environmental behaviors related to the learning content and encouraged a few students to extend these behaviors into public social spaces, thereby positively influencing the active dimension of EC. As Student 8 reported, "I applied for and became a docent at the Waste Sorting and Environmental Protection Experience Pavilion."

4. Conclusion

This study found that an AR-based gamified environmental education platform enhanced Grade 5 students' EC. Positive effects were observed across all four dimensions, with particularly strong impacts on the conative and active dimensions. By offering immersive environments, interactive gameplay, immediate feedback, and peer collaboration, the platform supported students' intentions to act pro-environmentally and their behaviors in learning and daily contexts. Overall, AR-based gamified learning can modestly foster students' cognitive and affective engagement, effectively promoting pro-environmental intentions and behaviors, thereby strengthening their EC.

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