

Virtual Reality as a Tool for Environmental Education: Enhancing Fear and Awe through Embodiment and Immersion

Bo-Cheng Lin¹⁾ Hsiwen Fan¹⁾

1) National Taichung University of Education

概要：本研究は、仮想現実 (VR) 環境における仮想身体 (あり、なし) とインターフェースの没入度 (VR と PC) が参加者の恐怖感と敬畏感に与える影響を調査した。過剰な海洋ゴミで満たされた没入型的水中環境を作成し、仮想身体の有無とインターフェースタイプを操作するために 2×2 の実験デザインを使用した。120 人の大学生が募集され、4 つの条件にランダムに割り当てられた。実験後、参加者は自己報告による感情の質問紙に回答した。結果は、仮想身体と VR インタ

Key Word : Virtual Reality, Fear, Awe

ーフェースの両方が恐怖感と敬畏感に対して有意な主効果を示し、VR を使用し仮想身体を持つ参加者がより強い感情的な強度を報告したことを明らかにした。しかし、相互作用効果は見られなかった。これらの結果は、仮想身体と没入の理論を支持し、没入型メディアが複雑な感情的反応を効果的に引き起こすことを確認した。本研究は、環境教育や効果的なコミュニケーションにおける VR の応用に対する実証的証拠とデザインの示唆を提供するものである。

1. Introduction

In the context of increasingly severe environmental issues such as climate change and marine pollution, enhancing the public's emotional engagement with ecological concerns has become a central challenge for environmental education and sustainability advocacy. Although awareness campaigns and policy messaging are widespread, many individuals remain cognitively informed but emotionally detached, resulting in limited behavioural change. Prior research suggests that environmental action is often driven more effectively by emotional arousal than by rational information alone.

Among environment-related emotions, fear and awe are particularly potent in fostering behavioural motivation. Fear raises threat awareness and prompts precautionary actions (May, 2015), while awe—often elicited by exposure to vast or sublime phenomena—can produce self-diminishment and cognitive accommodation (Keltner & Haidt, 2003), leading to stronger identification with nature and a heightened sense of responsibility. When effectively induced, these emotions can transform abstract environmental issues into embodied psychological experiences, enhancing engagement and intention to act.

With the development of virtual reality (VR), immersive and interactive experiences now offer new means of emotional elicitation. VR's capacity for heightened presence enables users to experience simulated environments as emotionally real. When combined with virtual embodiment—the sense of inhabiting a virtual body—users may develop deeper identification with their role and surroundings, amplifying emotional responses such as fear and awe. While previous studies have established VR's effectiveness in enhancing presence and emotion (Slater, 2009; Lemmens et al., 2022), few have examined how these design elements specifically impact emotional responses to environmental scenarios.

In this study, we designed a virtual environment based on undersea mega-trash, in which participants explored the trash-infested marine world from the first-person perspective of a

small fish. Through a 2×2 experimental design, the study manipulated the presence or absence of a virtual body (absent vs. present) and the type of interface (VR vs. PC) to examine the effects of these two variables on participants' perceived fear and awe. This study aims to:

- (1) Determine whether virtual embodiment increases participants' perceived fear and awe in a simulated environmental scenario.
- (2) Examine whether VR interfaces elicit stronger emotional responses than PC interfaces.
- (3) Explore whether there is an interaction effect between embodiment and interface type on emotional perception.

2. Methods

A 2×2 factorial design was adopted, manipulating two independent variables: virtual embodiment (present vs. absent) and interface type (VR vs. PC). Participants were randomly assigned to one of four conditions and experienced a five-minute immersive scenario before completing post-test questionnaires measuring fear and awe.

Participants were 120 university students (30 per group), selected based on their baseline digital literacy and screened for VR compatibility (e.g. absence of motion sickness). This demographic was chosen due to their known susceptibility to persuasive interventions in environmental contexts.

The experimental setting was a virtual underwater environment created with Unity, populated by oversized marine debris. Participants navigated the scene from a first-person fish perspective (see Figure 1). In the embodied condition, they could see their own fish body via reflective surfaces; in the non-embodied condition, no body representation was provided. The VR condition used a head-mounted display, while the PC condition involved traditional mouse and keyboard input.

Upon completing the virtual experience, participants filled out validated scales measuring fear (Cantor et al., 2010; Day, 2015) and awe (Yaden et al., 2019), both using seven-point Likert scales.

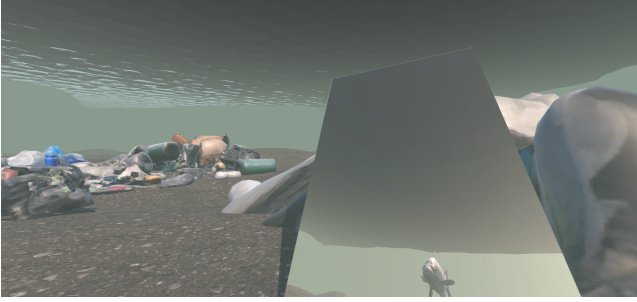


Figure 1. Experimental stimulus environment diagram

The procedure included participant recruitment, random assignment, immersion experience, questionnaire administration, and data collection. Data analysis included descriptive statistics and two-way ANOVA to examine main and interaction effects of embodiment and interface on emotional outcomes.

3. Results

3.1 Fear

A two-way ANOVA revealed significant main effects of embodiment ($F_{(1, 156)} = 11.135, p = .001$) and interface type ($F_{(1, 156)} = 14.804, p < .001$) on fear. Participants in the VR and embodied conditions reported significantly higher fear responses. The interaction between the two factors was not significant ($F_{(1, 156)} = 2.753, p = .099$). Among all conditions, the VR-embodied group reported the highest fear ($M = 5.450, SD = 0.999$), followed by VR-non-embodied ($M = 5.162, SD = 0.808$), while both PC groups reported lower scores.

3.2 Awe

Significant main effects were also observed for awe. Embodiment had a notable effect ($F_{(1, 156)} = 6.572, p = .011$), as did interface type ($F_{(1, 156)} = 26.606, p < .001$), with VR users reporting significantly greater awe. The interaction was not significant ($F_{(1, 156)} = 0.120, p = .729$). The VR-embodied group again reported the highest awe ($M = 5.727, SD = 0.677$), followed by VR without embodiment, and both PC groups were lower.

4. Discussion

The purpose of this study was to investigate the effects of the presence or absence of a virtual body and the level of immersion in the interface (VR vs. PC) on the participants' fear and awe in the virtual environment. These results align with prior studies on immersion and presence in VR settings (Lemmens et al., 2022; Slater, 2009), confirming that VR and embodiment each contribute to emotional amplification.

Fear was heightened in both the VR and embodied conditions, likely due to increased perceived threat and psychological immersion. The visibility of one's virtual body, especially when configured as a vulnerable marine creature, appears to strengthen the sense of danger and urgency.

Similarly, awe was significantly intensified in the VR condition, where full visual immersion amplified the scale and impact of the simulated marine debris. The embodied condition

further supported awe by reinforcing a sense of self-diminishment and environmental connectedness—key components of the awe experience (Keltner & Haidt, 2003; Yaden et al., 2019).

These findings highlight immersion and embodiment as two critical mechanisms for emotion elicitation in virtual environmental experiences. From a practical perspective, the study provides design guidance for future applications of VR in environmental education, demonstrating how visual scale, role perspective, and sensory presence can be effectively combined to trigger meaningful emotional responses.

Reference

- Cantor, J., Byrne, S., Moyer-Gusé, E., et al. (2010). Descriptions of media-induced fright reactions in a sample of US elementary school children. *Journal of Children and Media*, 4(1), 1–17.
- Day, T. W. M. (2015). *The Oculus Rift as a portal for presence: The effects of technology advancement and sex differences in the horror video game genre* (Unpublished Doctoral dissertation). Michigan State University.
- Lemmens, J. S., Simon, M., & Sumter, S. R. (2022). Fear and loathing in VR: the emotional and physiological effects of immersive games. *Virtual Reality*, 26(1), 223–234.
- May, J. (2015). Megalophobia: Fear of large things. *Callaloo*, 38(1), 75–75.
- Sahabuddin, E. S., & Makkasau, A. (2024). Utilization of virtual reality as a learning tool to increase students' pro-environmental behavior at universities: A maximum likelihood estimation approach. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(12), em2540.
- Slater, M., Pérez Marcos, D., Ehrsson, H., & Sanchez-Vives, M. V. (2009). Inducing illusory ownership of a virtual body. *Frontiers in Neuroscience*, 3, 676.
- Yaden, D. B., Kaufman, S. B., Hyde, E., Chirico, A., Gaggioli, A., Zhang, J. W., & Keltner, D. (2019). The development of the Awe Experience Scale (AWE-S): A multifactorial measure for a complex emotion. *The Journal of Positive Psychology*, 14(4), 474–488.