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Mapping the Evidence: A Scoping Review on Immersive Learning Media for Decreasing Psychological Distance From Environmental Issues

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Abstract. As we are living amid an unprecedented environmental crisis, the need to cultivate more environmentally aware citizens intensifies. However, a widely discussed barrier in environmental education is the psychological distance people often feel from contemporary environmental challenges. This work-in-progress paper presents a review study which examines whether empirical research provides evidence supporting the role of immersive learning media in reducing psychological distance for fostering pro-environmental engagement. The relevant literature was reviewed to shed light on the methodological underpinnings of the studies, the design aspects of the adopted immersive learning media as well as on their impact on perceived psychological distance (i.e., spatial, temporal, social, hypothetical). Overall, our review shows that while research in this area is emerging, empirical evidence in support of immersive learning media remains largely inconclusive. We conclude by reflecting on these findings and we outline future research directions, emphasizing that the effectiveness of immersive learning media is context-dependent and shaped by methodological, design, and individual factors.

Keywords: Immersive Learning Media, Psychological Distance, Pro-environmental Engagement, Environmental Education, Systematic Review.

1 Introduction and Theoretical Background

The risks of anthropogenic climate change and the degradation of environmental ecosystems are included among the greater societal challenges of 21st century. To this end, the 2030 Agenda for Sustainable Development places at its heart 17 Sustainable Development Goals (SDGs), many of which constitute an urgent call for environmental action, such as SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land) [1]. Unfortunately, it is still unclear how we can effectively foster people's pro-environmental engagement.

A widely discussed barrier in environmental education is the limited sense of personal relevance attached to contemporary environmental challenges [2]. Considering, for instance, the indirect, slow-paced, and distant consequences of climate change, it is not surprising that young people struggle to perceive it as an urgent issue [3]. In turn, this often leads to the adoption of attitudes such as 'that's not my problem' [2], since current environmental issues are frequently perceived as distant threats with no immediate personal consequences [4].

Environmental educators seeking to strengthen pro-environmental engagement are expected to create learning opportunities for people to experience environmental threats first-hand, thereby transforming abstract concerns into concrete realities to foster a stronger personal connection to environmental issue [5]. One way to address this issue is to reduce psychological distance, which has been identified as a key obstacle to pro-environmental engagement [2, 6]. Put simply, psychological distance, refers to the mental gap between oneself and an issue, which can manifest across dimensions of time, space, social relevance, or hypotheticality [7].

In this context, immersive learning media have been proposed as an effective tool for bringing socio-environmental issues and their impacts closer to people, to increase environmental awareness and foster pro-environmental engagement [8, 9]. By creating a sense of presence in remote or simulated settings, immersive learning media can help participants to encounter unfamiliar environmental conditions first-hand and observe their

consequences, transforming abstract concepts into vivid, concrete experiences [10]. Aligned with experiential learning approaches [11], immersive media are therefore argued to support in-situ learning by offering students more concrete and meaningful information, which in turn enhances environmental literacy.

Despite these claims, empirical research demonstrating the effectiveness of immersive learning media in fostering a sense of environmental "proximity" is still in its early stages. Moreover, given the inherently interdisciplinary nature of the field, studies are scattered across diverse domains (e.g. environmental education, psychology, communication, computer science), producing a fragmented body of knowledge that complicates the drawing of firm conclusions. To address this issue, the present study provides a systematic scoping review to map the existing evidence on how immersive learning media are designed, implemented, and evaluated, as well as on their impact on reducing psychological distance from environmental issues. More specifically, the present study is guided by the following research questions: (a) What research aims and methodological approaches have been employed to investigate psychological distance in the context of immersive learning media?, (b) How is psychological distance addressed in the design of immersive learning media?, (c) What is the impact of the adopted immersive learning media in reducing users' psychological distance from environmental issues?

2 Methodology

The published literature was surveyed using two electronic databases (*Scopus* and *Web of Science*) and followed the PRISMA standards. Our search strings focused on combinations of retrieval keywords related to "Immersive media" (e.g. virtual reality), "Pro-environmentalism" (e.g. pro-environmental engagement) and "Psychological distance" (e.g. perceived distance). After performing all keyword combinations, we retrieved 175 records enriched with an additional two records retrieved from Google Scholar.

These records were screened, and all duplicates were removed, resulting in a total of 123 records, which were filtered, to identify their eligibility. More specifically, to be included in our research corpus, a study should: (1) involve immersive learning media (e.g., VR, AR, 360° video); (2) be designed for, or address, environmental issues; (3) present original empirical data; (4) explicitly study and measure psychological distance. The selection process yielded 12 publications, supplemented by one additional record identified through reference screening, resulting in 13 empirical studies.

The studies included in this review were systematically analyzed according to the three research questions. More specifically, the first researcher conducted a bottom-up analysis to develop a coding scheme, enabling the inductive identification of research aims and methodological strategies, features of immersive learning media design, as well as their impact on reducing psychological distance for strengthening pro-environmental engagement. To ensure reliability, a second researcher applied the scheme to four studies, with an initial inter-rater agreement (Cohen's κ) of 0.87. After all differences were discussed and resolved, the first author proceeded with the coding of the remaining studies.

3 Findings

The majority of the reviewed studies (10 studies, 77%) were published in journals, with the remainder in conference proceedings. Publications were evenly split between HCI/digital technology and environmental/science communication venues. Nearly all appeared within the last five years, and most of them (8 studies, 62%) in the past two years, reflecting a growing interest in the topic. Table 1 provides an overview of the main findings, with the following sub-sections offering a synopsis of the main outcomes per research question.

Table 1. Overview of the research corpus.

Study	RQ1: Research aims & methods	RQ2: Immersive media type & focus	RQ3: Impact
Ahn et al. (2016)	• Media modality • Quantitative • College students • PD: Temporal	• Immersive Virtual Environment • Simulation • Biodiversity loss and ecosystems degradation	**Positive:** Compared to passive video viewing, embodying an animal in the IVE increased embodiment and presence, deepened connection with nature, and reduced temporal distance by making environmental change more immediate
Andrei et al. (2024)	• Exploratory focus • Mixed methods • Adult participants • PD: Spatial & Temporal	• VR • Simulations • Climate change	**Positive:** The co-designed VR simulations reduced PD and contributed to experiential climate learning

Attanasi et al. (2023)	• Contextual impact • Quantitative • University students • PD: All dimensions	• AR • Simulation • Environmental pollution	**Mixed:** AR reduced psychological distance among participants with low environmental engagement but increased it among those with high engagement, indicating a backfire effect
Breves & Schramm (2021)	• Media modality / design • Quantitative • University students • PD: Spatial, Temporal & Hypothetical	• 360º video • Immersive video • Biodiversity loss and ecosystems degradation	**Mixed:** Compared to regular video, the 360º video reduced temporal distance, but had no effect on spatial or hypothetical distance; when the issue was framed as geographically close, the 360º format was less effective
Bekoum Essokolo et al. (2022)	• Exploratory • Qualitative • Adult participants • PD: All dimensions	• Virtual environment • Serious game • Environmental (plastic) pollution	**Positive:** The digital game on plastic pollution reduced all dimensions of psychological distance due to its immersive affordances (i.e. sensory, narrative, systemic immersion)
Fauville et al. (2024)	• Exploratory • Qualitative • Adult participants • PD: Spatial & Temporal	• 360º video • Immersive video • Biodiversity loss and ecosystems degradation	**Positive:** The underwater virtual reality simulation reduced perceived spatial and temporal distance from marine environmental issues
Fernández Galeote et al. (2024)	• Media modality / design • Quantitative • Mixed population • PD: Spatial & Social	• Virtual environment • Serious game • Climate change	**Mixed:** The virtual environment had a positive impact on reducing perceived psychological distance. However, compared to text, the virtual environment did not significantly affect perceived spatial or social distance, and this null effect persisted regardless of whether the issue was framed as distant or near
Fox et al. (2020)	• Media design • Quantitative • University students • PD: Spatial & Temporal	• Virtual environment • Serious game • Environmental pollution	**Positive:** Participants who experienced a virtual simulation of a geographically and temporally proximal polluted river reported more positive environmental outcomes than those exposed to a distant river
Hurrel et al. (2024)	• Media modality • Mixed methods • University students • PD: Spatial & Temporal	• VR • Simulation • Climate change	**Mixed:** VR had a positive impact on reducing perceived psychological distance. However, the VR did not show a reliable advantage over desktop environment in reducing psychological distance from climate change
Meijers et al. (2023)	• Media modality • Mixed methods • University students • PD: All dimensions	• 360º video • Immersive video • Climate change	**Mixed:** The comparison of VR, video, and articles showed that VR did not reduce psychological distance; however, qualitative responses suggested greater sense of proximity in the VR condition, highlighting a mismatch between measured and experienced effects
Pimentel et al. (2024)	• Media modality/design • Quantitative • University students • PD: Spatial	• 360º video • Immersive video • Climate change	**Positive:** Communicating climate change through 360-degree video, compared to traditional video, enhanced students' cognitive absorption, increased presence, reduced psychological distance, and fostered more positive attitudes toward the environmental message
Plechata et al. (2023)	• Media design • Quantitative • University students • PD: Spatial & Temporal	• VR • Simulation • Climate change	**Null:** Neither VR exposure nor spatial framing affected psychological distance, but VR increased environmental knowledge, boosted response efficacy, and reduced dietary carbon footprints, suggesting behavioral outcomes were driven by other factors rather than perceived distance
Raja et al. (2021)	• Exploratory • Qualitative • Adult participants • PD: All dimensions	• Virtual environment • Simulation • Climate change	**Mixed:** VR engagement with ocean acidification reduced perceived spatial and social distance, but had a limited impact on temporal and hypothetical dimensions

3.1 Research Aims and Methodological Approaches

The analysis of the research corpus has revealed four main goals across the reviewed studies: (a) media modality (i.e. whether immersive learning media are more effective than other media/instructional approaches), (b) media design (i.e. whether specific design features contribute or not to reducing psychological distance), (c) contextual impact (i.e. whether the context in which immersive learning media are situated into has an impact), and (d) exploratory focus (i.e. whether and how immersive learning media reduce psychological distance).

More specifically, six studies (46%) examined how immersive media influence psychological distance and pro-environmental outcomes compared to less immersive formats [10, 12–16], while five studies (38%) focused on how design features affect these outcomes [10, 13, 16–18]. One study addressed contextual impact by comparing augmented reality in lab versus field settings [19], and four studies (31%) adopted a more exploratory approach to investigate whether and how immersive learning media reduce psychological distance for pro-environmental engagement [20–23].

Methodologically, most studies employed experimental, quantitative designs (7 studies, 54%), though some used qualitative [21–23] or mixed methods [14, 15, 20], and the majority measured psychological distance with close-ended items (10 studies, 77%), often supplemented with interviews, focus groups, or open-ended responses [14, 15, 20–23]. The reviewed studies focused on measuring the impact of immersive learning media on spatial (92%) and temporal (84%) distance, with social and hypothetical dimensions being less studied (38% each), while only four studies addressed and measured all four dimensions [15, 19, 21, 23]. Finally, more than half of the studies (54%) relied primarily on university students as a convenient sample [12, 14–19], while the rest of the studies employed adult participants (3 studies, 23%) or mixed populations (3 studies, 23%).

3.2 Types of Immersive Learning Media, Environmental Issues and Design Strategies

Our second research question explored the types of immersive learning media, environmental issues, and design strategies used in the reviewed studies. VR, 360° video, and virtual environments were the most common types, each appearing in four studies (31%), while AR appeared in only one study [19]. Next, focusing on the supported immersive experiences, we identified that simulations were the dominating type. More specifically, six studies (46%) used simulations [12, 14, 18–20, 23], followed by four studies (31%) which were grounded on immersive videos [10, 15, 16, 22] and three studies (23%) which adopted serious games [13, 17, 21]. Climate change was the most frequently addressed issue (7 studies, 54%), with the reviewed studies focusing on both causes (e.g., unsustainable diets) and consequences (e.g., wildfires, ocean acidification, extreme weather) of climate change [13–16, 18, 20, 23], while a limited number of studies focused on environmental pollution (3 studies, 23%) as well as on environmental degradation and biodiversity loss (3 studies, 23%).

Finally, our analysis identified seven design strategies which were used in the adopted immersive learning media to reduce psychological distance from environmental issues. More specifically, the most common design principle was the use of *temporal acceleration and environmental change visualization* (10 studies, 77%), seeking to place users in future contexts where environmental consequences were made tangible [12–18, 20, 21, 23]. This was followed by *localization & spatial proximity* (8 studies, 62%), which sought to increase immediacy by anchoring environmental issues in nearby and familiar locations [10, 13, 14, 16–20]. Additional strategies included narrative & storytelling techniques (38%), immersive sensory design (31%), interactivity & feedback mechanisms (31%), as well as embodiment & perspective taking (23%), often combined for stronger impact. A unique case was Fauville et al.'s [22] "double immersion", in which the researchers blended VR with physical submersion in water to enhance underwater marine education and ocean literacy, through a multisensory experience.

3.3 The Impact of Immersive Learning Media

Our review revealed a complex and inconsistent pattern of findings regarding the impact of immersive media on reducing psychological distance to achieve pro-environmental engagement. Nearly half of the studies (six studies, 46%) reported positive effects, showing that VR, 360° video, and immersive virtual environments could enhance a sense of presence, foster concrete mental representations, and increase perceived proximity to environmental threats, thereby motivating environmental concern and action taking [12, 16, 17, 20–22]. However, a substantial subset of studies (31%) reported mixed results.

Specifically, immersive media: (a) sometimes reduced certain dimensions of psychological distance (e.g., temporal or geographic) while leaving others unchanged [10, 23]; (b) reduced psychological distance but not more effectively than non-immersive media[13, 14]; (c) produced backfire effects depending on participant traits or media design[10, 19]; or (d) yielded conflicting outcomes across different evaluation methods [15]. For instance,

Meijers et al. [15] found that according to the qualitative analysis of participants' responses VR reduced psychological distance, whereas quantitative measures showed no effect and even an increase in perceived temporal distance. On the other hand, Attanasi et al. [19] reported that AR reduced psychological distance among participants with low environmental engagement but increased it among those with high engagement, while Breves and Schramm [10] observed that their 360-degree video lowered temporal distance but had no impact on spatial or hypothetical distance and was less effective when the issue was presented as geographically close. Finally, the study of Plechatá et al. [18] has found null effects; more specifically, according to this study, while VR exposure and geographic framing did not affect psychological distance, the VR experience enhanced knowledge, response efficacy, and reduced individually dietary carbon footprints, implying that psychological mechanisms other than perceived distance may have driven the improvement of pro-environmental behaviors.

4 Discussion

A key factor behind the current environmental crisis is the widening psychological gap between people and the global socio-environmental challenges they face [24]. As citizens become more distant their motivation to take pro-environmental action often decreases [6]. This sense of detachment, known as psychological distance, has become of great importance in the fields of environmental education and communication, as a potential intermediate mechanism which may shape pro-environmental engagement, attitudes and behaviors [2]. In this context, immersive learning media have been proposed as a way to close this gap by making environmental issues feel more immediate and emotionally relevant. However, educational research in this area is emerging and remains scattered, limiting a cohesive understanding.

To address this issue, in this study we have reviewed the related literature to shed light on how immersive learning media have been used to reduce perceived psychological distance and foster stronger connections with environmental issues. Our findings suggest that, in some cases, immersive learning media may foster psychological proximity to socio-environmental challenges and encourage pro-environmental behaviors; however, the evidence remains inconsistent. While some studies show that immersive learning media can make current environmental problems feel closer and more urgent [12, 16, 17, 20–22], others report mixed or even null effects [10, 13–15, 18, 19, 23].

This variability suggests that psychological distance may not be uniformly affected by immersive experiences as well as that psychological distance reduction alone may not fully account for observed outcomes. On one hand, while psychological distance may serve as a potential intermediate mechanism, immersive experiences may be also affected by additional psychological mechanisms (e.g., psychological immersion, affective engagement) which should be taken into consideration [19]. On the other hand, while the immersive affordances of a given medium may enhance vividness and presence, outcomes depend on an amalgam of cognitive, emotional, and contextual factors, which can either support engagement or lead to disengagement [25]. In turn, this may explain why psychological distance is reduced in some contexts but not others, highlighting immersiveness as a facilitating condition shaped by methodological, design, and individual factors.

More specifically, according to our findings, immersive learning media have been used particularly for climate change education, while issues like biodiversity loss and environmental pollution remained less underexplored. Common design strategies included localization as well as temporal acceleration and visualization of environmental change, which can make distant problems feel immediate. Yet, these strategies did not always succeed; in some cases, they overwhelmed or even alienated users depending on the media design or participants' prior environmental engagement. On one side, this underscores the need for further research into how socio-demographic traits and participant characteristics mediate the effects of immersive learning media on psychological distance and pro-environmental outcomes [24]. On the other side, it supports recent calls to move beyond traditional media comparison studies towards participatory design and user experience research, to better understand how immersive media can be designed to foster transformative learning experiences [26].

Finally, from a methodological perspective, the vast majority of the reviewed studies relied on quantitative experimental designs that primarily targeted the spatial and temporal dimensions of psychological distance. In contrast, qualitative and mixed-methods approaches, while offering richer insights, remained sparse and limited. Future research should therefore employ more diverse methodologies and systematically examine all four dimensions of psychological distance (spatial, temporal, social, and hypothetical) to capture their interconnections and provide a more comprehensive understanding of how immersive learning media may holistically foster a sense of environmental "proximity". Moreover, most studies focused on university students as a convenient sample; however, this group is often more digitally literate and environmentally aware [12, 18], which may reduce the generalizability of findings. Future research should therefore broaden its scope to include younger student

audiences, as well as learners from diverse cultural, socioeconomic, and geographic contexts to better understand how different student groups experience psychological distance and respond to immersive learning media.

5 Pedagogical and Instructional Design Implications

In this systematic review, we analyzed 13 empirical studies to synthesize existing evidence on the methodological foundations of the studies, the design of the immersive learning media employed, and their effects on perceived psychological distance and pro-environmental engagement. While the limited number of studies calls for cautious interpretation, our findings provide support for several implications for immersive instructional design.

First, design strategies such as temporal acceleration and localization appear most promising for supporting learning about abstract or temporally extended environmental challenges by reducing perceived psychological distance [4, 7]. From an instructional perspective, these strategies align with experiential learning principles that emphasize concrete experience and situated learning [11]. However, our review indicates that a range of less frequently employed design strategies (narrative and storytelling techniques, immersive sensory design, interactivity and feedback mechanisms, embodiment and perspective-taking), may play a complementary role by supporting meaning-making, emotional engagement, and active learning processes. Although these strategies were less consistently examined across studies, their integration alongside temporal and spatial design elements may enhance learning outcomes when appropriately scaffolded and aligned with instructional goals.

At the same time, prior research cautions that highly immersive or emotionally intense environments may produce cognitive overload or defensive disengagement if not carefully designed, particularly for learners with low prior environmental engagement or limited experience with immersive media [11, 20]. These findings highlight the need to more closely examine subjective learner factors (e.g., prior knowledge, emotional sensitivity, digital literacy), as emphasized by the EFiL framework, and their combined role in shaping responses to immersive learning experiences [25]. Accordingly, educators and instructional designers should consider tailoring immersive experiences by balancing sensory intensity, interactivity, and narrative depth, and by embedding immersive activities within broader instructional sequences that include preparatory framing and reflective follow-up. Moreover, adopting participatory and learner-centered design approaches may further help ensure that immersive learning media are responsive to diverse students' needs and educational contexts [26].

6 Conclusions

Overall, our results suggest that although immersive learning media hold promise for reducing psychological distance and fostering pro-environmental engagement, their effects are neither consistent nor guaranteed, and appear contingent on design features, measurement approaches, and participant characteristics. Future research should therefore clarify the underlying psychological mechanisms, strengthen methodological rigor, and account for participant characteristics to better inform the design of immersive learning media for environmental education and communication purposes.

7 Study Limitations

Despite the contribution of this review, several limitations should be acknowledged. First, the search was limited to Scopus and Web of Science as well as to English-language publications, which may have excluded relevant studies indexed elsewhere or published in other languages. Grey literature searching was also limited, potentially omitting practitioner-focused work. These choices were appropriate for the scope of this present scoping review, but future research could broaden coverage. Second, given the emerging nature of research in this domain, the review included only 13 empirical studies, which may constrain the strength and breadth of the conclusions. Finally, consistent with the objectives of a scoping review, this study focused on mapping the field (i.e. design aspects, methods, outcomes of immersive learning media) rather than conducting a formal quality assessment of individual studies. This decision reflects both the exploratory nature of the field and the aim of this study to provide an overview of emerging approaches rather than evaluative judgments. As research expands, future systematic reviews could build on this work by incorporating formal quality assessment frameworks.

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