

# Play, Learn, Empower: A Design Model of Student Engagement in Environmental Education

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**Abstract:** Amid the largely underrecognized and escalating textile waste crisis, this study explores student engagement in active, experiential learning for sustainability and personal responsibility. We developed *Aftermath*, an educational board game co-designed with students to raise awareness via accessible, design- and play-based learning. In Phase One, eight students contributed to 14 participatory design workshops guided by the Stanford Design Thinking framework (*Empathy, Define, Ideate, Prototype, Test*). Iterative cycles began with empathy, focusing on everyday players navigating sustainability challenges and communities experiencing environmental injustice. In the define phase, we identified the core problem, its consequences, and the target audience. During ideation, participants reviewed existing board games and generated novel concepts for theme, mechanics, and content. Prototypes were refined through sketching, digital tools, and multiple rounds of testing to enhance clarity, inclusivity, and engagement. The process culminated in a renewed focus on empathy and defining, establishing the game's name, *Aftermath*, and articulating its educational, pro-environmental aims. Each workshop concluded with qualitative group reflections, in which participants shared insights gained, changes in perspective, and recommendations for the ongoing development of the game's design and pedagogical value. As the game design evolved from competitive to cooperative, so did the participants: shifting from passive learners to active co-creators throughout cycles of play, learning, and empowerment. Data from group discussions and reflective narratives demonstrated that collaborative design fostered critical reflection on individual roles within larger systems, increasing awareness and encouraging more mindful consumption practices in daily life. Phase Two later expanded participation, engaging 13 high school students in an exploration of textile waste, gameplay, and the design process. Working in teams, students created their original board games addressing the issue of textile waste, reinforcing knowledge through creative, hands-on learning. The educational game design process became a catalyst for behavioural change and environmental responsibility. This work indicates that design thinking in education not only solves problems but also fosters imagination, agency, and collective action. Through play, participants gained not only sustainability knowledge, but the ability to rethink and reshape their communities for a more sustainable future.

**Keywords:** Design Thinking, Play-Based Learning, Environmental Education, Gamification, Textile Waste, Pro-environmental Behaviour

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## 1. Introduction

Despite its scale, textile waste remains insufficiently understood by the public. Many do not grasp the environmental or health impacts of textile waste or correct disposal practices (Paul et al., 2023). As a global crisis, textile waste contributes to nearly 10% of carbon emissions - a figure projected to rise by 50% by 2030 (Igini, 2023). This disconnect between the scope of the problem and public awareness presents an opportunity: How might communities be actively engaged in learning to recognize and help address textile waste?

Our work addresses student engagement via design futuring (Cooper, 2022), using design as a medium for problem-solving and rethinking relationships with waste, systems, and future possibilities. Rooted in participatory play - a vital aspect of human development - we employ game design as a pedagogical strategy to make environmental issues tangible and relatable (Dancis et al., 2023). In this framework, participants are not only learners but also co-creators of knowledge and futures.

Employing design thinking workshops, we encourage exploration of new perspectives and empower participants as active change agents. Through shared play, participants cultivate imagination, reflection, and collective responsibility - essential components for more just, inclusive, and sustainable futures.

## 2. Literature Review and Contextual Background

### 2.1 Textile Waste

The global textile waste crisis is a significant yet overlooked environmental issue. In the United States, post-consumer textile waste has increased tenfold since 1960, surpassing 34 billion pounds by 2018 (U.S. EPA, 2017). This injustice reflects structural inequities: communities with higher income and education produce disproportionate textile waste, yet the resulting health burdens fall on more vulnerable populations. Most remain unaware of fast fashion's consequences and improper textile disposal, which, alongside air and noise pollution, disproportionately affect poor regions (Tonne et al., 2018).

### 2.2 Participatory Design

Participatory design embodies equal power dynamics, context-based behaviours, bidirectional learning, and democratic practices (Luck, 2018). Literature affirms its role across contexts and adaptability for contributors as design partners or advisors (Literat et al, 2020). Participatory design empowers participants as stakeholders, fostering critical reflection on environmental impacts of everyday choices (Bell & Davis, 2016; Kafai & Burke, 2015).

### 2.3 Games for Good

While the *Aftermath* sculpture was impactful, large infrastructure limits its reach (Aftermath Sculpture, n.d.). "Games for good" leverage the motivational structures of play to address societal challenges, raising awareness and improving critical thinking (Gugerell, 2023). Examples include Fakeopoly, adapted from Monopoly to teach fake news literacy (Literat et al., 2020).

### 2.4 Game-based Learning

Game-based learning harnesses interactive, relational instruction technologies (simulation, role-play, cases) to unite pedagogy with play (Hromek et al, 2009). When games connect process and outcome, motivation and retention improve (Jabbar et al., 2015). Existing environmental games often present sustainability *too* broadly or are disconnected from participants' lived experiences. Our project seeks to close this gap through participatory play linked to concrete pro-environmental action.

## 3. Methodology and Materials

### 3.1 Phase One: Consciousness-Oriented Participatory Design

Eight college students (N=8) served as co-designers across 14 workshops, engaging in "future-state consciousness development" (Atance & Meltzoff, 2005). This approach fosters deep engagement, enabling rich qualitative data collection to map initial consciousness shifts. We focused on reshaping mindsets toward regenerative, collective practices.

The Stanford Design Thinking framework (*Empathy, Define, Ideate, Prototype, Test*) structured the 14 sessions (Figure 1). The initial Empathy phase centered on understanding the experiences of everyday individuals navigating sustainability challenges, as well as the systemic injustices faced by communities disproportionately impacted by environmental degradation (Workshop 1). In the Define phase, participants collaboratively identified the core problem, examined its social and environmental consequences, and determined the target audience (Workshop 2-3). During Ideation (Workshop 4-7), participants analysed existing board games and generated original concepts for game themes, mechanics, and narrative content. These ideas were developed into prototypes using both analogue sketching and digital tools. Multiple rounds of user testing and refinement were conducted to improve clarity, inclusivity, and user engagement (Workshop 8-12). The final iteration returned to the Empathy and Define phases to ensure alignment with the project's values and intentions, resulting in the naming of the game - *Aftermath* - and a clearly articulated set of educational and pro-environmental objectives (Workshop 13-14).

| No. | Stage & Details   | No. | Stage & Details   |
|-----|---|-----|---|
| 1   | <b>Empathy</b> - Empathize with environmental injustice and potential game users  | 8   | <b>Prototype</b> - Draw our ideas on paper  |
| 2   | <b>Define</b> - Define who, what, where of environmental injustice and board game | 9   | <b>Test &amp; Ideate &amp; Prototype</b> - Play the prototype, discuss positive and negative feedback, ideate solutions, prototype the next version |
| 3   | <b>Define</b> - Define the age range of target user                               | 10  | <b>Test &amp; Ideate &amp; Prototype</b> - Play the prototype, discuss the game them, ideate solutions, prototype the next version                  |
| 4   | <b>Ideate</b> - Learn from other board games and apply to ours                    | 11  | <b>Test &amp; Ideate &amp; Prototype</b> - Play the prototype, discuss the game mechanics, ideate solutions, prototype the next version             |
| 5   | <b>Ideate</b> - Ideate our board game theme                                       | 12  | <b>Test &amp; Ideate &amp; Prototype</b> - Play the prototype, discuss the game contents, ideate solutions, prototype the next version              |
| 6   | <b>Ideate</b> - Ideate our board game mechanics                                   | 13  | <b>Empathy &amp; Define</b> - Discuss Inclusion and Accessibility of our game   |
| 7   | <b>Ideate</b> - Ideate our board game contents                                    | 14  | <b>Define &amp; Ideate</b> - Generate Statement of Intent and our game name: Fast Fashion Fixer   |

**Figure 1: Participatory Design Workshop Plan**

Each one-hour workshop followed a structured format. Sessions began with a brief presentation introducing the Design Thinking phase under focus, followed by a short lecture on game design principles, emphasizing the characteristics of effective educational games. This was followed by hands-on Design Thinking activities such as crafting Point of View (POV) statements, generating How Might We questions, and visual ideation exercises. Each workshop concluded with a group reflection, during which participants discussed key insights, shifts in understanding, and offered recommendations for the ongoing development of the game's design and its educational impact (Figure 1) .

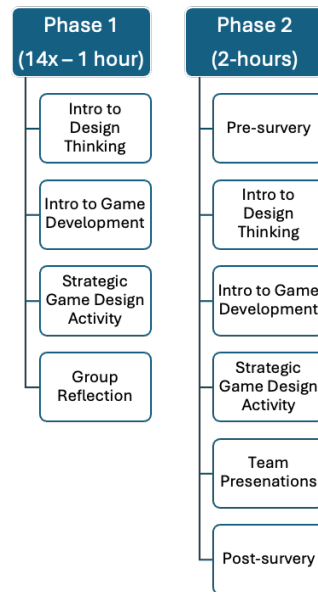
Three prototypes emerged during the design process:

- Version 1: Competitive, role-based gameplay (Consumers, Advocates, Landfill Manager) emphasizing extractive mindsets
- Version 2: Additional roles (Teachers, Lawyers, Fast Fashion Company Leaders, Policy Makers), systemic elements; increased inclusivity but retained competition
- Version 3: Fully cooperative model; shared destiny, mutual support, real-world solution networks

Themes from workshop reflections guided iterative redesign to ensure alignment with consciousness transformation and social action. Data arose from interactive activities, reflection, note-taking, ethnographic observation, and self-reported behavioural changes.

### 3.2 Phase Two: Consciousness Scaling and Impact Amplification

Phase Two engaged thirteen secondary-level students (N = 13) in a two-hour participatory design workshop. The session began with a pre-survey designed to assess participants' baseline knowledge, attitudes, familiarity, and ethical concerns related to textile waste. Following a structure similar to Phase One, students were introduced to the Design Thinking framework through a brief presentation, along with an overview of foundational principles in game development. Participants were then divided into three groups and guided through a rapid design sprint incorporating the five phases of Design Thinking (Empathize, Define, Ideate, Prototype, Test). Each group developed a playable game concept addressing textile waste and presented their prototypes to the larger cohort. The workshop concluded with a post-survey aimed at evaluating knowledge acquisition, shifts in mindset, and changes in ethical reasoning (Figure 2).



**Figure 2: Phase One and Phase Two Workshop Structure**

## 4. Results and Key Findings

### 4.1 From Awareness Gaps to Engagement

In Phase One, participants entered the workshop series with a limited understanding of textile waste and its environmental consequences. The game served as an informal and accessible entry point into this complex issue, introducing players to the broader global implications of individual consumption habits. The interactive and experiential nature of the game facilitated a smoother transition into the topic, creating space for genuine curiosity, engagement, and reflection. As participants became more comfortable exploring the subject, their initial curiosity evolved into deeper, more critical thinking.

Early reflections revealed low baseline awareness:

*"I didn't know much about textile waste before starting on the project, but I definitely found the game to be an approachable way to learn about the topic."* (Participant A, Phase One)

*"I don't think I knew much about textile waste prior to becoming very involved in game design. It was wholly unfamiliar to me."* (Participant B, Phase One)

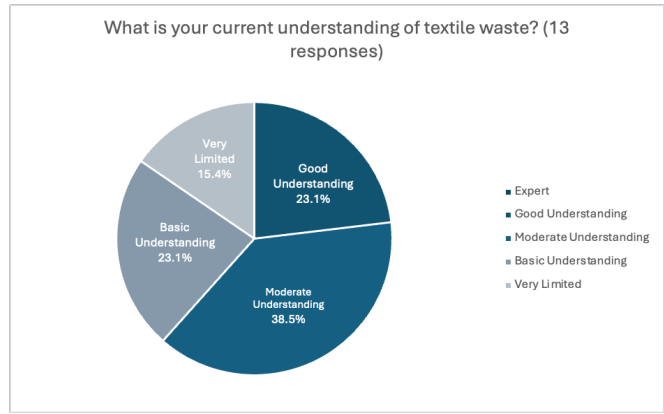
By the end of the workshop series, participants demonstrated a more interconnected and systems-level understanding:

*"The game led us to think about how all the elements of this global issue are interconnected and contribute to the problem."* (Participant A, Phase One)

*"Being involved in game designing pushed me to understand what textile waste is about, and furthermore it helped to think about how textile waste impacts daily life."* (Participant B, Phase One)

These qualitative insights point to a clear trajectory from unfamiliarity to meaningful engagement and critical reflection, facilitated through iterative, game-based learning.

Findings from Phase Two further corroborated the qualitative results from Phase One. Pre-survey data revealed that a majority of participants had limited prior awareness of the textile waste crisis. Specifically, 15.4% of respondents reported a "limited" understanding, 23.1% "basic," 38.5% "moderate," and 23.1% "good." No participant self-identified as having expert-level knowledge (Figure 3).

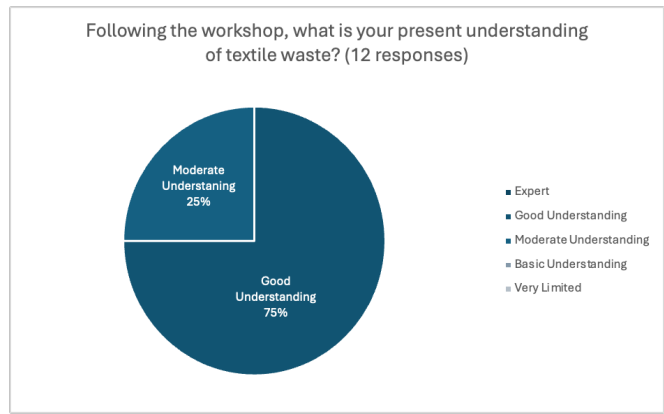


**Figure 3: Pre-survey results on current understanding of textile waste**

Post-survey results demonstrated significant improvements in comprehension:

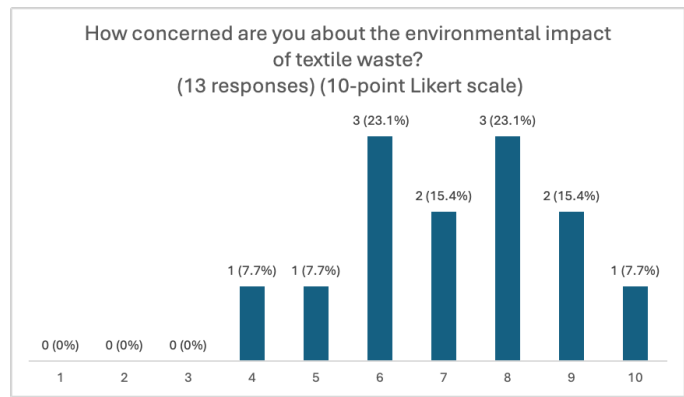
- 75% of participants reported a “good” understanding.
- 25% reported a “moderate” understanding.
- No participants reported “limited” or “basic” levels of understanding.

This shift represents a twofold (200%) increase in those reporting "good" understanding, and complete elimination of the lowest two categories, indicating not only improved awareness but a clear movement toward higher levels of conceptual grasp (Figure 4).

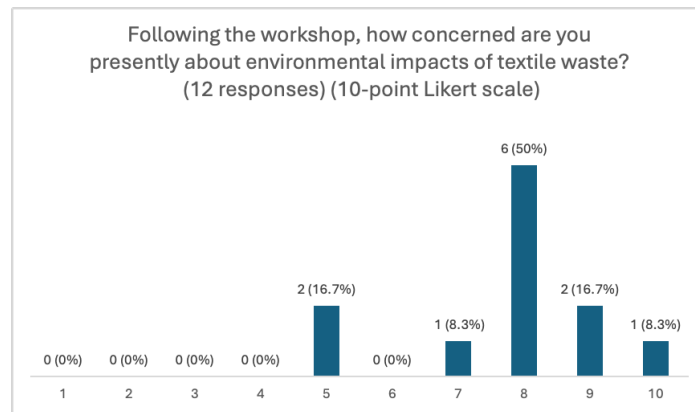


**Figure 4: Post-survey results on present understanding of textile waste**

In addition to increased understanding, participants reported heightened concern about textile waste. While pre-survey concern levels varied widely (ranging from 4 to 10 on a 10-point scale), post-survey responses skewed significantly higher, with no participant rating their concern below 5 and most selecting 8 or above (Figures 5 and 6). This suggests a measurable shift not just in awareness, but in emotional and ethical engagement with the issue.



**Figure 5: Pre-survey results on levels of concern regarding the environmental impact of textile waste**



**Figure 6: Post-survey results on levels of concern regarding the environmental impact of textile waste**

Across both phases, participants consistently found the game's interactive and creative elements essential for engaging with the topic. The hands-on, collaborative design process deepened their involvement, transforming initial curiosity into sustained, meaningful engagement.

#### 4.2 From Gameworld Choices to Real-World Habits

Participants noted connections between game scenarios and daily choices. Through play, personal consumption habits were reassessed shifts included interest in clothing swaps and mindful purchasing.

As Phase One participants noted:

*"Textile waste gradually became part of my everyday thoughts."* (Participant C, Phase One)

*"I think this was valuable practice for talking about it with others and helping them see how their habits can contribute to the problem and what changes could help."* (Participant D, Phase One)

In Phase Two, post-survey responses further emphasized the game's potential to spark both personal and collective action. Participants expressed a growing awareness of the systemic nature of textile waste and a desire to address it through advocacy and social innovation. Suggestions included:

*"Campaigns that collaborate with fast fashion companies, so that they can work around their marketing style to also incorporate textile waste awareness."* (Participant A, Phase Two)

*"Have social media movements and businesses which reuse clothes to manufacture pieces of clothing"* (Participant B, Phase Two)

Through the elements of play and collaboration, participants can see the in-game cards are a number of everyday choices that actually connect to each other. Before playing the game, what seemed like separate decisions - buying clothes, throwing things away, choosing where to shop - were later seen as part of a larger web of impact.

#### 4.3 When Designers Become Learners

The design process *itself* proved highly educational. Participants, initially unfamiliar with the textile crisis, deepened understanding while determining how to communicate issues through the game. As game creators, they also became educators, spreading awareness among peers.

In Phase One, one participant reflected that

*"After working on the game design, I felt like I had a better understanding of the different layers of the problem... we spent time thinking about how to talk about this issue and present it to young students."* (Participant F, Phase One)

In Phase Two, participants had not only internalized the issue but also began envisioning broader educational interventions. In post-survey responses, students suggested organizing "courses and student workshops" to further raise awareness. Others proposed creating a documentary, a museum exhibit, or an online course to "teach people about the issue" and "provoke more emotion from the audience."

Rather than being instructed on what to learn, participants - who also served as game designers - shaped the learning experience from the inside out, making meaning through iteration and collaboration.

#### 4.4 The Power of Small Actions (“Mattering”)

Students came to recognize that individual, everyday actions collectively drive broader environmental change and that small, intentional actions - such as reducing, reusing, and only then recycling - lead to measurable sustainability gains while reinforcing individuals’ sense of mattering and community leadership (O’Halloran, 2024). Adopting cumulative, sustainable, micro-actions can foster significant, lasting behavioral change at scale (Eilam, 2025). Reflection data echoed this insight that small, repeated actions are pivotal for challenging textile waste fast fashion at the grassroots level and leading to feelings of individual and collective positive impact and mattering (Flett, 2021).

*“It was valuable practice for helping others see how their habits contribute to the problem, and what changes could help.”* (Participant E, Phase One)

*“Spread the word on how much it is actually affecting the world and what the world could be if we cut down massively”* (Participant C, Phase Two)

Mattering emerged through curiosity - spotting patterns, building habits, and recognizing influence. As participants saw their actions as meaningful, they shared ideas and inspired others, creating a cycle where belief in impact led to real change.

### 5. Implications

*Aftermath* operationalizes the idea that incremental choices - reinforced via gameplay - drive meaningful outcomes. The game’s structure parallels child development theories (Vygotsky, Bronfenbrenner): cycles of play, learning, and empowerment facilitate both knowledge and systems-level transformation.

Participants gained an awareness by taking notice of how the small, repeated actions could lead to wider change. This reflects findings from Hvass (2015), who showed that second-hand business models both reduce textile waste and help shift consumer culture toward more mindful, sustainable habits. In these models, smaller actions and everyday habits like swapping clothes add up to challenge the fast fashion mindset starting at the grassroots level.

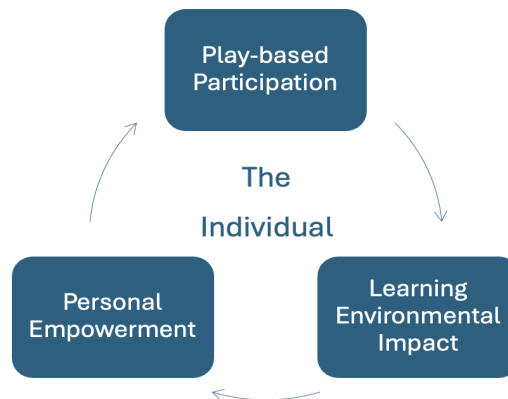
*Aftermath* builds on this idea by showing players how minor in-game decisions, made repeatedly over time, can have meaningful outcomes. The game helps people see that their actions matter, not just in theory, but in practice. We accomplish this by putting into practice current, real-world issues into its deck of cards. As the player progresses through the game, they are able to build agency and a sustainable mindset shift. A mindset that fosters long-term routine practices that are achievable versus an unreachable ideal of immediate change. Consequently, *Aftermath* helps reframe individual impact from an insufficient lens to one that is viewed as integral to systems-level change, echoing Hvass’s conclusion that meaningful transformation often begins at the micro level.

After identifying recurring patterns in participant reflections, we developed the *Aftermath* Cycle (Figure 7): a model that maps out the game’s prosocial and educational impact. The *Aftermath* Cycle shows how participants manoeuvre through a repeating loop of play, learn, and empower, with each round strengthening their awareness and expanding their range of impact. This cycle can be profoundly understood when applying the lenses of crucial child development theories such as, Vygotsky’s Zone of Proximal Development (ZPD) and Bronfenbrenner’s Ecological Systems Theory.

Vygotsky’s ZPD suggests that learners grow most when they are supported in taking on challenges just beyond what they could manage alone. Specifically, when the support is accomplished through social interaction and guided experiences (1978). In *Aftermath*, each card drawn invites players into conversations and choices about sustainability that might be new or unfamiliar. Through reflection and collaborative problem-solving, players get the social support they need to begin to become literate of relevant concepts like closed-loop supply chains, the social cost of cheap labour, and collective action vs. individual responsibility.

Bronfenbrenner’s ecological theory enhances this by emphasizing that learning is always shaped by context (1979). *Aftermath* places participants inside intersecting systems: their immediate social group (microsystem), the community setting where the game is played (mesosystem), and broader societal patterns around

overconsumption and sustainability (macrosystem). As participants learn and impart their knowledge on others, they start to play a part not only in their own choices, but also the practices of the systems they are associated with.



**Figure 7: The *Aftermath* Cycle: A continuous loop of play, learn, and empower**

## 6. Discussion

The evolution of *Aftermath* from a competitive to cooperative game mirrors a fundamental shift in how participants conceptualized environmental challenges - moving from individual competition to collective responsibility where learners become co-investigators of reality rather than passive recipients of knowledge. Our findings demonstrate that when students engage as co-designers rather than mere consumers of educational content, they develop deeper ownership of both the learning process and the environmental issues at hand.

The design thinking framework proved particularly effective in scaffolding this transformation. The iterative cycles of empathy, definition, ideation, prototyping, and testing created multiple opportunities for reflection and refinement of understanding. Notably, the empathy phase - often overlooked in traditional environmental education - emerged as crucial for connecting abstract global issues to lived experiences and local communities.

### 6.1 The Pedagogical Power of Play

Our results validate the theoretical foundations of play-based learning while extending them into environmental education. The dramatic improvement in textile waste understanding - from 23% "good" understanding to 75% achieving the level of knowledge - suggests that game-based approaches can effectively bridge complex environmental concepts with accessible learning experiences.

However, our findings reveal something more profound than knowledge transfer. The shift from "Gameworld choices to Real-world habits" indicates that play can serve as a rehearsal space for environmental citizenship. When participants made decisions within the game's safe space, they developed decision-making frameworks that extended beyond gameplay. This suggests that environmental games function not merely as information delivery systems but as laboratories for practicing sustainable behaviours and exploring their consequences without real-world risks.

### 6.2 Consciousness Development and Systems Thinking

The "consciousness-oriented participatory design" approach yielded insights into how environmental awareness develops. Participants progressed from viewing textile waste as an individual problem requiring individual solutions to understanding it as a systemic issue requiring collective action - and the ability to understand interconnections between personal actions and larger systems.

The concept of "*matter*" that emerged from participant reflections is particularly significant. Students' recognition that small actions contribute to broader change addresses a critical challenge in environmental education: overcoming feelings of powerlessness in the face of global crises. By experiencing how individual choices aggregate into collective impact through gameplay, participants developed the belief that groups can create pro-environmental actions required to produce positive change.

### 6.3 Design Thinking as Environmental Pedagogy

Our study extends the application of design thinking beyond product and service development into environmental education. The framework's emphasis on human-centered problem-solving proved particularly valuable for addressing the disconnect between global environmental issues and personal relevance. The iterative nature of design thinking allowed participants to continuously refine their understanding of both the problem (textile waste) and potential solutions (behavioural change strategies).

The emergence of three distinct prototypes reflects participants' evolving understanding of environmental challenges. The progression from competitive to cooperative models parallels broader shifts in environmental discourse from market-based competition to collaborative sustainability. This evolution was not predetermined but emerged organically from participants' deepening engagement with the issues, suggesting that design thinking processes can reveal insights that traditional instructional approaches might miss.

### 6.4 Scalability and Systemic Impact

Phase Two's expansion to high school students demonstrated the approach's scalability and highlighted key implementation considerations. The maintained effectiveness across different age groups suggests that the fundamental principles - participatory design, play-based learning, and consciousness development - transcend specific demographic boundaries. However, the need for sustained engagement and iterative refinement indicates that this approach requires more intensive facilitation than traditional educational interventions.

The finding that participants became 'educators' themselves - spreading awareness among peers - suggests a multiplier effect, extending impact beyond direct participants. This peer-to-peer transmission of environmental consciousness represents a form of learning that could foster broader cultural shifts toward sustainability.

### 6.5 Limitations and Future Directions

While our findings are promising, several limitations warrant consideration. The relatively small sample sizes (N=8 in Phase One, N=13 in Phase Two) limit generalizability, though the depth of qualitative engagement provides rich insights into the mechanisms of change. Future studies should explore larger-scale implementations while maintaining the intensive engagement essential to the approach's effectiveness.

The study's focus on textile waste, while addressing an important but underrecognized issue, raises questions about transferability to other environmental topic challenges. Research examining applications to climate change, biodiversity loss, or pollution could illuminate the broader applicability of this approach.

Additionally, the study period was insufficient to assess long-term behavioural persistence. Longitudinal follow-up studies tracking participants' sustained engagement with environmental issues would provide crucial insights into the durability of consciousness shifts achieved through this method.

### 6.6 Implications for Environmental Education

This research has significant implications for environmental education practice and policy. Our findings suggest that participatory, play-based approaches that position learners as co-creators of knowledge and solutions may be more effective for developing environmental consciousness and agency.

Educational institutions seeking to enhance environmental programming should consider incorporating design thinking frameworks and game-based learning. However, implementation requires significant shifts in pedagogical approach - from instructor-centered to learner-centered, from knowledge transmission to knowledge co-creation, and from individual learning to collective engagement.

Policymakers supporting environmental education should recognize that effective programs require sustained engagement, iterative refinement, and facilitation resources. The participatory nature of this approach also suggests the importance of community partnerships and local relevance in environmental programming.

## 7. Conclusion

The *Aftermath* project demonstrates that environmental education can be transformed through participatory design thinking and play-based learning. By positioning students as co-designers rather than passive recipients of environmental information, this approach fostered deep engagement, systems thinking, and sustained

behavioural change. The evolution from competitive to cooperative gameplay reflected participants' growing understanding of environmental challenges as collective rather than individual problems.

The dramatic improvements in environmental knowledge, coupled with reported behavioural changes and peer education activities, suggest that this approach addresses critical gaps in traditional environmental education. Emphasizing "mattering" - the recognition that individual actions contribute meaningfully to larger systems - can help counter the paralysis that often accompanies awareness of global environmental crises.

Perhaps most significantly, this work demonstrates that design thinking in environmental education serves not merely as a problem-solving tool but as a *consciousness-development process*. Through cycles of empathy, definition, ideation, prototyping, and testing, participants developed not only deeper environmental knowledge but also enhanced agency, imagination, and commitment to collective action.

As we face escalating environmental challenges, educational approaches that develop both knowledge and agency become increasingly critical. The *Aftermath* project suggests that when learners become co-creators of environmental solutions, they develop the consciousness, skills, and motivation necessary for sustained environmental engagement. Through play, participants gained not only sustainability knowledge but the ability to rethink and reshape their communities for a more sustainable future.

This research contributes to growing evidence that environmental education must evolve beyond information transmission toward approaches that develop environmental consciousness, systems thinking, and collective efficacy. The integration of design thinking, participatory learning, and play-based engagement offers a promising framework for this evolution, one that honours both the complexity of environmental challenges and the creative capacity of learners to address them.

## Ethics Declaration

This manuscript presents original research with accurate reporting and sufficient methodological detail for replication. All sources are properly cited, permissions obtained. All authors jointly responsible for the work.

## AI Declaration

ChatGPT assisted with rewording and rephrasing sections. All content was subsequently reviewed and edited by the authors, who accept full responsibility for the final version.

## Acknowledgements

We are grateful to both Boston College and the Design for Impact SDF Gift. The authors also thank the participants for their support to this research.

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