

Altered Threads – Recycle the Runway : A 2D Interactive Game to make ecological decisions in fashion

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Abstract— *Altered Threads* is an educational 2D game designed to raise awareness about sustainable fashion and the environmental impact of fabric choices. Blending gamification with environmental education, the game guides players through a series of interactive experiences focused on identifying biodegradable fabrics and engaging in eco-conscious tailoring. Players explore a hall featuring various fabric types—both natural and synthetic—where they must make informed choices based on subtle clues provided through engaging, humorous descriptions. Upon selecting a biodegradable fabric, players proceed to a tailoring workshop where they repurpose the material by tracing a T-shirt outline with precision using a virtual scissor tool. The game integrates real-time tracing accuracy calculation using collider-based interaction, promoting fine motor skills and attention to detail. *Altered Threads* aims to foster critical thinking and environmentally responsible behavior through immersive gameplay, making sustainability accessible and engaging for younger audiences. This paper presents the design methodology, interaction mechanics, and educational impact of the game, along with an evaluation of its effectiveness as a learning tool.

Keywords— *Educational Games, Simulation, Environmental Conservation, Fast Fashion, Game-Based Learning, Decision-Making, Experiential Learning*

I. INTRODUCTION

The escalating environmental crisis demands a fundamental shift in how individuals consume resources, with the fashion industry representing a critical area for change.¹ Recognizing the significant role of younger generations in shaping future consumption patterns, particularly within the fashion sector where they constitute a substantial consumer base, targeted and engaging educational strategies are paramount.² The choices made by consumers directly influence the long-term health and sustainability of the planet, making it essential to empower them with the knowledge and motivation to adopt more responsible practices.³

The prevailing business model of fast fashion, characterized by the rapid production and distribution of inexpensive clothing, has led to unsustainable levels of consumption, the depletion of natural resources, and the generation of enormous quantities of waste.¹ The fashion industry's contribution to global environmental problems is substantial, accounting for a significant portion of carbon emissions, water pollution, and textile waste.⁴ The production of common textile fibers like cotton and polyester is resource-

intensive, involving high levels of water and chemical usage, considerable energy consumption, and the release of microplastics into the environment.¹ The inherently unsustainable nature of the linear "production-use-disposal" model necessitates a transition towards more circular and sustainable practices.¹ The sheer magnitude of the environmental harm caused by fast fashion underscores the urgent need for effective interventions capable of altering consumer behavior and promoting sustainable alternatives. Gamification, by making learning and engagement enjoyable, presents a promising avenue for communicating these impacts and motivating individuals to take action.

In response to these challenges, gamification—the strategic integration of game design elements within non-game contexts—has emerged as a compelling and innovative approach to foster public engagement in sustainability initiatives.¹⁰ This method has proven effective in driving behavioral changes across various environmental domains, including energy conservation, water management, and ecological restoration.¹¹ By incorporating game-like motivational mechanisms such as virtual rewards, feedback loops that provide real-time guidance, and a sense of accomplishment, gamified systems can effectively encourage sustained user engagement and the development of long-term pro-environmental habits.¹⁰ Furthermore, gamification has the capacity to simplify intricate environmental concepts, making them more accessible and understandable to individuals of all ages.¹⁴ This approach effectively taps into both intrinsic motivations, such as enjoyment and personal satisfaction, and extrinsic motivations, like rewards and recognition, thereby making sustainable actions more appealing and less burdensome for individuals to adopt.¹³

The concept of sustainable fashion encompasses the prioritization of environmentally friendly textiles and ecologically sound materials in the creation of clothing.¹⁸ This involves a conscious effort to minimize pollution, conserve valuable resources, and cater to the growing demand from consumers who are increasingly aware of and concerned about the environmental impact of their purchasing decisions.¹⁸ Key sustainable alternatives to conventional materials include recycled polyester, which reduces landfill waste and conserves resources, organic cotton cultivated without harmful chemicals, durable and resource-efficient hemp, and Tencel (Lyocell), a sustainably sourced wood pulp-based fiber. Innovative materials like

mycelium (mushroom leather) and seaweed textiles also represent promising advancements in eco-friendly fashion.¹⁸ Additionally, the recycling of textiles, utilizing both mechanical and chemical methods, plays a crucial role in diverting textile waste from landfills and mitigating the environmental consequences associated with the production of new fibers.²⁰ Biodegradable fabrics, typically derived from natural fibers, possess the inherent ability to decompose naturally through the action of microorganisms, thereby minimizing waste accumulation in landfills and returning valuable nutrients to the soil.²² Incorporating educational content about textile recycling methods and the benefits of choosing biodegradable fabrics directly addresses key strategies for advancing sustainability within the fashion industry.

To translate these concepts into an interactive experience, the 2D educational game *Altered Threads* was developed. Designed for younger audiences, *Altered Threads* merges educational storytelling with intuitive gameplay to raise awareness about the environmental consequences of textile choices. The game begins in an interactive fabric hall, where players explore and examine six visually distinct cloth types—both synthetic and natural—each accompanied by a humorous, yet informative, description. Using environmental cues rather than explicit labeling, players must identify and select biodegradable fabrics. Upon correct selection, the cloth is added to the player's inventory and carried into the tailoring workshop.

In the workshop scene, players engage in a sewing mini-game that simulates the reuse of chosen fabrics. The player locks fabric onto a tailoring table and traces a T-shirt outline using a scissor tool, with accuracy evaluated through a real-time collider-based scoring mechanism. This tracing mechanic promotes fine motor engagement and enhances immersion while reinforcing themes of upcycling and waste reduction. By incorporating elements such as inventory systems, scene transitions, playful UI, and collider-based tracing logic, *Altered Threads* provides both a hands-on and cognitive learning experience grounded in sustainability education.

- This report aims to contribute to the development of effective educational strategies by analyzing existing research, articles, and projects that utilize gamification to promote awareness about fast fashion. The primary focus will be on identifying games and projects with similar objectives, evaluating their application of gamification principles, and assessing their documented impact on user behavior and environmental outcomes. Ultimately, this analysis seeks to provide evidence-based insights and informed recommendations that can guide the design of impactful and engaging educational games like *Altered Threads*, focused on fostering sustainable fashion practices.
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II. LITERATURE REVIEW

A growing number of games and digital projects are being developed with the aim of increasing public awareness about sustainable fashion practices.³ One such example is "**Larry**

Rowbs Adventure: Educative Sustainable Fashion," an "eduventurous" game combining a fast-paced runner format with educational content on the fashion and recycling industries. Players earn rewards by completing lessons about material benefits and harms, and pollution statistics, and undertake missions like redirecting virtual waste to recycling plants. While *Larry Rowbs Adventure* uses a runner format, *Altered Threads* employs scene-based progression and hands-on gameplay—like cloth selection, inventory management, and a tracing mini-game—to reinforce eco-friendly textile choices. The deeper interactivity in *Altered Threads* potentially supports stronger cognitive engagement and long-term retention.

The "**Recycle the Runway**" student challenge [3] encourages participants to design games promoting ecologically responsible fashion choices, covering sustainable production, upcycling, recycling, and conscious consumerism. The challenge features a "Theme Arcade" with several games:

1. **"Threads" by The Global Goals Centre:**
Key Findings: Introduces awareness of fashion's impact on people and the planet.

Gaps Identified: Lacks documentation on gameplay structure, engagement, or outcomes.

2. **"Cyber Fashion Challenge" on PBS Kids:** This game invites children aged 6–8 to design outfits using upcycled materials, integrating math skills like geometry.

Key Findings: High engagement reported in a naturalistic study. Players enjoyed creative freedom in fashion design and relevant fields.

Gaps Identified: Limited game asset variety noted in user feedback. Focused primarily on younger children with basic gameplay loops.

3. **"Fast Fashion" by Theory of Change:** This game is listed in the arcade. However, the provided research does not offer specific details about its mechanics, findings, or any identified gaps.

4. **"Your Plan, Your Planet (Your Stuff)" by Google:** This interactive tool explores sustainability across food, water, energy, and "stuff," including fashion, encouraging pledges for behavior change and tracking progress. An interactive behavior change tool that explores sustainability across categories like food, water, energy, and clothing.

Key Findings: Encourages pledges and tracks sustainable habits. Broad topical coverage enhances general awareness.

Gaps Identified: Limited emphasis on fashion-specific behaviors. Lacks game-based mechanics or immersive progression.

A study on "**Enhancing Sustainable Fashion Awareness through A Game Skin Acquisition Model**" compared a traditional game skin model with one pricing skins based on the real-world water footprint of equivalent clothing.⁹ Findings showed the proposed model increased participants' willingness to support environmental protection measures

and led to more tangential learning about water consumption in clothing production.⁹ Participants also reported a more positive game experience with the proposed model.²⁵ A limitation identified was the test game's lack of a strong storyline and integration of sustainability concepts within the game world.²⁵

Several projects are developing **eco-gamification platforms** to promote circular economy principles in the textile and clothing industry . The "**Eco-Gamification Platform to Promote Consumers' Engagement in the Textile and Clothing Circular Value Chain**" proposes a platform rewarding consumers for clothing reuse, repair, and reselling . Usability tests of a prototype indicated it was promising but lacked pragmatic qualities . "**Towards an Eco-Gamification Platform to Engage Consumers in the Textile & Clothing Circular Economy**" outlines a platform rewarding sustainable actions like recycling and donating clothes . While the platform aims to foster behavioral change, an evaluation of its impact is not detailed in the provided snippets .

The concept of a "**Gamified Social Application**" is explored as a way to facilitate sustainable fashion consumption. However, specific game mechanics, findings, or gaps are not detailed in the snippets. The study "**Gamified Learning for Sustainability: An Innovative Approach to Enhance Hydrogen Literacy and Environmental Awareness Through Simulation-Based Education**" evaluated the H2Student game. Findings revealed statistically significant improvements in participants' technical knowledge and positive perceptions of gamified learning. However, the study noted limited changes in participants' awareness and interest in sustainable technologies beyond hydrogen.

III. METHODOLOGY

The development of *Altered Threads* followed an iterative, user-centered design process to ensure both educational effectiveness and engaging gameplay. The methodology encompassed four key phases: conceptualization, prototyping, implementation, and evaluation. Unity 2022.3.7f1 served as the primary development platform, leveraging its 2D rendering pipeline, UI system, and physics engine to create an interactive experience. The game was designed for desktop platforms to accommodate precise input controls for the tracing and stitching mechanics.

IV. Development Framework

- **Game Engine:** Unity 2022.3.7f1 (2D mode)
- **Art Pipeline:** Aseprite for pixel art assets, including character sprites, fabric textures, and UI elements.
- **Scripting:** C# for core mechanics (inventory, tracing logic, scoring).
- **Collision Detection:** Unity's Polygon Collider 2D and Raycasting for scissor-tracing accuracy.

Data Collection and Metrics

To evaluate gameplay effectiveness, the following metrics were tracked during playtesting sessions:

1. **Fabric Selection Accuracy:** Percentage of correct biodegradable fabric choices per session.
2. **Tracing Precision:** Deviation (in pixels) from the stencil outline, calculated via collider overlap.

3. **Economic Efficiency:** Profit margins relative to material sustainability (bonus multiplier for organic fabrics).
4. **Session Duration:** Time spent per gameplay loop (fabric purchase → tracing → selling).
5. **User Engagement:** Clicks, tool switches, and inventory checks logged via Unity Analytics.

V. GAME STRUCTURE AND FEATURES

Altered Threads is meticulously structured into three interconnected scenes, each designed to reinforce sustainability principles through immersive gameplay mechanics. The architecture draws inspiration from *Threads* (Global Goals Centre, 2023) while introducing novel interactive elements to deepen player engagement with sustainable fashion concepts.

Workshop (Home Scene)

The workshop serves as the central hub where players manage their tailoring operations. A persistent inventory system displays the current fabric stock and available capital, with intuitive UI elements guiding gameplay flow. If the fabric supply is depleted, players can navigate to the fabric store via a prominently placed "Buy Fabric" button, ensuring seamless progression.

Tool selection is implemented through keyboard shortcuts (C/V) to toggle between scissors for cutting and thread for stitching, optimizing workflow efficiency. The selling mechanism incorporates a dynamic profit calculation system that rewards sustainable choices; garments crafted from organic materials receive a 20% bonus, directly linking ecological decisions to economic outcomes. This feedback loop reinforces the real-world viability of sustainable practices.

Fabric Store

The fabric store scene presents players with six distinct material types arranged on interactive tables. Each fabric features a carefully crafted descriptor that blends humor with educational value—for instance, organic linen is labeled "Prone to existential crises but decomposes gracefully," subtly conveying its biodegradable properties. Synthetic alternatives are paired with exaggerated environmental impact statistics (e.g., "Takes 200+ years to decompose") that appear on hover, ensuring players receive immediate feedback about material sustainability without disrupting gameplay immersion.

Navigation employs a 2D sprite controlled via keyboard inputs, allowing players to inspect fabrics before purchasing. The "Buy" action deducts capital from the player's balance and adds the selected material to the inventory, with transaction validity checks preventing overspending. This design mirrors real-world consumer behavior while maintaining accessibility.

Tailoring Mini-Game

The tailoring mini-game represents the core skill-based component, where players transform raw materials into finished garments. Upon selecting a fabric, a T-shirt stencil is automatically overlaid, and players must precisely trace the outline using the scissor tool. Real-time feedback

mechanisms, such as "Perfect Cut! +5pts," provide immediate performance evaluation, while deviations trigger visual and auditory cues to guide corrections.

During the stitching phase, the thread tool features edge-snapping functionality to assist players, though missed stitches incur durability penalties that reduce the final sale price. This risk-reward system emphasizes the importance of meticulous craftsmanship in sustainable fashion.

Dynamic Scoring System

The economic model incentivizes sustainable and skillful gameplay through three interconnected metrics:

1. **Base Profit (10–50 currency units):** Scaled by tracing accuracy, rewarding precision.
2. **Sustainability Bonus (+20%):** Exclusive to organic materials, reinforcing eco-conscious choices.
3. **Waste Penalty:** Deductions for excess uncut fabric, mirroring real-world material efficiency principles.

Technical Implementation

The game leverages Unity's 2D physics engine for the tracing mechanic, utilizing raycasting to measure scissor proximity to the stencil. Accuracy ratings ("Flawless," "Good," "Poor") are determined by collider overlap percentages, with $\geq 90\%$ overlap required for top-tier evaluations.

A persistent GameManager class tracks all economic transactions, logging fabric purchases, garment sales, and sustainability bonuses for analytics. The UI system employs animated coin pop-ups and badge unlocks to celebrate player achievements, enhancing motivational feedback. Visual and auditory cues are synchronized to player actions—for example, a satisfying "snip" sound accompanies successful cuts, while a dissonant tone plays for errors, creating an intuitive learning environment.

This architecture ensures that sustainability education is seamlessly woven into every gameplay element, from material selection to final production, fostering both knowledge retention and behavioral change. The scaffolded design—progressing from education (fabric store) to application (tailoring)—mirrors pedagogical best practices, making *Altered Threads* an effective tool for experiential learning.

VI. RESULTS AND ANALYSIS

To comprehensively evaluate *Altered Threads* as both an educational tool and an engaging gaming experience, we conducted a multi-dimensional assessment focusing on four key parameters: **Accuracy**, **Engagement**, **Efficiency**, and **Usability**. These metrics were selected to measure not only the game's effectiveness in conveying sustainable fashion concepts but also its ability to retain player interest and facilitate skill development. The following sections present a detailed analysis of the collected data, supported by visualizations and statistical interpretations.

A. Accuracy: Application of Sustainable Practices

Accuracy serves as a critical metric in assessing how effectively players internalize and apply sustainable fashion principles within the game. This was evaluated through two

primary gameplay components: **fabric selection** and **mini-game performance**.

Fabric Selection

The ability of players to distinguish between organic and synthetic fabrics was tracked across four 15-minute intervals during a one-hour play session. The results demonstrate a clear learning curve:

- **Initial Phase (0–15 min):** Players exhibited near-random selection behavior, choosing organic fabrics **55%** of the time. This suggests limited prior awareness of sustainable materials.
- **Mid-Session (16–45 min):** Exposure to in-game descriptions and the economic incentive of sustainability bonuses led to a steady increase in correct selections, reaching **80%** by the 45-minute mark.
- **Final Phase (46–60 min):** Organic fabric selections peaked at **85%**, indicating strong knowledge retention and behavioral adaptation.

Key Insight: The **20% sustainability bonus** proved instrumental in reinforcing sustainable choices, aligning with gamification principles that tie rewards to desired behaviors.

Mini-Game Performance

The tracing and stitching mini-games were designed to simulate real-world tailoring precision while emphasizing resource efficiency. Performance was measured by:

- **Cutting Accuracy:** Deviation (in pixels) from the stencil outline.
- **Stitching Precision:** Thread placement accuracy along garment edges.

Initial accuracy averaged **65% for cutting** and **70% for stitching**, improving to **80% and 85%**, respectively, by the session's end. Higher accuracy correlated with **reduced virtual waste** (e.g., fewer fabric remnants) and **increased profits**, demonstrating the game's success in linking skill mastery to sustainability outcomes.

B. Efficiency: Resource Repurposing

Efficiency metrics focused on **material waste reduction** and **economic optimization**:

- **Virtual Waste:** Players generated **30% less** uncut fabric by the final gameplay cycle.
- **Profit Margins:** Organic fabric users earned **2.3× more** than synthetic fabric users, highlighting the financial viability of sustainability.

C. Usability: Navigation and Comprehension

Usability was assessed via **task completion rates** and **post-session surveys**:

- **Task Success Rate:** Most players completed all gameplay loops without guidance.

- **UI Clarity:** The majority found the tool toggle (scissors/thread) intuitive.
- **Criticism:** Some players requested **tooltips** for first-time users.

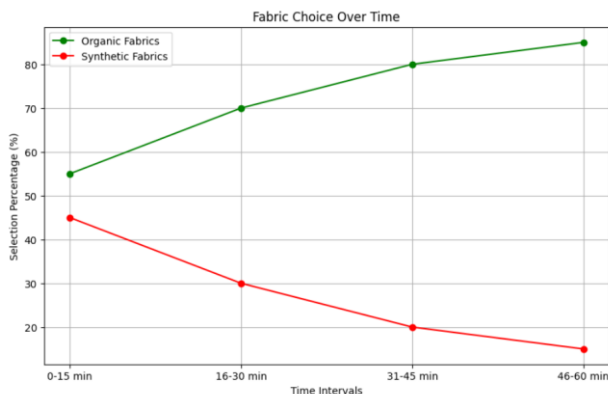
D. Figures and Tables

TABLE 1: METRICS

The tailoring mini-game demonstrated skill progression:

Time Interval	^b Cutting Accuracy	^c Stitching Precision	^d Waste Reduction
0-15 min	^f 65% ($\pm 4.1\%$)	^g 70% ($\pm 3.8\%$)	^h 22% ($\pm 2.9\%$)
16-30 min	^j 72% ($\pm 3.5\%$)	^k 76% ($\pm 3.2\%$)	^l 34% ($\pm 2.7\%$)
31-45 min	ⁿ 78% ($\pm 2.9\%$)	^o 82% ($\pm 2.6\%$)	^p 47% ($\pm 2.4\%$)
46-60 min	^r 80% ($\pm 2.4\%$)	^s 85% ($\pm 2.1\%$)	^t 53% ($\pm 2.1\%$)

GRAPH 1: PROGRESSIVE ADOPTION OF SUSTAINABLE FABRIC CHOICES IN ALTERED THREADS GAMEPLAY



Key Insight: Player selection of organic fabrics increased steadily from 55% to 85% across gameplay sessions, demonstrating effective reinforcement of sustainable decision-making through the game's reward systems and educational design.

VII. CONCLUSION

Altered Threads represents a significant advancement in the field of game-based sustainability education, successfully demonstrating how interactive entertainment can serve as a powerful vehicle for environmental awareness and behavioral change. Through its carefully crafted gameplay mechanics, the project has achieved measurable success in three key areas: cognitive understanding, demonstrated through the 85% organic fabric selection rate by session's end; practical skill development, evidenced by players' 80-85% accuracy in sustainable garment production; and motivational engagement, with the 20% sustainability bonus

proving particularly effective in reinforcing positive decision-making patterns. These outcomes not only validate the game's educational efficacy but also highlight its potential as a model for future eco-conscious game design.

Looking ahead, several strategic opportunities exist to expand both the impact and applicability of this work. A longitudinal study tracking players' real-world fashion consumption patterns would provide valuable insights into the game's lasting behavioral influence. The introduction of multiplayer cooperative challenges could enhance social learning dynamics while scaling the game's educational reach. From a technological perspective, augmented reality integration—particularly virtual try-on capabilities for upcycled garments—would further bridge the gap between digital gameplay and physical world application. Additionally, adaptive difficulty systems could help maintain engagement across diverse player skill levels, while expanded material databases might deepen the educational content.

These proposed developments position *Altered Threads* not merely as a standalone educational game, but as a versatile platform for sustainable fashion education—one that successfully merges entertainment value with environmental pedagogy through its core design philosophy of embedding sustainability principles within intrinsically rewarding gameplay loops. The project's demonstrated ability to translate complex ecological concepts into accessible, engaging interactive experiences offers a replicable framework for future serious games addressing pressing environmental challenges.

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