

Novel methods in corporate ESG education: A case study in Singapore

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Abstract

The increasing importance of Environmental, Social, and Governance (ESG) in corporate strategy necessitates effective educational tools that can bridge the current ESG literacy gap. Yet the effectiveness of play-based ESG education activities remains. This study examines the effectiveness of play-based learning in ESG corporate education by comparing an environment-themed escape room with a traditional workshop in Singapore. Participants were randomly assigned either the escape room or workshop and completed pre- and post-session surveys evaluating knowledge, engagement, and behavioural intentions. Analysis was built on six features of effective environmental games: immersion, engagement, learning by doing, real-world problem simulation, decision-making autonomy, and facilitator hosting. We found that both the escape room and workshop enhanced participants' understanding of sustainability concepts, with the escape room fostering collaborative problem-solving and the workshop supporting reflective dialogue. To strengthen future ESG-focused games, the study recommends a hybrid approach, embedding explicit cause-effect mechanisms, adopting phased game progression and adaptable difficulty, and promoting equal participation through role-based or task-diverse gameplay. Skilled facilitation and structured debrief remain essential for linking in-game learning experiences to real-world application. This research demonstrates the complementary value of play-based and discussion-based approaches in corporate ESG education, showing that well-designed hybrid models can enhance engagement, deepen understanding, and foster sustainable behavioural change in organisations.

Keywords: ESG (Environmental, Social, Governance), Gamification, Corporate Sustainability, Decision-making, Corporate Education, Environmental Education

Author Summary

As Environmental, Social and Governance (ESG) issues become central to how organisations operate, many companies struggle to find effective ways to build ESG understanding among employees that would translate into practical decisions. Traditional training methods often rely on presentation and discussions, which may not fully engage participants or help them connect concepts to real-world decisions. In this study, we compare two approaches to corporate ESG education in Singapore: a traditional workshop and an environment-themed escape room game. By surveying participants before and after each session, we explored how these formats influence learning, engagement, and intentions to apply sustainability ideas at work. We found that both approaches improved understanding, but in different ways. The escape room encouraged collaboration and problem-solving through active participation, while the workshop supported reflection and discussion. Our findings suggest that combining play-based and discussion-based methods can create more effective ESG learning experiences. Well-designed games, supported by phased difficulty levels, skilled facilitation and structured debriefs, can help employees better understand sustainability challenges and apply ESG principles in their workplace.

1. Introduction

As the stakes of the climate crisis rise, the corporate sector is no longer a passive observer but a central player in our Earth's arena. From climate-related health threats like dengue to disrupted supply chains and shifting markets, businesses now face escalating environmental

and social risks that directly impact their people, operations, and long-term viability (Williams & Barnes, 2024). This is true not only globally but also in countries like Singapore, where dense urban living and trade-dependent economies amplify such vulnerabilities (Ministry of Foreign Affairs [MFA], 2025; National Climate Change Secretariat [NCCS], 2025). In this context, corporate involvement in sustainability efforts is not just strategic – it is essential. This responsibility is embodied in the Environmental, Social, and Governance (ESG) framework, a structured approach that enables companies to assess and improve their practices across three pillars (Braithwaite & Đapo, 2023). The Environmental pillar focuses on a company’s direct and indirect impact on the planet, covering areas including carbon emissions, resource efficiency, and climate adaptation strategies. The Social pillar addresses the ethical and societal implications of business operations, including labour rights, community engagement, and equitable resource access. Finally, the Governance pillar evaluates corporate leadership’s accountability and transparency, emphasising ethical decision-making and compliance (Braithwaite & Đapo, 2023).

The growing emphasis on ESG practices stems from the urgent need for businesses to mitigate climate risks, address resource scarcity, and navigate evolving regulatory pressures, while meeting stakeholder expectations for sustainability (Braithwaite & Đapo, 2023). In particular, by prioritising the Environmental pillar, corporations can not only contribute to global climate action but also secure competitive advantages, such as improved compliance, stronger brand reputation, and long-term market positioning (McKinsey & Company, 2021; Leon-Gomez et al., 2023). However, businesses tend to place the least focus on the environmental component of ESG due to challenges like data gaps, limited interest, and insufficient political pressure (Leon-Gomez et al., 2023; Markopoulos & Ramonda, 2022).

Environmental sustainability practices—strategies to alleviate resource depletion and pollution, waste management, reducing carbon footprints, and aligning with national climate

objectives—remain mostly informal within businesses, especially small-medium enterprises (SMEs), and disconnected from broader business strategy (Sopiah et al., 2024; Martins et al., 2022). Despite growing commitments to lead environmental sustainability, SMEs continue to trail behind larger corporations in terms of active environmental engagement (Wildnerova et al., 2024). Yet, even among larger firms, only about half can be considered environmentally proactive, indicating significant gaps across the corporate spectrum (Wildnerova et al., 2024). These findings highlight the need for increased awareness and coordinated action from both leadership and stakeholders to prioritise environmental sustainability in business.

The increasing importance of ESG in corporate strategy necessitates effective educational tools that can bridge the current ESG literacy gap. Traditional teaching methods often struggle to convey the full breadth and depth of complex and multi-faceted sustainability concepts in an engaging manner (Zhang, 2024). Similarly, conventional ESG education formats—such as standard workshops that focus primarily on certification and compliance—may not sufficiently engage employees or support the practical integration of ESG principles into day-to-day decision-making (Seneca ESG, 2024). In contrast, environmental games are an emerging tool being used for its engaging and interactive formats, which can make ESG principles more accessible and relatable, thereby fostering higher levels of understanding, collaboration and motivation among participants (Markopoulos et al., 2022).

This research focuses on the Environmental pillar and addresses two main goals: (1) to develop an environment-themed escape room integrating ESG education material; and (2) to assess the impact of the game-based approach on employee ESG understanding compared to a conventional approach in the form of a workshop.

2. Literature review

2.1 Potential of Gamification for Environmental Education

Educating employees in environmental stewardship is crucial in cultivating a culture of sustainability within corporates (Wei et al., 2021; Mbonigaba & Sujatha, 2024). Yet, traditional methods of ESG education that focus on certification and compliance may not adequately engage employees or facilitate the practical application of ESG principles in decision-making processes (Zhang, 2024; Seneca ESG, 2023; Chen & Martin, 2015). Traditional corporate training, like seminars, has shown little impact on employees' voluntary pro-environmental behaviours since education often focus on cost-saving methods, not genuine conservation (Sult et al., 2024). Rather, emerging evidence suggests that gamification can enhance learning outcomes in ESG education by providing immersive, emotionally engaging, interactive experiences that mimic real-world environmental challenges — key elements for behaviour change (Markopoulos et al., 2022; Madani et al., 2017; Chen & Martin, 2015), and ultimately attitude changes (Kuntz et al., 2012). Therefore, it is critical that behaviour in environmental games mirror those in the real world (Costanza et al., 2014). While escape rooms — a live, interactive game in which a team of participants work together to find clues and solve puzzles within a set time limit to “escape” from a themed room — have the potential to create such real-world experiences, there are very few documented case studies of escape room experiences developed for ESG education. One example is Nespresso's partnership with Emeraude Escape to create a 2D virtual escape room for employees worldwide. The game, set across a coffee farm, boutique, and factory, aimed to raise awareness of sustainable coffee sourcing and manufacturing through interactive storytelling (Emeraude Escape, n.d.). However, little information is known about its efficiency. Given the scarcity of well-documented ESG-focused games in corporate settings, the following literature review will focus more broadly on environmental games.

2.2 Limitations of Current Environmental Games

Current environmental games often suffer from gaps and by extension, lack of long-term engagement and integration into broader corporate strategy (Costanza et al., 2014). One major gap is the challenge of transferring learning from the game environment to real-life contexts in terms of applying the knowledge outside of gameplay (Sopiah et al., 2024; Istrate & Hamel, 2023). Additionally, game designers often grapple with balancing simplicity and complexity in scenarios: overly simplistic games trivialise environmental issues, while overly complex games risk overwhelming participants, reducing engagement and learning retention (Douglas & Brauer, 2021). Environmental games also often lack clear pedagogical foundations, causing limited or inconsistent learnings (Madani et al., 2017). Another drawback is that many games are played digitally, away from the physical environment, creating a disconnect between the player and real environmental issues (Istrate & Hamel, 2023).

Moreover, most current games encourage individual actions rather than collective societal solutions (Georgiou et al., 2023). This lack of collaborative gameplay limits the potential for these games to model real-world systems that depend on group efforts and societal change (Georgiou et al., 2023). Furthermore, while some games address behaviour changes in areas like energy use, few address the broader spectrum of environmental behaviours that could drive more comprehensive change (Boncu et al., 2022). Finally, many games lack follow-up to assess the long-term impact on participants, making it challenging to gauge their true effectiveness over time (Istrate & Hamel, 2023; Boncu et al., 2022).

2.3 Shared Features of Successful Environmental Games and Escape Rooms

Interventional games function by fostering co-creation and collaborative decision-making through inconsequential, immersive experiences to develop actionable solutions (Istrate & Hamel, 2023; Bennett & Maton, 2017; Costanza et al., 2014). Unlike passive learning formats, escape rooms require active engagement, encouraging players to collaborate in solving puzzles

that mirror real-world environmental challenges. This makes them particularly effective for interventional purposes. As summarised in Table 1, escape rooms share six key features of successful environmental games: immersive experience, meaningful engagement, learning by doing, simulation of real-world problems, autonomy in decision-making, and presence of a facilitator (Tan & Nurul-Asna, 2023). These playability aspects are essential for learning outcomes in gamified education, as it facilitates both cognitive engagement and emotional involvement, which are often lacking in traditional or digital-only formats.

Table 1. Shared Key Features of Successful Environmental Games and Escape Rooms

Key Feature	Environmental Games	Escape Room
Immersive Experience	Compelling narratives and realistic settings enhance engagement and retention (Tan & Nurul-Asna, 2023).	Analog, narrative-driven, tactile, and spatial environments simulate real-world challenges, which can sustain attention and motivate participants to engage deeply with environmental concepts (Georgiou et al., 2023; Boncu et al., 2022).
Meaningful Engagement	Playing with or against others fosters discussion and deeper connection to material (Tan & Nurul-Asna, 2023).	Collaborative puzzle-solving encourages teamwork, flow, and emotional involvement, which are critical components for effective game-based learning (Madani et al., 2017).
Learning by Doing	Hands-on learning and active decision-making	Players must physically and mentally interact with clues, enabling trial-and-

reinforce experiential error learning (Bennett & Maton, understanding (Tan & 2017).
Nurul-Asna, 2023).

Simulation of Games mirror authentic Scenarios reflect sustainability
Real-World environmental issues to dilemmas, including underrepresented
Problems enhance relevance and areas like food and travel (Georgiou et
application (Tan & Nurul- al., 2023).
Asna, 2023).

Autonomy in Player control supports Participants co-create solutions and
Decision- exploration and personal follow diverse problem-solving paths
Making investment in outcomes (Costanza et al., 2014).
(Tan & Nurul-Asna, 2023).

Presence of Guided by a host to support Game masters or facilitators support
Facilitator learning and clarify gameplay and steer reflective debriefs,
complex concepts (Tan & enhancing comprehension (Istrate &
Nurul-Asna, 2023). Hamel, 2023).

2.4 Environmental Impacts of Meat Consumption and Transportation

Meat consumption

Food consumption within corporations, spanning meals, vending machine options, and catering, contributes to an organisation's Scope 3 emissions as defined by the Greenhouse Gas (GHG) Protocol (World Resources Institute [WRI] & World Business Council for Sustainable Development [WBCSD], 2015), yet is often underreported or excluded from corporate carbon

accounting practices (Hertwich & Wood, 2018; Crippa et al., 2021). Globally, food systems contribute over one-third of total anthropogenic greenhouse gas emissions, with animal-based foods responsible for nearly twice the emissions of plant-based foods (Poore & Nemecek, 2018; Crippa et al., 2021). Specifically, meat production alone accounts for 14.5 percent of total emissions (Food and Agriculture organisation for the United Nations [FAO], 2017). For example, producing 1 kg of beef emits an estimated 60 kg of CO₂-equivalent, compared to only 1.1–2.5 kg for legumes and grains (Poore & Nemecek, 2018). Within this context, meat-heavy meals at the workplace can disproportionately inflate an organisation’s carbon footprint. Although precise estimates of workplace food-related emissions vary by sector and company size, studies suggest that shifting institutional food offerings toward more plant-based options can reduce food-related emissions by 20–35% (Garnett et al., 2015). Even minor changes like reducing meat or offering more plant-based options in cafeterias can shift consumption patterns (Vlaeminck et al., 2020; Rust et al., 2020). Thus, focusing on food procurement and dietary choices presents key opportunities for reducing Scope 3 emissions and advancing the environmental goals of ESG.

This issue is particularly relevant in Singapore, which imports over 90 percent of its food supply (Singapore Food Agency [SFA], 2023). Although local meat production is limited, Singapore’s high meat consumption drives global demand. This reliance not only inflates Singapore’s carbon footprint due to extended supply chains and transportation emissions but also intensifies demand for resource-intensive food production, amplifying the country’s ecological footprint and exposure to vulnerable global supply chains. This, in turn, heightens local food insecurity (SFA, 2023).

Business Travel and Commuting

Global business travel is a significant contributor to transport-related emissions, with flights accounting for approximately 90 percent of the carbon footprint (Freed & Singh, 2021). Corporate practices, such as prioritising in-person meetings and frequent short domestic trips, exacerbate this impact. Business class tickets, popular among corporate travellers, result in carbon footprints approximately three times higher than economy class (Freed & Singh, 2021). Employee commuting is often the second largest contributor in companies' Scope 3 emissions of around 7 to 30 percent, particularly in service sectors like education and healthcare (Radonjić & Tompa, 2018; Huang et al., 2009). Widespread reliance on cars, particularly in urban areas, further amplifies this issue. In Singapore, transport accounts for around 16 percent of total carbon emissions (Chong et al., 2022). Promoting alternatives such as public transportation, carpooling, or cycling has the potential to reduce commuting emissions by up to 70 percent (Chong et al., 2022). These findings highlight the role corporations can play in reducing transport, boosting environmental impact and long-term sustainability by integrating ESG considerations.

3. Materials and Methods

3.1 Case Study Description

The research examines ESG education effectiveness in an experiment conducted with 42 corporate employees in Singapore, an island-state in Southeast Asia. Singapore is the wealthiest member (by GDP per capita) in the Association of the Southeast Asian Nations (ASEAN) (ASEAN, 2024). As a global financial hub and resource-constrained city-state, Singapore has positioned sustainability as a key pillar of its long-term economic strategy, outlined in national frameworks such as the Singapore Green Plan 2030. A combination of regulatory and voluntary efforts has been introduced in the country to encourage corporate

environmental responsibility. These include mandatory climate-related disclosures, green finance initiatives, capacity building for businesses transitioning toward low-carbon operations. Other initiatives comprise recommendations such as the Guide to Implementing Environmentally-Friendly Best Practices for Events, voluntary programmes like the Enterprise Sustainability Programme, and legislation under the Resource Sustainability Act (RSA) (Ministry of Sustainability and the Environment, 2025). Recent nation-wide mandates including the Disposable Carrier Bag Charge introduced in 2023, and the upcoming Beverage Container Return Scheme, signal a shift towards more structured sustainability policies (National Environment Agency, 2025). However, these measures primarily target organisational-level practices and consumer behaviour, offering limited mechanisms to directly engage employees within corporate environments. Consequently, existing regulations may fall short in fostering pro-environmental behaviours at the employee-level. This gap highlights the need for more interactive, participatory interventions that can complement top-down policies and cultivate sustainability from within the workplace.

The research examines the effectiveness of environmental policy education by comparing two formats, an escape room and a small group workshop. Both experiences focused on food and travel consumption, which are actionable focus areas that are insufficiently addressed in current games, as highlighted in the literature review.

3.2 Escape Room Design

The "Planet Disruptors" escape room was developed by the design firm Chemistry and launched in September 2024 in the context of the Singapore Design Week. The experience met the criteria for interventional games but mainly promoted individual actions, such as recycling, choosing sustainable fashion, and conserving electricity, rather than collective organisational change. For the purpose of this research, the author team adapted the escape room to align with

the ESG contents (meat consumption and transportation). The adaptation was led by the Chemistry team and took place iteratively, with meetings and beta testing, to co-design the narrative, key facts and figures, and puzzles.

The escape room format encouraged participants to actively engage in problem-solving and experimentation, requiring them to employ trial-and-error strategies to interpret clues and solve puzzles. Some puzzles were retained to reinforce energy conservation messages, while others were adjusted to focus on food, travel, and energy consumption in a corporate context (Figure 1). After the escape room experience, a detailed discussion on plant-based meats and low carbon travel was facilitated by one staff from the design firm during a debrief, helping participants to make sense of the puzzles that they solved as a team, and facilitating discussions on applying learnings to their respective roles in their organisation, as well as individual and organisational actions and challenges.



Figure 1. Examples of the puzzles created for the escape room design. A) *Clue for Food Ranking Puzzle - Legend for Ranking Food Impact by Carbon and Water Footprint*; B) *Food Impact Ranking Puzzle*; C) *Clue for Travel Emissions Puzzle - Boarding Passes with Information on Flight Destination and Travel Class*; D) *Clue for Travel Emissions Puzzle - Poster detailing Air Travel Emissions by Travel Class*; E) *Energy Consumption Puzzle*; F) *Participants' folder*

3.3 Workshop Design

The workshop was aligned with the objectives set for the escape room experience. To ensure consistency with established industry standards, materials from Nanyang Technological University Executive Certificate in Corporate and Environmental Sustainability program were used as references.

The workshop followed a guided approach, using tools like an ecological footprint calculator to illustrate resource consumption and compare sustainability habits between them. It introduced key concepts like ecological footprint, resource demand, and the impact of diet and travel-related emissions on carbon footprints. Additionally, the workshop incorporated ESG case study analyses from various corporate entities and facilitated discussions on workplace emission reduction strategies, covering individual actions, group initiatives, and organisational policies.

3.4 Recruitment of Participants

The author team leveraged their professional networks to recruit participants from companies based in Singapore. The selection criteria were organisations that lack explicit food and travel policies related to environmental sustainability, and, initially, to be an employee in the private sector. Due to the interest from participants in large public organisations, the latter criteria was latter relaxed to increase the number of participants. (Differences between private sector and public organisation participants were assessed in the analyses, as described in Section 3.6). Each company provided between six to ten participants—split equally for the escape room experience and for the workshop, at random. While participants did not need to be from the same organisational levels or departments, it was essential for balanced distribution within the two groups to maintain comparability. To align with the research timeline, we recruited six organisations, totalling 42 participants by the end of February 2025. The research received ethical clearance from NTU (IRB-2024-1069).

3.5 Experimental sessions

For each session, all participants of a group were scheduled to arrive at the experiment location at the same time and completed a pre-session survey (Supplementary Information) designed to assess their existing levels of environmental knowledge, beliefs, and actions. Following this, the participants were randomly divided into two sub-groups: half the group was directed to the escape room after a short briefing, while the other half engaged in the workshop. The total duration for both activities took between sixty minutes to ninety minutes, inclusive of discussion time.

Upon completion of their respective activities, both groups took a post-session survey aimed at evaluating variances in knowledge and behavioural willingness as influenced by their experiences. This post-session survey (Supplementary Information) focused on assessing various elements such as the structure and components of the escape room or workshop, knowledge transfer, intentions to modify behaviour, and organisational readiness to take action. The questions were crafted to capture similar dimensions of learning, engagement, and relevance across both formats. A 5-point Likert scale was used in both pre- and post-session surveys to assess participants' knowledge, engagement, and behavioural intentions related to ESG. For the purpose of analysis, scores were interpreted as follows: scores of 1–2 indicated low levels, 3 reflected moderate or neutral responses, and 4–5 represented high levels of agreement or confidence. This scaling allowed for a consistent evaluation of resulting data, facilitating a comparative analysis regarding the effectiveness of each format in achieving the aforementioned objectives.

3.6 Analysis Plan

The analysis plan for measuring the effectiveness of the proposed interventions utilised a two-part framework focusing on cognitive and behavioural outcomes, informed by the six features

of successful intervention games identified: immersive experience, meaningful engagement, learning by doing, simulation of real-world environmental problems, autonomy in decision-making, and hosting by moderator (Tan & Nurul-Asna, 2023). Fisher's Exact Test was also used for preliminary statistical analysis to identify differences between the escape room and workshop across the six features (Table S-1), and between participants from public service and private companies (Table S-2). This test was chosen due to the small sample size and the categorical nature of the data, ensuring more accurate significance testing.

Of the 42 participants, 15 were from the public sector, ensuring that a sufficient sample size remained for analysis. Differences between participants from public service and private companies were also explored, as organisational culture, governance structures, and sustainability priorities can vary significantly across sectors. These differences were expected to potentially influence how participants engaged with and responded to the ESG interventions. However, preliminary statistical analysis of the post-session survey results using Fisher's Exact Test indicated no significant differences between participants from the private and public sectors with respect to cognitive or behavioural outcomes (Table S-2). Consequently, responses from the public sector were incorporated in the discussion of subsequent analyses.

4. Results and Discussion

4.1 Analysis of Cognitive Effects on Participants

Pre-session surveys showed that while 75% of participants (n=42) had prior ESG training—which suggests familiarity with sustainability topics—their self-assessed knowledge remained moderate (2.7–3.0), indicating that most participants only rated themselves between somewhat knowledgeable and knowledgeable (Figure 2). The self-assessment focused on three key areas: general sustainability concepts, the benefits of plant-based food alternatives, and the

advantages of reducing business travel. Across all three categories, both the workshop and the escape room interventions resulted in large improvements (1–1.8 points) in self-perceived knowledge. Workshop participants reported slightly higher mean improvements (0.4–0.5 points) compared to escape room participants. While this trend suggests a modest advantage for the workshop format in terms of self-reported learning, the difference is relatively small and is not statistically significant by itself (Table S-1). The following section examines the six features of effective environmental games, discussing whether specific aspects of the escape room and workshop experiences contributed to variations in perceived knowledge improvement.

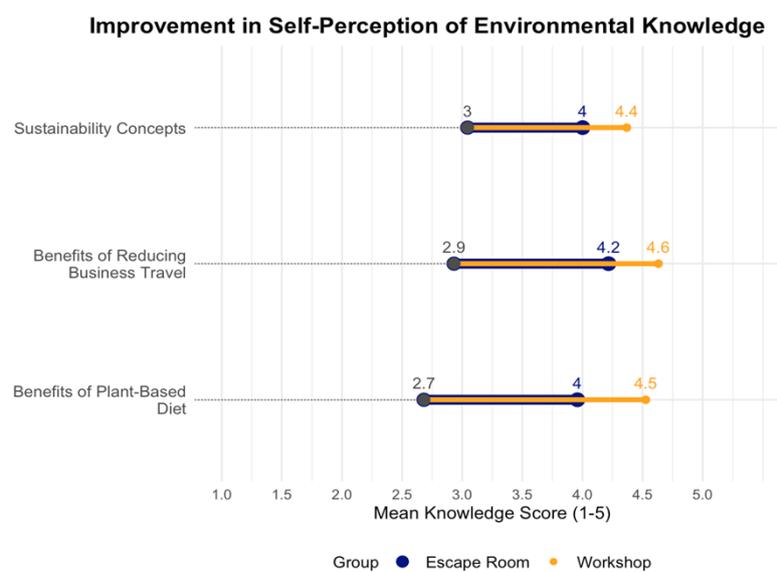


Figure 2: Improvement in Self-Perception of Environmental Knowledge. Grey dots on the left side indicate pre-intervention self-perceived knowledge, while the middle and right-side dots indicate post-intervention self-perceived knowledge for escape room (blue) and workshop (yellow) participants.

4.2 Evaluating the Escape Room and Workshop by Six Features of Successful Games

Both the escape room and the workshop engaged participants effectively, with Fisher's Exact Test showing no significant differences between the formats across the six key features, with exception to hosting by moderator (Table S-1). However, subtle differences emerged, highlighting each format's unique strengths. The escape room showed an advantage in providing an immersive experience, fostering collaboration, promoting autonomy in decision-making, and the debriefing process. Meanwhile, the workshop was marginally more effective in deepening learning through its activities and simulating real-world issues.

4.2.1 Immersive Experience

Workshop participants more frequently rated the format as "Highly Engaging" than those in the escape room, despite the latter's immersive storyline, props, and physical setting (Figure S-1 and S-2). This suggests the workshop's structure, visuals, and activities sustain engagement more effectively. We hypothesise that the small space and group size (about 5 participants), and real-life case studies, rather than a fictional persona, most contributed to the high level of engagement.

4.2.2 Meaningful Engagement

The escape room activity demonstrated a higher degree of collaborative effort and teamwork compared to the workshop on the highest scales (Very Effective to Extremely Effective) (Figure 3A), which we expected due to the nature of the puzzle-solving activities (e.g., teamwork to find clues in different parts of the room). It scored lower in providing equal participation opportunities for all participants (69.6%), a feature more prominently observed in the workshop setting (89.5%) (Figure 4). This discrepancy may be attributed to the presence of a facilitator in the workshop environment, who actively engages individual participants. In contrast, the escape room dynamics are predominantly influenced by the distinct personalities

and play styles of each participant, and the resulting group dynamic. The absence of a facilitator in the escape room scenario further compounds this effect, potentially leading to disparities in participation levels among individuals. Moreover, it was observed that collaboration and equal participation tended to decline when group size exceeded the optimal range of four to five participants (one round).

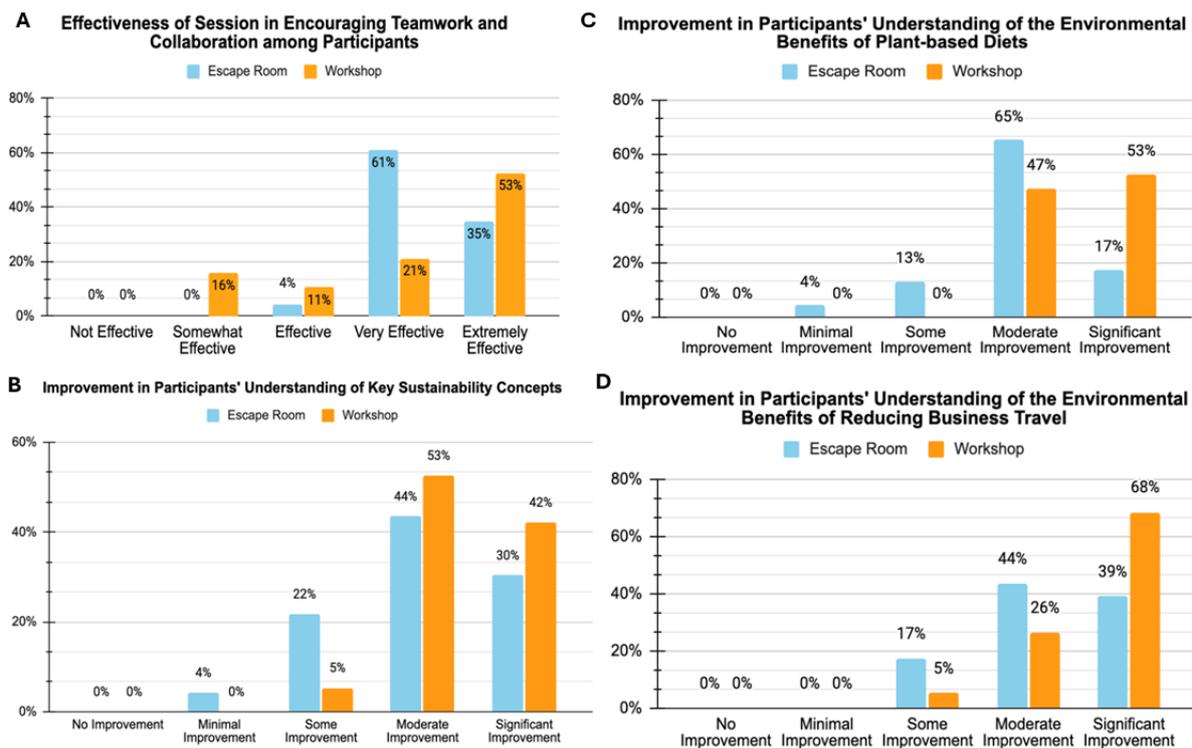


Figure 3. Effectiveness of Session in Encouraging Teamwork and Collaboration among Participants (A) and Improvement in Participants' Understanding of Key Sustainability Concepts (B), the Environmental Benefits of Plant-based Diets (C), and the Environmental Benefits of Reducing Business Travel (D)

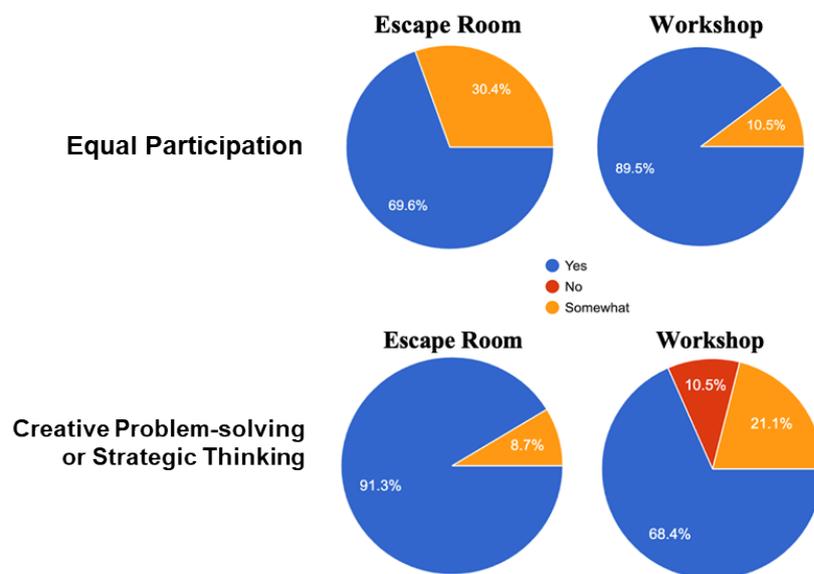


Figure 4. Opportunities for equal participation (top) and creative problem-solving or Strategic thinking (bottom) offered by the escape room and workshop

4.2.3 Learning by Doing

The workshop scored slightly higher than the escape room in enhancing participants' foundational understanding of sustainability concepts, likely due to its open-ended discussions. We hypothesize that this stems from the small-group nature of the workshop, where participants could ask questions freely, engaging in dynamic conversations, enriched by facilitators' expertise (Figure 3B).

While more workshop participants reported "significant improvements" in understanding the environmental benefits of adopting a plant-based diet than escape room participants, both formats demonstrate at least "some improvement" (Figure 3C). The workshop's structured format facilitated direct knowledge transfer, while the escape room encouraged discovery through interactive puzzles. For instance, while workshop participants were told that plant-based foods were low impact, escape room participants deduced sustainability principles by

ranking food items by carbon footprint (Figure 1A). This exploratory approach encouraged participants to piece together their insights across different moments in the experience, with the debrief reinforcing key takeaways. Learning in the escape room was more distributed, sometimes emerging unexpectedly through gameplay. Due to time constraints and problem-solving demands, deeper reflection often occurred in the debrief rather than in real-time, where participants ultimately surfaced similar conclusions.

A similar pattern emerged in understanding the environmental impact of business travel (Figure 3D). Workshop participants reported slightly greater improvements, though the gap was smaller than for plant-based diets. This may stem from puzzle mechanics: the food puzzle reinforced learning through comparative ranking (Figure 1-B), while the travel puzzle required manual emissions calculations (Figure 1-C & Figure 1-D), simulating real-world decision-making. These differences likely shaped how participants processed sustainability concepts—some insights were immediate, while others required post-game reflection.

4.2.4 Simulation of Real-World Environmental Problems

Both the workshop and escape room were well-received, but 20 percent more participants found the workshop a more effective simulation (Figure S-6). While both linked sustainability concepts to ESG and SDG issues, their approaches shaped perceptions differently.

The workshop's structured format, case study discussions, and ecological footprint calculator provided a direct, personalised link to real-world sustainability challenges. Discussions tied into participants' personal, professional, and industry experiences, ensuring relevance to their lived realities. The escape room, in contrast, immerses participants in a speculative future, requiring them to project forward and bridge insights back to the present. This thought-provoking approach demanded greater cognitive effort, especially for those with less prior exposure to sustainability concepts. The need to interpret future scenarios before connecting

them to present-day decisions may have delayed immediate reflections, which could emerge over time.

Furthermore, both formats focused on Scope 3 emissions, i.e. food and travel decisions, often underrepresented in traditional corporate sustainability discussions, which typically emphasise Scope 1 and 2 emissions. Several participants noted this unexpected shift challenged conventional corporate sustainability thinking.

4.2.5 Autonomy in Decision-Making

The post-session survey indicated that participants found the escape room more supportive of creative problem-solving and strategic thinking than the workshop (Figure 4). This difference in problem-solving opportunities can be attributed to the distinct structure and methodologies used in each format. The workshop used a guided format to prompt reflection on workplace strategies. In contrast, the escape room fostered independent, trial-and-error problem-solving through puzzles. While hints from the Chemistry team were offered, they were rarely utilised until prompted by facilitators, suggesting that participants were motivated to work through challenges independently. Facilitators also adapted the experience by extending time where necessary, ensuring participants could progress through the puzzles. This escape room fostered independent exploration of multiple solutions before arriving at the correct one. The level of challenge and time constraints may have demanded greater cognitive effort to connect the puzzles to sustainability themes, requiring post-session reflection to process key takeaways. In this manner, the two formats differently shaped how much freedom participants had in directing their learning, and, consequently, the clarity and immediacy of environmental takeaways.

4.2.6 Hosting by Moderator

The debrief sessions for the escape room and the workshop served distinct purposes, reflecting differences in their design and objectives. The workshop debrief primarily served as a factual summary of the content presented during the session. The discussion was less structured, centring on a Q&A format that, while informative, may not have facilitated the same level of participant engagement or critical reflection. This divergence in debriefing approaches is reflected in participant feedback, with 22 percent more attendees rating the escape room debrief as "Very Valuable" or "Extremely Valuable" compared to the workshop session (Figure S-6).

In contrast, the escape room debrief functioned as a reflective tool, guiding participants to process the various elements of their experience and consolidate key learnings in a way that encouraged continued reflection beyond the session. This structured approach included mechanisms such as the group participant file (Figure 1-F), which prompted players to document unsustainable habits observed during the game, fostering deeper engagement in post-game discussions. Facilitators also employed slides that explicitly linked game puzzles to relevant environmental concepts, reinforcing key takeaways. The escape room's structured and interactive debrief reinforces that its learning process unfolds across both gameplay and post-experience reflection.

4.3 Analysis of Behavioural Results on Participants

Behavioural effects can be assessed through studying participants' projected engagement with various environmental actions in the post-session survey, given the short time frame of this study (Figure S-7, Figure S-8 and Figure S-9). This approach helps evaluate the potential for meaningful contributions to ESG efforts. The likelihood of commitment to action was calculated by summing the "Very Likely" and "Likely" responses.

In general, participants in the workshop format demonstrated a stronger likelihood to commit, with a higher frequency of "Very Likely" responses and fewer "Neutral" responses. Notably,

there were no participants who selected “Unlikely” or “Not Likely.” Greater variation in likelihood was observed in relation to food-related actions, whereas differences for travel-related actions were minimal. When comparing the types of actions, both workshop and escape room participants expressed a higher likelihood of personally adopting, professionally supporting, and proactively leading strategies aimed at reducing travel-related emissions compared to those focused on promoting plant-based eating habits. Regarding the levels of action—personal realm, professional support, and proactive leadership—both escape room and workshop participants reported the lowest likelihood of taking action within their personal lives. In contrast, the highest likelihoods were observed for supporting strategies within the workplace, regardless of whether the focus was on food or travel.

Discussions with participants further shed light on these trends. On the individual level, factors such as the cost and accessibility of food were key considerations for adopting plant-based diets. Additionally, participants noted already high usage of public transportation, which may have influenced their reduced likelihood to take further action in the personal realm. At the organisational level, participants highlighted constraints such as cost limitations, partnership negotiations with local tenants and global partners, and decisions influenced by higher management. Trade-offs from organisational goals also played a role: the necessity for global education often required international travel, and maintaining strong global partnerships was believed dependent on in-person meetings. Furthermore, the lack of a single governing body overseeing sustainability efforts within organisations led to a heavy reliance on higher management for decision-making and enforcement, which might limit broader, more impactful organisational changes.

4.4 Strengths and Limitations of the Study

This study suggests that both the escape room and workshop were successful in facilitating ESG learning and encouraging environmental action. Each format offers distinct strengths in environmental education, catering to different learning styles and objectives. The workshop's structured approach and guided facilitation provided clear cause-and-effect explanations, enabling immediate comprehension, while the escape room encouraged active problem-solving and discovery, requiring participants to infer connections through immersive gameplay. Some participants may have found the exploratory nature of the escape room more cognitively demanding, particularly with time constraints and deferred explanations until the debriefing session.

One key limitation, which emerged from the workshop facilitation, is that both experiences can be considered as non-traditional. Although the initial intent was to contrast the escape room with traditional educational formats, the delivery of the workshop was with a small group (due to the challenge of recruiting large groups), and in a small office space around a table, conducive to rich, two-way sharing and high engagement, differing from what would be expected from traditional online learning or large-group in-person training. Although some of the previous results could be further compared with the performance of such educational experiences, e.g., in terms of engagement, the differences in goals and selected topics lower the significance of the comparison. Another limitation is the sample size, which could be increased in future studies to ascertain the findings.

For future applications, the choice between these formats should be guided by the specific objectives that corporations aim to achieve, as each offers distinct advantages. It is also important to consider that most study participants were likely already highly interested in ESG, which may have influenced their engagement and initiative levels. However, for less intrinsically motivated employees, the immersive and interactive nature of the escape room may be more effective in sparking initial interest. Even so, inherent challenges, like varying

levels of participation and perceived difficulty, present opportunities for further refinement of future environmental games.

4.5 Recommendations

To improve ESG-focused games, future designs should pay close attention to the learning experience by scaffolding cause-effect mechanisms throughout the gameplay. While not every principle needs to be fully revealed during the game itself, the unfolding of these elements is important, so that the final debrief can serve as a powerful reinforcement and leave a stronger impression of key sustainability principles. A phased learning approach, where players progress through stages, can prevent overwhelm and reinforce concepts incrementally. Reducing time pressures—despite the added excitement—allows for more deliberate reflection, shifting the focus from speed to understanding ESG concepts, thereby enhancing learning.

Ensuring equal participation is key; role-based gameplay, where each participant takes on a distinct and meaningful role, can encourage active involvement. If roles are not feasible, diverse tasks, such as logical, creative, and strategic challenges, can include all players. Additionally, adaptable difficulty settings, based on a brief pre-game assessment, can tailor experiences to different knowledge levels.

Critically, skilled facilitators and sufficient debrief time are essential in maximising the learning potential of ESG games. Beyond explaining mechanics, they create an inclusive, jargon-free space, manage group dynamics, and guide structured debriefs that connect gameplay to real-world action (Flood et al., 2018; Eisenack, 2012; de Suarez et al., 2012). As serious games cannot replace instructors, they should instead be designed to support facilitator roles (Taylor, 2014). Finally, structured debriefs should revisit key moments from the game,

reinforcing insights and translating them into actionable takeaways. Strengthening these elements can make ESG games more impactful in driving long-term sustainability engagement.

5. Conclusion

This study examined the effectiveness of an escape room and a small-group workshop as formats for engaging corporate participants in ESG learning. Both approaches proved successful in facilitating knowledge transfer, with participants reporting improved understanding of sustainability concepts, including plant-based diets and business travel. Each format demonstrated unique strengths: The escape room provided an immersive, interactive environment that fostered problem-solving, while the workshop offered a more intimate setting conducive to structured, in-depth discussions with facilitators.

Rather than viewing these methods as mutually exclusive, a blended approach may offer the most effective pathway for ESG education. To strengthen future research, broader participant recruitment across diverse industries and organisational contexts is recommended, alongside larger sample sizes to enhance the robustness of findings. Further research should also assess whether educational gains translate into actual policy changes within organisations, and how varying institutional characteristics influence ESG adoption. Through continued refinement of these educational strategies, ESG training can become a more powerful driver of corporate sustainability.

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Author contribution

PD, PH, and LT conceived and designed the study, workshop, analysis framework, and research methodology. TC, AD, and JC contributed to the escape room adaptation through iterative co-design, including narrative development, puzzle design, and beta testing. PD conducted the data analysis and wrote the manuscript. PH and LT provided substantive guidance throughout the research process and manuscript development. TC, AD, and JC reviewed and edited the manuscript.

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