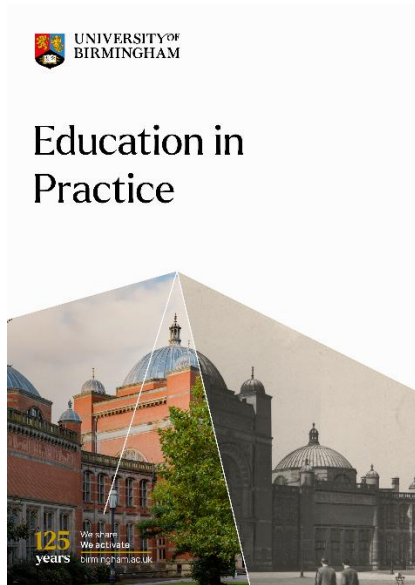




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Mainstreaming sustainability through games: integrating carbon literacy into accounting education

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Abstract

Business schools face increasing pressure to embed sustainability meaningfully within core curricula, yet traditional profit-oriented teaching structures make this challenging. This paper evaluates a curriculum-embedded carbon simulation game used to introduce sustainability and carbon regulation within a taxation seminar at a UK university. Drawing on thematic analysis of 43 student reflections collected immediately after the session, the study finds that the game fostered high engagement, collaborative decision-making, and critical exploration of tensions between profitability and environmental responsibility. Framed by dialogical learning and group flow theory, the findings show how short, immersive pedagogies can stimulate exploratory dialogue and deepen sustainability learning in mainstream business modules. Practical recommendations are offered for educators seeking scalable, transferable ways to integrate sustainability into business education.

Keywords: Sustainability Education, Game-Based Learning, Carbon Literacy, Business School Pedagogy, Dialogical and Experiential Learning, Group Flow, Profit-Sustainability Tensions

Introduction

Business schools are increasingly expected to prepare graduates capable of navigating complex sustainability challenges, including climate change, biodiversity loss, and social inequalities (Jones, Selby and Sterling, 2010; Figueiró and Raufflet, 2015). Yet sustainability remains difficult to embed meaningfully into mainstream business curricula. Core disciplines such as accounting, finance, and management often centre profitability, efficiency, and regulatory compliance, creating pedagogical tensions that marginalise environmental and social concerns (Gray and Collison, 2002; Rusinko, 2010; Waddock and Lozano, 2013). As a result, students rarely engage with the ethical, distributive, and long-term implications of sustainability

dilemmas, despite evidence that such tensions are central to contemporary business practice (Hahn *et al.*, 2015; Joseph *et al.*, 2020; Kurucz *et al.*, 2014).

Responding to these challenges, sustainability scholars advocate for experiential, dialogical, and transdisciplinary pedagogies that encourage collaboration, reflexivity, and co-construction of meaning (Cunliffe, 2002; Wright *et al.*, 2023; Gutierrez-Huerter *et al.*, 2024). Dialogical learning helps students interrogate assumptions, negotiate uncertainty, and explore competing values. These capacities are essential when addressing “wicked problems” that transcend disciplinary boundaries and resist simple solutions (Hahn *et al.*, 2015). Complementary to this, group flow theory (Lavoie *et al.*, 2024) highlights how deep, shared engagement emerges when learners pursue common goals, communicate spontaneously, and develop collective momentum. Together, dialogical learning and group flow offer a lens for understanding how collaborative pedagogies may support conceptual transformation, especially in short, immersive learning environments.

Game-based learning operationalises these pedagogical principles by creating structured yet flexible learning spaces in which students can experiment with decisions, observe consequences, and engage collaboratively with complexity. Research in business and management education demonstrates that games enhance motivation, deepen conceptual understanding, and support critical thinking (Azriel *et al.*, 2005; Boyle *et al.*, 2016; López *et al.*, 2021). They also provide opportunities to simplify and explore complex real-world phenomena, making them particularly well-suited to sustainability topics characterised by uncertainty and competing priorities (Kapp, 2012; Møller, 2020; Salas *et al.*, 2009). Despite this potential, the use of educational games to integrate sustainability within core business modules remains under-developed (Calabor *et al.*, 2019; De Silva and Nilipour, 2024), with most interventions occurring through electives, one-off sessions, or extra-curricular initiatives (Tijsma *et al.*, 2023).

This paper responds to these concerns by evaluating a carbon simulation game integrated within a taxation seminar at a UK university. Designed to prompt students to consider regulatory design, abatement costs, and ethical implications, the game required students to navigate three major carbon policy instruments: command-and-control, carbon tax, and emissions trading, while negotiating the tensions between profitability and environmental responsibility. The session was introduced without explicit sustainability framing, providing a context for examining how students engage with sustainability concepts when they are embedded within a profit-oriented disciplinary module.

The research question guiding this study is: *How does a game-based learning environment influence business students’ understanding of carbon regulation and their perceptions of the tensions between profitability and sustainability within a core business education module?*

Drawing on 43 reflective responses collected immediately after the session, supported by three years of teaching observations, the study investigates how the intervention fostered dialogical engagement, group flow, and deeper sustainability learning. The findings demonstrate how short-term, immersive pedagogies can bring sustainability to the forefront of mainstream business curricula and provide insights into how educators can foster exploratory and expansionary dialogue within disciplinary boundaries. This paper contributes to business education by:

1. demonstrating how a low-cost, scalable pedagogical intervention can integrate sustainability into a core business module;
2. extending dialogical learning and group flow theory to curriculum-embedded, short-duration activities; and
3. offering practical recommendations for embedding sustainability across business school programmes, thereby responding to institutional calls for transformative, transdisciplinary education (Brinkhurst *et al.*, 2011; Vienni Baptista and Rojas-Castro, 2020).

The remainder of the paper is structured as follows. Section 2 provides the background and pedagogical context for the study, including the rationale for integrating sustainability through game-based learning. Section 3 describes the carbon emissions game and its design. Section 4 outlines the methodological approach. Section 5 presents the findings across three themes: student engagement, learning outcomes relating to carbon regulation, and reflections on profit–sustainability tensions. Section 6 offers a discussion of these findings through the lenses of dialogical learning and group flow. Section 7 outlines practical implications and the transferability of the activity for business-school educators. Section 8 concludes the paper.

Background and pedagogical context

Integrating sustainability into accounting education presents several challenges. The discipline is traditionally focused on financial performance, and sustainability topics are often relegated to elective modules or guest lectures (Mburayi and Wall, 2018). However, professional bodies such as ICAEW and ACCA have begun embedding sustainability into their qualifications, signalling a shift in expectations for future accountants (ICAEW, 2023; ACCA, n.d.).

To address these challenges, this study adopts a “piggybacking” strategy, embedding sustainability into existing modules rather than creating standalone electives (Godemann *et al.*, 2011). The carbon emissions game was introduced within taxation seminars, aligning with existing learning outcomes while introducing climate-related content. This approach ensures that sustainability is treated as a core component of accounting education rather than an optional add-on.

Gamification has gained traction as a method for enhancing student engagement and learning outcomes. Educational games provide a structured yet flexible environment for exploring complex topics, allowing students to experiment with decisions and

observe consequences (Kapp, 2012; Salas *et al.*, 2009). In accounting education, games have been used to teach financial principles, but their application to sustainability remains underexplored (Coulson and Thomson, 2006; Tran and Herzig, 2023).

Integrating sustainability into mainstream business modules requires pedagogical approaches that help students engage with complexity, uncertainty, and competing priorities. Traditional lecture-based formats often reinforce disciplinary silos and managerial logics that marginalise environmental and social concerns (Rusinko, 2010; Waddock and Lozano, 2013). In contrast, dialogical learning emphasises the co-construction of meaning through interaction, reflexivity, and negotiation, enabling students to explore sustainability dilemmas collaboratively (Cunliffe, 2002; Gutierrez-Huerter *et al.*, 2024; Wright *et al.*, 2023). Such approaches are particularly relevant for sustainability topics, which frequently involve navigating tensions between profitability, ethics, and long-term environmental impacts (Hahn *et al.*, 2015; Joseph *et al.*, 2020).

Game-based learning provides a practical mechanism for fostering this form of dialogical engagement. Research in business and management education has shown that educational games enhance motivation, deepen conceptual understanding, and support critical thinking by allowing students to experiment with decisions and observe their consequences (Azriel *et al.*, 2005; Boyle *et al.*, 2016; Kapp, 2012). Games also create structured yet flexible environments for exploring complex and interdisciplinary phenomena, making them well suited to sustainability education (Møller, 2020; Salas *et al.*, 2009).

In addition, the concept of group flow, which reflects the collective experience of deep engagement characterised by shared goals, spontaneous communication, and co-creation, provides a useful lens for understanding how students learn collaboratively during simulations (Lavoie *et al.*, 2024). When game dynamics support group flow, students are more likely to engage critically, negotiate meaning, and sustain attention throughout the activity.

These theoretical perspectives justify the use of a carbon simulation game within a taxation module. They highlight how dialogical learning, collaborative decision-making, and immersive group engagement can support students in grappling with the ethical, strategic, and regulatory tensions inherent in sustainability challenges.

The carbon emissions game was designed to simulate real-world decision-making under different regulatory frameworks. It challenges students to reconcile financial performance with environmental responsibility, encouraging them to think critically about the role of business in addressing climate change. This design also reflects experiential learning principles, which emphasise learning through direct experience, reflection, and active experimentation (Kolb, 1984). In addition, the game provides a form of situated learning by embedding sustainability dilemmas within a realistic

business decision-making environment, enabling students to learn through participation in an authentic, practice-oriented task (Lave and Wenger, 1991).

The carbon emissions game

The design of the activity was inspired initially by Corrigan's (2011) pollution game, which demonstrates the comparative effectiveness of emissions taxes and tradable permits in economics classrooms. I subsequently discussed adaptations of this approach with Dr. Gautam Sethi at Bard College in New York, who has used a modified version of the game with economics students. Drawing on these initial ideas, I substantially redesigned the activity for taxation students by developing a narrative context, creating a structured slide deck to support live facilitation, and explicitly incorporating ethical, distributive, and policy-design dimensions. These modifications enabled the game to engage business students in exploring both the technical and normative tensions inherent in carbon regulation.

The game simulates three regulatory approaches: command-and-control, carbon tax, and emissions trading. Students work in teams representing companies with varying abatement costs, making strategic decisions across three rounds. Each round introduces a new policy framework, requiring students to adapt their strategies and consider the implications of their choices. The game was delivered to third-year undergraduate and postgraduate students across three academic years. In 2024, 43 students participated and completed reflective surveys immediately after the session. The game was designed to resemble real-world scenarios, encouraging students to think critically about policy design, corporate strategy, and ethical implications. The key learning outcomes of the session included:

- Understanding carbon regulation mechanisms
- None of the policies are perfect
- The choice would depend on the government's objective (Emissions reduction, Revenue generated, Economic costs)
- Recognising the impact of pricing and compliance costs
- Reflecting on ethical and strategic dimensions of sustainability

The game also aimed to foster collaboration, negotiation, and strategic thinking, which are transferable skills that are essential for future professionals navigating complex sustainability challenges. In practice, I facilitate the activity through a short slide deck, with group results completed live to support comparison and prompt discussion.

Methodology

Research context

This study evaluates a pedagogical intervention embedded within a taxation seminar at a UK business school. The session introduced students to carbon emissions regulations through an immersive, game-based activity simulating three regulatory

approaches: command-and-control, carbon taxation, and emissions trading. The game was refined over three years of teaching and was designed to support sustainability learning within a core disciplinary context, without requiring prior knowledge of carbon regulation or sustainability concepts.

Participants and data collection

The study involved 43 students enrolled in two taxation modules: 30 undergraduates and 13 postgraduates. The modules did not explicitly advertise sustainability content, ensuring that participants were not pre-selected for interest in the topic. Students worked in groups to play the carbon simulation game and were invited to complete a short reflective survey immediately after the session. The survey included open-ended questions about learning outcomes, decision-making, engagement, and perceptions of carbon regulation.

Completion of the survey was voluntary. Students were given approximately ten minutes to reflect on the session while their experiences were still fresh. Their reflections, combined with three years of teaching observations, form the empirical basis of this study. In reporting findings, undergraduate and postgraduate students are referred to using the labels “UG” and “PG”.

Analytical approach

The reflective responses were analysed using thematic analysis (Clarke and Braun, 2017). The analytical process involved several stages. First, initial codes were informed by the premeditated themes embedded in the survey design, which drew on three years of running the intervention (e.g., engagement, activities, decision-making, sustainability tensions). However, because students often responded holistically rather than question-by-question, the analysis shifted towards an inductive approach. This resulted in a hybrid analytical strategy, combining deductively informed initial codes with inductively generated themes emerging from the data.

Coding was conducted iteratively, beginning with repeated readings of each reflection to identify significant ideas. Initial codes were then grouped into broader categories based on conceptual similarity. Through this process, three overarching themes were developed: (1) student engagement and motivation during the activity, (2) learning outcomes relating to carbon regulation and sustainability trade-offs, and (3) reflections on the tensions between profitability and sustainability. These themes were triangulated with observations from three years of delivering the session to strengthen the credibility of the findings.

Reflexive notes were maintained during coding, and inconsistencies in initial interpretations were reconciled through re-review of the data. Although the sample is modest, the richness of the reflections and the consistency across multiple cohorts support the robustness of the themes. Theme development prioritised patterns that emerged consistently across both undergraduate and postgraduate reflections.

Ethical approval

This study received ethical approval from the University of Birmingham Humanities and Social Sciences Ethical Review Committee (Reference: ERN_2033-Jan2024). All participants provided informed consent prior to completing the survey. Consent was obtained through the first survey question, which asked students to confirm that their anonymised responses could be used for research purposes. Students received a small incentive (£10 Amazon voucher), and no identifiable data were collected. The project was supported by a £587 grant from the University's Education Enhancement Fund (Project Reference: PGCHE013).

The study draws on qualitative data from student reflections and teaching observations. The survey asked students to comment on their learning outcomes, decision-making processes, engagement levels, and attitudes toward carbon regulations. Thematic analysis was used to identify patterns and insights as mapped out in Appendix A.

Findings

The analysis generated three interconnected themes: (1) student engagement and the emergence of group flow during the activity, (2) learning outcomes relating to carbon regulation and sustainability tensions, and (3) students' reflections on how the game supported critical thinking about profit-sustainability dilemmas. Each theme is presented below with supporting illustrative extracts from the survey responses.

Engagement and Motivation

This theme explores how students experienced the carbon simulation game as an immersive and collaborative activity, and how shared goals, negotiation, and team interaction contributed to group flow. Many students described the session as highly engaging, emphasising the value of working in teams and making decisions collectively:

"I did love to work in teams and also I made new friends today." (PG10)

"The different outcomes motivated me and in the end I was satisfied as I felt like as a group we worked together to come to a solution." (UG25)

Students consistently identified the cooperative and strategic elements of the game as central to their sense of engagement. Several commented on the realism of the decision-making environment and the opportunity to practise skills relevant to real-world organisational contexts:

"[W]hat motivated my decisions was the interaction with colleagues and working as a team to solve a shared objective which is a key skill used in a real life environment. [M]oreover my competitive nature urged me to put in the most effort to ensure my team achieved the best results. [O]verall [I] was very satisfied with the outcome and progress made" (UG16)

Others highlighted a strong sense of ownership over team outcomes, frequently referring to “our company” and expressing pride, or frustration, based on their performance:

“My main motivation was to ensure my company’s costs were as low as possible. Therefore I used calculations that involved low cost. I was satisfied as I felt my company used its permits effectively” (UG29)

“Yes, [I] was very Satisfied with the outcomes as our company cut the cost from 1,690 to 1,500. The emission has reduced from 15 to 4 Tonnes. Our company has abated 11 tonnes of carbon” (PG5)

This personal investment is critical in sustainability education, where fostering a sense of responsibility and agency is key to long-term behavioural change.

While group activities were central, the game also accommodated individual preferences, such as a focus on calculations or strategic thinking. Group flow does not require everyone to engage identically; instead, it allows diverse contributions to enhance the collective experience:

“I like to be at the stage of calculating as it improves my numeracy skills as well as observing how much money I can save.” (UG11)

This versatility ensures that sustainability concepts are accessible to students with varying learning styles. Overall, the reflections indicate that the game created the conditions for collaborative engagement, helping students become immersed in the activity while contributing in ways that aligned with their strengths. These dynamics provided a foundation for shared discussion and reflective learning in the subsequent stages of the exercise.

Learning outcomes: understanding carbon regulation and sustainability tensions

The second theme examines the range of learning outcomes reported by students, focusing on their developing carbon literacy, conceptual understanding of regulatory mechanisms, and ability to identify sustainability trade-offs.

Through their reflective responses, students demonstrated increased understanding of:

- Carbon regulation frameworks (ETS, carbon tax, command-and-control)
- Policy design and implementation challenges
- Strategic responses to regulation
- Ethical and equity considerations

For example, many students reported increased carbon literacy, noting that the game helped them understand the structure and implications of different regulatory instruments:

“The game is good and interesting. It guided me to know three different types of policies on carbon emission. Carbon taxes and Emissions trading are more like market-based regulations than Command and control. I feel ETS is more flexible and can help companies achieve their emission goals better, even some companies can gain some profits from selling the permits for carbon emission.” (PG3)

“I learnt about grandfathering and how governments sometimes give out permits for free, I was previously unaware that these permits could be sold to competing firms, their impact seems positive as they not only target carbon emissions but also motivate firms to produce better technology that is more sustainable for the future to evade these costs (taxes)” (UG21)

Students demonstrated a growing appreciation for the complexities of carbon regulation, often commenting on the challenges governments face in designing effective interventions:

“It has allowed me to appreciate how it may be difficult to find the right way to implement them, however I still believe it is important to have them in place.” (UG23)

Many reflected on the limitations or trade-offs inherent in each policy instrument. Several noted that while ETS offers flexibility and cost-effectiveness, carbon taxes are easier to administer and predict:

“I have identified that carbon trading is the most effective way to motivate companies to reduce their carbon emissions” (UG6)

“After I participated [in] the game, I can now understand the basis of each policy option and I could differentiate and compare them. There is no best option though. But the best approach would be carbon tax.” (PG2)

Students also recognised that regulatory design shapes corporate behaviour and can lead to unintended consequences:

“It has made me think more about the effects on the businesses, which I didn't take into account before, and how the cost of abating is something to consider when creating a scheme e.g. if the carbon tax is lower than everyone's cost of abating they will just pay the tax and not actually reduce emissions” (UG4)

A striking proportion of students reported increased support for carbon regulation as a result of the activity. Their reflections often moved from technical understanding to normative endorsement:

“It has allowed me to visualise the impact they can actually have on carbon abatement and therefore, I am in support of these regulations.” (UG3)

“Experiencing the challenges and successes of implementing carbon regulations in my gaming environment has inspired me to support real-world emissions reduction policies and practices.” (UG11)

“I think it is not that easy to determine which approach should the government take for reducing carbon emission policy, but the action must be done so really quickly because if we wait too long, the impact of carbon emission will get worse.” (PG2)

These reflections illustrate that the game supported not only conceptual understanding but also personal engagement with the moral and societal dimensions of carbon regulation. The activity prompted students to reflect on the real-world implications of policy choices and to consider how economic and environmental priorities interact.

Navigating Profit-Sustainability Tensions

Students’ reflections revealed nuanced engagement with the tensions between profitability and sustainability. Although the game began within a familiar profit-oriented frame, many students moved beyond cost minimisation to question fairness, ethical implications, and broader societal impacts of regulatory design.

Several students recognised that companies face dual pressures: reducing emissions while remaining financially viable. UG reflections tended to emphasise the strategic challenge of minimising costs, whereas PG reflections more often articulated the normative dilemma of reconciling responsible business practice with profit expectations.

“The game has contributed to my knowledge and understanding of emissions regulations as it showed me how different policy instruments can have a significant impact on how companies would operate. They will always operate in the way that best benefits them to reduce their own costs, however in the sense there is further available social impacts such as improving green reputation, companies may look to spend excess or more money to improve this in this case, however this was not consider[ed] during the game...” (UG15)

“We have to be more concerned about climate change issues. As a government, we should make the best option policy. As a businessman, we should comply with the regulations and make the best decision to still make a profit in the responsible way.” (PG6)

Together, these reflections illustrate how the game helped students identify the inherent tension between commercial imperatives and sustainability goals, prompting consideration of both economic motivations and ethical responsibilities.

Students also demonstrated critical engagement with the ethical and practical limitations of market-based approaches such as emissions trading. UG students often questioned the legitimacy of trading permits, whereas PG reflections tended to critique market design, oversight, and risks of speculation:

“I just don't understand how government or companies can sell or buy co2 allowances, because no one actually owns them, it is from the nature... I think no one really cares about the environment, the allowances are just there to make extra money for the government.” (UG7)

“A market-based carbon policy might make carbon emissions permits an investment product... the government needs to weigh the pros and cons and strengthen supervision of the carbon permit trading market.” (PG1)

These reflections indicate that students not only learned how trading schemes function but also considered their fairness, ethical basis, and vulnerability to gaming.

Students also recognised that carbon regulations have unequal impacts across firms and society. Some students suggested improvements to regulatory design that reflected concerns about fairness, market oversight, or the distribution of burdens:

“I believe that there should be fewer permits given out so that companies are forced to either pay large sums for their emissions or eradicate their emissions” (UG29)

“I can now understand what policies the government could execute and what will be the impact on economy (like social cost, revenue, and excessive cost that will eventually affect customer/society).” (PG2)

Students also raised concerns about social equity, highlighting the potential for policies to disproportionately affect vulnerable stakeholders:

“I do believe the government should ensure they do not trickle down to consumers such as an individual who has to now pay more for gas than they used to, due to an increase in regulations and does not have the choice to not get gas as it is an important need” (UG21)

These reflections demonstrate emerging awareness of distributional justice issues and the social ramifications of carbon policy.

Overall, this theme demonstrates that the activity provided students with the opportunity not only to understand regulatory mechanisms but to critically interrogate their design, implications, and fairness. The reflections show evidence of early-stage ethical reasoning and policy critique, providing a strong foundation for deeper discussion in the subsequent section. Together, these themes illustrate how the carbon simulation game supported students in developing carbon literacy, engaging collaboratively with policy trade-offs, and reflecting critically on the tensions between profitability and sustainability. These insights directly inform the discussion that follows, which examines the pedagogical implications of the intervention for business-school sustainability education.

Discussion

This study asked: How does a game-based learning environment influence business students' understanding of carbon regulation and their perceptions of the tensions between profitability and sustainability within a core module? The findings indicate that the carbon simulation game (a) fostered high levels of engagement and collaborative problem-solving, (b) enhanced students' understanding of carbon regulation and

sustainability trade-offs, and (c) enabled students to identify and reflect on the tensions between profitability and environmental responsibility. In this section, I interpret these outcomes through the lenses of dialogical learning and group flow to explain why and how the intervention supported these forms of learning. I then consider the implications of these insights for the design of sustainability-related activities in business-school curricula.

Dialogical engagement in mainstream business modules

The carbon emissions game created opportunities for students to collaboratively explore sustainability dilemmas and compare the consequences of different regulatory approaches. This reflects the principles of dialogical learning, in which understanding is developed through interaction, questioning, and the co-construction of meaning (Cunliffe, 2002; Wright *et al.*, 2023; Gutierrez-Huerter *et al.*, 2024). Across the activity, students engaged in exploratory dialogue as they discussed abatement strategies, evaluated the implications of the three instruments, and negotiated with peers during the emissions-trading round. Several reflections showed evidence of movement from descriptive comments to more critical, normative concerns around fairness, pricing transparency, and distributive outcomes.

Embedding the activity within a taxation seminar also appeared to matter. Rather than treating sustainability as an add-on, the game allowed students to encounter policy design and ethical trade-offs within a familiar disciplinary frame. This aligns with arguments that sustainability education in business schools is strengthened when integrated into core modules and not siloed into electives (Rusinko, 2010; Waddock and Lozano, 2013). The shared decision-making context created by the game facilitated dialogical engagement by giving students a common reference point through which to articulate rationales, consider alternative perspectives, and negotiate meaning.

Group flow as the mechanism for collaborative learning

Patterns in the reflections and teaching observations also suggest that the activity created conditions associated with group flow: a collective state characterised by shared goals, deep engagement, and spontaneous communication (Lavoie *et al.*, 2024). The structure of the game, with rising complexity across the three rounds, appeared to help maintain a balance between challenge and skill. Immediate feedback from calculations, auctions, and group results, captured live during the seminar, supported students' sense of progression and collective focus.

This group-level engagement complements the dialogical processes described above. While dialogical learning explains how students interrogated assumptions and collaboratively constructed understanding, group flow helps explain why they remained absorbed, motivated, and willing to engage with one another's ideas. This finding aligns with research showing that game-based and simulation-based pedagogies can deepen learning by enhancing motivation, attention, and collaborative problem-solving when clear goals and immediate feedback are present (Kapp, 2012;

Salas *et al.*, 2009; Boyle *et al.*, 2016; López *et al.*, 2021; Møller, 2020). The combination of dialogical engagement and group flow appears to have enabled students to engage with policy complexity in a way that felt both cognitively demanding and socially rewarding.

Making profit-sustainability tensions thinkable

The activity also surfaced the tensions between profitability and sustainability in a way that felt authentic to business students. Rather than explaining these contradictions through lecture content, the game required students to experience them directly, balancing abatement costs, tax payments, trading decisions, and strategic considerations under uncertainty. This experiential encounter enabled students to articulate the kinds of trade-offs and ethical questions highlighted in sustainability-oriented management scholarship (Hahn *et al.*, 2015; Joseph *et al.*, 2020; Kurucz *et al.*, 2014).

Students responded differently depending on their priorities: some emphasised cost minimisation, others foregrounded environmental responsibility, and several questioned whether market-based mechanisms were ethically robust or fair to smaller firms. These reflections reveal the emergence of what Hahn *et al.* (2015) describe as paradoxical thinking, in which learners begin to recognise that economic and environmental goals are often competing yet interdependent. Students' suggestions for improving regulatory design, for example, restricting permit allocation, enhancing oversight, or considering consumer impacts, further demonstrate their ability to critically evaluate policy instruments rather than simply comparing them in abstract terms.

By making tensions visible and discussable through action rather than explanation, the activity supported students in grappling with sustainability challenges in a manner consistent with both dialogical pedagogy and experiential learning traditions (Kolb, 1984; Lave and Wenger, 1991). This provided a foundation for the more structured design principles and pedagogical implications discussed in the following sections.

Implications for business-school pedagogy (design principles and transferability)

The analysis offers several implications for how sustainability can be integrated into mainstream business-school curricula. First, the findings reinforce arguments that sustainability learning is most effective when embedded within core disciplinary modules rather than confined to electives or specialised sessions (Rusinko, 2010; Waddock and Lozano, 2013). By situating the activity within taxation teaching, the intervention enabled students to encounter sustainability dilemmas in a context that felt authentic and familiar, supporting calls for sustainability education to become a "normalised" aspect of business curricula rather than a peripheral addition.

Second, the game illustrates how carefully designed learning environments can support dialogical engagement. The shared task structure, opportunities for negotiation, and requirement to justify decisions created space for exploratory and

expansionary dialogue (Cunliffe, 2002; Gutierrez-Huerter *et al.*, 2024; Wright *et al.*, 2023;). For educators, this suggests that sustainability-related activities benefit from formats that prompt students to compare their reasoning, engage with divergent viewpoints, and collaboratively construct understanding rather than simply absorb content.

Third, the activity highlights the pedagogical value of creating conditions associated with group flow (Lavoie *et al.*, 2024). The balance between challenge and skill, the immediacy of feedback, and the progression across rounds appeared to sustain student attention and motivation: factors shown to enhance learning in game-based and simulation-based pedagogies (Kapp, 2012; Salas *et al.*, 2009; Boyle *et al.*, 2016). This points to the importance of designing learning tasks that are immersive, socially engaging, and sufficiently complex to prompt sustained intellectual effort.

Finally, the intervention demonstrates that short-form, experiential activities can make complex sustainability tensions accessible within limited teaching time. Students not only applied carbon-regulation concepts but also began to question fairness, distributional impacts, and policy design: outcomes aligned with sustainability-oriented competencies such as ethical reasoning, systems thinking, and reflexivity. This suggests that experiential micro-interventions can meaningfully contribute to the broader aim of cultivating responsible business graduates, even when curricula are tightly constrained.

Together, these implications highlight how experiential, dialogical, and collaborative pedagogies can be embedded within existing business-school structures to support sustainability learning without requiring extensive curricular redesign.

UG-PG differences and learning conditions

Although undergraduate and postgraduate students engaged with the activity in broadly similar ways, some subtle differences emerged. Postgraduate reflections tended to be shorter and more concise, which may relate to linguistic confidence, cohort size, or familiarity with reflective writing. Undergraduate reflections were often more elaborated and narrative in tone, offering more detailed accounts of their team discussions and reasoning processes.

Despite these stylistic differences, both groups demonstrated comparable forms of learning. Students across levels recognised the trade-offs embedded in each regulatory instrument, identified fairness and distributional concerns, and articulated tensions between profitability and sustainability. Both groups also reported high levels of engagement and described how the game helped them understand carbon regulation in practical terms. These similarities suggest that the activity was accessible and meaningful across different levels of study, while the variation in reflective depth highlights how learning conditions and prior experience may shape how students articulate their insights.

Validity considerations

The study has several features that strengthen the credibility of the findings. Reflections were collected immediately after the activity, allowing students to capture their impressions while the experience was still salient, and the analysis was supported by three years of teaching observations, which provided an additional interpretive lens. The use of a hybrid inductive–deductive coding approach also helped ensure that the themes reflected both the structure of the activity and the issues students raised spontaneously.

At the same time, there are limitations that shape the claims that can be made. The data reflect a single institutional context and rely on voluntary written reflections, which may privilege students who are more comfortable writing in English or more motivated to share their views. Immediate reflections provide insight into students' learning processes but do not capture long-term retention or application. These considerations do not undermine the value of the findings but indicate that future work could complement this design with follow-up measures, cross-institutional comparisons, or alternative modes of data collection to build a fuller picture of learning over time.

Practical Implications and Transferability

This study offers several practical implications for educators seeking to integrate sustainability into mainstream business modules. First, the findings illustrate that sustainability learning does not need to be confined to specialist or elective courses. Embedding a short, well-scaffolded simulation within a core disciplinary session can create meaningful opportunities for students to engage with complex policy instruments and to reflect on how organisational decisions intersect with environmental and societal concerns. For educators, this underscores the value of positioning sustainability not as an additional topic but as a natural extension of existing disciplinary content.

Second, the study demonstrates that game-based learning can provide an effective platform for fostering collaborative engagement and dialogical learning. The structure of the carbon simulation game, which requires students to work in teams, negotiate with peers, and respond to evolving scenarios, created the conditions for rich discussion about trade-offs, fairness, and policy design. Educators in other business disciplines can adapt this approach by designing activities that encourage students to compare alternative strategic or regulatory options, articulate rationales, and learn through interaction.

Third, the intervention is highly transferable. Because the game relies on simple materials and can be facilitated within a single seminar session, it can be integrated into a wide range of business subjects, including economics, operations management, strategy, public policy, and finance. In each case, the activity can serve as an entry point for exploring how sustainability considerations shape organisational decision-making and regulatory environments. With minor adjustments to the

scenarios or data, educators can tailor the simulation to highlight sector-specific challenges or disciplinary priorities.

Finally, the findings suggest that integrating opportunities for structured reflection is essential for supporting deeper learning. Short reflective prompts can encourage students to articulate what they have learnt, connect the activity to broader sustainability debates, and critically evaluate the implications of different policy instruments. Incorporating such reflective elements can enhance the impact of experiential activities in business education and help students develop more nuanced understandings of sustainability challenges.

A brief adaptation guide with optional steps and examples for educators wishing to integrate or modify the activity in their own modules is provided in Appendix B.

Conclusion

This study explored how a game-based learning environment can support sustainability learning within a core business module. By engaging students in a carbon simulation game that contrasted command-and-control, carbon taxation, and emissions trading, the intervention enabled learners to explore policy trade-offs, negotiate conflicting priorities, and reflect on the tensions between profitability and environmental responsibility. The activity prompted students to move from descriptive understanding to more critical and ethical reasoning, illustrating how sustainability concepts can be introduced meaningfully within profit-oriented disciplinary contexts.

The findings show that short, immersive activities can foster dialogical engagement, encourage collaborative problem-solving, and deepen students' understanding of carbon regulation. They also demonstrate that sustainability learning is strengthened when students have opportunities to compare alternative policy instruments and discuss their implications for different stakeholders. For educators, the study provides an example of how a low-resource, transferable activity can be embedded within mainstream business curricula to create space for discussion, comparison, and reflection.

While the study is based on a single institution and immediate reflections, the results offer a foundation for future work on game-based sustainability education in business schools. Further research could examine longer-term learning outcomes, test adaptations of the activity in other disciplinary areas, or explore how different student groups, such as experienced postgraduate learners, engage with similar pedagogical designs. Overall, the study demonstrates that well-designed interactive activities can help business students navigate complex sustainability issues and support institutions' broader efforts to integrate sustainability into their curricula.

Future work could also benefit from collaboration with educational psychologists and sustainability pedagogy specialists to deepen understanding of how dialogical engagement and group flow contribute to conceptual transformation.

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Appendix A: Reflective survey questions and premediated themes

Premeditated themes	Trigger questions
Profit-sustainability tensions	1) What, in your opinion, were the important issues that emerged during the game?
Activities during the session	2) What motivated your decisions during the game, and were you satisfied with the outcomes?
Learning outcomes	3) How has this game contributed to your knowledge and understanding of carbon emission regulations and their impact?
Impact of the session	4) What impact has the game had on your attitude towards carbon emission regulations?
Engagement	5) What aspects of the game did you enjoy, and why?
Suggestion for improvement	6) What aspects of the game could be improved, and how?
Reflections not captured by trigger questions	7) Any other comments about the game that you would like to share

Appendix B: Suggested adaptation guide for educators

This table summarises one possible way of facilitating the carbon emissions game, based on the author's experience. It is intended as a flexible resource, not a prescriptive template.

Component	Purpose	How Educators May Choose to Approach It
Pre-session preparation	Support basic understanding of policy instruments	Provide a short factsheet introducing <i>command-and-control</i> , <i>carbon tax</i> , and <i>emissions trading systems</i> , which students can skim ahead of the seminar.
Introduction (10 min)	Orient students to the setting: I used an imaginary country that currently has no	Briefly explain that students will explore how different regulatory instruments could be used to

	carbon emissions regulations	achieve the imaginary country's carbon emissions abatement goal.
Role briefing (5 min)	Create meaningful variation and interdependence	Assign each team an energy company with different abatement costs. Clarify their goal: minimise compliance costs while meeting regulatory requirements.
Round 1: Command-and-control (10–15 min)	Surface cost asymmetries and rigidity	Invite students to calculate the costs of adopting the mandated “best available technology” (I use RCP). Use the PPT to record group results in real time.
Round 2: Carbon tax (15–20 min)	Explore behavioural thresholds and abatement choices	Present the carbon tax rate (e.g., \$150/tCO ₂ e). Students compare abatement costs vs tax payments and report their chosen abatement levels. Summarise results on the PPT slide.
Round 3: Emissions trading (20–25 min)	Encourage negotiation, trading, and strategic decision-making	Share initial permit allocations and open the emissions market for trading. Facilitate briefly, then step back to allow student negotiation.
Short debrief after each round (3–5 min)	Maintain group flow and consolidate insights	Use the “impact table” to fill in emissions reduced, economic cost, revenue, and social cost for each round. Highlight differences without evaluating students' decisions. I use just one PPT slide pack for the whole session
Final reflection (10 min)	Encourage reflections (students often surprise me with what they pick up or think!)	Offer prompt questions (e.g., “Which instrument felt fair? What would you change if you were the regulator?”)
Design considerations	Support adaptation across modules	Educators may choose to: (a) contrast multiple instruments, (b) introduce heterogeneity in firm cost

		structures, (c) maintain a challenge–skill balance, (d) prompt reflection on fairness and distributional impacts.
Adaptation across business disciplines	Transferability	This activity can be adapted for strategy (competitive advantage), operations (process redesign & cost curves), public policy (instrument choice), economics (externalities & welfare), finance/accounting (carbon risk & disclosure), or entrepreneurship (innovation opportunities).
Resourcing	Keep preparation light	Only simple materials are required: the PPT, factsheets, calculators/spreadsheets, and a results table to be completed live.
Evaluating learning	Evidence impact	Educators may consider a brief group/individual discussion or a short reflective question at the end. I use both.