

Playing the Climate Future: Evaluating Climate-adaptation Games for Higher Education

Nadine Stecher, Ella Howard, Lauren Melfi, Aroni Kabita Porna, Thaddeus Guldbrandsen and Yalinu Poya

Wentworth Institute of Technology, Boston, Massachusetts, USA

stechern@wit.edu

howarde@wit.edu

melfil@wit.edu

kabitapornaa@wit.edu

guldbrandsent@wit.edu

poyay@wit.edu

Abstract: Climate change presents complex environmental challenges that require students to engage with systems thinking, uncertainty, and long-term decision-making. Instructors increasingly seek teaching approaches that allow students to explore these issues in interactive and applied ways. Game-based learning has emerged as one such approach within experiential and constructivist pedagogy. Climate-themed games can simulate environmental systems, governance processes, and collective decision-making, allowing students to experiment with adaptation strategies and policy trade-offs. Despite the growing number of climate games available, instructors have limited guidance on which games are practical and effective for use in university classrooms. This preliminary study introduces an evaluation of the classroom usability and educational potential of several climate-themed games across higher-education contexts through a comparative analysis of gameplay mechanics, classroom logistics, and relevance to university teaching and learning outcomes. The selection includes cooperative board games, narrative role-play scenarios, and global negotiation simulations. The analysis focuses on two aspects. The first aspect addresses practical classroom usability, including setup requirements, preparation time, player numbers, session length, cognitive complexity, and facilitation demands. These factors determine whether a game can realistically be implemented within typical class periods. The second aspect examines pedagogical framing, including how games potentially support systems thinking, climate literacy, adaptation and mitigation trade-offs, equity considerations, collaborative decision-making, and post-game reflection. The evaluation combines interdisciplinary faculty review, pilot play sessions with faculty, and a literature review of scholarship on game-based learning in higher education, with the emphasis on climate-themed games. Results identify which games are most suitable for short class sessions, which require extended play, and which most effectively support student understanding of climate systems, governance challenges, and long-term adaptation. The study provides a practical guide for instructors interested in integrating climate games into university courses and proposes a comparative framework for evaluating climate game pedagogy across disciplines and multiple game modalities that can inform course design, activity selection, and classroom facilitation.

Keywords: Climate education, Game-based learning, Board games, Higher education, Climate adaptation, Experiential pedagogy

1. Introduction

The contemporary learning environment in higher education is being reshaped by the rapid expansion of digital technologies, including generative AI tools and platforms for remote and hybrid instruction. These developments offer new opportunities for access and flexibility, while also raising questions about how learning is best structured, experienced, and assessed. In this context, there is renewed value in pedagogical approaches that complement technologically mediated learning with analog, screens-down engagement. Within increasingly digitized learning environments, pedagogical games help preserve spaces for interaction, ambiguity, collective problem solving, and learner agency.

In this spirit, analog pedagogical games should be engaging enough to invite the most passive students to participate actively. At the introductory level, the game should help students develop an intuitive understanding of key concepts of the course material. It is preferable to have the entire game, starting from set up to discussions, fit one class session. This implies that the rules of the game are straightforward and do not require any prior advanced knowledge. The gameplay should simplify but not oversimplify reality so that students would be able to reflect and engage in a meaningful discussion about how the game relates to real-world situations.

Simulations and games cast participants in active roles, fostering experiential learning (Kolb and Kolb, 2009; Gamson, 2013; Wu and Lee, 2015). Effective simulations carefully distill complex systems into targeted, simplified scenarios (Meadows, 2001; Klabbbers, 2025). Traditional educational methods can be enhanced

through such intentional and engaging, "designed experiences" (Squire, 2006, quoted in Wu and Lee, 2015, p. 413).

Climate games in particular ask players to simulate decisions and observe their effects to inspire understanding of environmental concerns (Sterman, 2011; Ahmadov et al, 2025). For such "microworlds" to be effective, they must accurately represent causal relationships (Egenfeldt-Nielsen et al, 2013, quoted in Fjællingsdal and Klöckner, 2020, p. 641; Meadows and Meadows, 2007). Such games and simulations seek to help players understand the impact of individual and local actions on broader global situations (Wu and Lee, 2015; Fjællingsdal and Klöckner, 2020).

Climate games often emphasize the connections between economic incentives, political systems, and environmental impacts (Eisenack, 2012; Wu and Lee, 2015). Trade-offs are a centerpiece of such games and simulations. Frequently, players must choose between short-term profit and long-term environmental quality (Eisenack, 2012; Meya and Eisenack, 2018). Climate games also encourage players to understand the "free-rider problem" by forcing them to weigh the benefits of collaboration versus the pursuit of individual goals (Eisenack, 2012; Fjællingsdal and Klöckner, 2020, p. 330). To reflect the complexity of climate issues, many games model feedback loops and path dependencies (Meadows and Meadows, 2007; Meya and Eisenack, 2018).

Although video games can be highly immersive, analog and board games are especially well suited to classroom use (Fjællingsdal and Klöckner, 2020). One benefit of physical games is that they translate complex and abstract concepts into tangible materials (Fjællingsdal and Klöckner, 2020, p. 634). Analog games foster collaboration, negotiation, and human communication without the need for digital devices (Fjællingsdal and Klöckner, 2020, p. 634). In general, scholars have found that such games can be effective learning experiences for university students (Eisenack, 2012; Kurisu et al, 2021).

Scholars have also raised cautionary notes regarding the academic rigor and practical implementation of climate games for classroom use (Westera, 2019; Ahmadov et al, 2025). For such games to be deployed effectively in the classroom, the session must be carefully planned, facilitated, and evaluated with the existing curricula in mind (Eisenack, 2012; Westera, 2019; Hügel and Davies, 2022). Sufficient time must be allocated to gameplay and preparation for facilitation of complex games (Eisenack, 2012; Fjællingsdal and Klöckner, 2020). Scholars thus express enthusiasm for the use of games and simulations in educational contexts, but relatively little guidance is available for the practical implementation of such materials.

This study seeks to address this gap by assessing a set of climate games for their classroom potential and pedagogical value. It is a component of the efforts by the team of authors to build a Center for Games-Based Learning at Wentworth Institute of Technology. Fundamentally, this study represents an initial approach to evaluating potentially pedagogical games and planning for their use in a contemporary undergraduate institution. It will also inform the team's future approach to designing, running, and evaluating effective gamification of education.

2. Analytical Framework

The analysis of the games considers two different aspects: 1. How practical is their use in the classroom, and 2. What is the pedagogical application of each game? For a game to be implemented realistically, instructors must be able to use their available space and class time, assistance, and to involve all students. For a game to support climate learning outcomes, they should address concepts such as climate policies, the impact of climate change, critical thresholds, and reactive and proactive measures.

3. Methods

3.1 Game Selection

The games studied here (Table 1) are drawn from the team's collection of climate games and scenarios. Most instructors will have the easiest access to low-cost, mass-market games, so *Carbon City Zero* (Laurence King Publishing) and *Kyoto* (Pegasus Spiele) are included as first and second selection, respectively. The third game to test, *Climate Cooldown* (Clean Earth Future), was selected as representative of new games produced by small, independent firms. Lastly, to offer guidance to instructors across a wide variety of academic disciplines, *Keep Cool* (Spieltrieb) was chosen to evaluate the potential of using climate games specifically in political science classes.

3.2 Evaluation Process

All games were play-tested by a team of three to four interdisciplinary faculty and staff with no prior experience with the games, which somewhat simulates the scenario of students encountering a game for the first time in the classroom. Players used videos and the rulebooks to learn game mechanics. While all selected games have online video tutorials, the tutorial for *Keep Cool* was not accessible. All players completed Likert-scale rubrics to assess a game's complexity, player engagement, and potential learning outcomes. An independent observer was present to record setup and play time, frequency of consulting the game rulebook during play, and to take notes of player comments throughout the game. The feedback from players and observers forms the base of assessing the practicality and educational value of the selected games.

Table 1: Two cooperative and two competitive games were included in this study. All games can be played by ages 10 and up, are primarily available in English; Keep Cool is also available in German. Carbon City Zero offers cooperative, competitive as well as solo playing options; the cooperative option was chosen for this study

Title of game	Number of players	cooperative objective
<i>Carbon City Zero</i>	2-4	Players create a carbon-neutral city by building green transport and industries.
<i>Climate Cooldown</i>	2-4	Representing different global regions, players manage resources, handle climate disasters, and lower the global impact.
		competitive objective
<i>Keep Cool</i>	3-6	Representing different global regions, players advance individual economic interests by building green and carbon-emitting factories while balancing climate protection to prevent global temperature rise.
<i>Kyoto</i>	3-6	Representing different countries, players advance individual, hidden agendas while balancing climate protection to reduce environmental damage.

4. Findings and Interpretation

4.1 Classroom Usability

Time requirement: Except for *Keep Cool*, all games required a considerably greater than estimated time investment (Table 2). In all games, the first round of gameplay took much longer than subsequent rounds because players had to familiarize themselves with the game mechanics. By the second or third round, players typically understood what actions they could take on their turn. The overall longer duration is likely caused by the inexperience of the players with the game and may be reduced in recurrent play sessions. In conclusion, instructors would need to dedicate a full two-hour class session to introduce any of these games into their curriculum.

Complexity: Players rated the rules of *Keep Cool* and *Climate Cooldown* as being harder to understand than those of the other two games, and *Kyoto* was rated the least complex. While players consulted the rulebook multiple times during the playing of all games, most prominently, the rules of *Climate Cooldown* necessitated frequent clarification. Players remained interested and felt engaged throughout all gameplays, with *Climate Cooldown* receiving the highest scores in these aspects despite being considered the most complex game. None of the games were criticized for being oversimplified or for misrepresenting climate concepts.

Facilitation needs: The most problematic aspects of the games, especially in *Climate Cooldown* and *Keep Cool*, were the identity and use of game components such as different trackers, differently colored cards and in-game currency. It is recommended that a facilitator is present to explain the game components before starting the first round, and to reiterate at least during the first round.

Table 2: Time requirements for the selected games (first time play only). “Setup time” is defined as the time spent assembling the tabletop game interface and introducing game mechanics via the rulebook. “First play duration” is defined as the time spent for setup, learning how to play the game, and playing until the winning (or losing) condition was achieved. Disassembling each game took less than 5 minutes. “Recommended class time” refers to credit hours (1 credit hour = 50 minutes) or academic hours (1 academic hour = 45 minutes)

	<i>Carbon city zero</i>	<i>Climate cooldown</i>	<i>Keep Cool</i>	<i>Kyoto</i>
Estimated Play time (per game instructions)	30-60 minutes	45 minutes	60-120 minutes	30-45 minutes
Setup time	10 minutes	15 minutes	>20 minutes	15 minutes
First play duration	80 minutes	104 minutes	75 minutes	55 minutes
Recommended class time	2 hours	2 hours	2 hours	2 hours

Scalability: The potential to successfully introduce these games into larger classes is largely limited by facilitation needs and the instructor’s educational objective. Having multiple simultaneous gaming groups may necessitate having multiple facilitators, at least in the early stages of gameplay. Different groups will likely reach the winning (or losing) conditions at different times. If the instructor aims to have a post-game discussion with the students, it would be important to provide students with a description of objectives and expectations ahead of playing the game. There is also the issue of initial acquisition costs, but that is a one-time expense.

Accessibility: The layout of all games includes a central game board with one-directional graphics and text, and card draw piles. Consequently, some players would need to be able to read upside down, and game components may be out of reach for some of the players. Furthermore, test players criticized some of the visual elements of *Carbon City Zero* for its small font and a lack of color contrast.

4.2 Pedagogical Application

Table 3: Summary assessment of educational value of the selected climate-themed games, based on Likert-scale responses from test players. Key: strongly disagree (--), disagree (-), neither agree nor disagree (o), agree (+), strongly agree (++)

	<i>Carbon City Zero</i>	<i>Climate Cooldown</i>	<i>Keep Cool</i>	<i>Kyoto</i>
Connects to real-world climate issues.	+	o	o	++
Illustrates cause-and-effect relationships.	o	+	+	+
Helps to understand climate-related concepts.	+	+	o	++
At least one concept can be better explained after playing.	-	o	-	+
Concepts are oversimplified or misinterpreted.	o	o	o	o

4.2.1 Cooperative games: *Carbon City Zero* and *Climate Cooldown*

In the two games with cooperative objectives, the victory condition is the environmental goal, which may be a combination of group and player targets (Table 4). Tradeoffs may be observed through the downsides of starting positions or actions but are not always incentivized or rewarded sufficiently to justify player choices. Randomness may also play a larger role in the manifestation of climate disasters within the game and the ability of players to take effective and positive actions at any given moment. The competitive variants of both games are races to see which player can meet the individual versions of these goals more quickly and effectively. Within the cooperative games, a high variability in board game knowledge and strategy among the players will lead to the primary social dynamics of the gameplay and learning experience.

Table 4: Winning conditions in the cooperative games *Carbon City Zero* and *Climate Cooldown*

cooperative game	victory conditions
<i>Carbon City Zero</i>	The counter on a track (representing carbon emission) reaches zero within nine rounds of play.
<i>Climate Cooldown</i>	Land and water masses on the world map are restored, and the global temperature reduced to a threshold, while each player must obtain a certain number of sustainable energy resources and divest from unsustainable ones within five rounds of play.

Carbon City Zero uses a cooperative and system-based approach to allow students to define sustainability and to discuss trade-offs between different climate policies to achieve a collective climate goal. However, its simplified framework may limit its ability to represent economic reasoning, strategic behavior, and other key concepts that are central in economics courses. Therefore, it could be used as a supplementary game rather than a primary pedagogical game in a course.

Using *Climate Cooldown*, students can be led to compare different climate policy options, differentiate between mitigation and adaptation strategies, and evaluate trade-offs that are made to address climate change. The game has a structured framework; the guided design of the game allows students without prior theoretical knowledge to describe the policy choices and their impacts. Although the game places less emphasis on strategic and incentive-driven behavior, which limits its ability to capture real-world complexities, it could be used as a primary pedagogical tool in an introductory economics course.

4.2.2 Competitive Games: Keep Cool and Kyoto

In contrast to even the competitive variant of *Carbon City Zero*, *Keep Cool* and *Kyoto* have distinct individual objectives (Table 5). Competitive actions are morally loaded in the context of climate games, particularly when played in a serious environment. Players may consciously or subconsciously avoid politically uncomfortable actions that were intended as part of the competitive gameplay experience. This has an overall effect on the balance and overall feel of the gameplay. However, all climate-friendly actions in a single game of *Kyoto* can comfortably be achieved with collectively available resources. Thus, a group of players who are predisposed to act cooperatively, who do not feel comfortable acting “selfishly” in the game, or who are not confident enough in their social gameplay to withhold resources from the group economy may end up playing the entire game without activating many of the game’s core mechanics (both social and environmental).

Table 5: Winning conditions in the competitive games Keep Cool and Kyoto

competitive game	victory conditions
<i>Keep Cool</i>	The winning player achieves both their unconcealed and concealed economic targets before global carbon emissions reach a critical threshold.
<i>Kyoto</i>	The winning player accumulates the most points by retaining resources and satisfying hidden goals at the end of 12 rounds and before environmental damage reaches a threshold.

Keep Cool provides experiential learning, where students realize that immediate economic growth and delayed effects of climate change work as incentives for countries which continue to emit carbon. Through this, concepts such as externalities and self-interest become more concrete. The game mirrors real-world conflicts and climate negotiation strategies while capturing the dynamics of the political economy. The game is engaging, and it demonstrates that climate policy decisions are inherently political rather than technical. However, the game requires strong debrief; otherwise, students may miss the more advanced economic intuitions embedded within the decisions and may focus only on gameplay. The game’s competitive framing can cause students to miss the underlying systemic failure and interpret outcomes only as individual wins or losses, which may be particularly risky for a positive game-playing experience given the imbalanced starting positions and varied win conditions of the different countries/players. The game also emphasizes mitigation over adaptation, which may potentially reinforce the misunderstanding that climate policies are limited to reducing emissions rather than also managing and coping with climate impacts. This board game is moderately suitable for economic-focused courses at an introductory level, but highly suitable for political science courses.

Kyoto provides a role-play experience as a simulation of institutional coordination, policy frameworks, and structuring agreements. The game requires students to handle a variety of real-world trade-offs, encouraging strategic thinking around abstract policy dynamics. Students represent countries or blocs who navigate multiple variables associated with economy, emissions, lobbying groups, and how their actions impact others. They negotiate agreements with each other and coordinate to overcome challenges, or they may deliberately push an initiative to fail in service of their individual goals. While the setup is relatively simple, the game introduces conceptual complexity through its layered decision-making and negotiation structure. Students may feel overwhelmed or uncertain in early rounds, but this may be mitigated by clear and careful facilitation. Team play may be more effective by providing more discussion at the table and encouragement to play strategically. This game is a useful tool for teaching an interdisciplinary course on climate change, as it seeks to bridge social, political, and economic perspectives within a diplomatic context.

With their emphasis on multilateral negotiations around international climate goals, the *Kyoto* and *Climate Cooldown* games are useful in courses that examine governance, policy, and international coordination. Within political science curricula, the games align with courses such as introductory political science, global sustainability, environmental policy, science and technology policy, international politics, where students are introduced to concepts of sovereignty, negotiation, and collective action. It is equally applicable in interdisciplinary settings, including climate resilience courses, such as Topics in Climate Change, Sustainability, as well as Anthropology of Human Challenges, Environmental Economics, and International Economics. Across these contexts, the game enables students to move from abstract discussion to applied decision-making, highlighting the tensions between national interest, economic development, and global environmental goals. Specifically, students may be tasked with analyzing how the national economic and political interests of their in-game geographic region influenced their climate-related decision-making, and how they balanced self-interest with international climate cooperation.

5. Conclusion

Among the games evaluated, *Kyoto* emerged as the most immediately classroom-ready, offering manageable setup, a realistic single-session time frame, and opportunities for negotiation and governance discussion, making it particularly well-suited to political science and interdisciplinary courses. *Keep Cool* addresses similar themes with greater mechanical complexity and requires strong facilitation and debrief to ensure students move beyond individual game plan toward systemic insight. *Carbon City Zero* offers the lowest barrier to entry as a cooperative experience and works best as a supplementary activity, rather than a primary pedagogical tool. *Climate Cooldown*, despite being the most complex to facilitate, offers the most structured framework for introducing climate policy options and is well-positioned as a primary tool in an introductory course. Across all four, a consistent finding holds: the pedagogical value of a game depends less on the game itself than on the integration into course design.

Across the games examined, in this study, a pattern emerged for the co-authors: pedagogical games are effective when they create structured environments in which students must make decisions under constraint, engage with one another, and reflect on the consequences of their actions. While the games vary in complexity, accessibility, and ease of implementation, each offers distinct opportunities to move beyond abstract discussion into applied learning.

The games that were reviewed in this study are not universally transferrable across all classroom contexts. Their effectiveness depends on factors such as class size, time constraints, student preparation, and the clarity of facilitation. Some games offer immediate accessibility and engagement, while others require more scaffolding to ensure that their pedagogical value is realized. This variable underscores the importance of careful selection and intentional integration into course design. The value of these games lies not only in their capacity to engage students, but in their ability to situate learning within systems of constraint, interdependence, and uncertainty. In an era of abundant information, the ability to navigate complexity together may be one of the most important outcomes higher education can offer.

6. Limitations of the Study

The conclusions resulting from this study may be limited by the authors' relatively early progress in planning, testing, and evaluating games as a teaching tool. For example, the evaluation rubrics used in this study will require further refinement in future iterations. It is unlikely that the evaluation of each game was influenced by the order in which the games were tested since players were mostly focused on game mechanics during the test, but it is possible that the testers' interpretation of the rubrics evolved as they participated in more games. One of the testers, who was the only player to engage with all games, has considerable experience with different board game mechanics, which was probably an asset during gameplay. Due to scheduling constraints, the games were only examined by a relatively small number of participants from various disciplines (Anthropology, Biology, Chemistry, Economics, History, and Mathematics). The games could not yet be tested in a classroom; thus, all recommendations are informed by the pedagogical expertise of team members.

7. Future directions

Future work may build on this analysis by refining the analytical strategies, exploring how these approaches can be adapted across disciplines, built into existing course lesson plans, and assessed for longer-term learning outcomes, and extending the evaluation framework to a broader range of pedagogical games across disciplines.

Ethics Declaration: Ethical clearance was not required.

AI Declaration: ChatGPT was used during the early planning stages to brainstorm structural approaches for organizing the paper. All substantive analysis, gameplay evaluation, interpretation, and final writing were conducted and verified by the authors.

References

- Ahmadvov, T. et al (2025) "A two-phase systematic literature review on the use of serious games for sustainable environmental education," *Interactive Learning Environments*, 33(3), pp. 1945–1966. Available at: <https://doi.org/10.1080/10494820.2024.2414429>.
- Dunlop, L., Jouscoski, E. and Sandbhor, P. (2025) "Learning through play? What board games reveal and conceal about climate change," *Environmental Education Research*, pp. 1–21.
- Eisenack, K. (2012) "A Climate Change Board Game for Interdisciplinary Communication and Education," *Simulation & Gaming*, 44(2–3), pp. 328–348. Available at: <https://doi.org/10.1177/1046878112452639>.
- Fjællingsdal, K.S. and Klöckner, C.A. (2020) "Green Across the Board: Board Games as Tools for Dialogue and Simplified Environmental Communication," *Simulation & Gaming*, 51(5), pp. 632–652. Available at: <https://doi.org/10.1177/1046878120925133>.
- Gamson, W.A. (2013) "Games Throughout the Life Cycle," *Simulation & Gaming*, 44(5), pp. 609–623. Available at: <https://doi.org/10.1177/1046878113503301>.
- Hügel, S. and Davies, A.R. (2022) "Playing for Keeps: Designing Serious Games for Climate Adaptation Planning Education With Young People," *Urban Planning*, 7(2), pp. 306–320. Available at: <https://doi.org/10.17645/up.v7i2.5113>.
- Klabbers, J.H.G. (2025) "Game Science: A Retrospect and a Prospect," in W.C. Kriz et al (eds.) *Legacy and Future Impact of Gaming Simulation Pioneers*. Singapore: Springer Nature Singapore (Translational Systems Sciences), pp. 77–88. Available at: https://doi.org/10.1007/978-981-96-4325-7_4.
- Kolb, A.Y. and Kolb, D.A. (2009) "The Learning Way: Meta-cognitive Aspects of Experiential Learning," *Simulation & Gaming*, 40(3), pp. 297–327. Available at: <https://doi.org/10.1177/1046878108325713>.
- Kurisu, K. et al (2021) "Development of board game to encourage life cycle thinking, and trial with university students in Japan," *Cleaner and Responsible Consumption*, 3, p. 100033. Available at: <https://doi.org/10.1016/j.clrc.2021.100033>.
- Meadows, D.H. and Meadows, D. (2007) "The history and conclusions of *The Limits to Growth*," *System Dynamics Review*, 23(2–3), pp. 191–197. Available at: <https://doi.org/10.1002/sdr.371>.
- Meadows, D.L. (2001) "Tools for Understanding the Limits to Growth: Comparing a Simulation and a Game," *Simulation & Gaming*, 32(4), pp. 522–536. Available at: <https://doi.org/10.1177/104687810103200408>.
- Meya, J.N. and Eisenack, K. (2018) "Effectiveness of gaming for communicating and teaching climate change," *Climatic Change*, 149(3–4), pp. 319–333. Available at: <https://doi.org/10.1007/s10584-018-2254-7>.
- Sterman, J.D. (2011) "Communicating climate change risks in a skeptical world," *Climatic Change*, 108(4), pp. 811–826. Available at: <https://doi.org/10.1007/s10584-011-0189-3>.
- Westera, W. (2019) "Why and How Serious Games can Become Far More Effective," *Journal of Educational Technology & Society*, 22(1), pp. 59–69.
- Wu, J.S. and Lee, J.J. (2015) "Climate change games as tools for education and engagement," *Nature Climate Change*, 5(5), pp. 413–418. Available at: <https://doi.org/10.1038/nclimate2566>.