Virtual Climate Activation: A Framework Approach to Sustainable Food Consumption in Games

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Abstract— **The climate, biodiversity, and inequality polycrisis is one of the most pressing issues humanity has to tackle. Demand-side changes in the food sector can help to address it. Video games have been identified as a potential tool to communicate environmental issues and support such societal change. This study analyzes three current games featuring sustainability messages in the food sector, Gibbon: Beyond the Trees, Beecarbonize, and Bear & Breakfast, to assess how they communicate these issues and what can be learned from them for future game development.**

Keywords— games, climate engagement, climate change, sustainability, food system

I. INTRODUCTION

Two of the most pressing crises humanity is facing are global heating [1] and rapid biodiversity loss [2], interlinked in form of a larger polycrisis [3]. Driven mostly by wealthier countries, their impacts on health and welfare are increasingly apparent and concentrated among vulnerable populations, exacerbating global inequalities [1], [4]. To alleviate impacts, global mitigation and adaptation efforts are needed, both from policy makers and through bottom-up action pushing this societal change [5]. Food production strongly affects the polycrisis as agricultural expansion drives land-use change, such as deforestation [6]. Livestock farming is especially impactful, due to resource needs and direct emissions [7], [8]. As such, the food sector bears large demand-side mitigation potential [1], primarily through meat-reduced diets [9]–[12].

However, the social process towards necessary changes is a difficult, even wicked challenge [13], [14]. It requires an informed and interested population that sees the necessity and net-benefits of these changes and supports them [14]. Games have been identified as a promising medium for promoting societal and behavioral change [15]–[17], showing success in promoting sustainable energy consumption and transportation among others. Despite this, only few games have been released to wider success that tackle environmental or climate issues [18]. Nearly none connect them to the food sector specifically, leaving this important demand-side link to the polycrisis mostly ignored.

In this work, as a first step to address this, a selection of current games is analyzed regarding their environmental, climate, and food system content as well as how they fit into the framework designed by Ouariachi *et al.* [15] for effective climate communication through games. Based on these examples, future games can be optimized regarding potential communication and impact goals.

II. METHODS

A. The framework

Based on expert elicitation, existing literature, and group discussions, [15] have created a framework of 15 key attributes for games with climate communication purposes to maximize their impact. They then classified them into three categories for climate change engagement, as shown in Fig. 1: cognitive, emotional, and behavioral reception. This links to the assessment by Lorenzoni *et al.* [19] that cognitive reception, i.e., knowledge about an issue, may not be sufficient to move a person to act. In the following, the 15 attributes from [15] are listed and concisely described:

A. **Achievable:** Actions in the game as well as suggested behavioral change need to be doable for the player.

B. **Challenging:** The game should be fair but also push players towards their limits rather than being too easy.

C. **Concrete:** Instead of walls of texts, players should receive clear, simple messages, embedded into the gameplay.

D. **Credibility:** Reliable sources should support the messages of the game, at best taking into account audience trust.

E. **Efficacy-enhancing:** The game should create a feeling of agency by allowing the players to choose their own path and showing their impact.

F. **Experiential learning:** Players should not be forced to overthink their choices but rather intuitively experiment and experience the results.

G. **Feedback-oriented:** The game should provide clear feedback to player actions and do so in a timely fashion to ensure high efficacy.

H. **Fun:** Players should experience fun or be otherwise engaged by the game to ensure they spend sufficient time with it and its content.

I. **Identity-driven:** The game should connect to who the players are and would like to be to strengthen their emotional engagement.

J. **Leveling-up:** Difficulty and personal achievements should increase over time to keep players engaged.

K. **Meaningful:** The game needs to highlight the importance of the issue. It should show both negative impacts and positive visions of the future.

L. **Narrative-driven:** Coherent and well-written stories or real-life connections can foster engagement and support the game messages.

M. **Reward-driven:** Rewards are an important driver of long-term engagement and can be anything from high scores to badges and unlockables.

N. **Simulating**: Simulations allow players to experience real-world phenomena they otherwise might not or not on short time scales.

O. **Social:** Social interactions are at the core of behavioral change, for example through high scores, multiplayer or real-world connections.

For each game, the presence of every attribute is evaluated on a binary scale. Then, selected positive and negative examples are highlighted. To evaluate this, the games have
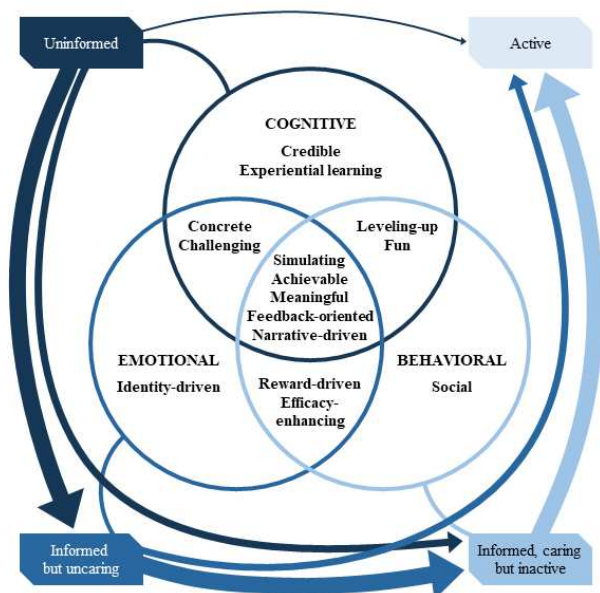
Fig. 1. Illustration of how cognitive, emotional, and behavioral reception of video games support behavioral change. First appeared in [18], adopted from [15].

been played for several hours each to ensure that most content has been experienced. Where playtime was not sufficient for all features, videos, guides, and wikis were consulted for additional insights.

B. Game selection process

In the selection process, environmental game databases [17], [20], [21] were consulted in addition to an expert forum and author knowledge. Games were considered if they

- are professionally produced, either by a commercial company or professional-level hobbyists;
- target mass appeal and a wide audience beyond classroom-settings;
- cover environmental issues related to the food system, at best showing their connection; and
- feature current design practices, i.e., have been released within the last 10 years.

Most games in the databases do not fullfil all of these criteria. Especially links between environmental issues and the food system are rare, even when interpreted widely. Where such a link was found, most games fell into a similar genre, i.e., high-level strategy, such as the selected *Beecarbonize* [22].

To assess a wider range of design choices despite the limited scope of this work, only one such strategy game was selected. In turn, to be able to include other genres, games were included that link to both the climate and the food system, but do not necessarily draw a strong connection between them.

Using this process, three games have been selected: *Gibbon: Beyond the Trees* (*Gibbon* for short) [23], *Beecarbonize*, and *Bear & Breakfast* [24], summarized in Table I. None of the three games primarily focus on the the connection between the food system and the current sustainability crises. Despite this, they do so more than the other games in the databases while also mostly fullfilling the outlined criteria in general.

III. RESULTS

The attribute evaluation is summarized in Table II. Both *Gibbon* and *Beecarbonize* show 12 of the 15 attributes, while *Bear & Breakfast* shows 11.

A. Gibbon: Beyond the Trees

Gibbon: Beyond the Trees is a narrative-driven platformer where players move as gibbon through a jungle. Over time, human encroachment into their habitat becomes visible through deforestation, plantations, and settlements.

Gibbon is a good example of identity and narrative-driven gameplay. The game revolves around the experience of being a gibbon and moving like they do. This supports experiential learning as deforestation affects the player's initial freedom. Instead of just showing the destruction, the game takes away part of the joy that players experienced jumping at high speeds through the jungle canopy.

The story transports meaningful messages about jungle biodiversity, ending on an empowering note. An encyclopedia combines rewards and concrete messages without large wall of texts, directly tied to credible sources.

However, the implicit call to action in the game is not as strong as it could be. Instead of specific actions, it hints in the direction of the partnering organizations. Especially regarding palm oil, where consumers may have an impact, the game does not provide a lot of information or suggestions. This would fit both the end of the story and the encyclopedia, as people who reach these points show openess to such input.

As social and replay mechanic, *Gibbon* employs a leaderboard for daily races. This fosters extended exposure to its messages, but is somewhat detached from the narrative and its links to sustainable change, climate or otherwise.

B. Beecarbonize

Beecarbonize is a card-based strategy game where players manage global decarbonization across four sectors. While they work towards victory, some cards as well as increasing emissions may spawn negative impacts, hindering progress.

Beecarbonize focuses on the high-level understanding of how society, climate and biosphere interact, and does so well with concrete messages and experiential learning. Each playable card has few and simple attributes, so that the game can be played without thinking too much about the underlying mechanics. The constantly upticking carbon counter, the

TABLE I.   GAME SELECTION

	Gibbon: Beyond the Trees	**Beecarbonize**	**Bear & Breakfast**
Developer	Broken Rules	Charles Games	Gummy Cat
Publisher	Broken Rules	Charles Games	Armor Games Studios
Genre	2D Platformer	Card-based strategy	Management simulator
Estimated reach	Over 500,000	Over 300,000	Over 500,000
Steam reviews	Very positive (91%)	Very positive (93%)	Very positive (90%)
Ecological themes	Biodiversity, climate	Climate, biodiversity	Wildfire, pollution
Food themes	Palm oil, deforestation	Production systems	Cooking

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Total
Bear & Breakfast	✓	✗	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	11
Beecarbonize	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✗	✓	✓	✗	12
Gibbon: Beyond the Trees	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	12

associated increase in negative events, and the relief when a winning card is played transport meaningful messages and show what a simple climate simulation can look like.

At the same time, such simulations need to be approached with care to avoid miscommunicating the need for action. For example, highlighting specific levels of global heating (e.g., 1.5 or 2°C) as triggers for catastrophic events may communicate wrong priorities, leading to an overestimation of the specific importance of these numbers compared to the overall increasing risk with every additional 0.1°C.

Furthermore, while it does not need an identity or narrative-driven approach to convey its systems knowledge, it may be easier for players to see *Beecarbonize* as a simple numbers game due to their absence. When a negative event is looming, players may calculate their gameplay cost instead of how this would translate to real-life suffering, as there is no character embodying it.

The game also uses several features to support repeated exposure to its messages. Players have a collection of uncovered cards, including six different ways to win the game, and are encouraged to find them all. Further, the 'hardcore' mode is unlocked after winning for the first time, creating a harder challenge and an opportunity for players to level up.

Regarding individual action and guiding behavioral change, *Beecarbonize* highlights 'Societal Change', in the form of the first playable card, at the core of the 'People' sector but then shows mostly high-level and abstract options such as a carbon tax, the move to a circular economy, or voluntary frugality. There are only a few ideas players can directly apply, such as guerilla gardening.

Several cards in the "Ecosystems' sector show changes to which and how food is produced, including permaculture, hydropony, or kelp. At the same time, neither the 'People' nor the 'Ecosystems' sector feature a card directly suggesting a move towards a more plant-based diet. Reducing cattle numbers is only addressed on the 'Laboratory food' card. This solution is already being investigated [8] and a legitimate addition to the game. But while this technology is still in development, other meat alternatives are already available and could have been added on the same level as 'Sustainable Transport' to communicate actionable food knowledge to players.

Further, during the main game, cards are only described in very short terms, with additional information only available in the encyclopedia. While this makes the game easy to read and messages very concrete, showing a short snippet of the encyclopedia information as a hover text could provide a bit more information and encourage further reading on specific ideas, such as 'lifestyle changes'.

C. Bear & Breakfast

Bear & Breakfast is a hotel manager with adventure elements. In form of a bear, the player finds and renovates run-down houses to turn them into bed & breakfasts to bring back humans to an area they have left due to a large wildfire.

Bear & Breakfast primarily uses environmental themes as backdrop for a management simulation. It does not mention the climate or biodiversity crisis directly but, since an increase in wildfire risks is directly linked to global heating [1], there is at least an indirect link to climate themes.

In addition to its story, it is driven by chats between the main character and animals as well as a few remaining humans in the region. Often, characters will note on humanity's destructive behavior and especially environmental pollution.

The game works a lot with rewards, as collected trash is a currency for items the player needs or wants. On one hand, this communicates positive change, as it encourages collecting trash. As such, the shop that rewards players with items is a good example of direct positive feedback to positive behavior. On the other hand, the game normalizes pollution by humans as a constant. Some characters in the game even celebrate their return because they are looking forward to the new waste.

Because of this, the game may actually train the player to hope for more wasteful guests instead of a cleaner environment as they need the trash income. As such, *Bear & Breakfast* seems very inconsistent in its messaging and does not create a vision where (human) society stops its wasteful behavior.

A possible solution could have been to enable players to build trash cans and show how guests start using those. This would make the player's life easier as they would not have to clean up anymore, creating a steady 'income' in fixed locations while also showing a positive impact on the environment, i.e., less trash in the area. The game also features a landfill. So, another option would have been to have the player find a lot of trash in the wilds in the beginning, but, once they have cleaned the environment, limit new trash to a dedicated area instead of any place where humans roam.

Regarding food consumption, *Bear & Breakfast* is the most direct of the three selected games. Here, players have to cook for their guests. To do so, they can learn nearly 60 recipes, all of which are either vegan or vegetarian. While the game does not highlight the relative advantage of these recipes for the environment, it normalizes non-meat option as the default.

To further improve on this, the vegan recipes, as the, in general, more sustainable option, could have been used more often for higher grade dishes. However, due to the way the game is balanced, players have to invest extra resources for livestock products, thus it makes sense that they are rewarded with higher grade recipes, creating more satisfaction for the player's guests.

Highlighting vegetarian and vegan food is an important message that can be directly translated into real-life action by the players. *Bear & Breakfast* does not feature a social

component, but, for example, a social media cooking challenge or even a cookbook for fans could be a good option to further support this message and the marketing of the game.

IV. CONCLUSION AND FUTURE WORK

All three assessed games show design principles that could strengthen the impact of future climate-themed games aiming to influence food consumption behavior – as well as design choices to be wary of:

Good design, narrative, or characters can strengthen the enjoyment and empathy players experience (*Gibbon, Bear & Breakfast*), especially if combined with gameplay features that create experiential connections like *Gibbon'* movement changes as a result of environmental destruction. Furthermore, narratives can give context to simulation features that may otherwise be detached from the real-world impacts they represent, as can happen in *Beecarbonize*.

Involving experts can strengthen an environmental message, give it credibility, and enable direct follow-up connections and additonal information (*Beecarbonize, Gibbon*). To fully utilize this, call-to-actions and links to the experts should be clear, strong and without barriers.

Keeping messages in the main game concrete and gameplay-focused while offering optional information in an encyclopedia satisfies curious players without overwhelming others who want to focus on the core loop (*Beecarbonize, Gibbon*). However, if the information is hidden this way, the feature should be actively introduced and reinforced, for example, through specific challenges or pop-ups (*Gibbon*).

Sustainability messages, like the normalization of plant-based cooking, can be embedded into a game even without a direct connection to an environmental message (*Bear & Breakfast*). At the same time, messages regarding player behavior and societal support as well as depicted visions for a more sustainable future should align (*Bear & Breakfast*).

Using increasing difficulty, rewards, or leaderboards can foster repeated exposition to the game message and communicate new sub-aspects, like new cards in *Beecarbonize*. However, if leaderboards or other features are only weakly linked to the core message, their replayability may not benefit the game's impact (*Gibbon*). Thus, replayability features should target the main story or mode, for example through branching stories, different win conditions, higher challenges, or embedded scores (*Beecarbonize*).

These fundamental concepts can guide the development of features or games linking the polycrisis and the food sector. In a next step, such new features and games should be investigated for their short and long term impact on user knowledge and behavior.

REFERENCES

[1] IPCC, "Summary for Policymakers," in Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, 1st ed., Cambridge University Press, 2022. doi: 10.1017/9781009325844.

[2] IPBES, "Summary for policymakers of the global assessment report on biodiversity and ecosystem services," IPBES, Nov. 2019. doi: 10.5281/ZENODO.3553579.

[3] P. Søgaard Jørgensen et al., "Evolution of the polycrisis: Anthropocene traps that challenge global sustainability," Phil. Trans. R. Soc. B, vol. 379, no. 1893, p. 20220261, Jan. 2024, doi: 10.1098/rstb.2022.0261.

[4] WMO, State of the Global Climate 2023. Geneva: WMO, 2024. Available: https://library.wmo.int/idurl/4/68835

[5] IPCC, "Summary for Policymakers," in Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, 1st ed., Cambridge, UK and New York, NY, USA: Cambridge University Press, 2022, pp. 3–48. doi: 10.1017/9781009157926.001.

[6] IPCC, Climate Change and Land: IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems, 1st ed. Cambridge University Press, 2019. doi: 10.1017/9781009157988.

[7] S. Frank et al., "Agricultural non-CO2 emission reduction potential in the context of the 1.5 °C target," Nature Clim Change, vol. 9, no. 1, pp. 66–72, Jan. 2019, doi: 10.1038/s41558-018-0358-8.

[8] F. Humpenöder, B. L. Bodirsky, I. Weindl, H. Lotze-Campen, T. Linder, and A. Popp, "Projected environmental benefits of replacing beef with microbial protein," Nature, vol. 605, no. 7908, Art. no. 7908, May 2022, doi: 10.1038/s41586-022-04629-w.

[9] W. Willett et al., "Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems," The Lancet, vol. 393, no. 10170, pp. 447–492, Feb. 2019, doi: 10.1016/S0140-6736(18)31788-4.

[10] FABLE, "Pathways to Sustainable Land-Use and Food Systems. 2020 Report of the FABLE Consortium," 2020, doi: 10.22022/ESM/12-2020.16896.

[11] Z. Sun et al., "Dietary change in high-income nations alone can lead to substantial double climate dividend," Nat Food, vol. 3, no. 1, pp. 29–37, Jan. 2022, doi: 10.1038/s43016-021-00431-5.

[12] F. Humpenöder et al., "Food matters: Dietary shifts increase the feasibility of 1.5°C pathways in line with the Paris Agreement," Sci. Adv., vol. 10, no. 13, p. eadj3832, Mar. 2024, doi: 10.1126/sciadv.adj3832.

[13] R. Grundmann, "Climate change as a wicked social problem," Nature Geosci, vol. 9, no. 8, pp. 562–563, Aug. 2016, doi: 10.1038/ngeo2780.

[14] B. W. Head, "Evidence, Uncertainty, and Wicked Problems in Climate Change Decision Making in Australia," Environ Plann C Gov Policy, vol. 32, no. 4, pp. 663–679, Aug. 2014, doi: 10.1068/c1240.

[15] T. Ouariachi, M. D. Olvera-Lobo, J. Gutiérrez-Pérez, and E. Maibach, "A framework for climate change engagement through video games," Environmental Education Research, vol. 25, no. 5, pp. 701–716, May 2019, doi: 10.1080/13504622.2018.1545156.

[16] B. D. Douglas and M. Brauer, "Gamification to prevent climate change: a review of games and apps for sustainability," Current Opinion in Psychology, vol. 42, pp. 89–94, Dec. 2021, doi: 10.1016/j.copsyc.2021.04.008.

[17] D. Fernández Galeote and J. Hamari, "Game-based Climate Change Engagement: Analyzing the Potential of Entertainment and Serious Games," Proc. ACM Hum.-Comput. Interact., vol. 5, no. CHI PLAY, pp. 226:1–226:21, Oct. 2021, doi: 10.1145/3474653.

[18] J. Steinhauser and D. Vollgruber, "Climate Survivors: A Bullet Heaven for Enhanced Climate Engagement," 2024 IEEE Gaming, Entertainment, and Media Conference (GEM), pp. 1-6, 2024. doi: 10.1109/GEM61861.2024.10585396.

[19] I. Lorenzoni, S. Nicholson-Cole, and L. Whitmarsh, "Barriers perceived to engaging with climate change among the UK public and their policy implications," Global Environmental Change, vol. 17, no. 3–4, pp. 445–459, Aug. 2007, doi: 10.1016/j.gloenvcha.2007.01.004.

[20] IGDA Climate SIG, "Games Database V1." Accessed: Apr. 22, 2024. [Online]. Available: https://docs.google.com/spreadsheets/d/1qdGB8W5FOUQKS_hlhHSInHqFZX75Ok2VXk-rURVFHBA

[21] IGDA Climate SIG, "Greener games for game developers." Accessed: Apr. 22, 2024. [Online]. Available: https://www.greengamedesign.com/?tool=games

[22] Charles Games, Beecarbonize. 2023. Accessed: Apr. 22, 2024. [Video game]. Available: https://charlesgames.net/beecarbonize/

[23] Broken Rules, Gibbon: Beyond the Trees. 2022. Accessed: Apr. 22, 2024. [Video game]. Available: https://www.gibbongame.com/

[24] Gummy Cat, Bear and Breakfast. 2022. Accessed: Apr. 22, 2024. [Video game]. Available: https://www.bear.game/.