A Collaborative Adaptation Game for Promoting Climate Action: **Minions of Disruptions™:**

Minja Sillanpää[1], AnaCapri Mauro[1], Minttu Hänninen[1], Sam Illingworth[2], Mo Hamza[3]

[1]Day of Adaptation, Haarlem, 2011 EP, the Netherlands
[2]Department of Learning and Teaching Enhancement, Edinburgh Napier University, Edinburgh, EH11 4BN, Scotland
[3]Division of Risk Management and Societal Safety, Lund University, Lund, 221 00, Sweden

Correspondence to: Mo Hamza (mo.hamza@risk.lth.se)

Abstract. With the onset of climate change, adaptive action must occur at all scales, including locally, placing increasing responsibility on the public. Effective communication strategies are essential, and adaptation games have shown potential in fostering social learning and bridging the knowledge-action gap. However, few research efforts so far give voice to participants engaging with collaborative games in organisational and community settings. This paper presents a novel approach to studying designer-participant interactions in adaptation games, diverging from traditional learning-focused frameworks. Specifically, it examines Minions of Disruptions™, a collaborative tabletop board game, through the lens of how participant perception aligns with the game's design intentions as described by the game designers and facilitators. Through focus group interviews with designers and facilitators, ten core design intentions were identified and compared with responses from post-game surveys of participants from 2019-2022. Key insights reveal that collaboration and team-building are highly effective frames for climate adaptation. However, some design elements, such as time pressure, can hinder discussion, suggesting a need to balance objectives. The method adopted manages to avoid traditional expert-to-public analysis structures, and places emphasis on the importance of iterative design based on participant insights. This approach provides valuable guidance for future adaptation game designs, demonstrating that games can effectively engage diverse groups and support local adaptation efforts by creating a sense of belonging and collective purpose.

1 Introduction

The impacts of climate change are intensifying, manifesting in extreme weather events that are becoming a norm rather than an anomaly (Seneviratne et al., 2021). The increasingly detrimental impacts on people's lives and livelihoods transform climate adaptation from a worst-case scenario to a reality that requires significant investments of resources at all levels: from government-led to individual household-level action (Noll et al., 2022). While adaptation has regionally and sectorally specific hard limits beyond which any adaptive action becomes impossible, concerted action can influence its soft limits, such as through lowering human system-related barriers, including limited financial resources. Today most reported adaptation actions are happening on the individual and household levels (Berrang-Ford et al., 2021) and many adaptation solutions and trade-offs are best discovered and implemented locally (Moser and Pike, 2015). Therefore, successful society-wide adaptation is currently

31 dependent on increasing local climate awareness (Illingworth and Wake, 2019) and capacity to make informed choices among

32 those who are neither scientists nor policymakers (Whitmarsh et al., 2013).

33 Prior instances of communicating adaptation to heterogeneous audiences has not resulted in the desired levels of public

34 engagement and commitment (Whitmarsh et al., 2013; Ouariachi et al., 2017). Communication strategies tend to build around

35 an information-deficit model, namely, the assumption that attitude and behaviour change is positively related to an increase in

36 information about a topic; even if the effectiveness of this approach is increasingly questioned in engaging non-scientist

37 audiences (Illingworth and Wake, 2019; Andersson et al., 2019; Badullovich et al., 2020). A so-called knowledge-action gap

38 is used to describe a situation where the audience has the appropriate level of information, yet no adaptive behaviour emerges

39 (Flood et al., 2018). Previous studies have found that a focus on the quantity of information may omit important considerations

40 if unidirectionality renders the audience passive (Illingworth and Wake, 2019; Ouariachi et al., 2017; Parker et al., 2016;

41 Illingworth and Jack, 2018); if jargon forms a barrier to comprehension (Illingworth and Wake, 2019); and if negative frames

42 lead the audience to apathy by triggering feelings of overwhelm and hopelessness (Ouariachi et al., 2017; Moser, 2016). Hence,

43 to bridge the gap, there is a call for more dialogical approaches to address the needs of diverse audiences (Illingworth and

44 Wake, 2019; Illingworth, 2020; Kumpu, 2022).

45 The attention toward climate adaptation games has increased substantially in the last decade (Flood et al., 2018). There is

46 increasing evidence pointing at the ability of games to address a wider range of audiences (Illingworth and Wake, 2019;

47 Ouariachi et al., 2017; Parker et al., 2016), and enable social learning (Ouariachi et al., 2017; Flood et al., 2018; Den Haan and

48 Van der Voort, 2018; Rumore et al., 2016). The field is still emerging, with several questions remaining unanswered, including

49 how to make the game messages fit for audiences with non-science and non-policy backgrounds (Parker et al., 2016; Galeote

50 et al., 2021; Neset et al., 2020).

51 This paper brings new insights into this topic by introducing a case study: an analogue and collaborative tabletop game,

52 Minions of Disruptions™ (MoD). The game, developed by a Dutch non-profit organisation Day of Adaptation in 2019, has an

53 explicit objective to engage diverse organisations and communities in collective climate adaptation, regardless of their prior

54 affiliation with climate change. Researchers conducted a focus group exercise with game designers and facilitators to determine

55 the intentions behind the design of MoD, and contrasted this information with participants' post-game survey responses, in a

56 new method to study the designer-participant interaction in adaptation games. This method sought to avoid replicating expert-

57 to-public communication structures by including the whole experience, not just participants as objects of study, as a part of the

58 analysis (Illingworth, 2020).

59 This article addresses the overarching question of what guidelines should be taken into consideration when designing analogue

60 climate adaptation games for the general public. It is further explored in three specific sub-questions regarding the intentions

61 behind the game design of MoD according to the designers and game facilitators, the extent to which the design intentions

62 behind MoD are perceived by the game participants, and how the reception of the design intentions by the game participants

63 align with the original objectives of the game.

64 This article is structured as follows:

2

2 Background: climate adaptation games

Generally, climate games can be thought to have three kinds of objectives: (1) increasing awareness of climate challenges; (2) increasing general knowledge, familiarity, and understanding; and (3) encouraging solution-finding and action-taking (Reckien and Eisenack, 2013). Additionally, adaptation games have a broad topical range including resource and environmental management, farming, coastal development, supply chain logistics and transport, disaster preparedness and response, food security, global impacts and change, policy, and climate services (Flood et al., 2018).

Flood et al. (2018) argue that even though the field is emerging, games are proving to be powerful communication tools, helping to realise climate change adaptation faster than with other existing means. They are additionally proposed as a way to address the aforementioned knowledge-action gap (Flood et al., 2018; Ouariachi et al., 2020). Adaptation and climate games succeed in not only creating cognitive, but also normative and relational learning (Flood et al., 2018; Den Haan and Van der Voort, 2018; Rooney-Varga et al., 2020). The reason for their effectiveness is understood to be a consequence of the way games package and deliver information: they are often narrative-based (Flood et al., 2018), more memorable (Parker et al., 2016; Ouariachi et al., 2017), able to capture and explain complexity (Parker et al., 2016; Flood et al., 2018; Den Haan and Van der Voort, 2018), and relatable, as they make use of familiar and locally relevant themes (Parker et al., 2016; Rumore et al., 2016; Galeote et al., 2021; Mitgutsch and Alvarado, 2012; Rodela et al., 2019; Nussbaum et al., 2015). The style of participation is also different because it invites the participants to assume roles and makes information reception more active (Parker et al., 2016; Flood et al., 2018; Galeote et al., 2021; Fjællingsdal and Klöckner, 2020). The participants get the opportunity to explore real-time hypothetical scenarios, which can help make connections between action and impact (Flood et al., 2018; Fjællingsdal and Klöckner, 2020).

From the perspective of local level adaptation, multiplayer collaborative games are a particularly interesting avenue because they provide the possibility for relational learning, which includes gaining a better understanding of others' mindsets and increasing trust and the ability to cooperate (Den Haan and Van der Voort, 2018). Moreover, social simulations can enhance affective learning paths, namely, associating emotions such as concern, importance, and outrage with climate change (Rooney-

Varga et al., 2020). If designed as a dialogical tool, games can help share and co-produce local knowledge (Flood et al., 2018; Den Haan and Van der Voort, 2018) and create an out-of-the-ordinary space for conversation (Flood et al., 2018; Rumore et al., 2016; Fjællingsdal and Klöckner, 2020) with fewer knowledge hierarchies (Illingworth and Wake, 2019; Illingworth, 2020; Rodela et al., 2019). Enabling such conversations is key in increasing normative reflexivity at the group level, which could change or facilitate internal decision-making (Flood et al., 2018; Rumore et al., 2016; Rodela et al., 2019). Games have also been seen to increase the perceived importance of cooperation, empathy, and respect toward other perspectives (Rumore et al., 2016; Galeote et al., 2021; Rodela et al., 2019; Abspoel et al., 2021), augment feelings of trust and ownership (Flood et al., 2018; Ouariachi et al., 2020), and even solve conflicts (Medema et al., 2016). Additionally, they may increase optimism about the effectiveness of local cooperation (Rumore et al., 2016; Galeote et al., 2021; Ouariachi et al., 2020).

While there is much traction around games, research gaps remain. Few climate games known to research propose collective-level solutions, create dialogue, focus on affective learning, or aim at achieving direct impact (Gerber et al., 2021). On the other hand, games enhancing cognitive learning are the highest represented in research, whereas normative and relational learning are rarely addressed (Den Haan and Van der Voort, 2018). Furthermore, games can fail to reach the objectives set for them: they sometimes narrate roles that the participants do not identify with (Galeote et al., 2021), fail to form linkages with real-life (Fjællingsdal and Klöckner, 2020), are not relevant (Lankford and Craven, 2020), or overwhelm participants with information, curtailing dialogue (Illingworth, 2020). There is an additional degree of ambiguity about the optimal medium: some studies question the effectiveness of digital games (Boomsma et al., 2018), whereas others find that, for example, video games deliver best results (Olivares-Rodríguez et al., 2022).

There are different climate game designs to address diverse target audiences, such as students, policymakers, professionals, or the general public (Gerber et al., 2021). The "general public" in particular is often loosely defined, but here it is understood as a group that engages little with climate change in their day-to-day; they do not have a science background, nor do they work with the topic professionally. This group tends to be the least represented in climate game reviews (Parker et al., 2016; Galeote et al., 2021; Neset et al., 2020), and generally in science engagement strategies (Illingworth and Jack, 2018). Gaining a better understanding of this interaction can help explain why the participants cannot always relate to the game content, or what kind of information might overwhelm them. The public may have an attitude, cognitive style, or mode of learning that diverges significantly from that of the communicators and of each other, and therefore presents a particularly important dimension of study. Exploring this topic might, therefore, give answers as to what contributes to gaps between knowledge and action, and how they could be bridged.

Effective climate communication requires that the audience(s) is determined and well-known in advance (Illingworth and Wake, 2019) and that their needs are understood (Ouariachi et al., 2017; Flood et al., 2018; Monroe et al., 2019). Therefore, it is proposed that this study enhances the game field through deepening the understanding about the needs of the audience and capturing their interaction with the game and the communicators. Designers play a key role in the outcome of the game, as they ultimately decide what information gets communicated via the game and in what way, thereby dictating what success looks like (Fjællingsdal and Klöckner, 2020). Scientific articles on climate games tend to focus on measuring the participant

131 experience pre-, post-, and post-post game events (Flood et al., 2018; Den Haan and Van der Voort, 2018) and by doing so

132 somewhat omit this relationship. In the interest of understanding how games could help realise rapid local-level adaptation,

133 design and engagement guidelines are needed to inform future designs and game iterations.

134 **3 Method**

135 **3.1 Minions of Disruptions™**

136 This research paper studies a collaborative and analogue tabletop game, Minions of Disruptions™ (MoD), created in 2019 by

137 a Dutch non-profit organisation, Day of Adaptation (https://dayad.org/). The organisation explores and innovates on climate

138 communication, targeting specifically groups that tend to be left out of the conversation. "Game Day," a facilitated gameplay

139 experience, is one of its communication tools. The game can be played by anyone, as there is no strictly defined target audience.

140 However, there is a general player typology: players are predominantly adults of various ages or university students,

141 representatives of the same or somehow affiliated communities and organisations, and most of the participants are not climate

142 professionals nor students of climate sciences. All groups enjoy the privilege of time to dedicate for such an activity, the costs

143 of which are covered by their employer or administration.

144 The data used in this study were collected by Day of Adaptation for monitoring and evaluation purposes (see Table 1 for an

145 overview). There are both online and in-person versions of the same game activity with an even split between events organised

146 in the Netherlands versus other countries. The range of organisation type is broad, and while the survey did not systematically

147 measure the general level of climate knowledge or the level of gaming experience of the participants, anecdotally it can be

148 said that it varies both between events and within groups. For instance, sometimes a Game Day might be organised by an

149 employee who is part of a sustainability committee at the workplace. This individual is bound to have a different level of

150 background knowledge in comparison with their colleagues. An average player is aware of the basics of climate change,

151 however, not necessarily familiar with its causes and consequences. Some groups or individuals might be taking some

152 collective climate action already, whilst others are only getting started, and hope to use the event to kickstart and get their team

153 or organisation engaged and involved.

154 **Table 1. The dataset used in this study, comprising 18 Game Days that took place between 2019 and 2022.**

ID	Date (y-m-d)	Organisation type	Country	Game Version	Participants	Surveyed Participants	Survey Participation (% of Participants)	Sample Distribution (% of total surveyed)
1	2019-12-02	University	Netherlands	In-person	25	19	76	13.57
2	2020-04-16	Activist Group	Netherlands	Online	3	2	66.7	1.43
3	2020-06-28	Association	Netherlands	In-person	5	4	80	2.86

4	2020-08-19	Bank	Netherlands	In-person	12	2	16.7	1.43
5	2021-01-24	Community of Climate Professionals	Netherlands	Online	60	14	23.3	10.00
6	2021-04-05	Activist Group	Chile	Online	4	3	75	2.14
7	2021-04-23	Non-profit Organisation	Germany	Online	9	6	66.7	4.29
8	2021-04-26	University	Philippines	Online	20	20	100	14.29
9	2021-04-28	Social Movement	UK	Online	8	5	62.5	3.57
10	2021-05-06	Non-governmental Organisation	Netherlands	Online	7	1	14.3	0.71
11	2021-05-12	University	Mexico	Online	13	10	76.9	7.14
12	2021-09-03	University	Netherlands	In-person	33	1	3.0	0.71
13	2021-09-03	Cross-regional government mandated body	Netherlands	In-person	19	16	84.2	11.43
14	2021-10-01	University	Netherlands	Online	35	1	2.9	0.71
15	2021-10-30	Development Institution	Saint Vincent	Online	9	6	66.7	4.29
16	2021-12-08	University	Sweden	In-person	25	10	40.0	7.14
17	2022-05-24	Private Company	Australia	Online	10	5	50.0	3.57
18	2022-05-25	Private Company	Australia	Online	24	15	62.5	10.71
	Total				**321**	**140**		**≅100**

3.1.1 The gameplay

The standard format for a session is a three-hour game activity, which can take place either in person or online. In-person events use physical versions of the game, while online events utilise an online conferencing software and Tabletopia. Tabletopia is a digital sandbox system for playing board games with no AI to enforce the rules, which allows for the game pieces to be manipulated by the players as they please, creating a life-like board game situation. Because the online version provides no feedback or automation, the in-person and online experiences are comparable for the purposes of this study.

Groups opt to play either a community or organisation version of MoD (see Fig. 1 for an example board). While the basic rules of the game are the same regardless of the version, the content is somewhat adjusted: the community version focuses on services such as housing, and the organisation version on operational functions. Sometimes the game content is even further adjusted, if requested by the community/organisation during the planning phase.

All events begin with splitting the group into teams of 3-4 people, each with their own board. The teams are given the basic rules of the game after which they learn the game experientially. All teams have the same goal: to implement climate actions

strategically and collaboratively in a game world where increasing carbon levels in the atmosphere increasingly slow them down and inflict continuous disruptions. Players move around the board pathways trying to remove tokens that represent vulnerability to the different sectors, while trying to protect and increase the resilience of these critical services to future climate disruption. The tokens signifying disruptions are removed by using the team's mutual funds for climate action (both mitigation and adaptation related), however the team needs to act fast because the disruptions increase exponentially. Different cards drawn by each player during their turn and sound effects played by the facilitator can alter the gameplay in either helpful or hindering ways. The team also needs to balance financial costs and can negotiate with other teams to move forward faster. Occasionally they are invited to share real-life knowledge and experiences, which have an impact on their gameplay. A team wins the game by protecting five of their organisation/community's essential sectors against disruptions, indicating climate resilience.

Gameplay takes 60-90 minutes, with the remaining time used for a brief warm-up and facilitated debrief. Depending on the participants' wishes the facilitators may include supporting team-building activities, and introduction of basic terminology (e.g., mitigation, adaptation). The debrief is structured into three parts. The first part focuses on a review of the game experience, including discussions of how realistic the game felt and how the teams interacted. The second part connects the game play to reality, including what climate change looks like for the organisation/community in question. The third part brings the discussion home to climate action and allows participants to discuss how they will take the Game Day experience back into their lives, including the barriers to action they may encounter and how to mitigate these real-life disruptions. This structure aligns more closely with the view of generating knowledge through action rather than trying to impart knowledge first and then expecting participants to transform this into action via the game (Crookall and Thorngate, 2009). The goal being that action in the game translates to knowledge and learning, and then into real-life action.
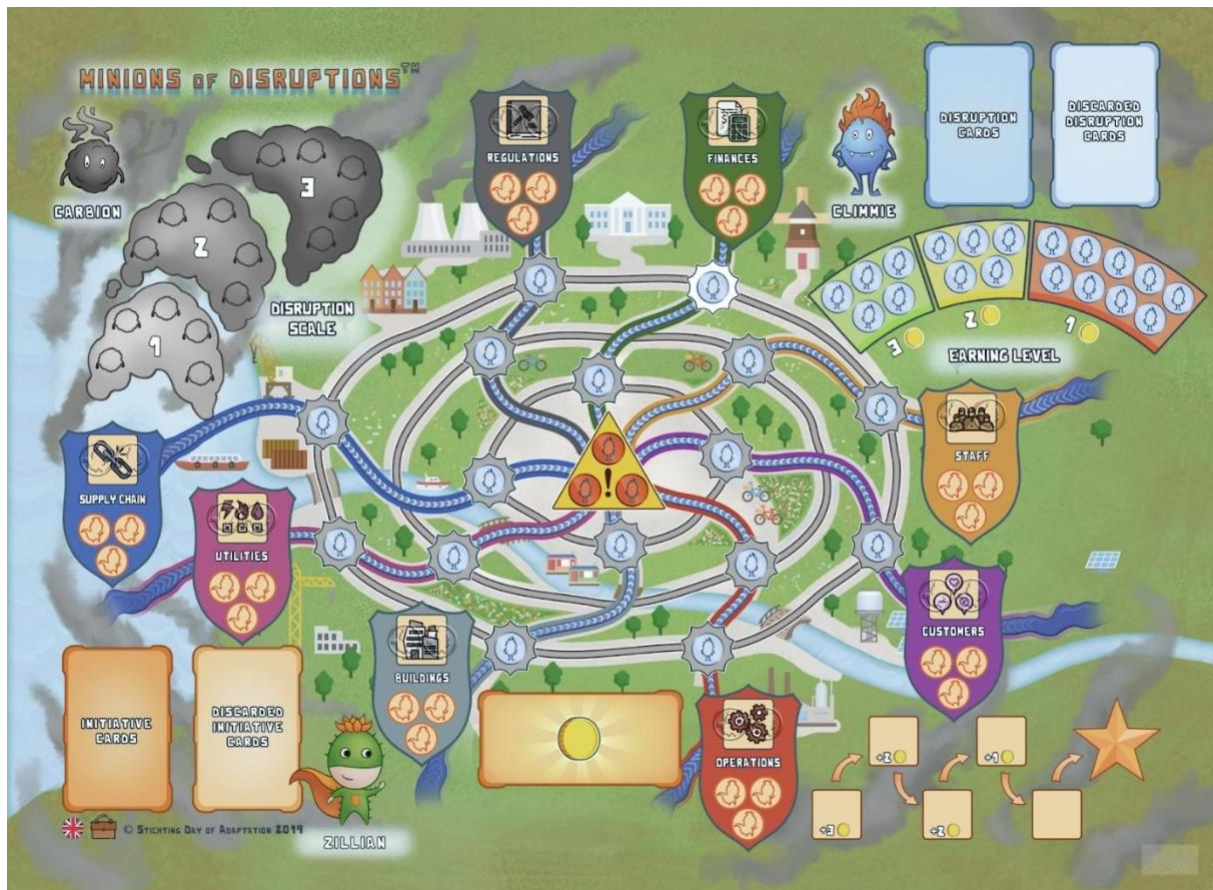
Figure 1. The visual layout of the MoD game board, which models climate disruptions in an organisation. The operational functions, or "shields", include operations, customers, staff, finances, regulations, supply chain, utilities, and buildings.

3.2 Methods and datasets

. This paper adopts a novel approach that combines data from game designers and facilitators with data collected from game participants. Unlike some participant experience focused -methods, which commonly evaluate games by observing gameplay or analysing participant surveys only (Flood et al., 2018; Den Haan and Van der Voort, 2018), the purpose of this method is to assess games as transitional objects, which may or may not succeed in conveying what the designers and facilitators of the game intended. In other words, this method forms a connection between design intent and how the gaming experience is perceived by participants by not only asking how the participants behaved, and what they perceived, but also what the original intention of the designers and facilitators was.

The reason for adopting such an approach over the more common participant observation is to address what has been found by others previously, namely, that intention-based designs should be analysed and understood in relation to their purpose (Neset et al., 2020). While this remains true, there are important factors that get omitted if it is taken for granted that the

8

designed purpose is fixed and unaffected by those who play the game. As previously found, there are confounding factors that mislead findings when measuring for social learning from games, for example, preheld notions of the game or gaming in general, the agency of the facilitators, and prior in-group relations (Den Haan and Van der Voort, 2018). In actuality, the participants construct their own experience, which may or may not stand in congruence with the intentions of the designers. Therefore, a game design may lead to emergent qualities. This method aims to capture such qualities, which may be unknowingly omitted when focusing on participant experience only. By first addressing a designer perspective followed by a participant perspective, a journey from a design intention to a lived participant experience is constructed, which allows one to study the contrasts between the two. For the purposes of this study, this approach remains qualitative due to the subjective and narrative nature of the data and the lack of strict uniformity of the game events. The conclusions drawn through this approach contribute to a validated foundation off which future quantitative studies could be built.

3.2.1 The designer perspective

A 1.5-hour online focus group interview was organised in April 2022 with three game designers/facilitators and two facilitators from Day of Adaptation. Eight participants in total were invited to take part, but three were unable to attend. This sample represents the majority of the designers, and at the time of the study, approximately a third of the active facilitators. The researchers set up the focus group with the objective of capturing *design intentions*, meaning, what kind of messages the designers and facilitators wanted to convey to the audience and what kind of elements they designed to fulfil this objective (e.g., tangible game pieces, rules, etc.). The participants were informed about the purpose of the focus group prior to and during the data collection, and they all consented to being featured in this research.

The session was managed with Zoom and Miroboard-platforms. As a warm-up, the participants took turns listing what different game elements they could remember, adding to each other's knowledge. In the second part, these game elements were momentarily set aside, and the participants were asked to reflect on high-level design intentions of the game and what core ideas it aims to address. In the third part, the game elements were reintroduced and the participants were asked to connect and cluster them with the design intentions.

Focus group as a method of data collection is often used when interviewees have a history of working together, when it is assumed that benefits can arise from immediate cross-checking of statements on a group-level, and when researchers wish to generate representative data whilst being mindful of participants' and their own time constraints (Creswell, 2013). In this case, most focus group participants and all designers had worked together previously. Given that three years had passed since the creation of the game, and two of the participants have not been involved with Day of Adaptation since, the focus group was intended to serve as a way to have an agreeable re-encounter, to help refresh memories, and bring about consensus-based answers to the interview questions.

This method has its pros and its cons. For the pros, it poses less pressure on a single participant and, therefore, given participants' busy schedules, it was considered the best option. Additionally, the organisers aimed to make the experience as stress-free as possible so, in addition to the researcher in charge of leading and directing discussion, two co-organisers joined

the session to manage the technical side and to note observations. No technical difficulties emerged, however, in the case they would have, the session would have been temporarily paused or postponed to ensure good quality discussion. The participants could, thus, simply focus on thinking, commenting, and answering questions, which helped to make the best use of their time and generate a great quantity of data in a short amount of time. Another benefit of the method was that there was no need to cross-check answers as that could be done in real time during the focus group.

For the cons, a focus group, as any group situation, is bound to follow pre-established group logics and power dynamics, which may influence which data are generated or excluded by the group. Moreover, such a form of interaction may not suit all personality types, and can favour individuals who are more inclined to speak in a group setting. Further, with small group sizes and self-reporting, there is the potential for biases such as social desirability bias, in addition to memory recall errors and reliance on subjective interpretations of individual experiences. In order to mitigate issues related to memory, the participants first got time to inspect the game board to trigger their visual recollection. The researchers aimed to enable such a space through specific design choices: in most cases participants were asked to answer in randomised turns, instead of giving an open floor, and they were also directly asked to comment on each other's contributions. Furthermore, both the designers and game facilitators were included in the same session. This allowed the game facilitators to pose questions to the designers, which could help challenge the internal dynamic of the designer group.

3.2.2 The participant perspective

The audience perspective is taken from a standardised post-game survey that all game participants were asked to fill out at the end of their group's Game Day (see Appendix A for a list of the survey questions). This survey is designed to collect monitoring and evaluation data for Day of Adaptation and was not originally intended to be used for research as such. The organisation gave consent to analysing these data, and the researchers received it anonymised so that only the organisation names and some basic demographic data were retrievable. The survey participants have not given their explicit consent for this research, but their participation in the original post-game survey was voluntary and they could opt-out from any question. To protect the integrity of the participants, demographic data are only treated on a general level so that it cannot be connected to any organisation or individuals. The age of participants spans from 18 to 65+, with an average age of 32 years. More than 60 percent of the participants identify as female, 36 percent as male, and 2 percent as non-binary. The participants represent a wide variety of organisations (see Table 1 for the breakdown of organisations included in the analysis). Anecdotally it can be said that apart from the student groups, the groups are teams that work together directly or under the same organisation, representative of a variety of job levels.

Previous survey research on games has found that not only is it a quick and inexpensive method to measure immediate impact, but it can also be considered robust insofar as the data are representative of a great number of game events (Flood et al., 2018). In total there are 140 survey answers from 18 game activities, played between 2019-2022, including both the online and in-person versions of the game. The survey consists of multiple choice and open field questions, but only the latter was included

10

269   in this study, as it was considered better suited to answer the research questions of this paper. This means that no connection
270   is drawn between sample demographics and the answers, but the focus is on the general participant level. Comparing and
271   contrasting between types of groups and institutions would add depth to our understanding of tailored climate communication.
272   This is excluded from the scope of this research, however, given that the researchers deal with third-party data in the selection
273   of which they had no part to play, nor did they receive sufficient background information on the profiles of the participants. It
274   was, therefore, deemed that generalisations on groups would be untenable.

275   **3.3 The analysis**

276   The analysis consisted of two steps. In the first step, the data collected during the focus group inquiry were processed; the
277   recording was transcribed, and participants were anonymised. During the focus group, the participants agreed in consensus
278   upon ten design objectives and related them to game design elements. While engaging in dialogue, their answers were
279   simultaneously modelled on a Miroboard by the organisers. The participants could immediately react to the accuracy of the
280   visual representation via screen-sharing. To ensure that all of the expressed ideas were correctly interpreted after the focus
281   group, the transcription and the language used by the participants was contrasted with the visual representation. The
282   transcription was prioritised in order to capture ideas that might have been omitted during the interpretation process.

283   The second step of the analysis mapped out how game participants perceived the game as a transitional object conveying the
284   ten design intentions. Once the ten design intentions were established, two researchers conducted independent Excel analyses
285   that coded the open-field questions of the post-game survey for all participants, both into the design intention categories and
286   then for positive (1), negative (-1), or neutral (0) alignment with the design intentions. These scores were then averaged to
287   determine an "alignment score" for each design intention. Statements were permitted to have no more than two design intention
288   categorisations as an analytical boundary imposed by the researchers. It is recognised that this may lead to a simplified version
289   of reality.

290   The aim was to connect entries with evidence for and against the fulfilment of a design objective. The two independent analyses
291   were compared and negotiated between the researchers to arrive at a mutually agreed upon categorisation. This information is
292   discussed both for the whole sample as well as divided based on how the game was presented, either online or in-person, to
293   demonstrate the general reception of the game as well as to observe any potential variance based on experience. Individual
294   groups were not analysed on their own due to wide variation in the number of respondents per session. While this approach
295   could potentially lead to one group's poor experience skewing the analysis, it was determined to be acceptable because of the
296   consistency observed in the data between groups.

4 Results

4.1 The design intent

The focus group participants elaborated on ten design intentions that they aimed to achieve with the game, as well as various design elements included to achieve the intentions. The design elements have been categorised in line with an applied framework combining typologies from Gerber et al. (Gerber et al., 2021), Lankford and Craven (Lankford and Craven, 2020) and Razali et al. (Razali et al., 2022) and are elaborated upon in appendix B. The following ten design intentions, in alphabetical order, were agreed upon by the focus group participants:

1. **Adaptive Action:** Addressing climate action both from mitigative and adaptive perspectives.
2. **Climate Science:** Increasing awareness of basic climate change elements in daily lives, as well as the anthropogenic cause-and-effect of climate change.
3. **Collaboration:** Addressing both individual and collective action but taking the organisation/community as the starting point.
4. **Language:** Communicating with simple language so that the game is accessible for a wider audience with varying education levels and interest.
5. **Moderation:** Autonomous gameplay with minimal moderation to emphasise the agency of the team.
6. **Organisational Relations:** Increasing understanding of the complexity of connectivity and interaction of essential services and functions of organisations and communities in an era of climate change.
7. **Psychological Resilience:** Triggering reflections within participants on adjusting to a new climate and its consequences.
8. **Relatability:** Being relatable through incorporating relevant current events, research, and unique examples from participants' lives.
9. **Setting:** Creating a fun and welcoming space to inspire and increase motivation to act through a positive solution-frame.
10. **Team-building:** Increasing intra-organisational conversations despite existing hierarchies; learning to collaborate and enhancing team-building to build bridges and synergies that can help with action-taking.
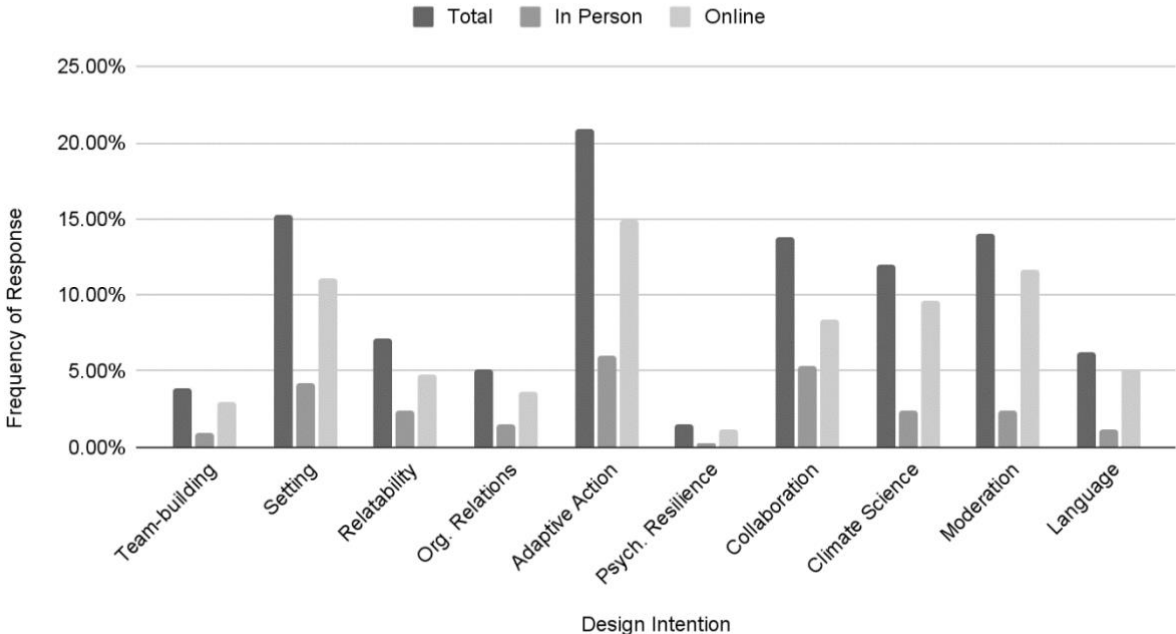
4.2 The participant experience

The ten game design intentions identified by the focus group participants created a framework through which to measure the impact of the game. All open-field responses of the post-game survey were coded into these intention categories. One hundred and forty participants responded to the survey, with 52 respondents from in-person Game Day events and 88 from online events. Not all participants answered every question, and 115 statements were omitted from the analysis due to ambiguity. Sixty-nine statements fell into two different design intention categories and were therefore counted twice. In total, 265 unique responses were included in this analysis, combined with the 69 responses falling into two categories for a total of 334

statements to be categorised (89 in-person and 244 online). Raw participant and statement numbers can be found in Appendix

331   C.

332

All design intentions were represented in the survey responses, though with varying frequency. *Adaptive Action* was the most represented design intention (20.96% of total), while *Psychological Resilience* was the least represented as a percentage of the total responses (1.5%) (Fig. 2). Following *Adaptive Action* were *Setting* (15.27%), *Moderation* (14.07%), *Collaboration* (13.77%), *Climate Science* (11.98%), *Relatability* (7.19%), *Language* (6.29%), *Organisational Relations* (5.09%), and *Team-building* (3.89%).

Figure 2. Percentage of responses (% of total) categorised by design intention for in-person and online events and the total for each design intention.

4.2.1 In-person versus online events

In-person participants accounted for 37% of survey respondents and approximately 26% of statements analysed. All design intentions were represented in responses as shown in Figure 3.

Event Statement Breakdown (% in each event type)

In-Person Events | **Online Events**

344
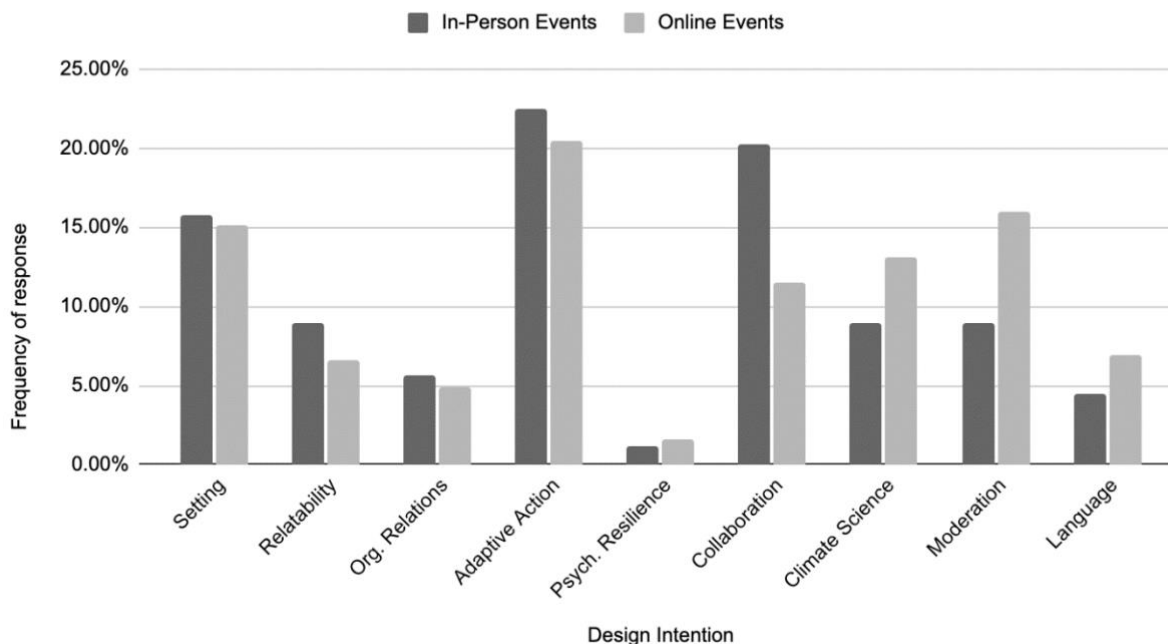
Figure 3. Distribution of design intention occurrence between in-person events and online events (percents from within each event type).

347

Though all intentions were mentioned, 42.7% of all statements fell into just two categories: *Adaptive Action* (22.5%) and *Collaboration* (20.2%). *Setting* (15.7%), *Climate Science* (9.0%), *Relatability* (9.0%), and *Moderation* (9.0%) also had a combined total of 42.7%, with these six design intentions dominating 85.4% of the statements included. The remaining four intentions, *Organisational Relations, Language, Team-building, and Psychological Resilience,* were the least represented.

Participants in online events accounted for approximately 63% of survey respondents and 73% of statements analysed. All design intentions were represented in responses as shown in Fig. 3, with a slightly more balanced distribution than noted in the in-person survey responses.

For online events, *Adaptive Action* was the most referenced intention at 20.4%, which is similar to the frequency found in in-person events (22.5%). *Moderation* and *Setting* were nearly tied for the second-most referenced design intention (15.9% and 15.1%, respectively), followed by *Climate Science* (13.1%), and *Collaboration* (11.4%), for a combined total of 75.9% of statements analysed. The remaining five design intentions, *Accessible Language, Relatability, Organisational Relations, Team-building, and Psychological Resilience* accounted for the final 24%. Except for *Relatability*, the least represented design intentions are consistent between in-person and online respondents.

15

4.2.1 Design intention and response alignment

While the initial part of this analysis demonstrates the frequency of the design intentions in survey responses, additional analysis was required to determine whether the statements align with or contradict the game designers' original intentions. Of the ten design intentions, all except *Accessible Language* and *Moderation* had overall positive averages in the survey responses (-0.33 and -0.38, respectively). *Team-building* and *Collaboration* had the highest overall averages at 1.00, followed closely by *Organisational Relations* (0.94) and *Climate Science* (0.90). *Adaptive Action* (0.80), *Relatability* (0.75), *Psychological Resilience* (0.50), and *Setting* (0.35) complete the list of positively aligned survey responses (See Table 2).
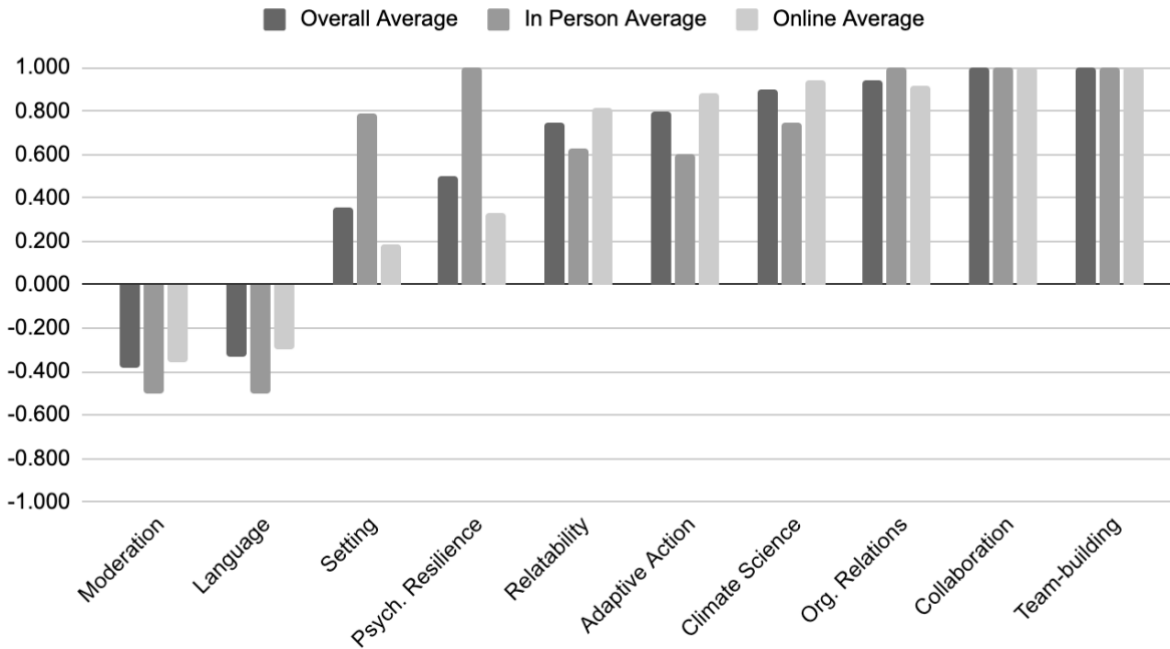
Table 2. Alignment score for each design intention, including overall average and adjustments for in person and online events. Higher averages indicate closer alignment.

Design Intention	Overall Average	In Person Average	Online Average
Adaptive Action	0.80	0.60	0.88
Climate Science	0.90	0.75	0.94
Collaboration	1.00	1.00	1.00
Language	-0.33	-0.50	-0.29
Moderation	-0.38	-0.50	-0.36
Organisational Relations	0.94	1.00	0.92
Psychological Resilience	0.50	1.00	0.33
Relatability	0.75	0.63	0.81
Setting	0.35	0.79	0.19
Team-building	1.00	1.00	1.00

The alignment changes when adjusting for in-person versus online Game Days. For in-person events, *Team-building* and *Collaboration* were joined by *Psychological Resilience,* and *Organisational Relations* at the 1.00 average, while *Moderation* and *Language* remained negatively ranked. The online Game Days maintained the same rankings as the overall average for all intentions except *Organisational Relations* and *Climate Science.*

When comparing the reception between in-person and online events, in-person events had five design intentions scoring lower than the online average (*Moderation, Language, Relatability, Adaptive Action, Climate Science)*, while *Setting, Psychological Resilience,* and *Organisational Relations* scored lower for online Game Days. *Collaboration* and *Team-building* maintained a 1.00 average for both online and in-person events (Fig. 4).

16

Design Intention Statement Alignment

379

Figure 4. Alignment scores for all statements to each design intention for overall, in-person, and online Game Day events.

5 Discussion

5.1 Understanding the results

5.1.1 Designer perspective

The inquiry yielded 10 distinct design intentions and 15 design elements, the latter of which includes aspects of medium, challenge, reward, level of abstraction, and player interaction, which the interviewees said were incorporated to realise the design intentions. For conceptual clarity the 10 design intentions are separated here into two categories. The first category is Primary Objectives, which describes the substantial content of the game. It was found deductively by contrasting the design intentions with Reckien and Eisenack's (Reckien and Eisenack, 2013) three-fold objectives, and seeing that some design intentions aim to raise awareness (*Climate Science* and *Psychological Resilience*), increase knowledge, understanding and familiarity (*Organisational Relations*); and promote action-taking or solution-finding (*Adaptive Action* and *Collaboration*). The corresponding design elements are shown in Table 3, and a detailed explanation of the connections can be found in

17

Appendix B.

Table 3. Presentation of the design intentions and elements of MoD in connection with game objectives as theorised by Reckien and Eisenack.

Primary Objective	Design Intention	Design Elements
Raise Awareness	1. Climate Science 2. Psychological Resilience	Aesthetic Experience Audiovisual Cues Challenge: Time Constraints Challenge: Uncontrollable Events Discussion Medium: Board Medium: Cards for Action Player Interaction: Collaboration/Competition between Teams
Increase Knowledge, Understanding, Familiarity	1. Organisational Relations	Abstraction Level: Qualitative Description Audiovisual Cues Challenge: Limited Funds Challenge: Time Constraints Challenge: Uncontrollable Events Discussion Medium: Board Player Interaction: Collaboration/Competition between Teams Reward Role Play: Explicit Role Assignment with Optional Roleplay Tactical Decision Simulation
Promote Action-taking and Solution-finding	1. Adaptive Action 2. Collaboration	Challenge: Uncontrollable Events Discussion Medium: Cards for Action Player Interaction: Collaboration/Competition between Teams Player Interaction: Team Collaboration Reward Tactical Decision Simulation

The remaining five design intentions, *Language, Moderation*, *Relatability*, *Setting* and *Team-building*, relate less to the game's content, but rather prescribe how the substance is to be conveyed. It was found that they closely correspond to the general climate change engagement framework by Ouariachi et al. (Ouariachi et al., 2020), as illustrated in Table 5 and explained in-detail in Appendix B. Here they are referred to as Secondary Objectives, as they are not lone standing, but support reaching the Primary Objectives. For instance, what the engagement framework defines as 'Concrete' is well-aligned with what the

designers call *Language*: both aim to package information in a way that is accessible and relevant to the audience in question who is expected to respond better to less abstract information.

Table 4. MoD' design intentions and elements connected with Ouariachi et al. climate engagement framework. The design intentions were connected to an objective in the framework with most resemblance in terms of purpose.

Secondary Objective	Design Intention	Design Elements
Achievable, Credible and Identity-driven	Relatability	Abstraction Level: Qualitative Description Audiovisual Cues Challenge: Uncontrollable Events Discussion Medium: Board
Concrete	Language	Aesthetic Experience Kinaesthetic Experience Character Design Discussion
Social and Reward-driven	Team-building	Discussion Moderation Type: Instructionist with constructionist elements Player Interaction: Collaboration/Competition between Teams Player Interaction: Team Collaboration Reward Role Play: Explicit Role Assignment without role play Tactical Decision Simulation
Fun, Meaningful and Reward-driven	Setting	Audiovisual Cues Challenge: Time Constraints Discussion Moderation Type: Instructionist with constructionist elements Player Interaction: Collaboration/Competition between Teams Player Interaction: Team Collaboration Reward
Experiential Learning	Moderation	Discussion Moderation Type: Instructionist with constructionist elements Player Interaction: Team Collaboration

Unpacking the game design of MoD confirms the preconceived notion that adaptation games offer the possibility for complex communication. The messages that the designers want to convey are nuanced and specific, but they can be seen connected to

19

409 Reckien and Eisenack's higher resolution three-fold division. On the other hand, connecting the specific design intentions with

410 the design elements in Table 3 gives an idea of how the messages are constructed with the help of different game mechanics.

411 Table 4 shows a blueprint of the engagement strategy that was designed with the intention that it would fit the needs of the

412 general public. By separating design intentions into objectives and engagement strategy, the topic could be separated from the

413 means. The characteristics and needs of an audience need to be understood if they are to be successfully engaged (Flood et al.,

414 2018; Ouariachi et al., 2017, 2020). For future game iterations and without compromising the action messages that the game

415 is aiming to convey, the information gained about the audience through this study can be used to enhance the engagement

416 strategy, specifically focusing on the Secondary Objectives.

417 **5.1.2 Participant perspective**

418 Games aiming to achieve social learning can be conceptualised as transitional objects (Den Haan and Van der Voort, 2018).

419 This implies that they are intended as communication vessels that transmit messages and achieve objectives predetermined by

420 designers and facilitators. However,as with any communication, messages about climate change are transformed by the

421 receiver; they do not simply flow unchanged from a designer to the audience (Illingworth, 2020). It, therefore, helps if the

422 audience(s) is determined and well-known in advance (Illingworth and Wake, 2019). This study explored a new way of

423 understanding the participant perspective by contrasting the designers' intentions with a post-game monitoring and evaluation

424 dataset. As the questionnaire was not designed to capture alignment with the design intentions, it can be said with somewhat

425 high confidence that the results organically represent the strongest and weakest communication aspects of the game across the

426 data sample.

427 Surprisingly, even when controlling for online/in-person interactions, all of the design intentions were referred to by the survey

428 participants. This is interpreted as validating the focus group method used to retrieve the design intentions. Furthermore, it

429 shows that despite the degree of design complexity, the game succeeds in transmitting all of its communication components.

430 Thus, the interesting question becomes where it was least and most successful. Considering first the Primary Objectives, a

431 great deal of variability could be detected in the distribution of answers: nearly two out of three of the participants referring to

432 Primary Objectives mentioned the action-taking/solution-finding dimension. The second biggest category was awareness-

433 raising. This paints a picture that the participants mostly perceive messages about *Adaptive Action* and *Collaboration*, while

434 few expressed comments about *Psychological Resilience* and *Organisational Relations.*

435 All Primary Objectives were found to be positively aligned with the original design intention, indicating success in conveying

436 the original message to the audience. *Collaboration, Organisational Relations* and *Climate Science* were particularly

437 successful in this regard. *Adaptive Action* largely aligns, yet a small number of participants expressed diverging experiences:

438 some perceived that climate action was poorly elaborated, it was shallow, overly complex, not realistic, or easy to fail at. In

439 terms of *Psychological Resilience,* there was only one participant who perceived that the game added to their despair. However,

440 given the infrequent mention of the category it ranks lowest in the alignment.

441

Table 5. The ranking of design intentions within the Primary Objectives by frequency (% of both Primary and Secondary responses) and alignment with the original intent (-1 - +1 scale).

Ranking by frequency	Ranking by alignment
1. Adaptive Action (21%)	1. Collaboration (1)
2. Collaboration (14%)	2. Organisational Relations (0.94)
3. Climate Science (12%)	3. Climate Science (0.9)
4. Organisational Relations (5%)	4. Adaptive Action (0.8)
5. Psychological Resilience (1.5%)	5. Psychological Resilience (0.5)

Of the Secondary Objectives, *Setting, Moderation* and *Relatability* were the most referenced, with *Setting* and *Relatability* positively aligning with the design intention. It should be noted that when controlling for an online versus in-person game experience, *Setting* shows the starkest contrast: the perception of the in-person experience is very positive, whereas the online one is noticeably lower, albeit still positively aligned. This contrast can be explained by the frequently cited technical difficulties reported by the online participants. *Team-building* ranked the highest in alignment with an overwhelmingly positive reception, but it was also one of the least mentioned design intentions.

Moderation and *Language* were the only two intentions that were negatively aligned with the original intention, with *Moderation* being the least aligned. While some participants reported enjoying the degree of facilitation, a large number of participants would have either liked to receive more, or conversely, less instructed gameplay. The *Language* intention was also negatively aligned and is closely related to *Moderation.* Participants experienced confusion in terms of game components and the instructions they were given, and some felt that trying to understand the game detracted from their capacity to reflect on the topic. However, other participants reported that the game was simple to understand.

Table 6. The ranking of design intentions within the Secondary Objectives by frequency (% of both Primary and Secondary responses) and alignment with the original intent (-1 - +1 scale).

Ranking by frequency	Ranking by alignment
1. Setting (15%)	1. Team-building (1)
2. Moderation (14%)	2. Relatability (0.8)
3. Relatability (7%)	3. Setting (0.4)
4. Language (6%)	4. Language (-0.33)
5. Team-building (4%)	5. Moderation (-0.38)

5.2 Lessons learnt

The purpose here was to advance the climate games and policy field by drafting guidelines for communicating adaptation to the public. Adaptation at a local level, among groups of non-professionals who are reliant on local trade-offs and knowledge exchange (Moser and Pike, 2015), can be facilitated via games, which create space for unordinary, and potentially transformative, conversations. MoD makes an interesting case study because of its focus on collective action and direct impact, as well as affective and relational learning, which are features seldom represented in climate game research. Many games tend to focus on cognitive learning (Gerber et al., 2021) and take the underlying assumption that increasing knowledge on adaptation will lead to more adaptation. However, research demonstrates that it is not solely the lack of information forming a barrier to action (Fox et al., 2020; Panenko et al., 2021). Therefore, only focusing on measuring the degree of learning from a baseline to post-game may mislead one to think that barriers to action are being brought down.

This study diverges from such approaches by looking at the challenge from a different angle: how the intended messages are being perceived, and if the participants are being engaged in a way that appeals to them. Given that such a focus has not, to the knowledge of the authors, been tested previously, this paper adopted a qualitative approach to gain insights on what can be learnt by asking such questions. This section of the paper discusses the key findings and insights from the analysis.

5.2.1 Inclusion of the participant perspective

There is a tendency in communication research to treat participants as recipients of information instead of persons actively engaging in a dialogue with the communicators, giving meaning to climate change and action (Illingworth and Jack, 2018; Kumpu, 2022). There is a risk that in such cases only aspects that the communicator deems important are measured, which may result in omitting important participant perspectives. Given the concern that misunderstanding central game assumptions leads to iterations that do not bring about learning (de Kraker et al., 2021), deepening the understanding of the interaction between designers and participants is important. Intuitively, the importance grows when communication is targeted at audiences whose world view and learning methods significantly differ from that of the game designers: as is allegedly the case when climate professionals communicate adaptation to the public via games (Illingworth, 2020).

By focusing on this interaction, instead of learning, the method applied here helped discern both strong and weak aspects of the communication, and served as the beginning of a conversation between designers, facilitators, and the target audience of the game. This, in turn, feeds into the monitoring and evaluation of the Game Day experience. Overall, the perception of the game is positive and aligns with the design intentions, which is an encouraging signal to develop similar designs or iterations of this game approach for similar non-professional audiences. As one participant summarised "This is definitely a very easy but effective way to engage my colleagues and friends about a serious subject of climate action", meaning that the game can help develop context and common language around the difficult topic.

Similar to other studies, the method used confirms that not only do individual game sessions lead to dissimilar results (Illingworth and Wake, 2021), but also that each audience member has unique perceptions of the messages conveyed.

491 Aggregating these results helps construct a picture of aspects that were most favourably regarded (approaching adaptive action

492 from collective and community/organisation level) and where the most distortion in communication emerged (engagement

493 strategy built around limited moderation and language used in the game).

5.2.2 Collective action – communities and organisations at the system level

495 Few adaptation measures are taken by single individuals, instead requiring collaboration on shared problems and negotiating

496 differences in opinions (Rumore et al., 2016). Nevertheless, the community or organisation-centred system level remains

497 mostly unexplored by climate games (Gerber et al., 2021). Much like other adaptation games, MoD conveys messages with

498 individualistic frames, breaking down complex scientific information to participants and pursuing cognitive learning, but it

499 also aims to achieve relational learning by addressing the collective (Flood et al., 2018). From a theory perspective, this could

500 create an out-of-the-ordinary scenario for the participants, which invites them to collectively explore alternative models for

501 action (Illingworth, 2020). Here, *Collaboration* and *Team-building* turned out to be most well-received by the participants,

502 signalling that this approach is welcomed as a way of communicating adaptive action to the general public. Participants shared

503 their key learning insights such as, *"*Collaboration must be done not only in the game but also in real life, because it would

504 help battle climate change and mitigate the pollutants and environmental pressures" and "Many people have interesting ideas

505 on what we can do. We should use more [of] the knowledge of the people around us and make it actionable"; and "Our actions

506 generate externalities and affect the most vulnerable groups. To achieve climate justice it is necessary to work as a team." This

507 shows clear support for the model adopted by the designers: a tactical decision simulation which requires collaborative

508 adaptation, and a narrative built around climate disruptions and team resilience.

509 Research has found that climate games sometimes struggle being relatable and relevant (Fjællingsdal and Klöckner, 2020),

510 however MoD succeeds in its intention of *Relatability*. This is encouraging given that if the audience perceives information

511 as relevant and engages with it in a dialogue, further action becomes more likely (Galeote et al., 2021). The reason for its

512 effectiveness here might have to do with the system level introduced: connecting knowledge, represented by *Organisational*

513 *Relations*, through the workplace guarantees a degree of familiarity and affection. Moreover, a good narrative is key for

514 decreasing abstraction for the public (Ouariachi et al., 2017) and relating the game to participants' experiences (Illingworth,

515 2020). The narrative of MoD presents a three-fold challenge common to most organisations: lack of time, resources, and

516 control. By playing together not all challenges are solved, but general resilience is gained, which appears to be a good pathway

517 on making climate change relatable for the general public.

518 Roleplay is frequently cited as an important factor contributing to learning through games (Parker et al., 2016; Flood et al.,

519 2018; Galeote et al., 2021; Fjællingsdal and Klöckner, 2020; Gerber et al., 2021). This case study confirms this in the sense

520 that immersing oneself into a game as a community member or a member of an organisation appears to be an effective way of

521 accessing the narrative. Additionally, this shows potential in triggering spill-over behaviour models from games to real life, as

522 the imagined threshold for action lowers (Ouariachi et al., 2017; Parker et al., 2016; Illingworth, 2020; Flood et al., 2018; Den

Haan and Van der Voort, 2018; Fjællingsdal and Klöckner, 2020). However, MoD also gives the option to roleplay different characters - for instance, people in more vulnerable or powerful positions - which could contribute to relational learning as described by den Haan et al. (Den Haan and Van der Voort, 2018). This message was not referenced by any participant, however, showing preference for playing as oneself. This is not surprising given that the experience for participants unfamiliar with games or climate change can already be overwhelming by itself. It is suggested that this type of roleplay is possible and could lead to interesting reflections relevant for relational learning, though it is more likely achieved if the game experience was repeated a second time with the same group.

5.2.3 Online or in-person engagement?

Many climate games have the tendency to focus on digital rather than analogue experiences (Illingworth and Wake, 2019) and computers are often used to interact with the general public. While MoD should not be compared to virtual games as such, the case study did bring about interesting results when the answers were controlled for different game environments. The general experience was somewhat different as *Setting* and *Psychological Resilience* came out as much more prominent in the in-person setting compared with the online environment. This suggests that creating a fun and welcoming space, and addressing topics that require significant self-reflection might be more easily done in-person. At the same time, however, no evidence was found that communication was hindered in the digitised version, as found by other studies (Boomsma et al., 2018; Ho et al., 2022). For instance, the perception of *Collaboration* and *Team-building* did not suffer, though they were much less frequently mentioned. Nevertheless, the results suggest that the communicators should expect the experience to be somewhat different depending on the platform that is used and that if certain topics, in this case Psychological Resilience, are to be introduced, an analogue rather than digital space would be preferable.

5.2.4 Moderation

The designers and facilitators of MoD viewed having limited facilitation as a way to encourage participants to have a positive experience with experiential learning. In game research there are cases being made for those with high levels of moderation (Neset et al., 2020; Marome et al., 2021), autonomous gameplay with a non-obtrusive moderator (Ho et al., 2022; Tsai et al., 2021) as well as games where participants construct either the entire game, or parts of it, themselves (Lankford and Craven, 2020). MoD adopts a largely hands-off approach during the actual gameplay, focusing the facilitation on initial framing and debriefing the experience post-game, and prioritising autonomous gameplay during the session. This proved to be a controversial technique, with some participants praising it and others feeling frustrated and confused.

The participants would have liked to have seen both more and less moderation. For instance, one participant explains: "I liked the energy of the person introducing the game. Then when playing the game leaders did not really explain or introduce the game. They played along and answered questions. After a short while I felt a bit silly saying 'I don't understand'". Those who

553 wanted more moderation implied that they were confused by the task at hand, which confirms that experiential learning of

554 games does not work in all contexts and can be itself a form of jargon (Illingworth, 2020). This highlights the need to strike a

555 balance, especially with individuals with little experience with games, and explaining the purpose of experiential learning to

556 them prior to the gameplay to reduce the confusion emerging around misaligned expectations.

557 At the same time, some participants experienced moderation very differently, for instance, according to one participant "It is

558 great that the participants are trusted with the process, and that there is not too much intervention." Those who wanted less

559 moderation, however, felt that the game rules, and especially the externally asserted time pressure, detracted from the quality

560 of their discussions and degree to which they related to the game. This shows an interesting conflict between design intentions,

561 as the time pressure is an important component of creating the game challenge, and generally appreciated by the participants.

562 While discussion is an element mentioned by the designers (both in-game discussion and debrief) its importance in contrast

563 with other design elements may have been underestimated. This is a quality uncovered by this study, which ought to be

564 explored and tested in the next iteration of this game. As discussion is found to be the key to most of the learning in game

565 communication (Neset et al., 2020), it seems that simply more time should be allocated; which is in line with the argument

566 that the simpler and more familiar the game, the better participants are able to have simultaneous discussions and gameplay

567 (Illingworth and Wake, 2021).

568 **5.2.5 General public as the target audience**

569 This study refers to the general public as an assortment of highly diverse groups. Their need for information, its reception, and

570 trust toward it is bound to differ (Illingworth and Jack, 2018), and their experiences are difficult to homogenise. The *Climate*

571 *Science* design intention, which was meant to capture the complexity of climate change, awareness, and urgency aligned

572 strongly in both the online and in-person events. Theoretically, this intention would be closely tied to the *Language* design

573 intention, as accessible language is a key component in expressing the complexity of the topic, yet this design intention was

574 negatively aligned. This might indicate that those who did understand the decomplexified message reported it in the survey

575 and, thus were categorised under *Climate Science* whereas those who struggled to follow referred to *Language*. As one

576 participant reports: "It felt like I was the only outsider and all the others already knew some aspects of the game. There was a

577 lot of jargon."

578 Games arguably have the potential to translate scientific knowledge making it accessible for the public (Gerber et al., 2021).

579 However, designing the right amount of complexity into a game and finding optimal language is challenging as participants

580 should not lose interest, but also not feel overwhelmed (Parker et al., 2016; Flood et al., 2018; Neset et al., 2020). This seems

581 to be amplified when designing for the public whose experience with games and levels of knowledge are bound to vary. The

582 role of facilitators is important with this audience type; moderation, and particularly its role during debrief, can unpack and

583 explain jargon and tease out connections to real life (Neset et al., 2020). However, even if the discussion design element was

584 connected to almost all design intentions of MoD, challenges emerged. This could suggest either that moderation/discussion

is not performed in a way which would address everyone's needs, or, as previously found (Flood et al., 2018), that addressing all needs within a short time window might simply be impossible and a series of engagements are needed. To resolve this issue, Neset et al. (Neset et al., 2020) propose that the same game could incorporate different levels of complexity which could be adjusted when needed.

Regardless, given that the overall reception was positive, this study reinforces the idea that games have a unique ability to cater to different needs, and this opens the conversation up to how games such as MoD can have increased relevance in the decision-making sphere. Games' ability to engage with diversity, be it in regard to attitudes, perception, behaviour, or cultural values, is what seems to make them so effective (Flood et al., 2018), and this presents a promising connection to using games as a way to help communities in, for example, local adaptation planning. Immersive experiences are needed to change the way that people relate to climate change (Bekoum Essokolo and Robinot, 2022), and it is encouraging to see that the general public shows eagerness to engage. The method applied here showcases clearly that when a game makes up such a complex package of information and is created to address different cognitive styles by including both textual, audiovisual and kinaesthetic aspects (Flood et al., 2018; Illingworth and Wake, 2021), the audience picks up on different features more strongly. The fact that collaboration was so positively reflected is an encouraging sign and demonstrates that games are effective when they create a sense of belonging and purpose for the participants (Illingworth, 2020) facing a shared problem they need to jointly tackle (Den Haan and Van der Voort, 2018). This can be designed to mimic the real-life circumstances of a community, as evident by a MoD iteration: a local advocacy tool co-created with a rural community in Kenya (Day of Adaptation, 2022). As positive local narratives correlate with the likelihood of action (Den Haan and Van der Voort, 2018), adaptation games such as this could ultimately serve as important tools to aid decision-making when adapted for specific local circumstances.

6 Conclusions

This paper presented a new method to study the designer-participant interaction in adaptation games, which takes a divergent approach to papers that focus on learning, or other analytical frameworks such as psychological distancing theory. Climate change and adaptation are experienced unequally around the world and this paper focuses specifically on communication within communities and organisations where the soft limits to adaptation can be influenced by reprioritising resources to climate action (O'Neill et al., 2022). From this standpoint, the following key insights were uncovered:

1. Collaboration and Team-building can be strongly recommended as frames for climate adaptation for the general public, as across the dataset they were found to align very well with the way the designers of Day of Adaptation intended. The results show that for the audience in question the actual knowledge shared in the game was less commonly reported as the key aspect, in comparison with the feeling of belonging and experience of solving challenges collectively.

2. Sometimes a game design may incorporate elements, which stand in conflict with each other, meaning that not all the objectives it sets out to achieve are synchronous. In the case of MoD, time pressure is designed within the game to create a metaphor for the climate emergency, yet several participants found that the sense of emergency distorted their ability to discuss and brainstorm with their colleagues. While both of these objectives are important, the facilitator may have to make compromises to achieve one or the other.

3. Measuring both the number of design objectives as well as their relative distribution is important, as it can help the designers identify the stronger and weaker elements of their communication approach. For instance, while MoD effectively communicates aspects such as complexity of the human-environment system, few participants related the game to an increase in their Psychological Resilience. If the designers were to incorporate this objective as well, they might have to revisit some of the fundamental design assumptions they drafted, including considering how the varied past experiences that participants bring into the game may lead to emergent or unanticipated outcomes.

The reason for implementing a new method comes from the attempt to avoid replicating expert-to-public communication structures, which only focus on the participants as an object of study instead of looking at the whole game experience as a dialogical event (Illingworth, 2020). Knowing if a knowledge-action gap has been bridged is difficult to measure because of the complexity of predicting behaviour, however, participants aligning positively on climate action and reporting feelings of empowerment is a good indication of receptiveness to the messages being conveyed. Developing iterations based on such feedback could further enhance the effect, as could further exploring action-knowledge game structure over knowledge-action layouts (Crookall and Thorngate, 2009).

This approach is recommended to game designers and evaluators who are interested in discovering which of the messages they aim to communicate are perceived as intended and where distortion takes place, and to simply expand upon the understanding of the needs of those with whom they communicate. While ideally the dialogue with participants is more immediate, this approach was found to be less resource-intensive, and still enabled co-creation, given that the inputs are used to inform future iterations. For instance, here *Collaboration* outshone *Psychological Resilience*, and while both are important messages to convey about adaptation, they might be difficult to fit within one single activity. Insights such as this can help with modifying future iterations of the adopted approach and afford an identity and voice to the recipients of the communication.

The method can be improved in some parts, which could inspire some further research activities. First, if more information were obtained from individual participants, it would be possible to test not only the strongest categories on an aggregate level, but also if a single participant perceives *all* the design intentions. As it stands, the design intentions were sometimes artificially split, and for instance, the difference between the *Team-building* and *Collaboration* design intentions may have been too nuanced for the realities of a complex three-hour activity. Having higher resolution data would provide deeper understanding of the relationships between the categories, the degree to which the communication experience is different between participants, and what its determinants are. Additionally, having more representative group level data from each event would allow comparison between game events, which could lead to studying, for instance, the influence of group size and composition

to the reactions. While there are reasons to assume that the participating groups have diverse backgrounds, the fact that the sample is neither randomised nor representative leaves some questions unanswered. A future research direction that would move forward with a post-game survey designed to draw group-level conclusions without obscuring the diverse backgrounds of participants could help answer questions such as how to design for diverse audiences, and which factors best predict positive alignment.

Moreover, while the focus group gave an idea about which design elements related to the intentions, very few participants referred to specific elements, which makes it difficult to say with certainty which specific aspects might have been hindering or facilitating success. This presents a limitation of the design of the survey, but also a further inquiry; a potential comparison of different elements aiming to achieve a similar intention would still be needed to understand strengths and weaknesses of specific elements. Finally, the method used to measure participant experience was easily skewed by negative experiences, which was most evident by the frustration with technical difficulties. This is a common issue known to survey research as well, as there is a tendency to report frustration over a session where no challenges emerge. Given the small size of the dataset this could still be considered within the results, as the researchers could look at each entry individually to see what fell under each design intention. If the study were to be scaled-up, a more sophisticated survey could be implemented, which would ask for feedback for all design intentions and elements. Ideally the participant experience would be captured during the game events as well, as this would provide a more complete snapshot of the game experience, off of which future tools could be based.

7 Appendices

Appendix A: Post-game survey questions

The following questions were presented in the post-game survey offered to all participants and used by the researchers to form the basis of the participant perspective for this study. Only open-field questions were included in this study, which are included in bold below.

1. **Please write down the first three (3) words that come to mind when describing your Game Day Experience.**
2. How would you rate your Game Day experience? (scale: 0-5)
   a. Please clarify if "unsatisfactory" or "improvement needed was selected
3. **What are the new perspectives or deeper understanding on climate action that you have gained on this topic, if applicable?**
4. **What is your key take-home message from the Game Day?**
5. How would you rate the organisation of the event? E.g., orderliness, easy to follow, engaging, etc. (scale: 0-5)
   a. Additional thoughts on the event organisation?
6. How would you rate the facilitator's performance? E.g., they explained things clearly, listened well, were engaging, etc. (scale: 0-5)
   a. Additional thoughts to share with the facilitators?

682   7.   I would recommend this event to friends and colleagues. (scale: 0-5)

683   **8.**   Any other comments or suggestions?

684   9.   Age of participant

685   10. Gender of participant

686

687   Appendix B: Connections between design intentions and elements

688

689   **Table B1. A list of Design Elements Incorporated into the collaborative adaptation board game Minions of Disruptions. The**

690   **categorisation applies frameworks created by Gerber et al. [29], Lankford and Craven [30] and Razali et al. [35] to break down and**

691   **understand different game types and elements. Note that several design elements are connected to more than one design intention**

692   **and appear, therefore, several times in the table.**

Design Intention	Design Element	Description
Raising awareness: Climate Science	Aesthetic Experience	Implicit messages are communicated via e.g. colours. For instance, the game board has carbon clouds which grow incrementally darker as emission levels increase and the climate impacts worsen. The purpose of this augmented sensory experience is to explain scientific concepts with the help of visuals and make memorization easier.
	Audiovisual cues	When the players hear the sound of a car engine they have to increase the difficulty level in the game. The purpose of this is to communicate urgency and draw a connection between the cause of climate change (emissions from driving) and the climate impacts.
	Challenge: Time Constraints	There is limited time to gain resilience; the feeling that time is running out creates a temporarily stressful ambiance and a sense of urgency. The purpose is to communicate the reality of the climate emergency.
	Challenge: Uncontrollable Events	There are aspects that players can control (i.e. actions), and that are out of their control (i.e. disruptions). This is a metaphor for climate change in the sense that some aspects of climate change can be locally influenced (i.e. adaptation), while addressing climate change as one organisation/community is impossible.
	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. The discussion is intended to empower questions and curiosity among players, but also to engage in the game by sharing their local knowledge about climate change. At the post-game discussion the purpose is to create a space where the participants can pose open questions, and the game facilitators can further explain the mechanics of climate change.
	Medium: Board	The board models the structure of a community/organisation, mounting greenhouse gas emissions, and the climate impacts. The board limits the experience to a single shared reality, where climate change happens in real time (instead of in the distant future).
	Medium: Cards for Action	Action Cards inject information about possible mitigation and adaptation perspectives. From the point of view of climate science, the aim is to convey that climate change is anthropogenic, and thus, it is also possible to take action to prevent the worst impacts, if the action is timely.
	Player Interaction: Collaboration / Competition between Teams	The game is not limited to a single game board but there is a possibility to collaborate or compete between teams to share or mitigate emissions. The purpose of this element is to show the players the complexity of climate change, and the way that decisions taken locally have global spill-over effects.

Raising awareness: Psychological Resilience	**Challenge: Time Constraints**	There is limited time to gain resilience; the feeling that time is running out creates a temporarily stressful ambiance and a sense of urgency. The players are to perceive first-hand how decision-making may feel like when they have to respond to climate impacts/disasters on multiple fronts.
	Challenge: Uncontrollable Events	There are aspects that players can control (i.e. actions), and that are out of their control (i.e. disruptions). As the sense of limited power to influence can be taxing on individuals and communities, the game is intended to provide a safe space where this emotion can be explored.
	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. The possibility to share frustrations, joy and reflections with one's community is believed to be key in building trust and resilience.
Increase Knowledge, Understanding, Familiarity: Organisational Relations	**Abstraction Level: Qualitative Description**	A simplified model of the operations of a community/organisation and reality-check cards which connect local knowledge with abstract concepts (e.g. "what measures are in place in your community/organisation in case of a heatwave"). This element aims to increase knowledge about the players' organisations and the organisational readiness for climate change.
	Audiovisual Clues	When the players hear the sound of a car engine they have to increase the difficulty level in the game. This demonstrates a connection between organisational activity (e.g. company cars) and the causes of climate change.
	Challenge: Limited Funds	The amount of climate actions that a team can take is dependent on the funds they are in possession of; All teams start with the same amount of funding in the game, but their ability to gather funds depends on their strategic choices. This element conveys a common reality of most organisations, namely, that limited resources pushes the organisation to choose and prioritize between different actions.
	Challenge: Time Constraints	There is limited time to gain resilience; the feeling that time is running out creates a temporarily stressful ambiance and a sense of urgency. By introducing a stressful scenario in a game setting, the purpose is to foster connections between the individuals playing the game, and train their ability to make decisions under pressure.
	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. The purpose of this element is to gather and share reflections about the current impact and perceived readiness of the organisation.
	Medium: Board	The board models the structure of a community/organisation, mounting greenhouse gas emissions, and the climate impacts. By showcasing the most essential functions of an organisation, the purpose of this element is to draw connections between functions and vulnerability.
	Player Interaction: Collaboration / Competition between Teams	The game is not limited to a single game board but there is a possibility to collaborate or compete between teams to share or mitigate emissions. This element is intended as a metaphor to explain how team collaboration can lead to more effective climate action, whereas dysfunctional team dynamics can hinder everyone's progress.

	Reward	There are no lose-scenarios, and therefore all participants experience successful building of joint community/organisational resilience.
	Role Play: Explicit Role Assignment with Optional Roleplay	The participants play as equal members of a community or organisation, most commonly the one they take part in real life. If they so wish, they can also roleplay as a community/organisation that they do not belong in and/or assume characters and character powers which are inscribed by the game. Depending on which choice the team makes, the intention is to either deepen knowledge about one's own community/organisation, or a community/organisation of relevance.
	Tactical Decision Simulation	The players create a unique group strategy to inform their decision-making. Time, disruptions, limited funds and carbon accumulation are elements that make collaboration feel advantageous but also stressful. The players can experiment in a safe game setting how successful the team's collaboration is despite the stress it experiences.
Promote Action-taking and Solution-finding: Adaptive Action	**Challenge: Uncontrollable Events**	There are aspects that players can control (i.e. actions), and that are out of their control (i.e. disruptions). This is a metaphor for climate change in the sense that some aspects of climate change can be locally influenced (i.e. adaptation), even if addressing climate change as one organisation/community is impossible, and moreover, that the least beneficial thing is to do nothing.
	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. The discussion is intended to act as a catalyst for action, and create a space for starting the discussion of how the given community/organisation could begin to take climate action.
	Medium: Cards for Action	Action Cards inject information about possible mitigation and adaptation perspectives. The purpose of these cards is to give real world examples of the array of possible actions, and also to convey that there are different scales at which action can be taken.
Promote Action-taking and Solution-finding: Collaboration	**Player Interaction: Collaboration/Competition between Teams**	The game is not limited to a single game board but there is a possibility to collaborate or compete between teams to share or mitigate emissions. If the teams collaborate, they are more quick to win the game, which is intended to signal that this is the case also in real life.
	Player Interaction: Collaboration	Although there are individual player turns, the player's team may help in decision-making. The aim here is to foster an experience that an individual does not need to face decision-making on their own, but that consultation and guidance from their community/organisation is beneficial and helpful.
	Reward	There are no lose-scenarios, and therefore all participants experience successful building of joint community/organisational resilience.

	Tactical Decision Simulation	The players create a unique group strategy to inform their decision-making. Time, disruptions, limited funds and carbon accumulation are elements that make collaboration feel advantageous but also stressful. The players are guided to make collective decisions and create their very own team strategy out of several options.
Achievable, Credible and Identity-driven: Relatability	Abstraction Level: Qualitative Description	A simplified model of the operations of a community/organisation and reality-check cards which connect local knowledge with abstract concepts (e.g. "what measures are in place in your community/organisation in case of a heatwave"). The fact that local knowledge can be introduced to the game makes the game and climate change more relatable as the players can draw upon real life examples.
	Audiovisual Cues	When the players hear the sound of a car engine they have to increase the difficulty level in the game. Whilst there are many different causes to climate change, by choosing one that is close to the participants, and the emitting capacity of which is known by most, the mechanics of climate change become more evident.
	Challenge: Uncontrollable Events	There are aspects that players can control (i.e. actions), and that are out of their control (i.e. disruptions). Whilst playing as an omnipotent decision-maker might give a greater sense of influence, it is believed that the participants can better relate to a scenario where they are not able to prevent climate change from happening in the short time frame.
	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. In the discussion, the lived experience and the game experience can be connected. Moreover, an added purpose of the discussion is to create room for sharing experiences, feelings and self-reflections on climate change and action, which can enhance relatability.
	Medium: Board	The board models the structure of a community/organisation, mounting greenhouse gas emissions, and the climate impacts. On the game board, the players recognise familiar concepts and structures from their everyday life, which should help them form a connection between the game scenario and the player's actual life.
Concrete: Language	Aesthetic Experience	Implicit messages are communicated via e.g. colours. Using non-verbal language can be more memorable and easier to decode for some cognitive styles.
	Kinaesthetic Experience	The players move around cards, coins and pawns. The physical touch and concrete movements can be more memorable and easier to decode for some cognitive styles.
	Character Design	The basic climate action elements are presented as personified characters (Carbions, Climmies and Zillians, or carbon, climate disruptions, and climate action respectively). This adds an element of a story to the game, and aims to create more memorable images of concepts, which may be hard to memorize or understand.
	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. In the discussion any matters related to concepts that are unclear can be verbally elaborated.

Social and Reward-driven: Team-Building	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. Sharing challenges, ideas and reflections can enhance team-building.
	Moderation Type: Instructionist with constructionist elements	The game rules are set and explained by facilitators, but the players are to learn the game experientially: no one controls for rule breaks. Players are given the possibility to inject their own knowledge into the game. Game organisers lead the post-discussion. The team will have to act autonomously during the game, fostering team-building.
	Player Interaction: Collaboration/Competition between Teams	The game is not limited to a single game board but there is a possibility to collaborate or compete between teams to share or mitigate emissions. This can foster team-building beyond the immediate team (game table) and more widely on the group level.
	Player Interaction: Team Collaboration	Although there are individual player turns, the player's team may help in decision-making. This cultivates a culture of supporting team members.
	Reward	There are no lose-scenarios, and therefore all participants experience successful building of joint community/organisational resilience.
	Role Play: Explicit Role Assignment with optional role play	The participants play as equal members of a community or organisation, most commonly the one they take part in real life. If they so wish, they can also roleplay as a community/organisation that they do not belong in and/or assume characters and character powers which are inscribed by the game. In either scenario (and especially in the role playing one) the team has to take into consideration different kinds of backgrounds, vulnerabilities and personalities.
	Tactical Decision Simulation	The players create a unique group strategy to inform their decision-making. Time, disruptions, limited funds and carbon accumulation are elements that make collaboration feel advantageous but also stressful. Collective strategy making can foster team-building.
Fun, Meaningful and Reward-driven: Setting	Audiovisual Cues	When the players hear the sound of a car engine they have to increase the difficulty level in the game. This sound may also add a layer of sensory experience and excitement.
	Challenge: Time Constraints	There is limited time to gain resilience; the feeling that time is running out creates a temporarily stressful ambiance and a sense of urgency. This also contributes to the game-like atmosphere, where players get engaged and motivated about the gameplay.
	Discussion	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. This also creates the opportunity to create a safe space for learning and interaction.

	Moderation Type: Instructionist with constructionist elements	The game rules are set and explained by facilitators, but the players are to learn the game experientially: no one controls for rule breaks. Players are given the possibility to inject their own knowledge into the game. Game organisers lead the post-discussion. Experiential learning is intended to give the players more room to engage.
	Player Interaction: Collaboration/Competition between Teams	The game is not limited to a single game board but there is a possibility to collaborate or compete between teams to share or mitigate emissions. This increases the dynamism of the game and creates the possibility for competitive interaction between teams.
	Player Interaction: Team Collaboration	Although there are individual player turns, the player's team may help in decision-making. This is intended to make the game more interactive.
	Reward	There are no lose-scenarios, and therefore all participants experience successful building of joint community/organisational resilience.
Experiential learning: Moderation	**Discussion**	Players reflect on their experience and share local experiences and knowledge during and post-gameplay. Discussion within the team is a key part in understanding the game rules and figuring out how the team will construct their game experience. In the meantime, the game organisers do help the players whenever they request for help or find themselves confused or lost.
	Moderation Type: Instructionist with constructionist elements	The game rules are set and explained by facilitators, but the players are to learn the game experientially: no one controls for rule breaks. Players are given the possibility to inject their own knowledge into the game. Game organisers lead the post-discussion. The constructionist elements are included to the game design to make sure that the players understand the game rules, and that they are correctly interpreting some themes, e.g. the mechanics of climate change.
	Player Interaction: Team Collaboration	Although there are individual player turns, the player's team may help in decision-making. The purpose of playing in a team is that no one is left behind and those that are slower to understand the game are able to follow thanks to the shared knowledge in the team.

694

695

696   11.

697   Appendix C: The raw participant and statement numbers

698

699   Table C1. Total number of participants and statements included in the analysis with breakdown between in-person and online events. Single Design Intention
700   is the number of statements representing only one design intention. Two Design Intentions are the number of statements that were coded as having addressed
701   multiple design intentions. Total Unique Statements represents the number of responses included for analysis; if a statement fit into two design intention
702   categories, it was counted twice (Total Statements Analysed). Total Statements Omitted are those that would have required too much interpretation by the
703   researchers.

	Total Participants	Single Design Intention	Two Design Intentions	Total Unique Statements	Total Statements Analysed	Total Statements Omitted
Question 2: How would you rate your Game Day experience?						
Total	140	20	4	24	28	7
In person	52	1	0	1	1	1
Online	88	19	4	23	27	6
Question 3: What are the new perspectives or deeper understanding on climate action that you have gained on the topic, if applicable?						
Total	140	59	24	82	106	21
In person	52	15	8	23	31	8
Online	88	44	15	59	74	13
Question 4: What is your key take-home message from the Game Day?						
Total	140	57	27	84	111	32
In person	52	18	7	25	32	12
Online	88	39	20	59	79	20
Question 5: How would you rate the organisation of the event? E.g. orderliness, easy to follow, engaging, etc.						
Total	140	35	3	38	41	9
In person	52	11	0	11	11	4
Online	88	24	3	27	30	5
Question 6: How would you rate the facilitator's performance? E.g. they explained things clearly, listened well, were engaging, etc.						
Total	140	15	6	21	27	25
In person	52	4	1	5	6	4

Online	88	11	5	16	21	21
Question 8: Any other comments or suggestions?						
Total	140	11	5	16	21	21
In person	52	2	3	5	8	3
Online	88	9	2	11	13	18

References

Abspoel, L., Mayer, I., Keijser, X., Warmelink, H., Fairgrieve, R., Ripken, M., Abramic, A., Kannen, A., Cormier, R., and Kidd, S.: Communicating Maritime Spatial Planning: The MSP Challenge approach, Marine Policy, 132, 103486, https://doi.org/10.1016/j.marpol.2019.02.057, 2021.

Andersson, K., Hylander, F., and Nylén, K.: Klimatpsykologi : hur vi skapar hållbar förändring, Natur & Kultur, Stockholm, 280 pp., 2019.

Badullovich, N., Grant, W., and Colvin, R.: Framing climate change for effective communication: A systematic map, Environmental Research Letters, https://doi.org/10.1088/1748-9326/aba4c7, 2020.

Bekoum Essokolo, V.-L. and Robinot, E.: «Let's Go Deep into the Game to Save Our Planet!» How an Immersive and Educational Video Game Reduces Psychological Distance and Raises Awareness, Sustainability, 14, 5774, https://doi.org/10.3390/su14105774, 2022.

Berrang-Ford, L., Siders, A. R., Lesnikowski, A., Fischer, A. P., Callaghan, M. W., Haddaway, N. R., Mach, K. J., Araos, M., Shah, M. A. R., Wannewitz, M., Doshi, D., Leiter, T., Matavel, C., Musah-Surugu, J. I., Wong-Parodi, G., Antwi-Agyei, P., Ajibade, I., Chauhan, N., Kakenmaster, W., Grady, C., Chalastani, V. I., Jagannathan, K., Galappaththi, E. K., Sitati, A., Scarpa, G., Totin, E., Davis, K., Hamilton, N. C., Kirchhoff, C. J., Kumar, P., Pentz, B., Simpson, N. P., Theokritoff, E., Deryng, D., Reckien, D., Zavaleta-Cortijo, C., Ulibarri, N., Segnon, A. C., Khavhagali, V., Shang, Y., Zvobgo, L., Zommers, Z., Xu, J., Williams, P. A., Canosa, I. V., van Maanen, N., van Bavel, B., van Aalst, M., Turek-Hankins, L. L., Trivedi, H., Trisos, C. H., Thomas, A., Thakur, S., Templeman, S., Stringer, L. C., Sotnik, G., Sjostrom, K. D., Singh, C., Siña, M. Z., Shukla, R., Sardans, J., Salubi, E. A., Safaee Chalkasra, L. S., Ruiz-Díaz, R., Richards, C., Pokharel, P., Petzold, J., Penuelas, J., Pelaez Avila, J., Murillo, J. B. P., Ouni, S., Niemann, J., Nielsen, M., New, M., Nayna Schwerdtle, P., Nagle Alverio, G., Mullin, C. A., Mullenite, J., Mosurska, A., Morecroft, M. D., Minx, J. C., Maskell, G., Nunbogu, A. M., Magnan, A. K., Lwasa, S., Lukas-Sithole, M., Lissner, T., Lilford, O., Koller, S. F., Jurjonas, M., Joe, E. T., Huynh, L. T. M., Hill, A., Hernandez, R. R., Hegde, G., Hawxwell, T., Harper, S., Harden, A., Haasnoot, M., et al.: A systematic global stocktake of evidence on human adaptation to climate change, Nat. Clim. Chang., 11, 989–1000, https://doi.org/10.1038/s41558-021-01170-y, 2021.

Boomsma, C., Hafner, R., Pahl, S., Jones, R. V., and Fuertes, A.: Should We Play Games Where Energy Is Concerned? Perceptions of Serious Gaming as a Technology to Motivate Energy Behaviour Change among Social Housing Residents, Sustainability, 10, 1729, https://doi.org/10.3390/su10061729, 2018.

Creswell, J.: Qualitative Inquiry and Research Design - Choosing Among Five Approaches, 3rd ed., SAGE Publications, California, 2013.

Crookall, D., & Thorngate, W. (2009). Acting, Knowing, Learning, Simulating, Gaming. Simulation & Gaming, 40(1), 8-26. https://doi.org/10.1177/1046878108330364

Day of Adaptation: Publication: Minions of Disruptions - Kenya Edition, https://www.dayad.org/publication-minions-of-disruptions-kenya-edition/, last access 2 June 2024, 2022.

Den Haan, R.-J. and Van der Voort, M. C.: On Evaluating Social Learning Outcomes of Serious Games to Collaboratively Address Sustainability Problems: A Literature Review, Sustainability, 10, 4529, https://doi.org/10.3390/su10124529, 2018.

Fjællingsdal, K. S. and Klöckner, C. A.: Green Across the Board: Board Games as Tools for Dialogue and Simplified Environmental Communication, Simulation & Gaming, 51, 632–652, https://doi.org/10.1177/1046878120925133, 2020.

Flood, S., Cradock-Henry, N. A., Blackett, P., and Edwards, P.: Adaptive and interactive climate futures: systematic review of 'serious games' for engagement and decision-making, Environ. Res. Lett., 13, 063005, https://doi.org/10.1088/1748-9326/aac1c6, 2018.

Fox, J., McKnight, J., Sun, Y., Maung, D., Crawfish, R.: Using a serious game to communicate risk and minimize psychological distance regarding environmental pollution, Telematics and Informatics, 46, 101320, https://doi.org/10.1016/j.tele.2019.101320, 2020.

Galeote, D. F., Rajanen, M., Rajanen, D., Legaki, N.-Z., Langley, D. J., and Hamari, J.: Gamification for climate change engagement: review of corpus and future agenda, Environ. Res. Lett., 16, 063004, https://doi.org/10.1088/1748-9326/abec05, 2021.

Gerber, A., Ulrich, M., Wäger, F. X., Roca-Puigròs, M., Gonçalves, J. S. V., and Wäger, P.: Games on Climate Change: Identifying Development Potentials through Advanced Classification and Game Characteristics Mapping, Sustainability, 13, 1997, https://doi.org/10.3390/su13041997, 2021.

Ho, S.-J., Hsu, Y.-S., Lai, C.-H., Chen, F.-H., and Yang, M.-H.: Applying Game-Based Experiential Learning to Comprehensive Sustainable Development-Based Education, Sustainability, 14, 1172, https://doi.org/10.3390/su14031172, 2022.

Illingworth, S.: Creative communication – using poetry and games to generate dialogue between scientists and nonscientists, FEBS Letters, 594, 2333–2338, https://doi.org/10.1002/1873-3468.13891, 2020.

Illingworth, S. and Jack, K.: Rhyme and reason-using poetry to talk to underserved audiences about environmental change, Climate Risk Management, 19, 120–129, https://doi.org/10.1016/j.crm.2018.01.001, 2018.

Illingworth, S. and Wake, P.: Developing science tabletop games: 'Catan'® and global warming, JCOM, 18, A04, https://doi.org/10.22323/2.18040204, 2019.

Illingworth, S. and Wake, P.: Ten simple rules for designing analogue science games, PLOS Computational Biology, 17, e1009009, https://doi.org/10.1371/journal.pcbi.1009009, 2021.

de Kraker, J., Offermans, A., and van der Wal, M. M.: Game-Based Social Learning for Socially Sustainable Water Management, Sustainability, 13, 4646, https://doi.org/10.3390/su13094646, 2021.

Kumpu, V.: What is Public Engagement and How Does it Help to Address Climate Change? A Review of Climate Communication Research, Environmental Communication, 16, 304–316, https://doi.org/10.1080/17524032.2022.2055601, 2022.

Lankford, B. A. and Craven, J.: Rapid Games Designing; Constructing a Dynamic Metaphor to Explore Complex Systems and Abstract Concepts, Sustainability, 12, 7200, https://doi.org/10.3390/su12177200, 2020.

Marome, W., Natakun, B., and Archer, D.: Examining the Use of Serious Games for Enhancing Community Resilience to Climate Risks in Thailand, Sustainability, 13, 4420, https://doi.org/10.3390/su13084420, 2021.

Medema, W., Furber, A., Adamowski, J., Zhou, Q., and Mayer, I.: Exploring the Potential Impact of Serious Games on Social Learning and Stakeholder Collaborations for Transboundary Watershed Management of the St. Lawrence River Basin, Water, 8, 175, https://doi.org/10.3390/w8050175, 2016.

Mitgutsch, K. and Alvarado, N.: Purposeful by design? a serious game design assessment framework, in: Proceedings of the International Conference on the Foundations of Digital Games, New York, NY, USA, 121–128, https://doi.org/10.1145/2282338.2282364, 2012.

Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A., and Chaves, W. A.: Identifying effective climate change education strategies: a systematic review of the research, Environmental Education Research, 25, 791–812, https://doi.org/10.1080/13504622.2017.1360842, 2019.

Moser, S. C.: Reflections on climate change communication research and practice in the second decade of the 21st century: what more is there to say?, WIREs Climate Change, 7, 345–369, https://doi.org/10.1002/wcc.403, 2016.

Moser, S. C. and Pike, C.: Community engagement on adaptation: Meeting a growing capacity need, Urban Climate, 14, 111–115, https://doi.org/10.1016/j.uclim.2015.06.006, 2015.

Neset, T.-S., Andersson, L., Uhrqvist, O., and Navarra, C.: Serious Gaming for Climate Adaptation—Assessing the Potential and Challenges of a Digital Serious Game for Urban Climate Adaptation, Sustainability, 12, 1789, https://doi.org/10.3390/su12051789, 2020.

Noll, B., Filatova, T., Need, A., and Taberna, A.: Contextualizing cross-national patterns in household climate change adaptation, Nat. Clim. Chang., 12, 30–35, https://doi.org/10.1038/s41558-021-01222-3, 2022.

Nussbaum, E. M., Owens, M. C., Sinatra, G. M., Rehmat, A. P., Cordova, J. R., Ahmad, S., Harris, F. C., and Dascalu, S. M.: Losing the Lake: Simulations to Promote Gains in Student Knowledge and Interest about Climate Change, International Journal of Environmental and Science Education, 10, 789–811, 2015.

Olivares-Rodríguez, C., Villagra, P., Mardones, R. E., Cárcamo-Ulloa, L., and Jaramillo, N.: Costa Resiliente: A Serious Game Co-Designed to Foster Resilience Thinking, Sustainability, 14, 16760, https://doi.org/10.3390/su142416760, 2022.

O'Neill, B., Aalst, M. K. van, Ibrahim, Z. Z., Ford, L. B., Bhadwal, S., Buhaug, H., Diaz, D., Frieler, F., Garschagen, M., Magnan, A., Midgley, G., Mirzabaev, A., Thomas, A., and Warren, R.: Key Risks across Sectors and Regions, 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, Cambridge University Press, 2411–2538, https://doi.org/10.1017/9781009325844.025, 2022.

827 Ouariachi, T., Olvera-Lobo, M. D., and Gutiérrez-Pérez, J.: Gaming Climate Change: Assessing Online Climate Change
828 Games Targeting Youth Produced in Spanish, Procedia - Social and Behavioral Sciences, 237, 1053–1060,
829 https://doi.org/10.1016/j.sbspro.2017.02.154, 2017.

830 Ouariachi, T., Li, C.-Y., and Elving, W. J. L.: Gamification Approaches for Education and Engagement on Pro-Environmental
831 Behaviors: Searching for Best Practices, Sustainability, 12, 4565, https://doi.org/10.3390/su12114565, 2020.

832 Panenko, A., George, E., Lutoff, C.: Towards the development of climate adaptation knowledge-action systems in the
833 European Union: An institutional approach to climate service analysis, Climate Services, 24, 100265,
834 https://doi.org/10.1016/j.cliser.2021.100265, 2021.

835 Parker, H. R., Cornforth, R. J., Suarez, P., Allen, M. R., Boyd, E., James, R., Jones, R. G., Otto, F. E. L., and Walton, P.: Using
836 a Game to Engage Stakeholders in Extreme Event Attribution Science, Int J Disaster Risk Sci, 7, 353–365,
837 https://doi.org/10.1007/s13753-016-0105-6, 2016.

838 Razali, N. E. M., Ramli, R. Z., Mohamed, H., Mat Zin, N. A., Rosdi, F., and Mat Diah, N.: Identifying and validating game
839 design   elements   in   serious   game   guideline   for   climate   change,   Heliyon,   8,   e08773,
840 https://doi.org/10.1016/j.heliyon.2022.e08773, 2022.

841 Reckien, D. and Eisenack, K.: Climate Change Gaming on Board and Screen A Review, Simulation & Gaming, 44, 253–271,
842 https://doi.org/10.1177/1046878113480867, 2013.

843 Rodela, R., Ligtenberg, A., and Bosma, R.: Conceptualizing Serious Games as a Learning-Based Intervention in the Context
844 of Natural Resources and Environmental Governance, Water, 11, 245, https://doi.org/10.3390/w11020245, 2019.

845 Rooney-Varga, J. N., Kapmeier, F., Sterman, J. D., Jones, A. P., Putko, M., and Rath, K.: The Climate Action Simulation,
846 Simulation & Gaming, 51, 114–140, https://doi.org/10.1177/1046878119890643, 2020.

847 Rumore, D., Schenk, T., and Susskind, L.: Role-play simulations for climate change adaptation education and engagement,
848 Nature Clim Change, 6, 745–750, https://doi.org/10.1038/nclimate3084, 2016.

849 Seneviratne, S. I., Zhang, X., Adnan, M., Badi, W., Dereczynski, C., Luca, A. D., Ghosh, S., Iskandar, I., Kossin, J., Lewis,
850 S., Otto, F., Pinto, I., Satoh, M., Vicente-Serrano, S. M., Wehner, M., Zhou, B., and Allan, R.: Weather and climate extreme
851 events in a changing climate, edited by: Masson-Delmotte, V. P., Zhai, A., Pirani, S. L., and Connors, C., Cambridge University
852 Press, Cambridge, UK, 1513–1766, 2021.

853 Tsai, J.-C., Liu, S.-Y., Chang, C.-Y., and Chen, S.-Y.: Using a Board Game to Teach about Sustainable Development,
854 Sustainability, 13, 4942, https://doi.org/10.3390/su13094942, 2021.

855 Whitmarsh, L., O'Neill, S., and Lorenzoni, I.: Public engagement with climate change: What do we know and where do we
856 go from here?, International Journal of Media & Cultural Politics, 9, 7–25, https://doi.org/10.1386/macp.9.1.7_1, 2013.

857