# Gameful Interventions for Climate Communication

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# Statement of Originality

I hereby declare that the work undertaken in this thesis has been conducted by me alone, except where indicated in the text. I conducted this work during the period I was a PhD student at the Australian National University. This thesis, in whole or any part of it, has not been submitted to this or any other university for a degree.

December 5, 2024

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# Dedication

To my parents, who unreservedly give me their love and support.

And to Amir, my fellow, my treasure, my sunshine.

# Abstract

Video games can be persuasive assets in climate communication and serve to direct pro-environmental attitudes by engaging players with interactive gameplay, persuasive narratives, and immersive simulated realities. However, there is limited knowledge on how to employ specific game design aspects to influence attitudes in the context of climate change. This thesis investigated how, and to what extent, game design and player experience processes can contribute to effective and creative climate communication. My research developed a conceptual Climate-Oriented Persuasive Edutainment (COPE) model to describe how game design features and elements wrapped in a climate-themed message frame can form player experiences that contribute to pro-environmental attitudes. Employing the model as a criterion, I conducted two parallel within-subjects experiments using two eco-games, where participants were randomly assigned to play either Beyond Blue in Experiment 1 (N=36) or Plasticity in Experiment 2 (N=37). The experiments employed a pre/post-test design with a delayed post-test administered three to five weeks after the intervention. Through collecting a combination of quantitative and qualitative data, this research investigated how, and to what extent, participants' experiences of the intervention's aspects of game design, based on the COPE model, influenced their pro-environmental attitudes. The experiments examined the effects of the interventions' message framing on pro-environmental attitudes, using both explicit and implicit attitude measurements and in three phases (pre-test, post-test, delayed post-test). Furthermore, my research measured the effects of feature-based game design (mechanics, narrative, and animation) and element-based game design on attitudes. The qualitative data (semi-structured interviews and a set of open-ended descriptive survey questions) served to identify patterns and trends to produce themes. The combined quantitative and qualitative evidence aided in framing a set of persuasive design directives (MICRO-GATES). The results showed that both eco-games increased players' pro-environmental cognitive attitudes after gameplay. The findings also revealed that playing Plasticity increased short-term threat perception and long-term positive eco-emotion in participants. By demonstrating the efficacy of persuasive design and environmental message framing in gameful interventions using explicit and implicit measures, this research contributes to the application of interactive technology for effective climate change communication in the short and long term. Also, my work demonstrates that climate communication can benefit from a carefully designed theme-centric, detail-driven video game as an effective creative tool.

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Chapter 1

# Introduction

The variation of the Earth's climate cycles and weather patterns, coupled with dangerous anthropogenic interferences, have destabilised nature's balance, exerting pressure on a plethora of regions (Lee et al., 2023). History shows that neither acknowledging drastic erratic changes in the weather since the 13th century ('Little Ice Age') (Degroot, 2018), nor confirming the carbon dioxide and human activities' connection to the 'climate variability' since the 19th century (Stehr et al., 1995; Feldman, 1992), encouraged societies to take serious actions in solving the 'climate problem' (Le Treut et al., 2007). In fact, it was not until later in the 20th century that the media started making continuous reports on global warming and the greenhouse effect, prompting the public to become wary of climate change and its associated environmental effects (Bhartia and McPeters, 2018; Thompson et al., 2011; Ashmore and Bell, 1991).

The ecological, social, economic, and medical impacts of climate change pose a threat to existential human needs (Lee et al., 2023). Human-induced activities in the last few decades have multiplied and magnified the repercussions of this problem (Stearns, 2012), showing that human beings have become 'geological agents' (Lubowiecki-Vikuk et al., 2021), leaving their damaging trails and footprints on the ecosystems and bio-networks, intensely influencing the Earth. Nevertheless, reports show that we still have the opportunity to mitigate the adverse effects of climate change if we adopt adequate measures to reduce anthropogenic greenhouse gas emissions (O'Neill et al., 2018). Yet, the challenge remains with embedding pro-environmental mindsets and attitudes in people and persuading the public to adopt environmentally friendly lifestyles (Wynes and Nicholas, 2017). While many people report being worried about climate change, only a small percentage practice sustainable routines (Whitmarsh and Capstick, 2018; Lubowiecki-Vikuk et al., 2021).

How the public perceives the climate crisis, and its associated risks is essential in meeting the global objectives of reducing greenhouse gas emissions (Brechin, 2010). The risks posed by climate change are psychologically distant for the public in several ways (Spence et al., 2010, 2012; Milfont, 2010). Due to its complex and long-term impacts, climate change is perceived as an obscure, remote, and inextricable threat (McCright et al.,

2014) and a daunting continuous social dilemma with immense proportions (Van Lange et al., 2018). In facing social dilemmas, individuals must contend with prioritising either their provisional personal gain or the prospective shared interests (Van Lange et al., 2013, 2018). The public's abstract perception of the issue has impeded effective climate communication (Spence et al., 2012, 2010). Experts and educators in different fields, as well as administrators and policymakers, have put an array of efforts to reduce the 'psychological distance' between climate change and people by promoting the matter as a real, evident, imminent, and pressing issue (Spence et al., 2012, 2010).

As an initial attempt at climate communication, conventional knowledge transfer theory argued that the delivery of climate-related scientific facts is the key to motivating the public to get involved with the issue. Nevertheless, this technique did not work as planned (Gustafson and Rice, 2016; Rooney-Varga et al., 2018; McDivitt, 2016), proving that top-down science-focused informational initiatives are not sufficient to improve engagement or eliminate scepticism among people (Whitmarsh et al., 2013). In the execution of risk communication, there has been a growing interest in transitioning from official, hierarchical methods grounded in scientific facts to using informal, creative, and community-centred approaches (Yamori, 2011; Clerveaux et al., 2008). The main appeal of this shift is that such participatory creativity-oriented approaches do not regard the recipients as mere targets or consumers, but rather as collaborative partners in a synergistic learning experience. This tactic embraces the contributions made by the recipients (Roncoli, 2006), making way for different perspectives and a broad range of solutions to emerge (Yamori, 2011). Thus, the focus of some researchers' efforts has been directed towards 'edutainment' methods, where the practicality of education meets the creativity of entertainment to make risk communication (including climate change communication) interesting and engaging (Cordero et al., 2008; Flora et al., 2014). Direct and personal interaction with climate change via playful and social programs was regarded as an effective method to enhance understanding, empathy, and involvement (Senbel et al., 2014; Satchwell, 2013; Ojala, 2012).

## 1.1 Gameplay and Climate Communication

Effectual climate communication requires situations in which people can encounter, perceive, and feel the consequences of climate change in a risk-free and affordable setting, where the experience can augment their degree of attention, concern, and vigilance (Ouariachi et al., 2018b). Experience has been an essential mentor to humans, enhancing our ambient awareness and invoking a variety of emotive responses (e.g., dread, desire, anger, or hope), that guide us towards the best decisions and actions (Rooney-Varga et al., 2018). People tend to re-evaluate their knowledge, views, and priorities through taking

on participatory, engaging, or experience-based learning strategies (Bentz and O'Brien, 2019). Practical experience can form new perspectives and unique modes of thinking and performing (Singh, 2013). Yet, the grave nature of environmental issues makes climate communication researchers opt for simulated experience as opposed to direct physical experience in understanding the urgency of this crisis (Rooney-Varga et al., 2018). A gameful virtual environment can help achieve this objective. Video games are convenient interactive tools that can fulfil the resourceful, creative, and visionary ways needed to approach complicated risk-riddled issues such as climate change and sustainable development (Bontchev et al., 2022; Rooney-Varga et al., 2020, 2018; Rumore et al., 2016; Li et al., 2022). Video games provide the simulated experience crucial to expanding awareness and triggering sentimental responses towards environmental issues because being playful can empower us to tackle formidable and exhausting tasks (Kelly and Nardi, 2014). Play is a broad term that refers to the intrinsic dynamic practice deep-rooted in animals' behaviours, while games are cultural products developed by humankind (Klabbers, 2018). Therefore, games are characterised as a certain form of play that has been elaborately and systematically evolved and enhanced by humans' socio-cultural development (Lange et al., 2018). Digital games, as a type of play, can promote and improve our deep-seated tendency for playful cognitive processes (Lange et al., 2018). Thus, interpretations relevant to play are also broadened to digital games. This project explores how gameplay, as an attractive, innovative, persuasive, and transformative strategy to adapt to different conditions and surroundings (Lange et al., 2018), can contribute to climate communication and pro-environmental attitudes.

Integrating digital gameplay as a medium for climate communication presents considerable potential benefits in improving people's understanding, awareness, and engagement with environmental issues. My research explored the multilayered opportunities of applying video games as a tool for conveying environmentalism, investigating the gameful features and elements' capacity to influence players' attitudes towards climate change. The intent of my research was to develop a comprehensive conceptual model that describes how game design and player experience procedures can facilitate pro-environmental attitudes. Also, through a combination of empirical and theoretical analyses, my academic endeavours aimed to explicate the efficacy of video games in enhancing climate communication. In this project, I referred to gameplay as the distinct way through which players engage and interact with a game. My work investigated video games as popular cultural tools that are built around a central theme to transmit sense and meaning (Baranowski et al., 2008; Salen and Zimmerman, 2005). I argued that their structured and controlled environment has the potential to serve as effective climate communication settings, where players have the luxury of repeated trial and error sessions that make grasping intricate and complicated problems easier (Toh and Kirschner, 2020; Tussyadiah et al., 2018; Baranowski et al., 2008), influencing theme-relevant ideas and attitudes

(De La Hera and Conde-Pumpido, 2013; De La Hera and Raessens, 2021).

Reflecting on the findings revealed that the convergence of gameplay and climate change is thought-provoking in a risk/climate communication aspect. This research also showed that the combination of these subjects can open interesting doors in the fields of persuasive design and attitude studies. Video game features and elements have the flexibility and prospects to portray grave environmental situations with interactive gameplay, relatable scenarios, and immersive virtual worlds. In line with the earlier series of studies on games' persuasive potential (Ouariachi et al., 2018b; De La Hera and Raessens, 2021; Flanagan and Nissenbaum, 2014; Salen and Zimmerman, 2005; Sherrick, 2018; Bogost, 2007), applying gameplay in a persuasive context has the capacity to shape, modify, or reinforce players' attitudes (De La Hera and Raessens, 2021) towards critical matters such as climate change. Therefore, I chose to study gameplay as a creative and persuasive climate communication mediator that has design potentials to influence pro-environmental attitudes. Since attitude development and adaptation are key to better understanding creative learning and complicated issues (Sanbonmatsu and Fazio, 1990), this project is concerned with whether and how climate-themed gameplay, and its design features/elements, relate to players' explicit and implicit pro-environmental attitudes in both short and long intervals.

In a mixed-method approach, I studied how certain experiences of gameful persuasive design could impact the varieties of attitudinal effects via video games. My work also evaluated the importance of effective persuasive design in high-risk climate-focused contexts and how subtle differences in game design can direct audiences' pro-environmental attitudes. This project advanced recent dialogue on persuasive game design, climate change communications, and attitude studies. In the project, I differentiated between the notions of 'the virtual' and 'the material', as an alternative to 'the virtual' and 'the real'. This distinction is to affirm that virtual interactions are another form and kind of reality experienced in another level and setting (Harmon, 2011). Additionally, this research investigated how understanding attitudes helps us comprehend the details and subtleties of edutainment-based learning and persuasion processes that can eventually facilitate climate communication. My work also highlighted how video games, as cultural popular artefacts, can serve as suitable tools in this transformative journey.

In this thesis, I use the terms 'climate-themed game/gameplay' and 'eco-game/gameplay' interchangeably to refer to video games with climate and environmental themes/messages that concentrate on the essential factors, repercussions, and reactions to climate change (Wu and Lee, 2015), spanning topics from international climate policy (Waddington and Fennewald, 2018) to diminishing insect populations (Newsome, 2020). Also, I define 'gameful interventions' as digital or non-digital interactions/means that incorporate elements of games, gamification, or playful approaches to foster player engagement. In this

research, my work focuses only on video games as digital gameful interventions.

## 1.2 Research Gaps, Aims, and Questions

Despite the growing interest in creating games that employ various persuasive mechanisms (Peng et al., 2010) and a range of studies on whether video games can impact social matters (Ruggiero, 2015; Barthel, 2013; Bogost, 2007), there is a notable literature gap on how game features and elements contribute to the process of persuasion and attitude change (De La Hera and Raessens, 2021). Even with an increasing volume of persuasive game studies in the health domain (Griffiths et al., 2017; Orji et al., 2017) and standards of living (DeSmet et al., 2014; Johnson et al., 2016; Kracht et al., 2020) or pedagogical purposes (Barr, 2017; Dishon and Kafai, 2022; Ravyse et al., 2017), research targeting social change (Jacobs, 2018; Klimmt, 2009) and their role in attitude formation or modification is inadequate (Ruggiero, 2015; Soekarjo and Oostendorp, 2015). Additionally, limited empirical work has been done on video games and attitude change (Whitby et al., 2019). There are also insufficient studies targeting the issue in the context of climate change and sustainability challenges. On top of these gaps, there is a lack of models or frameworks that explain the processes and define the design factors involved in how video games have the potential to target players' pro-environmental attitudes. To address the identified gaps, I asked: **How can we improve gameful design for effective climate communication?** To unravel this question, a series of research questions were formed:

- **RQ1-** How can game design and player experience processes impact pro-environmental attitudes?
- **RQ2-** To what extent can a climate-themed gameful intervention effect pro-environmental attitudes?
- **RQ3-** On what attitudinal levels can persuasive climate-themed games influence players?
- **RQ4-** Which gameful features and elements can predict pro-environmental attitudes?

I employed a combination of quantitative and qualitative measures to approach these questions. First, a cross-disciplinary and multi-disciplinary literature review in the fields of design, persuasion, attitude, and climate communication studies served to devise a Climate-Oriented Persuasive Edutainment (COPE) model, which conceptualises the effective design and player experience procedures necessary to influence pro-environmental attitudes. Employing the model as a criterion, then, I used two climate-themed avatar-based video games, **Beyond Blue** and **Plasticity**, as case studies to assess their environ-

mental potential on both implicit and explicit attitudes in a pre-test/post-test/delayed post-test experiment design. As exploratory goals, my research also 1) examined the between-subjects distinctions between the message design and framing mechanisms employed in the two experiential interventional games, and 2) tested how and to what extent participants' experiences of different design factors were associated with different aspects of pro-environmental attitudes.

Through these two parallel within-subjects interventional experiments, this project examined the effects of Beyond Blue ($N = 36$) and Plasticity ($N = 37$) and measured their overall pro-environmental persuasiveness, with implications of their message framing techniques. Furthermore, to reveal the nuances of climate communication and pro-environmental attitude prediction via digital games, this research went beyond the overall persuasive potency of the interventions and assessed game design decisions on two levels: 1) a **feature-based** design that targeted the three main aspects of game design (mechanics, narrative, animation), and 2) an **element-based** design that broke each feature into more detailed elements to address their contribution to participants' attitudes. My work examined the persuasive communicative strategies on both implicit and explicit attitude levels in both the short-term and long-term by comparing pre-test, post-test, and delayed post-test responses to the two gameful interventions. In addition, this project explored various impacts of the two differently designed gameful interventions on their players' perceptions of the message frames. My research also evaluated how different game design features and elements can predict different layers of players' pro-environmental attitudes. The exploratory goals assisted as a starting point towards acquiring an in-depth knowledge of climate-themed game design. Moreover, interviews and a set of descriptive questions embedded in the survey were my qualitative measures to further explore and explain nuances of my topic. The main goal of the qualitative approach was to complement the quantitative method and help identify the shortcomings and strong points of the interventions' design.

## 1.3 Thesis Statement

This thesis argues how video games can be persuasive assets in pressing matters such as climate communication and serve to direct pro-environmental attitudes by engaging players with interactive gameplay, persuasive narratives, and immersive simulated realities. Thus, I argue how the interactive mechanics, persuasive narrative, immersive animation, and framing message design are integral in creating games. The central argument revolves around how the combination of these design aspects helps to evaluate and design effective games that can direct players' attitudes toward critical topics (e.g., environmental issues). Through developing the Climate-Oriented Persuasive Edutainment (COPE)

model, my project conceptualises the efficient design and player experience procedures necessary for successful climate communication to influence pro-environmental attitudes. A combination of theoretical and empirical evidence (in both short and long term) will support my arguments. Through the quantitative and qualitative findings, the thesis further develops persuasive steps (MICROGATES) as specified action-based design instructions to explain how a combination of macro and micro persuasion is essential to understand and implement effective eco-design.

## 1.4 Contributions

My research contributed to the literature on attitude, persuasion, climate communication, and game studies in several ways. My work demonstrated how digital gameplay could provide a setting to study the underexplored creative persuasive design necessary for successful risk and climate communication. Drawing from a multi-disciplinary literature (Prospect Theory (Kahneman and Tversky, 1979), Framing Effect (Tversky and Kahneman, 1986, 1981), Procedural Rhetoric (Bogost, 2007), Narrative Persuasion (Green and Brock, 2000; Appel and Richter, 2010; Murphy et al., 2013), and Immersion (Mcmahan, 2003; Ryan, 2003)), in my research, I developed a Climate-Oriented Persuasive Edutainment (COPE) model, which incorporates the message frame, mechanics, narrative, and animation design aspects into attitudinal evaluation. This model theorises the effective design and player experience processes needed to impact pro-environmental attitudes. Through a mixed methodology, I showcased how and to what extent the design aspects and message framing techniques of climate-themed perspective-taking gameplay in a simulation (Beyond Blue, 2020) and a puzzle-platformer (Plasticity, 2019) impacted players' pro-environmental attitudes. I further demonstrated the extent the two games' design features (mechanics, narrative, and animation) and nuances in their elemental design related to player attitudes. Evaluating the long-term and implicit layer of attitudes (in addition to the short-term and explicit attitudes) in my methodology added to the depth of experimental designs in game-based attitudinal studies. Through a combination of quantitative and qualitative findings, this project displayed how subtle differences in theme-centred design factors and message framing mechanisms could influence (or not influence) different layers of pro-environmental attitudes. It also demonstrated how an effective message framing technique could benefit from a balanced dosage of pessimism (conveying the sense of tension, apprehension, or menace) and optimism (transmitting the senses of empowerment, hope, and engagement) to generate long-term effects. My empirical and qualitative data analyses unpacked the strengths and shortcomings of the intervention's design aspects, which produced a series of design recommendations and a 10-step set of design directives (MICROGATES) on how to promote promising persuasive outcomes in a risk-related gameful setting.

## 1.5 Thesis Structure

This project investigated digital games as potential climate communication tools for engaging the public with the pressing ecological crisis. I examined how video games can offer a crucial setting in which to expand current human-computer interaction conceptions of climate change dialogue in ways that reveal important and often underexplored research opportunities. This chapter has shed light on the wider relevance of research on video games and persuasive design within the context of pro-environmental attitudes and climate communication studies. Specifically, I explored the challenges of engaging the public with the risks of climate change and described how video games could work as experimental settings and experience-focused arenas in climate communication, highlighting the potential they hold in this matter. This chapter also defined the research questions, exploratory goals, methodological approach, contributions, and my objectives for conducting this research. Here is a synopsis of the thesis structure:

- **Chapter 2** presents an interdisciplinary literature review, simultaneously defining some terms and notions, shedding light on backgrounds, and identifying methodological gaps and research opportunities. In this chapter, I provide an analysis of the risk/climate communication literature, describe persuasive games as a format, and introduce the climate-themed (eco-game) genre and its historical and industrial backgrounds. I also define attitude and its different aspects and discuss the research potential and literature gaps where the fields of climate communication, attitude, persuasion, and game studies collide.
- **Chapter 3** presents the Climate-Oriented Persuasive Edutainment (COPE) model that can be implemented to inform successful climate communication. In this chapter, I develop the connection between game design and persuasive strategies, opening arguments on how designing gameful messages, mechanics, narrative, and animation aspects can contribute to pro-environmental attitudes. I also describe the conceptual basis and theoretical frameworks behind my model necessary for the experiments. Through an extensive review and in-depth synthesis of literature (Prospect Theory, Framing Effect, Procedural Rhetoric, Narrative Persuasion, Immersion), I propose COPE as a multi-stage model with key qualities that serve as potential indicators of how video games can influence pro-environmental attitudes.
- **Chapter 4** presents the research methodology, procedure, and measures (quantitative and qualitative) that allowed me to address the research questions and exploratory goals. In this chapter, I introduce and justify the interventions used in the project and rationalise the hypotheses around each experiment.
- **Chapter 5** presents the quantitative data analyses and results.
- **Chapter 6** presents the qualitative data analyses and results.

- **Chapter 7** presents my discussions on the findings, their implications, how they are embedded in the existing literature, and how they address the hypotheses. I also discuss the limitations of the project as well as potential for future studies.
- **Chapter 8** presents a series of design implications learnt from the project, including a series of design recommendations and a set of design directives (MICROGATES), working as a blueprint with multiple micro strategies to facilitate the processes of persuasion in gameplay.
- **Chapter 9** presents my concluding thoughts and final remarks.

Chapter 2

# Literature Review

The heavy costs of climate change for the local and global biomes, communities, and economies make clear that we must communicate its grave impacts in the hopes of inspiring strong global action on the problem. Effective communication on climate change is essential to advance public understanding, ignite sustainable action, and initiate the policies needed to meet emissions targets. Nevertheless, the complexities of climate communication stem from its diverse and complex nature. Climate communication is a multidisciplinary field of research, nourished by different scientific domains and distributed across various areas of studies. Navigating this field requires a sophisticated approach reflecting multifaceted scientific ideas, creative views, and socio-economic standpoints. In my research, I aimed to understand digital gameplay potential in climate communication. To achieve this aim, I drew knowledge from a range of fields including risk studies, climate communication, attitude studies, persuasion studies, gameful design, and player/user experience domain to find my answers (see Figure 2.1).

At its core, my research topic is where the game, attitude, persuasion, user experience, and climate/risk communication converge. Understanding the link between game design and climate communication led me to first seek how the risk literature and climate communication studies, as two interconnected fields, can rely on persuasive interventions to influence attitudes. Indicating how embedding topic-relevant persuasive themes in virtual gameplay can impact players' attitudes led me to investigate the historical and industrial context of the eco-game genre in the video game industry. An introduction to persuasive technology and persuasive video games made provision for how persuasive processes impact attitudes, the definition of attitude and its different aspects, including pro-environmental attitudes, as well as debates around the process of attitude formation and modification. The overlap of game studies with the fields of persuasion and attitude studies also revealed some methodological gaps and experimentation opportunities that can advance climate communication research. Furthermore, learning the research capacity and methodological gaps in studies measuring attitudes using gameful interventions and persuasive design helped me to form a suitable inclusive methodology that can cover the multi-layered facets of climate communication and pro-environmental attitudes.

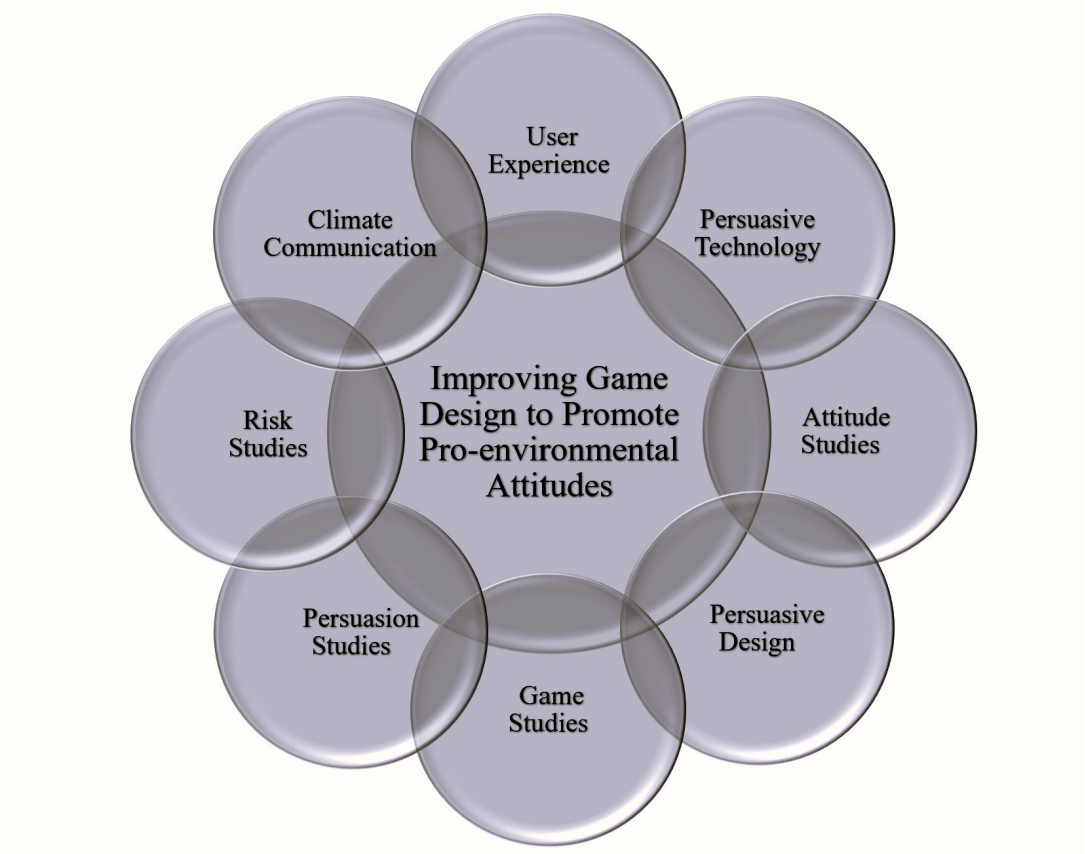


**Figure 2.1**: The Interdisciplinary Nature of this Project

## 2.1 Risk and Climate Communication

The increasing local and global environmental risk events of the late 1970s and early 1980s led to an increasing demand to inform and train the public about existing and imminent ecological and health risks, giving prominence to risk communication (Plough and Krimsky, 2013; Heath and O'Hair, 2010; Gurabardhi et al., 2004). Risk communication is a dynamic procedure in which the involved parties trade knowledge of risk to bridge the information gap between specialists and non-specialists (National Research Council (U.S.). Committee on Risk Perception and Communication, 1989). Risk communication is imperative as it allows individuals to make educated decisions and impacts public understanding of, and reaction to, various threats (Renn, 2020). The initial approach of risk communication was based on a 'deficit model' where communication efforts pointed to justify scientific facts about risk factors to target recipients with reliable, authoritative information (Hilgartner, 1990; Frewer, 2004). In this phase, specialists and authorities delivered technical and statistical risk information to the public (Frewer, 2004). The logic behind this approach was that through actualising the sources, chances, and impacts of risks, people and communities could apply the necessary measures to mitigate the potential for harm (Heath and O'Hair, 2010). This push strategy was later found to be ineffective at engaging the public with the depicted issues, highlighting the urgent

need for more persuasive risk communication models (Höppner et al., 2012; Sellnow and Sellnow, 2010; Frewer, 2004). Researchers started to argue that gaining information does not automatically lead to understanding. Instead, the best way to communicate risk is through a reciprocal and bidirectional process (Sellnow and Sellnow, 2010; Höppner et al., 2012; Frewer, 2004).

Climate communication is a focused subdivision within the greater field of risk communication, concentrating on the details and distinctions of conveying knowledge and understanding about climate change. Climate communication also draws knowledge from a broad range of scientific, aesthetic, social, and philosophical studies. Following the risk literature, initial climate communication studies assumed that facts alone would break the barriers of awareness and action between the issue and people, and thus mainly concentrated on promoting knowledge and clarifying the science of climate change (Rosentrater et al., 2013). However, soon it became evident that although scientific insight and training should not decline (Simonet and Fatorić, 2016), Science is not sufficient to build solidarity between humans and other inhabitants of the earth with whom we share climate-linked repercussions (Germaine, 2023) as scientific facts alone do not stir motivation towards taking the necessary steps (Rosentrater et al., 2013).

Encouraging people to act on climate change is a critical challenge in climate communication. A wide range of recipient-focused studies emerged, targeting factors that influence the formation of motivation (Howell and Allen, 2017; Howell, 2013; Van der Werff et al., 2013; Brick et al., 2021), with an emphasis on decision-making and how the unpredictability of such issues can impact the way we can communicate them (Capstick and Pidgeon, 2014; Haltinner and Sarathchandra, 2021; Orlove et al., 2020; Poortinga et al., 2011). Therefore, the literature saw a transition towards enabling and stimulating action (Bain et al., 2016; Milfont, 2012; Busch et al., 2019; Sinatra et al., 2012; Poumadère et al., 2011; Kolenatý et al., 2022). Additionally, to express and visualise the intricacies of the Earth's climate cycle, along with the sources and reasons for climate change, some climate communication scholars adjusted their research priorities to focus on addressing the implications and practicalities of innovative communication tools in this field (Ballantyne et al., 2016; Schroth et al., 2014; Walsh, 2015). This body of research put its focus on graphical, interactive, and recipient-focused strategies using creative formats such as narrative (Miller et al., 2015; Moezzi et al., 2017; Veland et al., 2018; Bowman and Germaine, 2022; Bowman et al., 2024) and playful tools (van Beek et al., 2022; Vervoort et al., 2022; Germaine, 2023; Galeote et al., 2021; Rooney-Varga et al., 2018, 2020; Rumore et al., 2016; Lee et al., 2013; Barreto et al., 2013) to communicate climate change through planning and decision-making exercises.

As researchers stepped away from a one-sided communication approach that focused on plugging deficits in knowledge and inclined towards more dialogue-based forms of com-

munication for climate change (Pearce et al., 2015), we observed studies exemplifying how the latter approach can contribute to recipients' motivation, expand their mindsets, nurture sympathy and empathy, as well as guide views, values, and attitudes (Orji et al., 2018; Ojala, 2012; Barreto et al., 2013; Ouariachi et al., 2020; Kwok, 2019; Germaine, 2023). Using creative methods and edutainment approaches, scholars are also giving momentum to the concepts of hopefulness, optimism, and positive sentiments in climate communication (Marlon et al., 2019; Ojala, 2023, 2012; Chadwick, 2015). However, one of the most notable gaps in the literature is understanding and measuring the long-term engagement and effect of climate communication on people. There has been a call for more research on this aspect and recognising ways for continued engagement on multi-faceted and bleak topics like climate change, particularly with the younger generation and vulnerable groups (Orji et al., 2018; Goldberg et al., 2020; Howell, 2014; Hauk, 2015; Riebel, 2015).

Nowadays, the focus of risk/climate communication studies is on communication tools and persuasive technologies that manage the flow of data, increase awareness, drive responses and consequently improve the validity and adequacy of risk/climate communication (Ogie et al., 2018; Kar, 2016; Lee et al., 2019; Anniés et al., 2023). Nonetheless, one of the prevalent concerns among experts is the incorporation of humane aspects of risk communication (e.g., trust, intuition, previous experiences, social cues, cultural background, or personal challenges (Schiavo et al., 2022; Khan et al., 2017; Balog-Way et al., 2020; Engdahl and Lidskog, 2014)) into technological tools. Because digital games can convey the message of climate change in a creative and persuasive way, they are uniquely placed to address climate communication. In this thesis, I investigate video games' potential as a technological tool in climate communication and explore the short and long-term effect of eco-games on players' pro-environmental attitudes.

## 2.2 Games as Persuasive Tools

The case of employing persuasive technology has enticed much curiosity and enthusiasm from both researchers and practitioners since the introduction of 'captology' (the study of Computers As Persuasive Technology) by BJ Fogg in the 1990s (Fogg, 1998). Research in the domain of captology discusses the prospect and concerns associated with using technology for persuasion. Persuasive technology is an interactive form of information technology intended to alter users' attitudes or behaviours without deception or compulsion (Fogg, 2003c). Persuasive technology has been employed in a broad spectrum of scientific endeavours, including higher education (Orji et al., 2019a; Widyasari et al., 2019), tourism (Kim et al., 2016; Vičič and Šukljan, 2016), marketing (Wang et al., 2023; Nkwo and Orji, 2018), health care (Schoufour et al., 2021; Matthews et al., 2016;

Orji and Moffatt, 2018; Specker Sullivan and Reiner, 2021), and military (Hirst, 2022) domains.

Video games have solidified their place in social communication and entertainment over the past few decades, becoming characterised as a mounting, multinational, and multifarious market (Patterson et al., 2017). One key advantage of these gameful platforms is the ability to demonstrate alternative worlds and create virtual immersion opportunities. Part of alerting people to the climate crisis is to help them feel the consequences of climate change to enhance their attention, interest, and willingness to act. Video games can create the right setting for players to experience this impact and encourage pro-environmental attitudes (Ouariachi et al., 2018b,a). By allowing people to have their own experiences in a virtual world, video games can create compelling learning experiences to direct players' views and actions (Toh and Kirschner, 2020; Tussyadiah et al., 2018; Baranowski et al., 2008). Taking the perspective of an avatar can provide active learning as players can directly take part in the game scenario and gain first-hand experience through a virtual avatar in a mediated setting dealing with various situations that might not be possible in the present real world (Li et al., 2022; Freeman et al., 2020; Song et al., 2013).

The capability to learn from one's own experience through a simulated depiction of the self or avatar, is a potent quality of video games that can help people experience the consequences of their decisions and learn from their own mistakes in a low-risk simulated environment (Fox and Bailenson, 2009; Rheu et al., 2020; Song et al., 2013). This feature can be applied in a persuasive context (perspective-taking as an act of observing a situation or comprehending an issue from a different point of view), impacting the formation, reinforcement, and modification of attitudes towards the content depicted in gameplay (De La Hera and Raessens, 2021). That is why some scholars see digital games as meaningful cultural objects that, regardless of their developers' initial goal, always send a message (Baranowski et al., 2008; Salen and Zimmerman, 2005). They assert games have the power to induce action or ideas, and can be used to purposefully impact players' attitudes or behaviours (Ouariachi et al., 2018b; De La Hera and Raessens, 2021; Flanagan and Nissenbaum, 2014; Sherrick, 2018).

Video games put considerable attention on employing designs and simulated settings to pursue their desired goals and messages. Scholars using gameful tools have observed a broad range of motivational, affective, cognitive, and behavioural influences (Aldenaini et al., 2020; Boyle et al., 2016). Video games have the capacity to operate as an optimal forum for altering attitudes and behaviours by integrating persuasive designs and strategies into their structure (Bogost, 2007). The interest to use gameful interactive platforms with persuasive visions and approaches gave rise to a genre known as persuasive games, which has been the subject of scholarly inquiry in various cases and varying implications, for the past few decades. Persuasive games are established as a form that shares a com-

mon goal; to shape, change, or reinforce a set of attitudes among their players and impact their beliefs, opinions, and knowledge on the presented topic (De la Hera et al., 2017; Jacobs, 2018).

For centuries, humans have employed play and games to improve essential skills (Lange et al., 2018). One of the earliest recorded examples of games devised to modify attitudes and behaviours is a British board game titled 'The New Game of Human Life' in 1790. In the game, parents were urged to provide their children with moral and astute observations about each character as they progressed through the game. The goal was to compare the blessings of leading a virtuous and well-spent life with the cynical effects of committing sinful and malicious actions (Norcia, 2019; Wood, 2018). In 1843, another board game with persuasive intent, 'Mansion of Happiness', was released in the United States, containing instructions to guide players in making good and moral decisions to acquire the seat of happiness (Donovan, 2018; Whitehill, 2015). The second part of the 20th century saw a remarkable boost in the popularity of multiplayer simulations and the production of several war board games (specifically targeting the Cold War) with educational pursuits and persuasive objectives (Emery, 2021; Sprengeler, 2013).

Multiple classic games contain underlying motifs that have gone unnoticed by a substantial portion of their players (Flanagan, 2009). Yet, persuasive games have not acquired proper academic recognition until recently, when some researchers took on the task of validating this genre (e.g., (Peng et al., 2010; Alhabash and Wise, 2015; Barthel, 2013)). Persuasive games are evolving as a prominent part of the video game industry, drawing the attention of the media (Lavender, 2007) and scholars (e.g., (Bogost, 2007; Orji and Moffatt, 2018; De la Hera Conde-Pumpido, 2017)) in both commercial and indie sectors. An overview of how cultivating issue-focused motifs and themes have been used to influence players, in this section, has served as an initial step towards understanding the persuasive genre. Next, I will review how climate communication meets game studies. Specifically, I give a historical review of how environmental and climate-oriented themes worked in the video game industry to describe the start and development of the climate-themed genre (also known as eco-games).

## 2.3 Climate Communication Meets Game Studies: Eco-games

Regardless of their primary intentions, climate-themed games have an underlying persuasive message embedded in their design. Video games with climate themes concentrate on the essential factors, repercussions, and reactions to climate change (Wu and Lee, 2015), spanning topics from international climate policy (Waddington and Fennewald, 2018) to diminishing insect populations (Newsome, 2020). The employment and promo-

tion of a wide range of examples in this genre have inspired collaboration among Human Computer Interaction (HCI) sectors, game experts, non-profit organisations, and businesses (Moulder et al., 2018). Students have also contributed to the field by making some decent-quality climate-themed games (Troiano et al., 2020). Evaluation of underlying environmental themes in recent decades demonstrates the emergence and growth of this game format. While Ulrich (1997) identified only five relevant games, Reckien and Eisenack (2013) reported 52 games with environmental and climate themes, Gerber et al. (2019) found 95 games in this genre, and Galeote et al. (2021) documented 150 games, including both the serious ($n = 109$) and entertainment ($n = 41$) formats. The appraisal of a combination of technical, historical, and political circumstances can help further comprehend the rise and development of environmentalism in the video game industry.

So, let us explore the late eighties, when the conclusion of the Cold War was perceived as a news vacuum in the political press and the threat of climate change was seen as an opportunity to fill that void (Riendeau, 2017; Koebler, 2017). By the end of the 1980s, attempts to raise public awareness about the consequences of climate change had progressed, elevating this issue to the political and popular discourse on a global scale. The new decade accelerated political action that further changed the media representation of the matter. The Earth Summit conference was held in June 1992 in Rio de Janeiro, Brazil. The next global-scale treaty was the United Nations Framework Convention on Climate Change (UNFCCC) on 21 March 1994 (Alwin and Penz, 2018; Dryzek et al., 2011). Then, the Kyoto Protocol was signed by 160 countries in 1997, binding collaborating countries to reduce their greenhouse gases to an agreed level. This agreement was based on scientific proof that global warming was happening and that human-caused emissions played a significant role in causing it (Zillman, 2009; Moser, 2010).

Consequently, as a market strategy, the video game industry also embraced the opportunity in converting the subject into its game content, depicting the prevalence of this ecological menace in different forms. One of the first recorded examples in this era is the early colony simulation game 'M.U.L.E.' (1983), as strategy games gradually found a venue on home computers (Wolf, 2008). In the game, random weather circumstances, such as cosmic storms, can have unforeseen effects on the player's settlements. Another early example with environmental tones is a video game titled 'Growl' (1990), where the player is tasked with acting as a forest ranger assigned to stop illegal trafficking and killing of wildlife (Museum of the Game, 1991). With the introduction of home consoles, game designers had the chance to focus more on telling stories in their games, which paved the way for climate-themed narratives. The competition between Sega and Nintendo, known as one of the major 'console wars' in video game history, set the stage for experimenting with environmental tones in a handful of early Sega Genesis titles (Harris, 2014; Kent,

2001). Video games of this era depicted climate change more subtly, using adventure elements as their gameplay device. These games would encourage players to rejuvenate the ecosystem by introducing opponents who jeopardise the natural balance (e.g., 'Sonic 2' (1992), 'Ecco the Dolphin' (1992), 'Awesome Possum... Kicks Dr Machino's Butt' (1993), or 'Vectorman' (1995)) (Op De Beke et al., 2024b; Davis, 2022).

Ecological views and sustainability themes have long impacted gameplay in commercial game series, such as 'SimCity' (Andrade, 2020). In SimCity (1989), the player is given the task of maintaining a place where the main objective is to balance city-planning and manufacturing plans with energy resources and environmental impacts. Unlike SimCity, which concentrated on a single scenario in a single city, 'SimEarth' (1990) enabled the player to control the evolution of a planet (Op De Beke et al., 2024a). 'Sid Meier's Civilisation' (MicroProse, 1991) also incorporated strong environmental themes and narratives, revolving around tackling the long-term impacts of global warming (Makai, 2023). However, the predominant audiences were not interested in the difficulties that the game offered. Therefore, in the subsequent instalments, the series simplified the gameplay around environmental crises in an attempt to make it accessible to a larger number of people. Eventually, they went so far as to refrain from including climate-themed gameplay at all in their later games (Capps, 2016).

The science of climate change began getting politicised by the early 2000s (Painter and Ashe, 2012; Farrell, 2016), marking a paradigm shift in the gaming industry. In the late nineties, when world leaders came together in Kyoto, Japan, to discuss the limitation and reduction of greenhouse gases (GHG), game makers started experimenting with the notion of radical environmentalism in the form of 'eco-terrorism' (Spadaro, 2020; Loadenthal, 2017). As a means to intimidate or coerce administrations or civilians, 'eco-terrorism', also known as 'ecological terrorism' or 'environmental terrorism', refers to the demolition, or threat of demolition of the environment by states, groups, or individuals (da Silva, 2020; Loadenthal, 2017; Spadaro, 2020). Using malicious measures, including parcel bombs, sieges, arson, or property wreckage, these organisations diffuse their ideas to a broad variety of the public to mandate their version of environmental conservation (Spadaro, 2020; da Silva, 2020; Loadenthal, 2017). An example of eco-terrorism is 'Final Fantasy VII' (1997), which broke from a commercially successful lineage of mediaeval and fantasy-themed series, depicting an environmental terrorist group (Davis, 2022). 'Metal Gear Solid 2: Sons of Liberty' (2001) is another instance that sheds light on the much-needed responsibilities involved in oil drilling (Davis, 2022). This era saw gloomy apocalyptic futures become the dominant settings of the video game industry, laying the foundation for the dark post-apocalyptic setting of games like the first 'Fallout' (1997), where the governments bring a pessimistic environmental end to the world, and 'Sid Meier's Alpha Centauri' (1999), where the Earth is destroyed and players should go to other parts of

the galaxy to find haven (Murray, 2024; Stephens, 2023).

With the decline of home video game consoles in the late 20th century and the expansion of the digital gaming industry to more affordable and convenient platforms, where wider dissemination of digital games was possible, independent (indie) game developers emerged (Wardyga, 2023). By not being tied to major game companies, these indie developers were free to go beyond the limits (Parker, 2020). These low-budget and crowdsourced games had the capacity to explore controversial aspects of climate change and even left room for an educational angle for the public (Darvasi, 2014). Indie developers had the chance to experiment with new ways of communicating the environmental message. For example, 'Flower' (2007) is an independent (indie) game example where symbolism is used to indicate the advantages of renewable energies and environmental revival (Chen and Santiago, 2013). Also, satirical games can deliver new and entertaining outlooks on environmental problems. An example in this category is 'Pipe Trouble' (2013), an arcade-style game that lets players establish oil pipelines over fields. The game's screen splits in two, with a farmer on the left asking you to leave the land and an oil manager on the right urging you to establish additional pipelines. The game drew criticism for mocking eco-terrorism as some radical acts, such as bombings, are shown by the non-player characters (McGuire, 2013).

Soon, universities and institutions began experimenting with video games as a pedagogy tool. They even created their own digital games, where scientific environmental data were used to educate players. For example, 'Fate of the World' (2011) was made in collaboration with Oxford University, based on climate prediction models (Yanes, 2019). 'Future Delta 2.0' (2015), by the University of British Columbia, is a location-based educational video game, investigating climate change challenges and resolutions (Angel et al., 2015). Also, simulations available on websites such as 'Climate Interactive' allowed for processing variables such as energy use and population growth to model the effects on global climate (Ouariachi et al., 2017). Moreover, mobile games like 'Climate Mission 3D' (2018), enabled players to learn how to reduce their carbon footprint as they engaged in a series of minigames (Ouariachi et al., 2017). Climate-related academic-based games continuously evolved, especially in an online format, with examples like 'reClim'Way' (2010), 'BBC Climate Challenge' (2010), 'EnerCities' (2011), and 'CityOne' (2011) (Ouariachi et al., 2021). In the meantime, a flourishing community of academics at the University of Washington started testing serious gameplay through an initiative called 'Earth Games UW' (Kwok, 2019). In 2016, they started creating a variety of short climate-centred mobile games, one of which being 'Climate Quest' (2016). They did this project as a response to a user engagement gap in the climate-themed genre (Fernández Galeote and Hamari, 2021).

On the other hand, some developers incorporated adventure and roleplay elements into

their games, enabling the player to personally encounter the environmental crisis in nature and become emotionally invested in the problem (Op De Beke et al., 2024a; Davis, 2022). Taking the perspective of non-humans was a clever trick used in some designs. 'Shelter' (2013) is a survival game where the player is a badger mother who needs to take her cubs to another den. The gameplay describes the struggles to survive while exposed to natural or man-made risks (Chambers 2013). 'Rain World' (2017) employs a similar approach by putting a slugcat in a post-apocalyptic future with dramatically limited resources. The gameplay design was to make the player decide whether to fight rivals over rare resources or to evade fighting and continue foraging (Cook 2014). 'Bee Simulator' (2020) aims to let players see the world via a bee's point of view. The aim is to highlight the value of bees in the ecosystem. 'Endling: Extinction is Forever' (2022) is a survival adventure game where the player takes the role of a fox mother (the last survivor of its species) who goes through the dystopian future with her three cubs. The experience of an exploited Earth, lacking resources is moving and emotional (Op De Beke et al., 2024a; Davis, 2022).

As developers kept creating new strategies for cultivating active learning to raise environmental awareness, sandboxing (Frohlich et al., 2018; Breslin, 2009) became another trend in climate-themed games. This design is a type of game development that encourages unstructured play by using flexible rules and loose objectives, where engagement and experimentation are the focus (Frohlich et al., 2018; Breslin, 2009). 'Minecraft' (2011) is a highly successful indie case in this category. In its educational version, 'Climate Hope City', the environment serves as an interactive, enjoyable, and informative element for users to explore and understand how to create and manage a sustainable and low-carbon system (Stuart, 2015). 'Eco' (2018) is a simulation game similar to Minecraft that enables players to build a new world, fostering the conscientious application of natural resources (Parlock, 2017). Another well-known example is 'Block'hood' (2017), an urban building game that was inspired by the harmony of resources versus demands (Parlock, 2017). Concurrently, commercial games have seen a new surge of environmental themes. 'Horizon Zero Dawn' (2017) used climate change as a background story to appeal to the market. The game depicted a post-apocalyptic future, with references to a fictional historical past (our modern present) (Abraham and Jayemanne, 2017). The 'Sims 4: Eco Lifestyle' (2020) is an expansion pack for 'The Sims 4', with several significant new sustainable-focused elements (Stanitsas et al., 2019). 'Beyond Blue' (2020) is an exploration game created to draw attention to the magnificence of submarine life (Maher, 2020), while simultaneously highlighting how ephemeral this marvellous underwater world is.

Reviewing this short literature reveals that, apart from the limited focus on environmentalism in attitudinal game studies, the study of climate change representations in commercial climate-themed games specifically has been scarce in scholarly discourse. As

a result, we have a limited understanding of the ways games designed for entertainment and commercial purposes work in this domain and the extent to which they can effectively hook players. In this project, I chose two video games for the interventional studies: one with a commercial basis (Beyond Blue) and the other with indie roots (Plasticity). This way, I had representatives from both parties, which gave me the opportunity to discuss their specific design choices in more details, keeping their production context in mind. As previously stated, the objective of persuasion processes is to influence attitudes or behaviours. Thus, in the next section, it is essential to define attitude and describe its different aspects to further understand transformative operations.

## 2.4 Climate Communication Meets Attitude Studies

Understanding attitudes, views, beliefs, and values has become a key emphasis when studying climate communication (Markowitz et al., 2014; Crompton and Lennon, 2018; Price et al., 2014; Barreto et al., 2013). Relevant climate communication literature reasons that our interpretation and evaluation of our surroundings are swayed by the attitudes, values, and views we have acquired from our society and culture (Weber, 2010; Adams, 2021). This influence is inevitable, but we can become mindful of it and dynamically inspect and recognise it. Also, our attitudes, views, beliefs, and values impact how we observe and understand climate change, as well as our determination to accept climate science (Milfont, 2010; Sinatra et al., 2012). Notably, our attitudes and beliefs also play a vital role in verifying whether we find projected behavioural adjustments, technological remedies, or enforced environmental regulations acceptable (Ballantyne et al., 2016; Bilandzic et al., 2017; Walsh, 2015; Bostrom et al., 2013). Furthermore, understanding the attitudes and value systems of different audiences can increase the chances of acceptance and motivation to action in various communities (Scannell and Gifford, 2013; Martel-Morin and Lachapelle, 2022; Leiserowitz et al., 2021). This stress on attitudes and values has shaped substantial interest in the efficiency of various messaging systems and technological tools (Bilandzic et al., 2017; Bostrom et al., 2013; Ballantyne et al., 2016; Schroth et al., 2014; Walsh, 2015).

The topic of attitude is arguably one of the most crucial ideas in psychology (Gawronski, 2007). Quantifying attitude was a major turning point in social psychology, establishing avenues for the creation of one of its most indispensable scientific notions (Gawronski, 2007). Attitudes are the cognitions and affects experienced with reference to an object of thought. These thought-objects can vary from the mundane to the abstract, including individuals, groups, entities, and ideas (Bohner and Dickel, 2011). In other words, attitudes are the assessments that incorporate and outline a combination of cognitive and affec-

tive reactions towards different entities (Petty et al., 2005; Holland et al., 2002). Since humans tend to constantly appraise various items and occasions in their surroundings, attitude studies are concerned with exploring different layers of evaluations (Gawronski and Brannon, 2019). Still, scholars have different ideas on the formation and operational aspects of attitudes. In one doctrine, an attitude is defined as a stable and consistent frame of mind, assembled by our long-term memory (Fazio, 2007; Eagly and Chaiken, 2007). While another school of thought regards it as the instantaneous appraisal of an object of thought. They believe attitude to be the product of circumstance-dependent and context-sensitive information and long-term memory knowledge (Gawronski and Bodenhausen, 2007; Schwarz, 2007).

The divergence of these definitions led to the dualistic disposition and layered characteristic of attitudes, catalysing the development of persuasive processes and tools (Crano and Prislin, 2006). The conscious, intentional, and deliberate layer is the explicit attitude (Bassili and Brown, 2005), which mirrors evaluative considerations collected from previous information regarding the thought-object (Bohner and Dickel, 2011; Gawronski and Bodenhausen, 2014). The instinctive and inadvertent layer of attitude is the implicit aspect, which is unconsciously formed (Wilson et al., 2000; Fazio, 1990) and is established on similarity to, or familiarity with previous ideas kept in our mind (Bohner and Dickel, 2011; Gawronski and Bodenhausen, 2014). The examination of both explicit and implicit attitudes enables greater insight into the mechanisms underpinning evaluative judgements, the process that helps direct attitude formation and modification (Gawronski and Brannon, 2019). The Associative-Propositional Evaluation (APE) model illustrates how explicit and implicit attitudes are driven by various, and frequently interplaying, processes (Gawronski and Bodenhausen, 2006; Gawronski, 2007; Gawronski and Bodenhausen, 2014).

According to the dual process APE model, attitudes are formed through associative evaluations and propositional reasoning. Both processes are fundamentally distinctive, but they are interrelated. The model asserts that associative evaluations can be explored using implicit attitude tests (Gawronski and Bodenhausen, 2006, 2014). Associative evaluations serve as the foundation for implicit attitudes and provide an innate and emotive reaction to the thought-objects. Associative evaluations, according to the model, are characterised as the stimulation of conceptual links based on attribute resemblance and coherence (Gawronski and Brannon, 2019). Simply put, implicit attitudes are generated from spontaneous emotive responses to an item derived from its relevance or connection with other concepts in our mind. The APE model indicates that these conceptual links are established within the long-term memory (Gawronski and Payne, 2010), which can be modified when two notions repeatedly appear together. When such Joint existence of two notions happens, it either strengthens an current conceptual link or shapes a new

one. The more strong the link, the more promptly it can be triggered (Gawronski and Brannon, 2019; Gawronski and Payne, 2010). Furthermore, associative evaluations rely on prompt contextual insights to choose what kind of recorded links can be retrieved. Associative evaluations operate separately from what an individual perceives to be factual (Gawronski and Bodenhausen, 2006, 2014).

Propositional reasoning is a conscious process in the APE model and serves as explicit attitudes' foundation (Bohner and Dickel, 2011). This reasoning process uses general and logical knowledge to authenticate the evidence implied by associative evaluations (Bohner and Dickel, 2011; Gawronski and Bodenhausen, 2014; Gawronski and Brannon, 2019). The decisions are determined based on the coherence of the obtained knowledge with other key insights about the item kept in memory. Maintaining two opposing propositional reasonings about one item over an extended period is not feasible (Bohner and Dickel, 2011; Gawronski and Bodenhausen, 2014). As a result, when new propositional reasoning conflicts with previous reasoning, it will drive a person to resolve this inconsistency. This resolution can be achieved either when one of the propositions is rejected or when new knowledge is acquired to address the generated dissonance (Festinger, 1958), leading to a viewpoint modification. Still, it is difficult to capture changes in propositional reasoning via explicit attitude assessments, as personal accounts are limited by people's recall and desire to express their views (Kolek et al., 2019, 2021). Rather, a combination of explicit and implicit attitude measurements can avoid participants' impression management in an effort to look more socially acceptable (Tedeschi, 2013) towards sensitive topics such as climate change and yield more trustworthy results.

This project focuses on how, and to what extent, players' perceptions of environmental issues change following a climate-themed gameplay session. In this context, attitudes play a crucial role in processing complex concepts (Sanbonmatsu and Fazio, 1990) by impacting our information sampling and evaluation (DeMarree et al., 2017; Case and Given, 2016; Vogel and Wanke, 2016) and our analysis of the legitimacy of the presented sources (Van Strien et al., 2016). In addition, knowledge acquisition serves as the primary strategy in attitude development and alteration (Vogel and Wanke, 2016). As such, attitudes are a central focus for comprehending the dynamics behind informal learning (e.g., edutainment schemes) and the roles video games play in the process.

Attitudes influence behaviour (Glasman and Albarracín, 2006), prompting researchers in climate-change communication to pay considerable attention to pro-environmental attitude, as it could anticipate environmental behaviour (Bamberg and Möser, 2007). A pro-environmental attitude is an individual's interest in the natural world (Hawcroft and Milfont, 2010) and represents prevalent beliefs and attitudes regarding nature. For example, someone who has a pro-environmental orientation may hold the attitude that the earth's capacity is limited, the ecosystem must be in balance, humans are a part of

nature, and economic development cannot come at the expense of the natural environment (Dunlap et al., 2000). Virtual gameplay is an innovative way to address pro-environmental attitudes.

## 2.5 Attitude Studies Meets Game Studies

Despite the growing body of research on attitude and video games, the impact of video games on attitude is still not well understood (Soekarjo and Oostendorp, 2015). Most empirical investigations on the topic (e.g., (Tragazikis and Meimaris, 2009; Knol and Vries, 2011; Cuhadar and Kampf, 2014, 2015; Jacobs, 2018; Hawkins et al., 2019)) focus only on examining short-term explicit attitudes, yielding mixed results. The scarcity of studies that focus on implicit attitudes or a combination of explicit and implicit attitudes is due to the demanding requirements for the interpretation of the implicit data obtained, as well as the low availability of free software for testing implicit attitudes (Gerling et al., 2014). Current studies typically adopt a post-test-only methodology concentrating on college or psychology students (e.g., (Saleem and Anderson, 2013; Yang et al., 2014)). However, the introduction of implicit attitude tests (IATs) (Greenwald et al., 1998) has aided the formation of a few video game studies with methodologies that incorporate the intricate nature and various facets of attitudes in their research design. For example, Alblas et al. (2018) used a pre-test/post-test methodology to examine implicit attitudes (as opposed to explicit attitudes) and discovered a substantial group difference. Also, Kampf (2016a) and Ruggiero (2015) measured long-term explicit attitudes in their studies. Furthermore, there are limited studies employing implicit attitude measurements in a longitudinal research design or investigating the long-term effects of gameplay employing both explicit and implicit attitude scales. The study by Kolek et al. (2021) is the only video game study, to the best of my knowledge, that has considered both implicit and explicit attitudes in a combined short and long-term design. Overall, the majority of this array of research has overlooked two critical aspects: the implicit aspect of attitudes, and the long-term impact of gameplay on any kinds of attitudes.

In terms of subject matter, attitudes have been examined in relation to different topics, such as exercise (Kracht et al., 2020), diets and lifestyles (Orji et al., 2017), promoting empathy (Kors et al., 2016, 2018), and cross-cultural or inter-generational relationships (Alencar and De la Hera Conde-Pumpido, 2018; De la Hera et al., 2017). However, few studies have focused on understanding attitudes towards climate change (e.g., (Knol and Vries, 2011; Tragazikis and Meimaris, 2009; Markowitz et al., 2018). Moreover, little is known about persuasive elements in video games, including the impacts of message design and framing on pro-environmental attitudes, or to what extent game design features (mechanics, narrative, animation) or their relevant nuanced elements can predict

attitudes. I aimed to address the identified literature gaps by providing needed empirical and theoretical evidence regarding the effects of climate-themed video games and exploring different gameful and persuasive design strategies on players' explicit and implicit pro-environmental attitudes in the short and long-term.

## 2.6 Persuasion Studies Meets Game Studies

Investigating persuasion in digital games spans a variety of domains in the literature, covering topics such as sociocultural challenges (Pena et al., 2018; Peña and Hernández Pérez, 2019; Yang et al., 2014; Ruggiero, 2015), physical (e.g., dietary choices and health (Barwood et al., 2020; Sharma et al., 2015; Greer et al., 2017), self-efficacy (Chen et al., 2020; Květon and Jelínek, 2019), and mental health (Cangas et al., 2017), or controversial subjects such as domestic violence (e.g., the games 'Power and Control' (Jennifer Ann's Group, 2011) and 'Another Chance' (TimeWizardStudios, 2017)), Israeli-Palestinian conflict (Kampf, 2016b,a; Kampf and Cuhadar, 2015), or sexual violence and bystander intervention (Potter et al., 2021, 2019).

Regardless of the topic, the methodology involved in this type of research is constantly evolving, making room for more questions and opportunities for research. The first wave of persuasive studies focused on understanding games' overall persuasive potential with methodological flexibilities around the use of the gameful intervention. There have been cases where players were exposed to the entirety or certain pivotal parts of a game (Van 't Riet et al., 2018) or had access to an unlimited period of play time (Jacobs, 2018), or the time effect being examined immediately after the intervention (Kampf and Cuhadar, 2015; Peng et al., 2010) or with long intervals between the gameplay and test sessions (DeSmet et al., 2014; Ruggiero, 2015). Sometimes the employed testing approaches have been self-reports (Kampf, 2016a; Ruggiero, 2015) and sometimes more complex response-time-based paradigms have been employed (Gerling et al., 2014; Gutierrez et al., 2014). Nevertheless, capturing the essence of how persuasion in a gameful context works has come a long way.

With more studies appearing in the field, it became evident that measuring the overall persuasiveness of a game is not necessarily useful for facilitating game designers in creating more compelling games. The complexity of games, their different genres, and the elaborateness of the topics they target make findings hard to generalise to other games with distinct designs. Therefore, researchers have started investigating which game factors are responsible for specific impacts. So, while the first wave of persuasive game studies adopted a technique to measure their overall persuasiveness (sometimes by comparing games to other persuasive media), the second wave directed its attention to game elements (Jacobs and Jansz, 2021). For example, Gerling et al. (2014) designed

a game with the aim of improving attitudes towards people with disabilities. Studying the impacts of embodied interaction by means of two distinct types of control systems (a customised control system designed to integrate into wheelchairs or a standard conventional controller), the findings revealed that the way players engage with and control the game can significantly impact the game's impact on attitudes. Also, Steinemann et al. (2015) found interactivity to be a key game aspect in shaping players' attitudes and views regarding the presented topic. Additionally, Jacobs et al. (2019) found that games' rule-based mechanics and narrative had separate effects on players and deduced that the two methods could achieve comparable outcomes when employed efficiently. Lin and Wu (2020) inquiry into the impact of visual fidelity revealed that, compared to a game with an animated or unrealistic design, a more representative and authentic design could evoke more intense feelings in players. Figuring out how each game design factor works towards persuasion can yield beneficial results and facilitate applying the outcomes to other persuasive games (Jacobs and Jansz, 2021; Van 't Riet et al., 2018). This approach can function as a guide for designers in creating influential games. Accordingly, in this project, I measured both the overall persuasive message of the climate-themed interventions (Beyond Blue and Plasticity) and players' experiences of their specific design features (mechanics, narrative, animation) and elements to inform design guidelines in the context of eco-games.

## 2.7 Conclusions

The fields of risk and climate communication have encountered numerous changes in the past few decades. Originally, they assumed a rationalist method that favoured technical and scientific information. Next, they evolved to incorporate speculative-oriented perspectives with non-analytical standpoints, and then turned to interactive, dialogue-focused, creative, and action-based approaches (Balog-Way et al., 2020; Renn, 2020). Creative tools (including digital games) could be a valuable addition to increase public involvement and engagement with the issue of climate change.

Yet, using gameful interventions for climate change requires a deep understanding of the mixture of historical, political, and industrial circumstances that have led to the advent and advancement of environmentalism in the game industry (i.e., the rise and growth of eco-games), as well as understanding the bond between attitudes and persuasion as key components of creative gameful climate communication. Attitudes' dual nature, containing explicit and implicit aspects, facilitates our grasp of the ways creative edutainment tools can persuade effectively, making persuasive games a distinctive format in the game industry with immense potential for conveying the message of climate change.

Upon surveying the landscape of climate communication, several noticeable patterns can

be identified. 1) The field of climate communication has considerably benefited from flexible, cross-disciplinary collaboration research. 2) The complexity and divergence of recent methodologies (including, interactive approaches and qualitative research) have contributed to a considerable number of developments in the field. 3) The emphasis on attitudes, views, and values has played a critical role in reinstating the human factor and the status and value of society and culture in communicating pressing issues such as climate change. In turn, this shift illuminated 4) the importance of interactive and participatory approaches in this field, giving momentum to technological tools (including digital games) and their rightful potential to communicate and engage the public with this matter. Using multi-disciplinary research and linking findings, visions, and approaches across a myriad of areas can help scholars reach these research opportunities.

Research focused on using persuasive tools in climate communication could use models that develop how game design choices can enhance pro-environmental attitudes. Also, studies that examine the attitudinal effects and persuasion processes of digital gameful interventions suffer from fundamental methodological gaps, including a shortage of knowledge concerning the influence of video games in the long-term and on implicit attitudes as well as evaluating the persuasive capacity of game design details and elements. Additionally, more attention needs to be devoted to the climate-themed genre as the subject of attitudinal studies and persuasion studies via gameful interventions. My research tackled the knowledge gap in this area of study by conceptualising a model and providing the missing empirical data regarding the explicit and implicit aspects plus short and long-term impacts of video games in general and eco-games in specific. Also, my research not only measured the overall impact of the gameful interventions, but also evaluated their feature-based and element-based design choices. The next chapter delves into my Climate-Oriented Persuasive Edutainment (COPE) model and explains how it describes the effective design and player experience processes essential to influence pro-environmental attitudes.

Chapter 3

# Climate-Oriented Persuasive Edutainment (COPE) Model

The main objective of this work is to explain how game design considerations can advance climate communication and contribute to pro-environmental attitudes. To decode this process, first, we need to understand how persuasion and persuasive processes can work towards effective climate communication. The study of persuasion dates back to ancient Greece, where Aristotle asserted that the key to persuasion is rhetoric, an idea containing three fundamental segments: ethos, pathos, and logos (Braet, 1992). Ethos employs assertions about the influencer's integrity, a fundamental element necessary for successful persuasion (Evans, 2011; Ruggiero, 2014). Pathos comprises a sentimental draw designed to elicit reassuring feelings from the audience and gain their goodwill, whereas logos applies a rational view to the equation to appeal to the recipient's logical intellect. Although Aristotle's categorisation system has been built on throughout time, it remains a valuable tool in understanding persuasive design (Bogost, 2007). State-of-the-art technological innovations and digital gameplay have sparked a brand-new interest in this domain, opening new conversations for risk studies and climate communication.

The complexity of climate change communication lies in providing a balance of information, engagement, optimism, and level of threat (McCright et al., 2014; Whitmarsh et al., 2013). However, identifying effective communication strategies is challenging due to the perception some hold of the problem as imperceptible and abstract, rather than the pressing issue that it truly is (McCright et al., 2014). Successful climate communication can be possible by applying creative measures with compassionate, empathetic, and engaging approaches that simultaneously raise a sense of climate urgency (Cordero et al., 2008; Flora et al., 2014) and make the message personally relevant (Senbel et al., 2014; Satchwell, 2013; Ojala, 2012). Eco-games have been developed to target different intellectual, motivational, and entertainment aspects of environmentalism. However, scholars have highlighted the need for structuring sound and vigorous theories that can combine interdisciplinary perspectives with the game development domain, grounding design choices on a robust framework and making productive links between game elements and

their objectives (Lameras et al., 2017). Raising actionable awareness and directing pro-environmental attitudes include various aspects and many interest groups, complicating the process. This fact underscores the essential role of technological tools in managing the multiple corresponding aspects of climate change from various vantage points and the importance of persuasive design models.

During my research, I developed a conceptual model that explains how game design choices can lead to pro-environmental attitudes. I used an interdisciplinary approach to theorise the Climate-Oriented Persuasive Edutainment (COPE) model. Growing from a multi-disciplinary literature (Prospect Theory (Kahneman and Tversky, 1979), Framing Effect (Tversky and Kahneman, 1986, 1981), Procedural Rhetoric (Bogost, 2007), Narrative Persuasion (Green and Brock, 2000; Appel and Richter, 2010; Murphy et al., 2013), and Immersion (Mcmahan, 2003; Ryan, 2003)), my COPE model incorporates the message frame, mechanics, narrative, and animation design aspects into gameful attitudinal evaluation. The game design includes an overall risk-focused message framing quality and three main features: mechanics, narrative, and animation. This model conceptualises the efficient design and player experience procedures necessary for successful climate communication to influence pro-environmental attitudes.

My investigation started by identifying how the gaps in the persuasive design and climate-focused gameful design literature could make room for improvement in creating persuasive models with climate communication opportunities and intentions. As part of the groundwork for the proposed model, I identified the theories and concepts that describe attitude change and persuasion. The model was also informed by an understanding of game-focused persuasive design, eco-design, and user experience, which led me to categorise game design into three features within the model (mechanics, narrative, animation) and ten elements. Unraveling how the risk-related literature can enhance the message design by offering differences between distinctive message framing strategies highlighted the key role of message framing in my proposed model. Furthermore, the link between each design feature/element and attitude was supported by distinct theories of persuasive processes.

## 3.1 Designing for Crisis

In order to prepare for, respond to, recover from, or even alleviate hazardous events (such as climate change), various communication models have surfaced in the literature that target individuals and/or institutions (e.g., IDEA model (Sellnow-Richmond et al., 2018), evaluation framework (Dickmann et al., 2015), value model (Finucane and Holup, 2006), mental model (Atman et al., 1994; Bostrom et al., 1994)). Still, the applications of most frameworks, models, and approaches in this domain were inflexible and lim-

ited, or in need of a more vibrant multidisciplinary vision to address numerous aspects of risk-related issues (Balog-Way et al., 2020). Thus, scholars have added edutainment methodologies, creative measures, and technological tools to climate communication studies. Using computer-based devices as a participatory interactive tool (Fogg, 2003b, 1998) can help to motivate, drive, influence, persuade, or encourage (Fogg, 2003d,a) topics such as climate-themed messages and eco ideas. In attempting to capture the delicate nuance of persuasive design, Fogg (2003c) introduced seven types of persuasive technology tools, which became the most fundamental formulation of persuasion in the human-computer interaction literature. Oinas-Kukkonen and Harjumaa (2009) adopted and modified Fogg's design tools to develop the Persuasive Systems Design (PSD) framework, which consisted of 28 principles for explaining how design can and should be translated into software requirements and what type of content and software functionality should be considered in building persuasive systems.

Given the growing prevalence of persuasive technologies across a broad range of fields, their use in the domain of sustainability remains an underexplored area of research. One of the prominent examples in modelling the persuasive potential of climate-directed systems is Wibeck et al. (2013) framework for exploring the content, structure, setting, and applicability of information and communication technologies (ICT) and their visualisation in climate change conversations. Shifting to gameful systems and digital games, one of the primary theories focusing on climate awareness and persuasion was the Information Deficit model, which states that provision of certain types and amounts of knowledge can change users' values; value change can transform attitudes; and attitude change can nurture changes in behaviour (He et al., 2010). Organisations dedicated to endorsing social change, such as Games for Change Society (2014), frequently used this model in designing game-based tools for attitude/behaviour change towards climate change. However, deficit model as a school of thought proved insufficient to make necessary changes in players. Hence, this model was criticised and replaced by theories that centred on interaction and engagement (Bogost, 2007). Still, there are ongoing debates about how effective contemporary game design models are at describing the ways in which games can persuade and change attitudes (Sicart, 2011; Heide Smith and Norholm Just, 2009; De la Hera et al., 2017; De La Hera and Raessens, 2021).

In exploring the persuasive potency of video games, even though theories have been applied to game-based interventions (De La Hera and Raessens, 2021), such as perspective-taking (Gutierrez et al., 2014), identification (Walz, 2003), and stages of change (Slater, 1999), the existing literature on persuasive games provides limited knowledge on theoretical and psychological processes that target specific design factors. Based on this gap, I ask: **How can game design and player experience processes contribute to pro-environmental attitudes?** Developing a model that can classify game design

aspects and link theoretical processes to pro-environmental attitudes could be key to a successful gameful climate communication. Categorising the design features and their detailed elements while explaining how they can influence players' pro-environmental attitudes through specific theories, could not only help scholars understand the process but also could guide game designers in creating more engaging, effective, and persuasive games. Additionally, there remains a substantial knowledge gap about the way players interact with persuasive games, their underlying stimuli for playing, and the degree of effect these games have on attitudes after controlling for certain player characteristics and topic-relevant attributes.

Video games are equipped with essential features and elements that can facilitate adhering to persuasive designs and transmitting conservation communications through converting persuasive ideas to gameful means. Thus, digital games have been the subject of curiosity and exploration in environmental research. For example, some researchers have used media enjoyment and motivation theories to model the psychological processes involved in gameful directed climate action and views (e.g., (Antle et al., 2014; Fjællingsdal and Klöckner, 2017; Weiser et al., 2015; Huber and Hilty, 2015), or used pedagogical frameworks to identify potential catalysts of sustainability learning via games (Fabricatore and López, 2014; Diniz Dos Santos et al., 2019). In defining climate-themed design frameworks, Fabricatore and López (2014) introduced a model for the design and evaluation of game-based sustainability educational clues to comprehend how motivational factors add to the overall gaming experience. Ouariachi et al. (2017) introduced an array of criteria to determine the communicative facets of climate-themed video games, indicating some narrative trends, content-related patterns, and gameplay approaches. Woolbright (2017) outlined some eco-game design recommendations, highlighting digital games' narrative and representational capacities to engage players with climate activism. Also, Flood et al. (2018) proposed a set of sustainable game guidelines. Diniz Dos Santos et al. (2019) established a set of sustainability design concepts, and Galeote et al. (2021) presented a series of recommendations for climate-themed digital games, accentuating their performance and research potential. Still, these models and recommendations lack an exhaustive coverage of game design components and are seldom substantiated by any empirical evidence. Another noticeable shared feature among most of these methodologies is how they place a low priority on the entertainment aspect compared to the educational dimension. Entertainment is a key feature, as it cultivates an actively engaging setting conducive to learning (Mokhtar et al., 2023). Nevertheless, how to accomplish this goal is the subject of extensive debate among scholars.

## 3.2 Towards Interactive Climate Messages

In the course of crisis preparation and responses, hierarchical communication has been proven to be unreliable and inept (Nicholls et al., 2019; Scolobig et al., 2015). Thus, the risk communication research adopted dialogue-based, recipient-oriented strategies. An introductory and noteworthy example in this regard was the Seven Cardinal Rules of Risk Communication (Covello and Allen, 1988), published by the U.S. Environmental Protection Agency (U.S. EPA). The Cardinal Rules were environmental/health risk communication guidelines (Covello and Sandman, 2001) developed to establish communication goals, arrange and direct decisions, and evaluate achievement in health/environmental risk communication planning, implementation, and appraisal (Covello and Sandman, 2001). The Rules promoted interactive tactics and open dialogues that incorporated people's sentiments, concerns, views, and responses to risk messages (National Research Council (U.S.). Committee on Risk Perception and Communication, 1989). The Seven Cardinal Rules of Risk Communication (Covello and Allen, 1988) included the following criteria:

1. Accept and involve the public as a legitimate partner.
2. Plan carefully and evaluate your efforts.
3. Listen to the public's specific concerns.
4. Be honest, frank, and open.
5. Coordinate and collaborate with other credible sources.
6. Meet the needs of the media.
7. Speak clearly and with compassion.

By adding people to the equation, this approach proved an improvement compared to the preceding limited risk communication exertions (Covello and Sandman, 2001). However, the Cardinal Rules still followed a pattern that depicted specialists as sources, messages as knowledge, media correspondents as negotiators, and people as mere receivers (as opposed to collaborators in the matter) (Heath and Nathan, 1990). It showed that the Rules followed still the old-fashioned strategy of directing people towards the rightful scientific way by aligning the individuals' flawed intellectual models with the correct logical model, highlighting the duty of risk communicators in this process (Boholm, 2009). In essence, without a creative tool to implement the Cardinal Rules, they continued the previous linear, informant-leaning model that depended on authoritarian and banal implications (Heath and Nathan, 1990). Simply put, despite the people-focused aspects of the Rules ('accept and involve the public as a legitimate partner'(Covello and Allen, 1988) and 'listen to the public's specific concerns'(Covello and Allen, 1988)) emphasise the public's viewpoints more than preceding risk communication attempts, these Rules were an extension of the traditional models. In the absence of an interactive tool to platform

the Rules, they were not expressive ways for people to dynamically participate in the communication procedure. The development of successful risk communication models should consider a more proactive role for the message recipients that endure and carry the potential risks (Heath and O'Hair, 2010). The Cardinal Rules can be dexterously translated into game design as Video games can accommodate the need for interactively engaging users/players with environmental messages.

## 3.3 Framing the Climate Message in Game Design

Previous research examining the persuasion capacity of video games resulted in mixed findings (Jacobs, 2018; Van 't Riet et al., 2018; Jacobs et al., 2019). While some studies found that persuasive games influence players in the way that their developers planned (Ruggiero, 2015; Kampf and Cuhadar, 2015; Peng et al., 2010), others have found that not all persuasive games work the way their designers intended, or that they are not any more persuasive than conventional media (Van 't Riet et al., 2018). De La Hera and Raessens (2021) attributed this inconsistency to a lack of understanding and differentiating between the tactics and methods used to persuade players through gameplay and their varying levels of effectiveness, which raises the question: **How can games be designed to successfully impact players' attitudes?** According to Mitgutsch and Alvarado (2012), apart from the players' pre-existing attitudes and the circumstances of the gameplay, how goals and messages of games are communicated through their conceptual design determines how impactful the video game is. Although implanting subject-specific messages within video games plays an important role throughout the process of persuasion, the mechanism and technique of framing and designing messages in a risk-related context, such as climate change, is a complex matter and needs further investigation. In achieving our goal to introduce a comprehensive conceptual gameful model that can address a crisis (climate change), we need to consider decision-making tactics.

Prospect Theory (Kahneman and Tversky, 1979) explains how people decide between choices containing hazards and unpredictability. In doing so, individuals analyse the problem from a variety of angles. Typically, these viewpoints centre on their choices' potential positive and negative outcomes. In this sense, the framing of a situation can impact the perspective from which individuals observe the problem (Tversky and Kahneman, 1986, 1981). This phenomenon is known as the framing effect (Tversky and Kahneman, 1986, 1981), which refers to how the same information can have varied impacts on its recipients depending on how it is presented (Tversky and Kahneman, 1986; Gallagher and Updegraff, 2012). According to this argument, people would be more willing to avoid prospective losses than to acquire potential rewards. This messaging strategy is especially relevant for perilous situations (Batson et al., 1997).

The ability to alter risk-related messages so that they can be presented either positively or negatively to influence an individual's attitudes or behaviours makes message framing especially helpful for studying critical issues (Cho and Boster, 2008). According to research on message framing, communications with the same content but different framing can have varied persuasive effects (Yi and Baumgartner, 2008), making message framing a valuable strategy (Cho and Boster, 2008). Additionally, narratives are a powerful tool for persuasion since they allow the message to be woven into the narrative (Hamby et al., 2017; Van Laer et al., 2014; Moyer-Gusé and Dale, 2017). As an interactive form of narrative, video games are a potential platform to present ideas and embed messages in a creative way.

Most research on Prospect Theory and simulated experiences concentrates on distinctions in message framing. In the case of messaging meant to influence attitude or behaviour, the framing of the message typically centres on two approaches: gain-frame or loss-frame, each with its own body of literature. A gain-frame focuses on the advantages or favourable effects of following a particular manner or viewpoint (i.e., positive emotions such as feeling motivated or happy). A loss-frame concentrates on the casualties or adverse outcomes of failing to follow a specified manner or viewpoint (i.e., negative emotions such as apprehension or anxiety) (Sallam et al., 2022). The negativity bias posits that people give more weight to negative information than positive information of equal intensity (Rozin and Royzman, 2001). Therefore, one argument for the loss-frame is that it contributes to a greater level of message elaboration and, consequently, a more persuasive argument. Another argument for the loss-frame stems from the Elaboration Likelihood Model (ELM) (Petty and Cacioppo, 1984). ELM theory argues that the loss-frame is likely to be analysed more thoroughly since it commands more attention and has the potential to challenge assumptions (Maheswaran and Meyers-Levy, 1990; Rothman et al., 1993). The literature on fear appeal provides another explanation as it argues that the loss-frame and hazardous components of a fear appeal message share key features (O'Keefe and Jensen, 2008). Also, research in this area has found that fear can enhance message processing (De Hoog et al., 2008; Slater et al., 2002). Moreover, cognitive-motivational-relational theory (Kemper and Lazarus, 1992) suggests fear protects against hazards as it pushes people to seek information that enables them to reduce the risk (Das et al., 2003; Nabi, 2003).

On the other hand, psychological reactance offers an explanation in support of the gain-frame (Reinhart et al., 2007) and argues that the loss-frame may be viewed as more threatening to an individual's freedom as it depicts adverse outcomes using intense cues and elicits stronger negative emotions via manipulation (Witte, 1994). Consequently, the loss-frame manipulative strategy could evoke a stronger psychological reaction, making the gain-frame more appealing and persuasive. Ahn et al. (2015) discovered that individ-

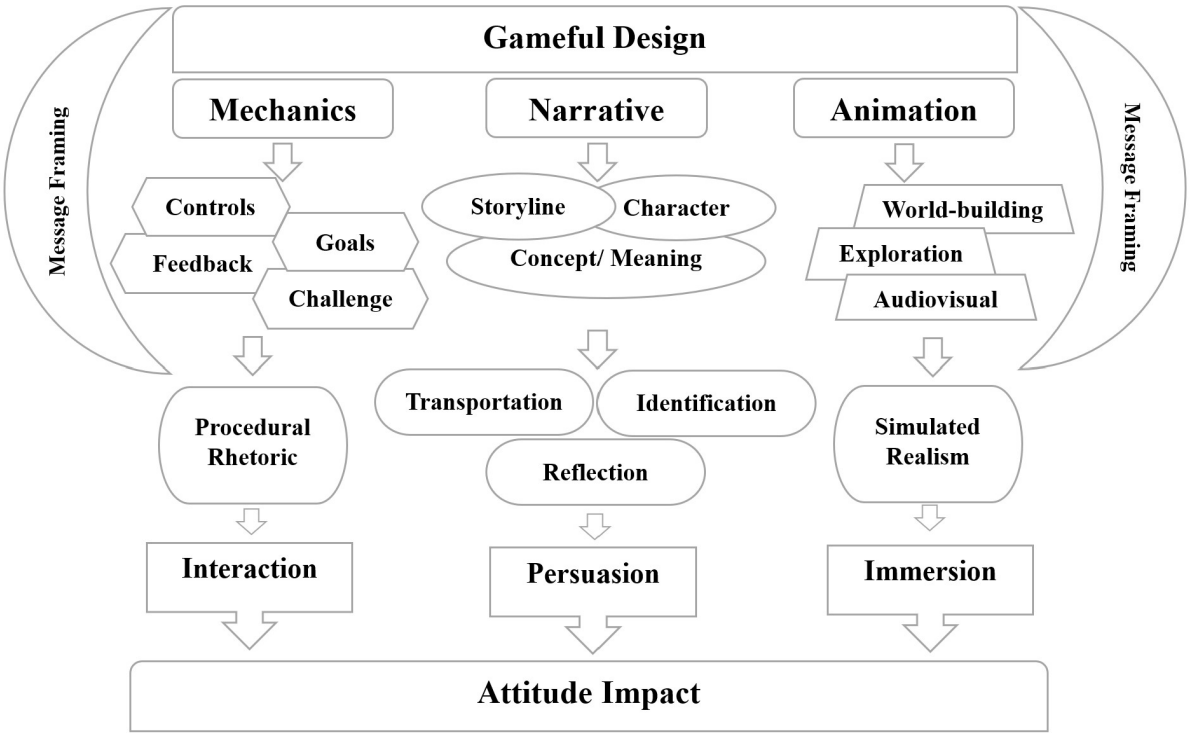


**Figure 3.1**: Climate-Oriented Persuasive Edutainment (COPE) Model

uals who were approached through gain-framing techniques have more intended action than those who were approached through loss-framing methods, advancing previous research suggesting that gain-framed messages have more positive attitude and behavioural impacts than loss-framed messages (Maibach et al., 2010).

Despite research on the effects of gameful intervention message framing in various fields such as health communication (Kim et al., 2022; Yadav et al., 2021), entertainment (Marta et al., 2021), or marketing (Lapierre et al., 2017), the effects of framed environmental messages have remained underexplored in video game studies (Ahn et al., 2015; He, 2015). Generally, gain-framed messaging has been considered effective for earlier stages of preventing issues, while loss-framed messages have been effective for treatment adherence to risk-related matters (Gray and Harrington, 2011; Gallagher and Updegraff, 2012). Message framing has a decisive role in developing effective persuasive games. In designing for a crisis (climate change), framing the overall message and thematic idea of the game could impact the potency of all the design factors (game features/elements).

## 3.4 Theories of Change and Translation to Design

As a fundamental step of developing the proposed COPE model, I looked for theories of persuasion and attitude change from the perspective of design. With respect to games

and persuasion, the procedural rhetoric model (Bogost, 2007) was one of the most prominent design frameworks used. The Procedural Rhetoric model of persuasion stemmed from game studies in the wake of disputes that the Games for Change projects, which were founded on the Information Deficit model, were either ineffective, unattractive, or both. Procedural Rhetoric was coined by Bogost (2007) to decipher how to make arguments in interactive systems. In this model, the process of persuasion is conveyed using interaction (game mechanics) instead of information (Antle et al., 2014). As a substitute to presenting a set of information, procedural rhetoric games allow their players to set out on a journey and venture the targeted conceptions by making choices and adopting decisions to reach specific goals (Antle et al., 2014). However, proceduralism relies mainly on the interactivity aspect of games to explain their persuasive potential (Bogost, 2007; Antle et al., 2014) and has been criticised for excluding other aspects of gameplay and game design in its evaluation, making it a limited approach to understanding the full potential of gameful persuasion (De La Hera and Raessens, 2021; Heide Smith and Norholm Just, 2009; Sicart, 2011; Evans, 2011).

Critics argued that video games have multiple transmission avenues that could facilitate the conveyance of persuasive themes (Partan and Peter Marler, 2005) via various channels (e.g., visual or sensorial experiences). De La Hera Conde-Pumpido (2018) introduced signs, system, and the context as the three basic requirements for impacting players' attitudes. Game scholars put forward a series of gameful elements (including story, optics, sonics, script, cinematics, haptic symbols, and mechanics) as indispensable factors to enhance the process of persuasion and essential ingredients of in-game persuasion (De La Hera Conde-Pumpido, 2018; De La Hera and Raessens, 2021). These arguments made studying design aspects beyond procedural rhetoric (mechanics) a required step to exposing the full persuasive potential of gameful systems (De La Hera and Raessens, 2021; De la Hera et al., 2017).

I identified factors related to message, narrative, and aesthetic aspects of game design as the most noticeable missing parts in a comprehensive design model. Persuasion through the narrative has been a topic of interest in literary studies, with previous research (e.g., (Burrows and Blanton, 2016; Slater et al., 2002; Dal Cin et al., 2004; Bilandzic and Busselle, 2012) verifying the importance of narrative for persuasion. Therefore, I used narrative persuasion theory as a basis to build the 'narrative' feature of design in my model. I also used the aesthetic aspect of design to link how a state of immersion can lead to a perceived realism, bringing the game world to life (animate). Studies show that immersion exposes players to the persuasive ideas embedded in the game (Burrows and Blanton, 2016; Markowitz et al., 2018). Therefore, I used immersion to build the 'animation' feature in my model.

Video games have the potential to conform to persuasive design models and convey

environmental messages by translating persuasive concepts into gameful elements. I conceptualised a Climate-Oriented Persuasive Edutainment (COPE) model (see Figure 3.1) that can interpret gameful attitudinal effects towards climate change. In developing the model, my approach involved refining and translating theories that explain persuasion and attitude change (Procedural Rhetoric (Bogost, 2007), Narrative Persuasion (Green and Brock, 2000; Appel and Richter, 2010; Murphy et al., 2013), Immersion (Mcmahan, 2003; Ryan, 2003), Framing Effect (Tversky and Kahneman, 1986, 1981), and Prospect Theory (Kahneman and Tversky, 1979)) to adapt to game design features and elements by employing the recurring heuristics in the games design and user-experience literature. To put it briefly, in my model, Procedural Rhetoric is linked to interaction and game mechanics, Narrative Persuasion (Green and Brock, 2000; Appel and Richter, 2010; Murphy et al., 2013) encompasses the story-related aspect of game design, Immersion (Mcmahan, 2003; Ryan, 2003) links the aesthetics design factors to attitude change, while Framing Effect (Tversky and Kahneman, 1986, 1981), and Prospect Theory (Kahneman and Tversky, 1979) considers how the message and themes should be presented. In line with these theories, I categorised game design into three fundamental features (mechanics, narrative, animation) to define how persuasion works in a gameful context.

As an essential supplement to these design features, my model integrated message framing into the assessment of overall design potency. Message framing acts as the overarching climate-oriented theme and an essential part of climate communication. The result was a detailed and comprehensive framework for persuasive design evaluation. The proposed model is a three-stage conceptual framework. The first stage describes the design dimension in the gameful design stage, where three main features and their relevant elements are wrapped in a signature message framing arch. Next, the model demonstrates how assigning game design features/elements to their pertinent theoretical processes can predict the prospective impact of a successful climate-themed gameful intervention in the last stage.

In a nutshell, from a design angle, the proposed model considers the message framing aspect as an umbrella design point that impacts the overall theme of the game and influences the tone and the mood of the game as a whole experience, including several details and elements. Aside from the message framing that works as an overarching design approach, the model categorises the mechanics, narrative, and animation features of game design in the gameful design stage to elaborate on how these dimensions can facilitate persuasion. A combination of quantitative and qualitative data gained from studying the two case studies of Beyond Blue and Plasticity, in this project, helped me hone and construct more details into the structure of this model, making way to present a set of heuristics specific to each aspect of the process in the end.

### 3.4.1 Mechanics Design and Attitude

Mechanics is the first design feature in my COPE model (see Figure 3.1). This aspect is informed by the procedural rhetoric theory (Bogost, 2007), which argues that equipping players with the opportunity to pursue a body of rules and interactions can form a dynamic game environment and convey certain themes and messages. Thus, the game conveys its core themes through interaction, participation, goals, choices, and consequential feedback in an ongoing causal loop, creating an effective approach of transferring ideas in an interactive way with the objective of impacting players' attitudes (Bogost, 2007). Interactive game rules and mechanics differentiate persuasive games from other types of persuasive devices (De La Hera and Conde-Pumpido, 2013). From a persuasive angle, the principal aim of the game mechanics is to define how players should behave in the game by providing directions and guidance. Hence, during gameplay, the game rules are constantly being deciphered by the players, simultaneously boosting players' capacity to understand the goals, feedback, and challenges, building further interactions between the player and the game via input devices (Fogg, 1998; Connolly et al., 2012).

I identified four recurring elements in user experience and game design literature that were related to game mechanics: the controller, feedback, goal-setting, and challenge. The controller is the initial element that awards players agency within a virtual domain, enabling them to actively interact with and participate in the virtual setting (Crick, 2011). Convenience and intuitiveness of a controller add to its functionality and persuasive effectiveness (Rigby and Ryan, 2007). Also, feedback improves player-game interaction by responding to the quality of a player's performance, which in turn encourages or discourages certain actions (Rogers, 2017). Feedback is an integral tool that enables players to not only learn from their mistakes but to measure and estimate their progression towards a particular goal, all the while serving as an incentive for further determination and attention (Rogers, 2017). Positivity or negativity of feedback can lead to theme-consistent positive or negative attitudes (Kluger and Denisi, 1996). Goals are another means of interacting with the game world. Goals are prominent ingredients of games that separate them from basic 'play' (Salen and Zimmerman, 2005). Goal-setting increases performance, enhances motivation (Locke and Latham, 2006), and promotes the sense of efficacy (Ryan et al., 2006) by controlling attention, influencing determination, encouraging the use of appropriate information and tactics, and stimulating attitude and behaviour (Locke and Latham, 2006). Challenges (e.g., combat, trial, battle) also motivate players to move on in the game (Ryan et al., 2006) and interact further with theme-consistent beliefs and ideas (Bogost, 2007). Understanding how to design a suitable set of playful challenges has an important function in determining the bond between players and the game (Vahlo and Karhulahti, 2020; Ryan et al., 2006). The mechanics connect the player to the gameplay by delivering instructions and guidelines throughout the journey, enabling the player

to control the game as they benefit from the feedback to interpret the main goals and challenges (Fogg, 1998; Bogost, 2007; Connolly et al., 2012). For the mechanics aspect of design, I ask: **To what extent can participant experiences of the mechanics feature in a game predict pro-environmental attitudes?**

### 3.4.2 Narrative Design and Attitude

Narrative is the second design feature in my COPE model (see Figure 3.1). Narrative theory (Fisher, 1984) argues that the structure of a narrative can trigger plot-consistent morals and beliefs. To uncover the cogency of the narrative aspect of game design, I draw on narrative persuasion theory to elucidate how shifting the recipient's focus to the story (Transportation) (Green and Brock, 2000; Green, 2021), relocating their perspective to the character/avatar's outlook (Identification) (Cohen, 2001; de Graaf et al., 2012; Chen and Koek, 2020), and developing meaning through connecting the narrative to the physical world (Reflection) (Hamby et al., 2018; Van Laer et al., 2014) can activate plot-consistent views and values. As an interactive form of narrative, video games have the capacity to persuade players to change their attitudes (Bril et al., 2018) by stimulating the cognitive aspect of the mind, suspending doubt and cynicism towards the presented topic, and diminishing the potential counter-arguments, giving rise to persuasion (Dal Cin et al., 2004; Busselle and Bilandzic, 2008; Bilandzic and Busselle, 2012; Green and Brock, 2000; Green, 2021). As a device of narrative persuasion (Green and Brock, 2000; Appel and Richter, 2010; Murphy et al., 2013), transportation is the state of assimilation in the story events (Green and Brock, 2000; Green, 2021), where the affective and cognitive parts of the psyche can engage with the views and values in line with the narrative (Green et al., 2004; Green, 2021). Depending on the universality of the presented theme, transportation can occur even in short stories (Green, 2021). Narrative absorption through the outlook of a story character is called identification (de Graaf et al., 2012; Busselle and Bilandzic, 2008; Van Looy et al., 2012; Turkay and Kinzer, 2016; Chen and Koek, 2020). In this state, the player is on the same wavelength as the character and can empathise and understand their feelings and journey (Turkay and Kinzer, 2016; Chen and Koek, 2020). A deep connection with a character is formed, where adopting their goals and perspectives is favourable. The dual cognitive and emotional aspects of identification resolve the relation between narrative and persuasion (de Graaf et al., 2012). Reflection is the practice of internalising the game concepts and externalising the gameplay experience to the real world as a means of assessing its meaningfulness (Hamby et al., 2018; Van Laer et al., 2014). This process can lead to persuasion (Hamby et al., 2017) by changing the player's viewpoint and/or using the story-consistent themes to offer new attitudes and behaviours (Hamby et al., 2018; Van Laer et al., 2014). In fact, how the concept of content (in this case the game) has been meaningfully represented determines the potential

for persuasion (Hamby et al., 2017). Transportation, identification, and reflection enable narrative persuasion to take place by pausing recipients' scepticism, absorbing them in the plot, and reducing their capacity to counterargue and challenge the presented topic (Dal Cin et al., 2004; Busselle and Bilandzic, 2008). Based on these theories, the narrative design aspect of my model incorporates elements of storyline, character design, and concepts/meanings. My research question concerning the narrative design aspect is: **To what extent can participant experiences of the narrative feature in a game predict pro-environmental attitudes?**

### 3.4.3 Animation Design and Attitude

Animation is the third design feature in my COPE model (see Figure 3.1). I use the term 'animation' to refer to the design factors that augment the immersive nature of gameplay by breathing life (animate) into the game world, acting as the heart and soul of a video game. This branch of the model is informed by immersion theory (Mcmahan, 2003; Ryan, 2003) to investigate the persuasiveness of the animation dimension of game design. Immersion is associated with the concept of persuasion, as earlier studies have shown that higher levels of immersion increase acceptance of the persuasive message (Graesser et al., 2009; Burrows and Blanton, 2016; Cairns et al., 2014). In a digital setting, immersion is the hyper-focused experience of accepting the game world as the reality (Hafner and Jansz, 2018; Cairns et al., 2014). The animation design has the potential to impact players' attitudes by immersing them in a hypnotic form of simulated realism. I identified three recurring gameful elements in the user experience and game design literature that connect to my definition of animation feature; worldbuilding, exploration, and audiovisual design.

Worldbuilding refers to the inventive setting and production process of a game world, which together convey a sense of presence and realism to players (Mckernan, 2017; Wolf, 2012). Building an authentic game world needs specific designs to achieve a certain dash of realism, engage players' attentions, and create an immersive gameful experience (Shinkle, 2020; Lin and Wu, 2020). Digital games are microworlds with enough realism to immerse players in an alternate reality. Researchers mostly refer to two different kinds of realism for a game to be authentic in players' views, 'graphical realism' and 'behavioural/simulational realism'. Improved graphical realism refers to the quality of a game's graphics, which is expected to amplify effects, intensify player's perceived realism, and modify mental processing of views, attitudes, and manners (Shapiro et al., 2006; Shinkle, 2020; Lin and Wu, 2020). On the other hand, behavioural or simulational realism describes the authenticity and validity of gameful rules and how things and characters behave compared to the same items in real life (Krcmar et al., 2011; Zendle et al., 2018). Creating the illusion of an alternate reality within the virtual microworld of the game

needs specific designs to achieve both graphical and behavioural/simulational realism and immerse the players. Eco-realistic games could boost players' comprehension of real-life ecological crises, either by consciously or unconsciously shaping environmental engagement and agency (Chang, 2019).

Exploration design is all about the player's experience of discovery and curiosity. The literature focuses on how the excitement to explore game worlds initiates from humans' intrinsic curiosity and the possibility of safely journeying through a game world and testing its limits and what it has to offer in games' built-in risk-free environments (Gómez Maureira et al., 2019; Xu et al., 2023; Zhan et al., 2018). Exploration expands understanding and perception, facilitating access to new kinds of knowledge and the creation of views, beliefs, attitudes, and experiences (Kelly, 1963). Audiovisual design is a pivotal part of game development as it stimulates players' sentiments, paving the way to creating more authenticity and realism (Evans, 2011), as well as enhancing the immersive experience and influencing theme-coherent views and attitudes (De La Hera Conde-Pumpido, 2018). Visual cues prompt intended messages and themes by transmitting meaning in the form of representational signs, graphical codes, and optical symbols (Kjeldsen, 2012). While the sonic aspect can convey meaning by creating music, sound, noise, dialogue, and silence (Collins, 2008). Addressing the senses unlocks emotional portals, opening up a game to be more real, genuine, convincing, and influential (Evans, 2011). Audiovisual design not only promotes immersion but also goes along with players' sense of agency and can be employed to affect players' attitudes in an immersive experience (De La Hera Conde-Pumpido, 2018). Regarding the animation feature, my research question is: **To what extent can participant experiences of the animation feature in a game predict pro-environmental attitudes?**

## 3.5 Conclusions

Researchers are continuously working on design theories, frameworks, formulas, or guidelines to contribute to effective climate communication. Given the multidisciplinary nature of climate communication, this field has benefited from a wide range of studies and approaches. Harnessing the persuasive nature of technology has been a favourite approach recently. Consequently, tackling gameful measures including video games has gained momentum. Understanding the existing gaps and research opportunities in the climate/risk-related message and the persuasive/climate-focused design domains has paved the way for presenting gameful persuasive models that can describe critical issues more clearly. Focusing on game design, I proposed the Climate-oriented Persuasive Edutainment (COPE) model. In developing this model, I argue that understanding the design specifics and theoretical processes that contribute to climate communication could aid game designers in

making more engaging games that allow players to make informed decisions and draw well-grounded inferences on targeted issues.

Chapter 4

# Methodology and Interventional Experiments

Climate change has been frequently addressed as a 'wicked problem' (Hulme, 2009; Gibbon and Mensah, 2012), signifying how innately complex it is to transmit the gravity of the situation to lay audiences to the point of impacting their attitudes/behaviours towards it. Thus, approaching the topic of climate change communication requires careful methodological considerations. Accordingly, I used a mixed method approach (combination of both quantitative and qualitative knowledge) to tackle the issue. Mixed method is described as a research design or methodology in which the researcher gathers, examines, connects, and contrasts insights from both quantitative and qualitative data in a study (Creswell and Clark, 2007). I used a mixed methodology because the blend of theoretical and empirical information improves the reliability of the results (Hurmerinta-Peltomäki and Nummela, 2006), the veracity of interpretation (Morse and Chung, 2003), and the validity of the conclusions (O'Cathain et al., 2010), while adding to knowledge production (Hurmerinta-Peltomäki and Nummela, 2006) and improving the audience's trust (O'Cathain et al., 2010). Also, integration of data in this approach promotes the generation of ideas for future investigations (O'Cathain et al., 2010).

## 4.1 Procedure

In a mixed method approach, I used two parallel within-subjects experiments, where participants were randomly assigned to play either Beyond Blue in Experiment 1 ($N = 36$) or Plasticity in Experiment 2 ($N = 37$) as the intervention. The experiments employed a pre/post-test design with a delayed post-test administered three to five weeks after the intervention (see Figure 4.1). I conducted the experiments online due to prolonged lockdowns in Australia and to reduce COVID-19-related risks.

In the quantitative component of the research, first, I measured both explicit and implicit environmental attitudes before, immediately following, and again three to five weeks after playing the intervention to determine the extent of the interventions' overall impacts

on attitudes. Then, I examined players' experiences of these two games (Beyond Blue and Plasticity) against my conceptual COPE model to evaluate how successful these interventions' design was in communicating the environmental theme of the game and impacting players' pro-environmental attitudes. I also measured the extent to which each intervention's design choices (features and elements) predicted attitudes towards environmental issues. In the qualitative component of the research, I used data from interviews and descriptive questionnaires to explain the strengths and shortcomings of the games' designs in more details and develop a series of design recommendations/heuristics suitable for successful eco-games. The ethical aspects of all phases of the research were approved by the university ethics committee.

Each experiment included two sessions with an interval of three to five weeks (see Figure 4.1). A preparation email containing the required steps and links, a synopsis of the schedule, device and system requirements, and a personalised link to the scheduled video conference was sent to the participants beforehand.

- The first session of each experiment was undertaken as asynchronous online sessions, using Zoom and Microsoft Teams. The first session included a short introduction, experiment overview, instructions for participants, informed consent form, pre-test, a short tutorial on the game, the main gameplay stage (35-40 minutes), the post-test, and an interview. The pre-test involved inserting a chosen anonymous identifier and completing a survey (PANAS test, Implicit Attitude test (IAT), Explicit attitude test, which are explained in detail in section 4.4). The anonymous identifier was a code that participants made based on answering three questions: 1) What is the first letter of your mother's/guardian's first name? (e.g., "J" for Julie). 2) What is the first letter of the street where you live? (e.g., "P" for "Pleasant Street"). 3) What day of the month were you born on? (e.g., "20" for February 20). The code was used to pair pre and post-test as a way to maintaine participants' anonymity. The post-test incorporated re-inserting the anonymous identifier and doing the PANAS test, Implicit Attitude test (IAT), Explicit attitude test, and a demographic/background questionnaire. Session one lasted about 3.5 hours and was conducted one-by-one.

- The second session of each experiment (delayed post-test) followed the same pattern as the pre-test survey (plus an extra set of descriptive questions regarding the experimental task) and occurred three to five weeks after the first session. Participants were emailed a link to the delayed post-test questionnaire to complete. The second session required about an hour to complete.

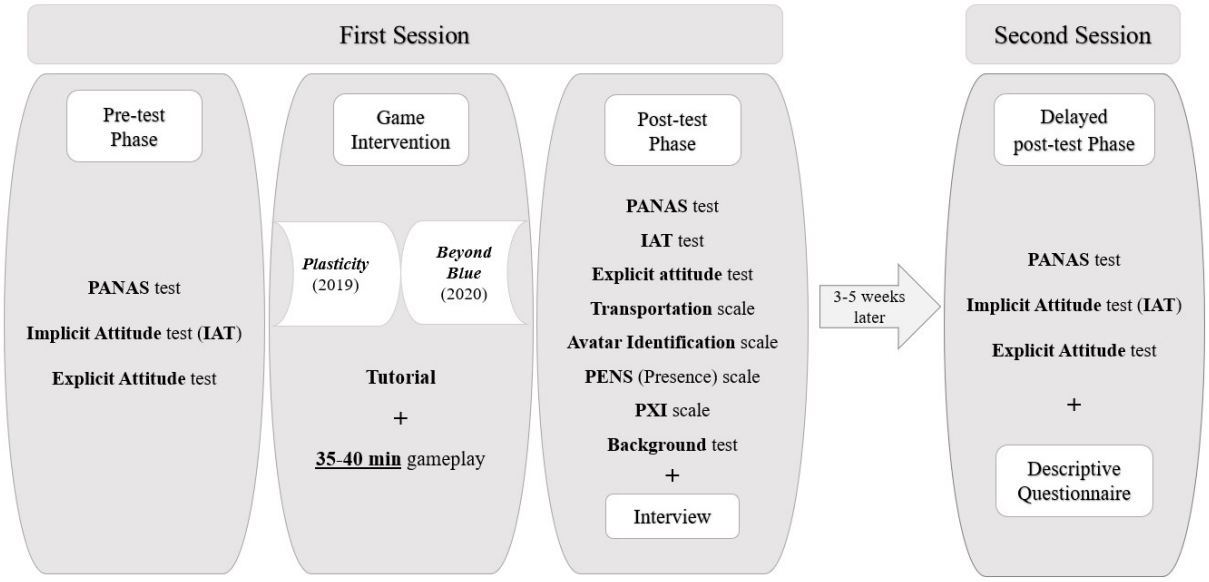


**Figure 4.1**: The Methodological Design of the Experiments

## 4.2 Participants

A total of 73 participants started the experiments. Participants were randomly assigned to the gameful interventions, Experiment 1: Beyond Blue ($N = 36$) and Experiment 2: Plasticity ($N = 37$). Two Beyond Blue Experiment participants and one Plasticity participant opted out of the interview (Beyond Blue: $N = 34$, Plasticity: $N = 36$). For the delayed post-test, all participants were invited to complete the survey again, and 53 participants (Beyond Blue: $N = 22$, Plasticity: $N = 31$) returned three to five weeks after the gameful intervention.

Inclusion criteria for participants consisted of residing in Australia, being at least 18 years old, and having access to the internet and a computer to play the assigned game. Computers required at least a Microsoft Windows 10 x64 system, as Mac computers were not compatible with the games. To complete the questionnaires, participants also needed access to a keyboard.

Participants were mostly recruited through online advertisement portals ($N = 57$) such as Facebook, Telegram, Twitter, LinkedIn, Instagram, and articles on the Australian National University's website. The advertisements stated that I sought participation in a project dealing with video games and their impact on game players' 'views' and 'values' about 'ecological issues'. I avoided the terms 'climate change', 'environmental issues', and 'attitude' in the advertisement pieces to avoid bias regarding the topic. The participants were compensated with a gift card (value 10 AUD) upon finishing the delayed post-test. The remaining participants ($N = 16$) were psychology students at The Australian

National University who were offered to either choose the gift card or credit for their coursework.

Participant ages ranged from 18 to 50 years ($M = 27.45$; $SD = 8.56$), with 49.3% identifying as male, 47.9% female, 1.4% other, and 1.4% undisclosed. Most participants were from major cities (65.8%) and inner regional parts of Australia (27.4%). Also, the majority reported their ethnicity as Middle Eastern (37.0%), Caucasian (27.4%), and Asian (19.2%). Most participants reported having no religion (58.9%). Also, the majority of participants were either completing an academic qualification at undergraduate level (26.0%) or postgraduate level (17.8%) or held a university degree (12.3% bachelor's degree, 24.7% postgraduate degree). In terms of their familiarity with playing avatar-based games, 13.7% reported no experience, 17.8% little, 27.4% some, 12.3% very much, and 28.8% a great deal of experience.

## 4.3 Gameful Interventions

Participants were assigned to play one of two climate-themed games as interventions: Beyond Blue (2020) and Plasticity (2019). These two games were chosen because their gameplay revolves around environmental concerns and how to tackle them. Also, their message designs differ, with Beyond Blue applying gain-framing as its main messaging strategy, and Plasticity employing loss-framing as the central messaging tactic for portraying its futuristic world. Moreover, with Beyond Blue as a commercial simulation and Plasticity as an indie game, these two interventions are representatives of two different production directions in the Eco genre. Choosing these two different games in my experiments demonstrated some interesting production differences in climate-themed video games industry.

### 4.3.1 Experiment 1: Beyond Blue

Beyond Blue is a near-future underwater exploration game based on biological realism and naturalistic features (see Figure 4.2). It was developed by E-Line Media in collaboration with BBC Studios. Beyond Blue is a commercially successful environmental game that has received very positive reviews (87% on Steam) in the game community. There is limited knowledge about design opportunities and choices in commercial games with climate-related themes. Understanding the extent of this genre's impact and studying its design considerations in detail (mechanics, narrative, animation) could provide direction for game makers to create effective and dynamic environmental games that can target the public on a large scale.

In Beyond Blue, the player controls Mirai, a scientist who explores the ocean with a team of marine researchers to provide a unique virtual perspective on the ocean's bi-


**Figure 4.2**: Beyond Blue (2020) gives players the chance to explore the marine ecosystem.

ological marvels and highlight conservation issues. The gameplay is educational and exploratory, taking the player to different parts of the ocean (including the coral reefs and the dead zone) to highlight how human-induced activity negatively affects marine life. Throughout the game, Mirai live-streams her discoveries around the noise pollution that is bothering whales. Via this avatar, the player can use innovative technology to see, hear, and interact with marine life. Players are prompted to scan approaching marine life, which reveals information about each species, such as its scientific name, the number of individuals seen, and, crucially for the plot, its overall wellbeing. There are also distinctive mini-documentaries, titled Ocean Insights, which can be discovered and reveal the real-world locations that inspired Beyond Blue's landmarks. The game holds a gain-framed messaging strategy, concentrating on the advantages of marine life preservation and its favourable effects on the Earth, while delivering the climate change message subtly scattered among the dialogues, visual graphics, and gameplay in a serene and positive atmosphere. It takes around 4 hours to play through Beyond Blue in its entirety. Participants had the chance to play it for 35-40 minutes.

#### 4.3.1.1 Experiment 1 (E1) Hypotheses

To examine the overall effect of Beyond Blue on participants' pro-environmental attitudes, I formed the following main hypothesis: **E1-H1: Beyond Blue will positively impact players' pro-environmental attitudes.** E1-H1 is justified by the principle of Prospect Theory (Kahneman and Tversky, 1979) that affirms gain-framed messaging can

influence people by providing incentives through amplifying positivities and diminishing negativities. Also, using a gain-framed strategy is an appealing, non-manipulative, and persuasive way of communication (Reinhart et al., 2007; Witte, 1994), which has been shown to encourage recipients' environmental intentions in virtual settings (Ahn et al., 2015). I divided the main hypothesis into three sub-hypotheses on the magnitude of Beyond Blue's influence on explicit and implicit attitudes in the short and long term.

**E1-H1a: Beyond Blue will positively impact short-term explicit pro-environmental attitudes.** I expect to see a positive explicit pro-environmental attitude shift (i.e., an increase in scores from pre-test to post-test) following the initial game exposure. The premise for E1-H1a is that Beyond Blue's overall gain-framed messaging tactic, accompanied by perspective-taking, and the introduction of new information on how climate change is affecting marine life, backed up by scientific resources (mini-documentaries and technological tools), will influence players' propositional reasoning. Founded on general and logical knowledge gained from facts about the item under consideration, propositional reasoning is a conscious process that serves as the foundation for explicit attitudes (Bohner and Dickel, 2011; Gawronski and Bodenhausen, 2014; Gawronski and Brannon, 2019). Therefore, inducing the propositional reasoning in players can result in more positive explicit pro-environmental attitudes in the short term.

**E1-H1b: The explicit pro-environmental attitude change in players will not be long-term.** Beyond Blue offers a distinctive virtual viewpoint on the natural wonders of the ocean while addressing conservation issues. Nevertheless, it is an exploration game in a semi-open world, where messages concerning the consequences of climate change are subtly implied in a gain-framed design. Propositional reasoning is informed by general knowledge on the item in question (Bohner and Dickel, 2011; Gawronski, 2007), and the conclusions derived from them are created based on their reliability with pertinent ideas about the item that we have placed in our recollection (Gawronski and Brannon, 2019; Bohner and Dickel, 2011). However, for a long-term impact to happen, we need to form strong links between the topic depicted in the game and other propositions in one's memory (Gawronski and Bodenhausen, 2014). I predict that, due to the intervention's brief duration and the subtle messaging strategy used to address the climate change crisis, a durable explicit pro-environmental attitude change will not be formed in the Beyond Blue participants. As a result, I do not anticipate a significant change in explicit pro-environmental attitude between the pre-test and the delayed post-test.

**E1-H1c: Beyond Blue will not positively impact implicit pro-environmental attitudes.** To influence players' implicit attitudes, the intervention must stimulate and revise pre-existing associative links (Gawronski and Bodenhausen, 2006; Gawronski and Brannon, 2019) between the games' displayed concepts and other general ecological ideas preserved in participants' memories that they see as adverse (e.g., collective guilt or

personal sense of responsibility and remorse towards climate change). These revised associative links will have an impact on the participants' overall associative evaluation (Gawronski and Bodenhausen, 2014; Gawronski and Brannon, 2019) of the encounter. However, I believe Beyond Blue lacks the necessary elements to trigger and revise associative evaluations of the topic at hand. Specifically, the central gain-framed messaging of this game takes away the urgency of climate change delivering the issue in an indirect and subtle way. The complexities of climate change are unlikely to be conveyed through an indirect messaging approach and the short gameplay duration of the experiment. Consequently, I do not predict a positive shift in participants' implicit pro-environmental ratings in neither short nor long term.

To measure Beyond Blue's design features' contributions to predicting pro-environmental attitudes, I defined the next hypotheses. For Beyond Blue's mechanics, I hypothesise: **E1-H2: The intervention's overall mechanics design will positively predict players' pro-environmental explicit attitude.** As a rationale for this hypothesis, I exemplify how Beyond Blue's overall mechanics help to deliver environmental information through rule-based representations in gameplay, aspiring to influence attitudes (Bogost, 2007). This game empowers its players to undertake a virtual tour of the ocean to experience the game's central themes and achieve certain goals. As a simulation, it benefits from gameful rules and interactive settings to persuade within a playful context. Beyond Blue's mechanics facilitate interaction and engagement with the game and accelerate venturing into the gameplay and experiencing its environmental message. As an exploratory goal, I also investigated which element(s) (controller, feedback, goal-setting, challenge) are individually effective predictors of pro-environmental attitudes.

For Beyond Blue's narrative feature, I hypothesise: **E1-H3: The intervention's overall narrative design will positively predict players' pro-environmental explicit attitude.** To justify this hypothesis, I refer to how the game begins with an anecdote from the main character to explain why she is personally invested in her job as a marine scientist. I believe this introduction sets the mood for further engagement with the game and its characters while carrying the player into the game world and conveying the main ideas and meanings. Moreover, the notion of appreciating the marine ecosystem and preserving it is specified from the beginning, enticing players to re-evaluate the importance of the aquatic biome as the gameplay and the story continue. In the analysis, I aimed to also explore how the game element(s) (storyline, character design, concept/meaning) showed unique associations with pro-environmental attitudes.

For animation design, I hypothesise: **E1-H4: The intervention's overall animation design will positively predict players' pro-environmental explicit attitude**. My rationale is that Beyond Blue has a remarkable aesthetic and simulation structure, which I speculate could provide an immersive experience, leading to a theme-relevant increase

in pro-environmental attitudes. With noteworthy visual cues (e.g., texture and quality of objects and environments) and sonic prompts (e.g., soundtracks and music), coupled with a semi-open world game that depicts a futuristic setting (e.g., the hi-tech gadgets), this game creates a realistic and plausible microworld. Moreover, in the analysis, I explore which element(s) (world-building, exploration, audiovisual design) significantly predicts pro-environmental attitudes.

### 4.3.2 Experiment 2: Plasticity

Plasticity depicts a world conditioned to exist alongside hills of trash and waves of waste (see Figure 4.3). It is the future Earth (the year 2140) in which plastic consumption never ceased, leaving behind barren regions, submerged cities, scattered litter, and wretched scenes. This game's setting is mainly focused on loss-framed environmental messaging, where it portrays the planet in ruins and puts the player in a situation where they undergo a deep feeling of loss for a world devoid of natural balance. This side-scroller puzzle-platformer game was developed by students in the USC Games Program, who have embedded a persuasive climate change message in a narrative that focuses on the adverse outcomes of collective failure to act on environmental issues. I chose this game because the complexities of a loss-framed message approach mixed with the design opportunities of an indie game give Plasticity an interestingly multifaceted theme and design. Developers frame the message in a simplified and direct way, which is a strategy to prevent the receiver from being overwhelmed with details and information, especially when the implicit connection to the issue is recognisable (Fernández Galeote and Hamari, 2021). However, some little-known details regarding the gravity of plastic consumption (especially via food) are also embedded in the storyline, which could challenge the player's present views on the subject. In this puzzle-platformer, the player plays the role of Noa, a girl who can carry out small acts of kindness to life around her, in pursuit of step-by-step recovery of what is left of the planet. Although every choice has repercussions, some cannot be changed. The player might stumble or collapse along this journey, but rescuing the planet is the burden on their shoulders.

Despite having an overall loss-framed messaging tactic, accompanied with the melancholy soundtrack, tragic trash backgrounds, and trapped wildlife scenes, the game gives the players two distinct ending options based on the decisions they made along the way. The game has a hopeful conclusion if the player performs basic acts of compassion toward life around them (e.g., helping animals, picking up rubbish, or joining up with others to restore Earth). Otherwise, the game ends with a bleaker and harsher fate for the remaining population of the Earth. Plasticity requires 20-40 minutes of gameplay. The participants played the game for 35-40 minutes. I monitored the gameplay process and the ending each participant experienced. The majority of the participants ($N = 31$)

**Figure 4.3**: The futuristic world created in Plasticity (2019)

finished the game during the experiment, with most ($N = 26$) who completed the game finishing with the hopeful ending. Four participants (who were experienced players) managed to complete the game twice during the experiment. Three of them experienced both endings ($N = 3$) and expressed that the hopeful outcome compensated and overshadowed the hopeless one for them. One of them experienced the hopeless ending in both rounds of the gameplay. One other participant also ended the game with the hopeless conclusion, bringing the total of two participants with only the hopeless ending as their game conclusion ($N = 2$). The complexities of a central loss-framed strategy combined with a potential hopeful ending and a direct message approach give this game a multi-layered message design.

#### 4.3.2.1 Experiment 2 (E2) Hypotheses

To investigate the overall impact of Plasticity on participants' pro-environmental attitudes, I formed the following main hypothesis: **E2-H1: Plasticity will positively impact players' pro-environmental attitudes.** The rationale behind E2-H1 is that perspective-taking offers a distinct viewpoint on avatar-based games, as users interact with situations and perform tasks from the avatar's vantage point (von Salm-Hoogstraeten and Müsseler, 2021). Therefore, players can evaluate their decisions and contemplate whether they involve themselves in like manner in the physical world. Given the preceding arguments regarding the importance of framing effects (Tversky and Kahneman, 1986, 1981) in risk-related and climate change communication, I predict that as a gameful

intervention containing the loss-frame, perspective-taking, central topic-related narrative, and some new information, playing Plasticity will increase players' pro-environmental attitudes. The main hypothesis can be broken down into four sub-hypotheses, testing the gameful intervention's level of impact on explicit and implicit attitudes in the short and long term.

**E2-H1a: Plasticity will positively impact short-term explicit pro-environmental attitudes.** I anticipate a positive explicit pro-environmental attitude change (i.e., an increase in scores from pre-test to post-test) immediately after exposure to Plasticity. The rationale for H2a is that Plasticity portrays the future earth in ruin, due to generational negligence of the pressing environmental issues and disregard for climate change and shows the inevitable chain of cause and effect of a societal inability to recognise this issue. I anticipate that the overall loss-framed messaging tactic combined with the perspective-taking, and the introduction of subject-specific insights in the gameplay will impact propositional reasoning, resulting in more positive explicit pro-environmental attitudes.

**E2-H1b: The explicit pro-environmental attitude change in players will be long-term.** I predict a positive explicit pro-environmental attitude change between the pre-test and the delayed post-test (i.e., an increase in scores from pre-test to delayed post-test). E2-H1b is justified by the fact that explicit attitudes stem from propositional reasoning about a specific thought-object. This proposition should align with other ideas and beliefs (Gawronski and Bodenhausen, 2014). I anticipate that there will be explicit attitude modifications that contain reevaluating one's position on the matter (Gawronski and Brannon, 2019). Re-visiting ideas can be a time-consuming procedure. Thus, based on the characteristics of the intervention, the anticipated instant shift in explicit pro-environmental attitudes will endure, becoming long-term.

**E2-H1c: Plasticity will positively impact short-term implicit pro-environmental attitudes.** To impact the implicit layer of attitudes, the intervention must provoke and modify pre-existing associative links (Gawronski and Bodenhausen, 2006; Gawronski and Brannon, 2019) between the games' presented ideas and players' unfavorable environmental notions (e.g., shared guilt or individual sense of remorse or responsibility towards the climate crisis). These adjusted associative links will influence the participants' overall associative evaluation (Gawronski and Bodenhausen, 2014; Gawronski and Brannon, 2019) during/after gameplay. For Plasticity, I anticipate a significant positive implicit pro-environmental attitude shift immediately following game exposure (i.e., an increase in scores from pre-test to post-test). The rationale behind E2-H1c is that Plasticity places the player in a scenario filled with horrific debris landscapes, bleak lands, flooded towns, and entrapped wildlife images, all complemented by a gloomy score to make the player experience a profound sense of loss and grief for the world left behind. As a result, I antic-

ipate that the intervention will temporarily activate pre-existing but infrequently utilised associative links between the game events/themes and other unfavourable ecological notions stored in participants' memories, impacting their overall associative evaluation of the experience (Gawronski and Bodenhausen, 2014). As a result, I anticipate a positive short-term shift in implicit pro-environmental assessments.

**E2-H1d: The implicit pro-environmental attitude change in players will not be long-term.** To observe a long-term implicit pro-environmental attitude change, we should attempt to impact the associative evaluations of climate change. This impact is possible via the recurring simultaneity of this issue with the rest of pertinent notions participants hold as undesirable in their memories (e.g., collective guilt, sense of responsibility/remorse towards climate change, or any personal memory of an experience with an ecological collapse) stimulating the associative links between them (Gawronski and Brannon, 2019; Gawronski and Bodenhausen, 2014). However, in this experiment, I do not expect this impact to occur due to the duration and structure of the intervention, which will only trigger the associative links sporadically. Consequently, I do not anticipate that the gameplay will have a long-term impact on implicit pro-environmental attitudes.

To measure Plasticity's design features' contributions to predicting pro-environmental attitudes, I defined the next hypotheses. For Plasticity's mechanics design, I hypothesise that: **E2-H2: The intervention's overall mechanics factors will *not* predict players' pro-environmental attitudes**. Plasticity mechanics show some glitches and bugs, which could deter players from fully interacting with the game's environmental ideas and objectives. While the mechanic aspect's limitations could be due to budget constraints associated with a student-led indie project, I think the faulty interactivity system would dissuade players from fully participating in the game and interacting with its main theme.

For Plasticity's narrative design aspect, I hypothesise: **E2-H3: The intervention's overall narrative design will positively predict players' pro-environmental attitudes**. Plasticity opens its plot with the death of a character due to plastic pollution, making a heartfelt persuasive connection to the real consequences of the environmental crisis. This introduction makes the narrative tangible and persuasive and sets the scene for emotional investment, while transmitting the main theme and eco-concerns.

For Plasticity's animation design aspect, I hypothesise: **E2-H4: The intervention's overall animation design will positively predict players' pro-environmental attitudes**. Even with a low budget, Plasticity builds a world that can capture the attention of players through detailed visuals of plastic-packed environments, haunting soundtracks, and a variety of locations that give players sufficient space to explore the game world. Depicting a detailed world (e.g., the wastelands, flooded regions, dispersed trash), Plasticity can give players a sense of presence in a simulated desolate reality, enhance their

immersion into the game world, and influence pro-environmental attitudes. For each feature, as an exploratory goal, I examined which individual elements significantly predicted pro-environmental attitudes.

### 4.3.3 Exploratory Goals

I examined the differences in pre-post and pre-delayed post change between the two gameful interventions to explore how two distinct games' message design tactics may have a varied influence on their players' pro-environmental attitudes. The exploratory goal specifically looked into the differences and subtleties in message framing (loss-framed and gain-framed) strategies employed in the two gameful interventions as a first step to understanding persuasive gameful messaging in the context of climate change communication. In addition to the hypothesised design features, I examined which individual elements significantly predicted pro-environmental attitudes.

## 4.4 Quantitative Measures

The measures employed in each experiment included a demographic and background questionnaire, PANAS test (Positive and Negative Affect Scale), Implicit Attitude Test (IAT), Explicit Attitude Test (Positive and Negative Eco-Emotion scale, Cognitive Attitude scale, Threat Perception scale), the Player Experience Inventory (PXI), the Player Experience of Needs Satisfaction (PENS), the Transportation, and Avatar Identification scales. As the experiment was conducted online, all the questionnaires were computer-based. In this section, I describe each of the measures used in each phase of the study. The only difference between Experiment 1 and Experiment 2 was the gameplay phase (i.e., which of the two games were played).

### 4.4.1 The Pre-Test Measures

The pre-test contained the PANAS test, the Implicit Attitude Test (IAT), and the explicit attitude test.

#### 4.4.1.1 Positive and Negative Affect Schedule (PANAS)

Participants' moods can influence attitudes (Schwarz and Clore, 1983; Wegener et al., 1994), so I included the Positive and Negative Affect Schedule (PANAS test) (Watson et al., 1988). This self-report questionnaire has two 5-point Likert item mood scales (20 items), and each scale asks participants to rate the extent they are undergoing each emotion from 1 (very slightly or not at all) to 5 (extremely) (Magyar-Moe, 2009). The positive affect includes 10 items; (pre-test $\alpha = .87$, post-test $\alpha = .89$, delayed post-test $\alpha$

*= .93*), with emotions such as 'enthusiastic', 'determined', and 'inspired'. The negative affect also includes 10 items (pre-test $\alpha$ = *.85*, post-test $\alpha$ = *.95*, delayed post-test $\alpha$ = *.92*), with emotions such as 'scared', 'guilty', and 'hostile'. I computed the mean scores ranging from 1-5, where lower values represent less positive or more negative affect. Multiple studies have determined that the PANAS is valid and reliable for measuring positive and negative affect (Merz et al., 2013). The PANAS test was implemented in the pre-test, post-test, and delayed post-test of both studies.

#### 4.4.1.2 Implicit Attitude Test (IAT)

The Implicit Association Test (IAT) (Banaji and Greenwald, 2013) is a multipurpose method for identifying implicit attitudes by assessing the level of automatic connections between different items and ideas (Steiner et al., 2018). In contrast to explicit self-reporting, the IAT evaluates spontaneously triggered associations, making it exceptionally hard, if not impossible, for participants to fabricate or manipulate their answers (Asendorpf et al., 2002; Banse, 2001). Therefore, using IATs mitigates participants' impression management efforts to look more socially acceptable (Tedeschi, 2013) towards topics such as climate change. The purpose of the IAT is to measure the extent to which target pairings and categories are conceptually connected (Lane et al., 2007) and is based on the concept that participants can respond faster to strongly related, compatible categories than to loosely associated, conflicting categories. In other words, the IAT assumes that people can categorise stimuli more quickly if groupings are compatible with associations.

To cover a broad range of pro-environmental attitudes, I chose the sustainability IAT by Steiner et al. (2018), which is an empirically tested 'standard IAT'. This type of IAT comprises four simple categories for intuitive or 'fast thinking' decision-making (Kahneman, 2012) (see Table 4.1). This test employs the categories 'good' and 'bad' to target participants' 'Sustainable' and 'Unsustainable' choices. Throughout the process, specific phrases ('stimuli') are displayed, and participants must make an instantaneous choice as to which category they belong. Based on the stimulus, they need to choose between qualitative judgments ('good' versus 'bad') or determine if the object in question meets the standard of Sustainability (Steiner et al., 2018) (see Figure 4.4). To conduct the test, I utilised the supplementary tool developed by Carpenter et al. (2019). I used the web-based platform that facilitates IAT generation (and analysis) via on-screen menus and delivers a downloadable, readily accessible Qualtrics IAT survey. The IAT was implemented in the pre-test, post-test and delayed post-test of both studies.

To ensure data quality, responses with a reaction time of less than 300 milliseconds or greater than 10,000 milliseconds were eliminated (Beattie and McGuire, 2015). From the Beyond Blue experiment (Experiment 1), one respondent in the pre-test, one in post-test,

**Table 4.1**: Sustainability IAT – Four categories with five stimuli per category.

| Sustainable | Unsustainable | Good | Bad |
|---|---|---|---|
| Continuing education | Energy-intensive | Happy | Bad |
| Re-use | Short-term orientation | Peace | Failure |
| Economic sustainability | Speculation | Pleasure | Terrible |
| Social commitment | Pure profit orientation | Joy | Pain |
| Product stewardship | One-way products | Laugh | Disgusting |


**Figure 4.4:** IAT- test of incompatible categories (left) and compatible categories (right). Stimuli are shown in the center.

and two in the delayed post-test were filtered due to excessive speed. Also, one participant of the Plasticity experiment (Experiment 2) in the post-test and two in the delayed post-test were automatically omitted for the same reason. To account for order effects (such as training and exhaustion), the sequence of the test's incompatible and compatible phases was randomised (see Table 4.2 for the different phases in the IAT). For the IAT a difference score (Dscore), which indicates the standardised mean response time of the compatible and incompatible phases of the test, was calculated for each respondent (Greenwald et al., 2003). In this design, high scores show a strong association between 'Sustainable' and 'Good,' whereas low scores indicate a strong association between 'Sustainable' and 'Bad' (Steiner et al., 2018).

#### 4.4.1.3 Explicit Attitude Tests (Positive & Negative Eco-Emotion scale, Cognitive Attitude scale, Threat Perception scale)

For the explicit attitude test, I selected scales to measure the social (cognitive) attitude, the eco-emotional attitude, and the threat perception sections of the questionnaire used in the longitudinal series of the annual survey of Australian attitudes to climate change (Leviston et al., 2015). The explicit attitude measurement was implemented in the pre-test, post-test and delayed post-test of both studies. To assess the cognitive part of

**Table 4.2**: The 7 phases of the Standard IAT.

| Phase | Left category | Right category | No. stimuli | Aim |
|---|---|---|---|---|
| 1 | Good | Bad | 20 | Preparation |
| 2 | Sustainable | Unsustainable | 20 | Preparation |
| 3 | Good / Sustainable | Bad / Unsustainable | 20 | Preparation |
| 4 | Good / Sustainable | Bad / Unsustainable | 40 | Test |
| 5 | Bad | Good | 20 | Preparation |
| 6 | Bad / Sustainable | Good / Unsustainable | 20 | Preparation |
| 7 | Bad / Sustainable | Good / Unsustainable | 40 | Test |

the respondents' explicit attitude, they were asked to rate their agreement with eleven climate-related statements on a scale of 1 (strongly disagree) to 5 (strongly agree), with four items reverse scored so that higher scores represent greater belief that Australia and individuals can act to address climate change. The cognitive attitude measure was highly reliable (pre-test $\alpha = .81$, post-test $\alpha = .80$, delayed post-test $\alpha = .80$). To capture participant's eco-emotional attitudes, I asked them whether climate change makes them feel a series of emotions, with responses from 1 (strongly disagree) to 5 (strongly agree). Principal components analysis identified that eight emotions formed two underlying factors, interpreted as negative and positive eco-emotions. Negative eco-emotions included feeling angry, fearful, irritated, guilty, and ashamed about climate change (5 items; pre-test $\alpha = .72$, post-test $\alpha = .82$, delayed post-test $\alpha = .73$), while positive eco-emotions included feeling excited, hopeful, and joyful (3 items; pre-test $\alpha = .72$, post-test $\alpha = .66$, delayed post-test $\alpha = .80$). Climate change threat perception was measured with six items, with participants rating from 1 (not at all) to 4 (a great deal) how much climate change would harm six groups (e.g., them personally, their family), with a response option 0 – Don't know, removed prior to analysing the data. The measure was highly reliable across each time point (pre-test $\alpha = .86$, post-test $\alpha = .77$, delayed post-test $\alpha = .84$), thus mean scores were computed allowing for up to three missing data points.

### 4.4.2 The Post-Test Measures

I began the post-test with a repetition of the PANAS, IAT, and explicit attitude tests, in addition to a series of demographic questions (described in Section 4.4.2.4). Furthermore, participants completed a series of player-focused questionnaires to measure players' experiences of different game design factors, including the Player Experience Inventory (PXI) (Abeele et al., 2020), the Player Experience of Needs Satisfaction (PENS) (Rigby and Ryan, 2007), the Transportation (Green and Brock, 2000; Maxwell and Tefertiller, 2019), and Avatar Identification (Van Looy et al., 2012) scales.

#### 4.4.2.1 Mechanics

I used the PXI to measure how game design choices can impact player experiences (Abeele et al., 2020). Based on the dual functional and psycho-social facets of video games, this self-report test measures several constructs, each measuring a specific gameful element (with three items each) and uses a seven-point Likert scale (Abeele et al., 2020). All elements of the mechanics feature were measured by the PXI:

- PXI 'Ease of Control' ($\alpha = .87$) (e.g., 'It was easy to know how to perform actions in the game.') evaluated participants' experiences of the **controls**.
- PXI 'Goal and Rules' ($\alpha = .85$) (e.g., 'I understood the objectives of the game.') measured participants' experiences of the **goal-setting** design.
- PXI 'Progress Feedback' ($\alpha = .83$) (e.g., 'The game informed me of my progress in the game.') evaluated participants' experiences of the game's **feedback** design.
- PXI 'Challenge' ($\alpha = .84$) (e.g., 'The challenges in the game were at the right level of difficulty for me.') measured participants' experiences of the **challenge** design.

#### 4.4.2.2 Narrative

I used a range of scales to measure the narrative design aspect, including the Transportation Scale, Avatar Identification Scale, and the PXI 'Meaning' construct.

- Transportation Scale: I wanted to estimate the quality of the intervention's **storyline** design. Thus, I measured participants' experiences of narrative transportation by the transportation questionnaire (Green and Brock, 2000), used for digital games (Maxwell and Tefertiller, 2019) ($\alpha = .77$). With eleven statements (e.g., 'I wanted to learn how the video game ended.') and a seven-point Likert system, this measure elucidated how the storyline influenced players' experiences. I reverse-coded three items so that higher scores represented a higher level of transportation.
- Avatar Identification Scale: I wanted to know if the game **character** could establish a bond with players. Therefore, I employed the avatar identification component of the Player Identification test by Van Looy et al. (2012) to measure players' perceived identification with the character and estimate the quality of the character design ($\alpha = .95$). With 17 items (e.g., 'When playing, it feels as if my character's body becomes my own.') in a 5-point Likert system spanning from 1 (strongly disagree) to 5 (strongly agree).
- PXI 'Meaning': With three items (e.g., 'Playing this game was valuable to me.'), this construct ($\alpha = .88$) used a seven-point agreement Likert scale (Abeele et al., 2020) to assess participants' experiences of the intervention's **concept/meaning**.

#### 4.4.2.3 Animation

I employed a series of scales to measure the animation design aspect, including the PENS 'Presence', PXI 'Curiosity', and PXI 'Audiovisual Appeal' constructs.

- PENS 'Presence' construct: I was interested to see if Plasticity's **worldbuilding** could convey a sense of presence and realism. With nine items (one item reverse-coded) and a seven-point Likert structure, the PENS 'Presence' construct ($\alpha = .87$) (e.g., 'I had reactions to events and characters in the game as if they were real.') assessed participants' perceived presence in the intervention's simulated world to estimate players' experiences of the quality of the game's worldbuilding design.
- PXI 'Curiosity': The charisma of discovery and exploration of virtual worlds has been linked to humans' innate curiosity (Gómez Maureira et al., 2019; Zhan et al., 2018). So, for assessing the quality of the intervention's **exploration** design, I used this scale to measure players' perceived sense of curiosity ($\alpha = .92$) (e.g., 'I wanted to explore how the game evolved.').
- PXI 'Audiovisual Appeal': This construct ($\alpha = .82$) (e.g., 'I liked the look and feel of the game.') measured participants' experiences of the game's **audiovisual** design.

#### 4.4.2.4 Players' Demographics

A set of questions in the survey focused on participants' demographics to record the sample's background, including participants' gender, age, education, ethnicity, religion, political views, geographical area, and socioeconomic status.

### 4.4.3 The Delayed post-test Measures

The delayed post-test repeated the pre-test stage (the PANAS and implicit and explicit attitude tests).

## 4.5 Qualitative Measures

Due to the intricacies of the research topic, I incorporated qualitative information (interviews in the post-test phase and descriptive questions in the delayed post-test phase) as an essential part of the research design. The qualitative portion of the project was an exploratory investigation to accumulate a collection of viewpoints and expectations regarding the interventions' design strong/weak points and design opportunities. The aim was to understand and interpret shared patterns and qualities in the sample (Queirós et al., 2017).

### 4.5.1 Interviews

Interviews are one of the most frequently employed qualitative data-gathering techniques (Cassell, 2005). Researchers carry out qualitative interviews to obtain a thorough understanding from individuals on specific situations or experiences (deMarrais, 2004). In my project, during the first session of the experiments, after completing the post-test phase, an online one-on-one semi-structured interview was conducted using Zoom or Microsoft Teams (based on the participant's preference). For the interview phase, Experiment 1 (Beyond Blue) consisted of 34 participants ($N = 34$), while Experiment 2 (Plasticity) had 36 participants ($N = 36$). The main objective was to further explore the interventions' design considerations' effects on the participants and produce a set of guidelines based on the weak and strong design points recognised by participants. To have a concrete process, I developed an interview guide with five phases (Robson, 2011):

1. Introduction: Giving a short overview of the study. Re-checking the participant's anonymous identifier.

2. Warm-up: beginning with icebreaker and informal questions to make the participant comfortable (e.g., 'Could you tell me a little bit about yourself?').

3. Main body: focusing on the central subject of the research and the main questions (e.g., 'What do you think you took away from the experience of playing the game?' or 'What kind of adjustments/ improvements would you want to make to this game?').

4. Cool-off: Concluding with simple questions, feedback requests, concerns, or final comments (e.g., 'Do you have something more that you wish to share?').

5. Closure: thanking the participant for their time and contribution. Emphasising that they must NOT play the intervention game anywhere until the second session is completed in the next few weeks.

### 4.5.2 Descriptive Questions

Descriptive questions aim to facilitate understanding, analysis, and interpretation of data, explaining the participant's perspective and experience and providing in-depth insight about the topic investigated (Magilvy and Thomas, 2009). To this end, I integrated a series of descriptive open-ended questions (e.g., What part/aspect/element of the game do you remember most after these few weeks? Why do you think that part/aspect/element stood out? Please, explain as much as you can) to the second session of the experiments (delayed post-test). These descriptive questions further investigated the extent of the potential long-term impact of the game design on participants.

## 4.6 Conclusions

Climate change is a multifaceted issue. Developing creative and gameful interventions to communicate this issue can benefit from a mixture of quantitative and qualitative methods to shed light on its diverse aspects. Mixed method makes use of both theoretical and empirical measures to address elaborate issues and accommodate the requirements of interdisciplinary researchers (Tobi and Kampen, 2018). To have a grasp of the complexity of my research topic, I employed a mixed methodology. I conducted two parallel within-subjects interventional experiments. That is to say I used Beyond Blue and Plasticity as climate-themed gameful interventions to collect a combination of quantitative and qualitative data regarding how, and to what extent, participants' experiences of the aspects of game design used in my Climate-Oriented Persuasive Edutainment (COPE) model influenced their pro-environmental attitudes. The experiments examined the effects of the above-mentioned eco-games on pro-environmental attitudes, using both explicit and implicit attitude measurements and in three phases (pre-test, post-test, delayed post-test). The qualitative data (semi-structured interviews and a set of open-ended descriptive questions) helped to describe and interpret the data and set a game design guideline.

Overall, my methodological design not only facilitated finding answers and explanations to my research questions, it also boosted my confidence in the validity and reliability of the findings, interpretations, and concluding thoughts. Moreover, this research design helped me to develop rapport with participants, which greatly assisted with the interviews, specifically regarding how participants could open up in more details about their experience and perspectives. The next chapter presents the data analyses and results, firstly for the quantitative and then for the qualitative data.

Chapter 5

# Quantitative Data Analyses

This research used a mixed-method approach (quantitative and qualitative methodology) to examine the effects of two eco-games (Beyond Blue and Plasticity) on participants' pro-environmental attitudes in both the short-term and long-term. The quantitative portion of my methodology involved examining how and to what extent the two interventions impacted participants' explicit and implicit attitudes and identifying which design features/elements contributed to the attitude impact. The exploratory analyses included investigating the differences between the message design and framing mechanisms used in the two interventional games.

I performed quantitative data analysis to test the hypotheses (outlined in the previous chapter) by 1) determining pro-environmental changes throughout each phase of the study, and 2) identifying the role of each gameful feature/element in the estimated changes. As described in detail in the previous chapter, my experimental design contained three phases: pre-test, post-test, and delayed post-test. First, participants completed the pre-test survey. Then, they played the eco-game (Beyond Blue or Plasticity). Participants were tasked with navigating their assigned game for 35-40 minutes as the experimental intervention. Next, each participant filled out several scales and provided background information, including their prior video game playing experience, positive and negative affect, socioeconomic status, gender, age, education, ethnicity, political view, and religion. Participants were invited to complete the delayed post-test 3-5 weeks after the main gameplay session, which replicated the pre-test design. I conducted a set of descriptive analyses, repeated measures t-tests, and multiple regression analyses to detect the overall persuasive impact of the intervention on participants' pro-environmental attitudes across different stages of the experiments. Furthermore, I investigated how the features and elements of the intervention's game design predicted the outcome variables. I used SPSS version 28 for the data analysis to test the hypotheses and address the research questions.

## 5.1 Examining the Interventions' Overall Effect (Message Framing)

I analysed changes across each stage of the experiments and between the two gameful interventions. In this section, I report the data analysis process and results regarding the interventions' overall effect on participants' pro-environmental attitudes, including hypotheses testing, descriptive analysis, Pearson correlations, and t-tests.

**Table 5.1:** Repeated measures t-tests comparing pre-test with post-test and delayed post-test scores for Beyond Blue (Experiment 1) and Plasticity (Experiment 2).

| | Game/Experiment | T-test | Cohen's d |
|---|---|---|---|
| *Comparing pre-test and post-test scores* | | | |
| Negative Eco-emotion | Beyond Blue (E1) | t(35) = 1.02, p = .32 | 0.17 |
| | Plasticity (E2) | t(36) = -0.42, p = .68 | -0.07 |
| Positive Eco-emotion | Beyond Blue (E1) | t(35) = 1.84, p = .07 | 0.31 |
| | Plasticity (E2) | t(36) = -1.84, p = .08 | -0.30 |
| Cognitive Attitude | Beyond Blue (E1) | t(35)= -2.99, p < .01 | -0.50 |
| | Plasticity (E2) | t(36)= -3.84, p < .01 | -0.63 |
| Threat Perception | Beyond Blue (E1) | t(35)= -0.49, p = .63 | -0.08 |
| | Plasticity (E2) | t(36)= -2.49, p = .02 | -0.41 |
| Implicit Attitude | Beyond Blue (E1) | t(33)= 1.80, p = .08 | 0.31 |
| | Plasticity (E2) | t(35)= 0.43, p = .67 | 0.07 |
| *Comparing pre-test and delayed post-test scores* | | | |
| Negative Eco-emotion | Beyond Blue (E1) | t(21) = -0.07, p = .95 | -0.01 |
| | Plasticity (E2) | t(30) = 0.82, p = .42 | 0.15 |
| Positive Eco-emotion | Beyond Blue (E1) | t(21) = 0.00, p = 1.00 | 0.00 |
| | Plasticity (E2) | t(30) = -3.46, p < .01 | -0.62 |
| Cognitive Attitude | Beyond Blue (E1) | t(21)= 0.85, p = .40 | 0.18 |
| | Plasticity (E2) | t(30)= 1.85, p = .07 | 0.33 |
| Threat Perception | Beyond Blue (E1) | t(21)= 0.36, p = .72 | 0.08 |
| | Plasticity (E2) | t(30)= -0.55, p = .59 | -0.10 |
| Implicit Attitude | Beyond Blue (E1) | t(18)= 0.56, p = .58 | 0.13 |
| | Plasticity (E2) | t(28)= 0.05, p = .96 | 0.01 |

### 5.1.1 T-tests: Experiment 1 (Beyond Blue)

I investigated the impact of a commercial game (Beyond Blue) on implicit and explicit pro-environmental attitudes in both the short and long term via a parallel within-subjects experiment. My hypotheses specified the expected pro-environmental impact of this game on players throughout the pre-test, post-test, and the delayed post-tests. To test the hypotheses, I conducted repeated measures t-tests to determine how attitudes varied through each stage of the experiment. Table 5.1 presents the results from a series of paired samples t-tests and Table 5.2 shows Mean scores in both Experiment 1 and 2.

**Table 5.2:** Descriptive statistics results for each stage for Beyond Blue (Experiment 1) and Plasticity (Experiment 2)

| | | *Mean (SD)* | |
|---|---|---|---|
| | | Beyond Blue (E1) | Plasticity (E2) |
| Positive Affect | Pre-test | 3.24 (0.54) | 3.13 (0.81) |
| | Post-test | 2.91 (0.76) | 2.81 (0.78) |
| | Delayed Post-test | 2.46 (0.78) | 2.63 (0.92) |
| Negative Affect | Pre-test | 1.43 (0.53) | 1.42 (0.47) |
| | Post-test | 1.36 (0.48) | 2.27 (1.00) |
| | Delayed Post-test | 1.55 (0.70) | 1.76 (0.74) |
| Cognitive Attitude | Pre-test | 3.79 (0.50) | 3.63 (0.62) |
| | Post-test | 3.91 (0.51) | 3.84 (0.54) |
| | Delayed Post-test | 3.77 (0.51) | 3.70 (0.58) |
| Negative Eco-Emotion | Pre-test | 3.42 (0.78) | 3.32 (0.66) |
| | Post-test | 3.33 (0.69) | 3.37 (1.03) |
| | Delayed Post-test | 3.33 (0.68) | 3.19 (0.78) |
| Positive Eco-Emotion | Pre-test | 2.06 (0.71) | 1.68 (0.70) |
| | Post-test | 1.89 (0.71) | 1.89 (0.64) |
| | Delayed Post-test | 1.97 (0.69) | 2.15 (0.96) |
| Threat Perception | Pre-test | 3.40 (0.54) | 3.39 (0.48) |
| | Post-test | 3.43 (0.41) | 3.52 (0.50) |
| | Delayed Post-test | 3.28 (0.52) | 3.49 (0.53) |
| Implicit attitude | Pre-test | 0.75 (0.25) | 0.65 (0.33) |
| | Post-test | 0.64 (0.34) | 0.63 (0.33) |
| | Delayed Post-test | 0.68 (0.36) | 0.63 (0.46) |

Based on the results and as predicted by E1-H1, participants who played Beyond Blue

showed higher cognitive attitudes at post-test compared to pre-test, with a moderate effect (pre-test: *M = 3.79, SD = 0.50*, post-test: *M = 3.91, SD = 0.51, t(35) = -2.99, p = .005, Cohen's d = -0.50*). This result partially supports E1-H1a and demonstrates that Beyond Blue as a gameful intervention can have a significant impact on an aspect of explicit pro-environmental attitudes in the short term. See Tables 5.1 and 5.2 for detailed results. However, as expected in E1-H1b, participants' explicit attitude scores (eco-emotion, threat perception, and cognitive attitude) did not significantly change between the pre-test and the delayed post-test, indicating there were no long-term changes to explicit attitudes. As predicted in E1-H1c, implicit attitude scores did not significantly change in the pre-post and the pre-delayed stages of this experiment, suggesting there were no changes to implicit attitudes.

### 5.1.2 T-tests: Experiment 2 (Plasticity)

I investigated the impact of an independent (indie) game (Plasticity) on implicit and explicit pro-environmental attitudes in both the short and long term via a parallel within-subjects approach. My hypotheses tested the pro-environmental impact of this intervention on players throughout the pre-test, post-test, and the delayed post-test stages of the experiment. To test my hypotheses, I conducted repeated measures t-tests to determine how attitudes differed across each stage of the experiment. Table 5.2 presents Mean scores and Table 5.1 shows the results from a series of paired samples t-tests.

The results showed that E2-H1 was supported, as there was a significant difference between the ratings of threat perception in the pre-test (*M = 3.39, SD = 0.48*) and post-test (*M = 3.52, SD = 0.50*) with a medium effect (*Cohen's d = -0.41*) for Plasticity. This finding means that people felt more aware of the climate change threat after playing Plasticity. Also, participants reported higher cognitive attitudes at post-test compared to pre-test, with a medium effect (pre-test: *M = 3.63, SD = 0.62*, post-test: *M = 3.84, SD = 0.54, t(36) = -3.84, p <.001, Cohen's d = -0.63*). These findings partially support E2-H1a because the intervention had no significant effect on one of the explicit attitudes (participants' eco-emotions). Interestingly, I observed a significant increase in positive eco-emotion rating after comparing the pre-test (*M = 1.68, SD = 0.70*) and post-test (*M = 2.15, SD = 0.96, t(30) = -3.46, p <.001, Cohen's d = -0.62*) and also between the post-test (*M = 1.84, SD = 0.64*) and the delayed post-test (*M = 2.15, SD = 0.96, t(30) = -2.29, p = .03*). This result suggests that three to five weeks after the intervention, participants who played Plasticity felt more hopeful and positive in dealing with climate change compared to before and immediately after playing. This finding partially supports E2-H1b. The results further showed that participants did not show significant changes in their implicit attitudes between the pre-test and post-test, which does not support E2-H1c. Moreover, I observed no significant changes in participants' implicit

pro-environmental attitudes between the pre-test and the delayed-post test, consistent with E2-H1d.

### 5.1.3 Descriptive and Exploratory Analysis

Descriptive statistics for the scores on each of the measures evaluated in the three stages of the experiments (pre-test, post-test, delayed post-test) are shown in Table 5.2. Independent samples t-tests were conducted to compare the test scores between participants of the two gameful inventions (see Table 5.3). The goal was to explore how two different message design tactics can have varied impacts on players' pro-environmental attitudes. I specifically examined the differences and subtleties in message framing (loss-framed and gain-framed) strategies as a first step to comprehend persuasive messaging features in climate-themed video games. The results showed no significant between-subjects differences in any of the outcome variables, except for the post-test negative affect (equal variances not assumed: *t(52.3) = -4.98, p <.001, Cohen's d = 1.16*), showing Plasticity increased negative affect relative to Beyond Blue. This finding suggests that people felt more negative affect after playing Plasticity (the game with the central loss-framed message design).

Since participants' affect can influence attitudes (Schwarz and Clore, 1983; Wegener et al., 1994), I ran correlation analyses between the post-test negative affect and the post-test explicit and implicit attitude scores. There were no correlations detected for Beyond Blue (Experiment 1). However, for Plasticity (Experiment 2), negative affect was moderately correlated with negative eco-emotion (*r(35) = 0.63, p <.001*) and threat perception (*r(35) = 0.50, p = .002*). Based on these findings, I argue that, although the loss-framed messaging seems more promising to impact pro-environmental attitudes, I need further data to justify this claim. Also, although there appeared to be a slightly stronger effect size on cognitive attitudes for Plasticity players (Experiment 2), the effect sizes for each intervention were contained within the confidence intervals of the other's effect size, suggesting no statistically stronger effect for any one intervention (Cumming, 2009) (*Cohen's d Plasticity = -.63, 95% CI [-.98, -.28]*; *Beyond Blue = -.50, 95% CI [-.84, -.15]*). Table 5.3 shows t-test results comparing Plasticity and Beyond Blue players' attitudes.

**Table 5.3:** Independent samples t-test results for each stage of the experiments. Note. + represents t-tests where Levene's test was significant and thus I present results where equal variances are not assumed.

| | | *Independent Samples T-test* | |
|---|---|---|---|
| | | T-test | Cohen's d |
| Positive Affect | Pre-test | +t(63.4) = 0.71, p = .48 | 0.17 |
| | Post-test | t(71) = 0.56, p = .58 | 0.13 |
| | Delayed Post-test | t(51) = -0.69, p = .50 | -0.19 |
| Negative Affect | Pre-test | t(71) = 0.12, p = .90 | 0.03 |
| | Post-test | +t(52.3) = -4.98, p <.01 | -1.16 |
| | Delayed Post-test | t(51) = -1.05, p =.30 | -0.29 |
| Cognitive Attitude | Pre-test | t(71) = 1.21, p = .23 | 0.28 |
| | Post-test | t(71) = 0.58, p = .57 | 0.14 |
| | Delayed Post-test | t(51) = 0.46, p = .65 | 0.13 |
| Negative Eco-Emotion | Pre-test | t(71) = 0.61, p = .54 | 0.14 |
| | Post-test | +t(63.3) = -0.19, p = .85 | -.05 |
| | Delayed Post-test | t(51) = 0.65, p = .52 | 0.18 |
| Positive Eco-Emotion | Pre-test | t(71) = 2.32, p = .02 | 0.54 |
| | Post-test | t(71) = -0.02, p = .99 | -.00 |
| | Delayed Post-test | t(51) = -0.76, p = .45 | -0.21 |
| Threat Perception | Pre-test | t(71) = 0.06, p =.96 | 0.01 |
| | Post-test | +t(69.2) = -0.78, p =.44 | -0.18 |
| | Delayed Post-test | t(51) = -1.40, p =.17 | -0.39 |
| Implicit attitude | Pre-test | t(70) = 1.46, p = .15 | 0.35 |
| | Post-test | t(69) = 0.18, p = .86 | 0.04 |
| | Delayed Post-test | t(47) = 0.43, p = .67 | 0.12 |

## 5.2 Examining the Interventions' Design Effect (Mechanics, Narrative, Animation)

I conducted a set of multiple regression analyses to detect how the features and elements of the interventions' game design predicted the outcome variables. I will report the results in detail in the following sections.

### 5.2.1 Multiple Regression Analyses: Experiment 1 (Beyond Blue)

To comprehend how players' experiences of the intervention's design aspects can predict attitudes, I ran a series of multiple linear regressions to investigate participants' pro-environmental cognitive attitudes with respect to three major game design features (mechanics, narrative, animation). The results reported above showed that playing Beyond Blue can impact participants' cognitive pro-environmental attitudes. To understand how Beyond Blue's design features and elements could predict attitudes, I conducted several multiple linear regressions to examine participants' cognitive attitudes in relation to the game's mechanics, narrative, and animation features (see Table 5.4). Initial analyses of the data certified that there was no breach of the assumptions of normality, homoscedasticity, and the linear relationship between the predictor variables and the outcome variable. There were also no outliers in the sample and no multicollinearity between the predictor variables.

E1-H2 targeted the impact of the intervention's overall mechanics feature on players' pro-environmental attitudes. The multiple regression outcomes showed the significance of the overall regression ($R^2 = .27$, $F(4,31) = 2.92$, $p = .037$). The 'adjusted $R^2$' ($= .18$), which controls for overestimation of the population $R^2$ in small samples, showed that 18% of the variance in the dependent variable (cognitive attitude) was described by Beyond Blue's overall mechanics. Moreover, as the exploratory goal, I calculated the coefficients to determine the effect of each element on the dependent variable (cognitive attitude) (see Table 5.4). There was no evidence of an effect on cognitive attitudes via Beyond Blue's controls, feedback, or goals. However, players' experiences of the challenge design positively predicted pro-environmental cognitive attitudes.

Consistent with E1-H3, the overall narrative feature of the intervention positively predicted players' pro-environmental explicit (cognitive) attitude ($R^2 = .24$, $F(3,32) = 3.28$, $p = .033$). The 'adjusted $R^2$' ($.16$) showed that 16% of the variance in the participants' cognitive attitude (dependent variable) was explained by Beyond Blue's overall narrative feature. Furthermore, as the exploratory goal, I examined regression coefficients to understand whether each narrative element independently predicted cognitive attitude. There was no evidence of an effect on pro-environmental cognitive attitudes by individual narrative elements. E1-H4 expected Beyond Blue's overall animation aspect to positively predict players' pro-environmental cognitive attitude. The findings did not show evidence to support this hypothesis ($R^2 = .19$, $F(3,32) = 2.48$, $p = .079$). Consequently, I needed to take a cautious approach to examining the individual regression coefficients as the exploratory goal. Nevertheless, I found no evidence of an effect on pro-environmental cognitive attitudes by the players' experiences of the individual animation design elements (see Figure 5.1 for the significant results).

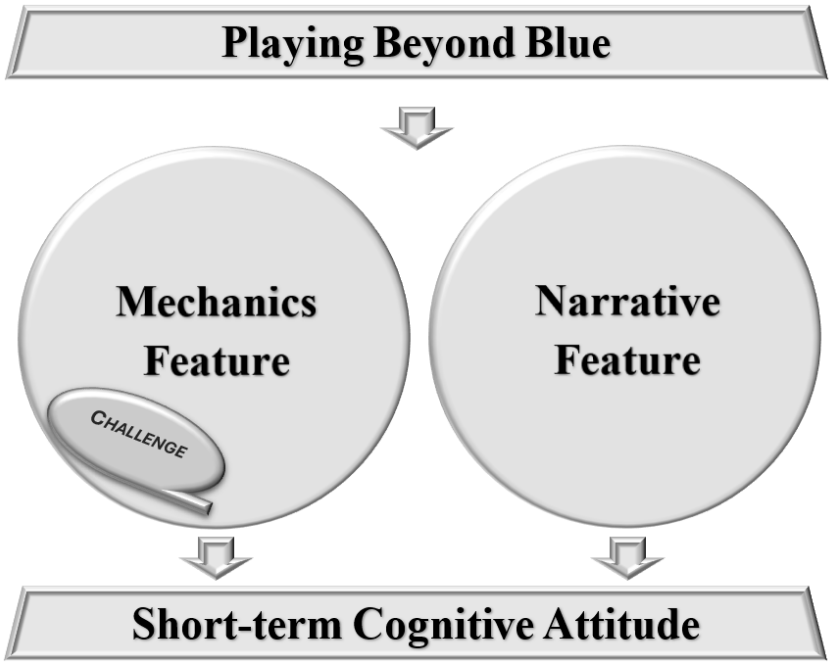


**Figure 5.1:** The aspects of Beyond Blue's design that predicted participants' pro-environmental cognitive attitudes in short-term.

**Table 5.4:** Multiple Regression Analysis for Beyond Blue's Design Elements' Individual Impacts on Cognitive Attitude (short-term)

| | | Beta | t-value | p-value |
|---|---|---|---|---|
| Mechanics | Controls | -.18 | -0.92 | .364 |
| | Goal-setting | .18 | 0.84 | .409 |
| | Feedback | .22 | 1.00 | .325 |
| | Challenge | .41 | 2.65 | .012 |
| Narrative | Storyline | .20 | 0.81 | .424 |
| | Character | -.15 | -0.65 | .522 |
| | Concept/Meaning | .42 | 1.53 | .136 |
| Animation | Worldbuilding | .08 | 0.34 | .736 |
| | Exploration | .07 | 0.26 | .798 |
| | Audiovisual | .33 | 1.45 | .156 |

### 5.2.2 Multiple Regression Analyses: Experiment 2 (Plasticity)

To understand how the participants' experiences of the intervention's design decisions can predict attitudes, I conducted a set of multiple linear regressions to examine participants' pro-environmental cognitive attitudes in relation to three major game design features (mechanics, narrative, animation). I hypothesised that playing Plasticity would have persuasive implications on players and impact participants' explicit pro- environmental attitudes. The results presented above partially confirmed this hypothesis, showing that exposure to Plasticity can significantly influence participants' cognitive attitudes and perception of climate threats immediately after gameplay. I also saw evidence that participants' positive eco-emotion improved in the long-term (delayed post-test). However, I did not find any evidence for Plasticity's effect on implicit attitudes. Therefore, in evaluating the predictive capacity of the game's design features and elements, I only examined the cognitive attitude, threat perception, and positive eco-emotion. I assessed three major game design features (mechanics, narrative, animation) to determine the scope each design aspect can predict these explicit aspects of pro-environmental attitudes.

Following E2-H2, Plasticity's overall mechanics feature predicted a part of the total pro-environmental attitudes (threat perception) in the participants. As per E2-H3, the game's overall narrative feature explained a portion of the participants' pro-environmental attitudes (threat perception). Also, consistent with E2-H4, the intervention's overall animation feature predicted part of the participants' pro-environmental attitudes (cognitive attitudes). Overall, the results show that E2-H2, E2-H3, and E2-H4 are all partially supported. I break down the findings as follows:

I used multiple linear regression analysis to predict participants' pro-environmental cognitive attitude based on Plasticity's game design features. I formed a multiple regression model for each design feature (mechanics, narrative, animation). Beforehand, I affirmed that the preliminary assumptions required for the models were not violated, including the normality of data distribution in the outcome variable, the lack of outliers in all variables, a linear relationship between the predictor variables and the outcome variable, the lack of multicollinearity between the predictor variables, and homoscedasticity. Regarding predicting the cognitive attitude, I found that only the overall animation design feature was statistically significant ($R^2 = .21$, $F(3,33) = 2.94$, $p = .047$). The 'adjusted $R^2$', which controls for overestimates of the population $R^2$ in the small sample, showed that the overall animation design ($R^2 = .14$) explained 14% of the variance in pro-environmental cognitive attitude after playing Plasticity. As the exploratory goal, I also tested the coefficients to see the potential unique effect each of the elements had on cognitive attitude (see Table 5.5). I found that none of the mechanics elements were significant predictors of the pro-environmental cognitive attitude. For the narrative aspect, the storyline was the only significant element, while for the animation design aspect, the exploration element

was the only significant predictor of cognitive attitude (see Figure 5.2 for the significant results).

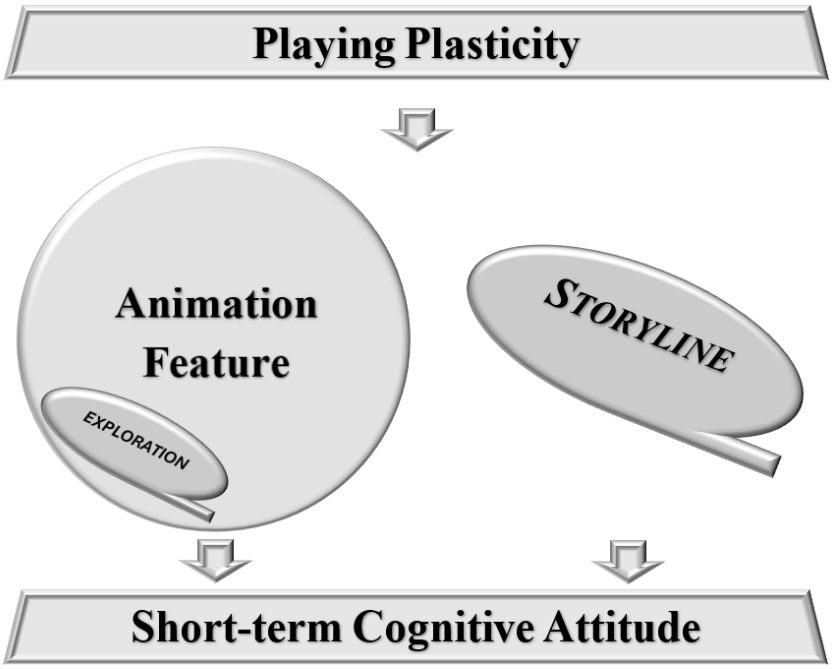


**Figure 5.2:** The aspects of Plasticity's design that predicted participants' pro-environmental cognitive attitudes in short-term.

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**Table 5.5:** Multiple Regression Analysis for Plasticity's Design Elements' Individual Impacts on Cognitive Attitude (short-term)

| | | $\beta$ | t | p |
|---|---|---|---|---|
| Mechanics | Controls | .23 | 1.16 | .256 |
| | Goal-setting | -.25 | -1.17 | .252 |
| | Feedback | .29 | 1.62 | .116 |
| | Challenge | .30 | 1.79 | .083 |
| Narrative | Storyline | .54 | 2.37 | .024 |
| | Character | -.18 | -0.98 | .333 |
| | Concept | -.04 | -0.19 | .853 |
| Animation | Worldbuilding | -.13 | -0.71 | .482 |
| | Exploration | .48 | 2.27 | .030 |
| | Audiovisual | .07 | 0.39 | .701 |

I subsequently used a series of multiple linear regression models to test if Plasticity's game design features (mechanics, narrative, animation) significantly predict threat perception.

For the mechanics feature, the preliminary tests showed an outlier in the sample (*std. residual = -3.35*). After removing the outlier for this analysis, I conducted the multiple regression analysis again. For the narrative and animation features, all prerequisite assumptions were tested and confirmed. I found that Plasticity's overall mechanics ($R^2 = .31$, $F(4,31) = 3.49$, $p = .018$) and overall narrative feature ($R^2 = .26$, $F(3,33) = 3.93$, $p = .017$) significantly predicted the outcome variable (threat perception). The adjusted $R^2$ showed that the overall mechanics ($R^2 = .22$) explained 22% and the overall narrative feature ($R^2 = .20$) explained 20% of the variance in participants' climate-related threat perception after playing Plasticity. Furthermore, I checked the coefficients (see Table 5.6) to see if there were any unique associations between the elements and the dependent variable (threat perception). I found that participants' experiences of Plasticity's challenge design ($\beta = .46$, $t = 2.91$, $p = .007$) and storyline element ($\beta = .56$, $t = 2.57$, $p = .015$) each had unique effects on threat perception towards climate change (see Figure 5.3 for the significant results).

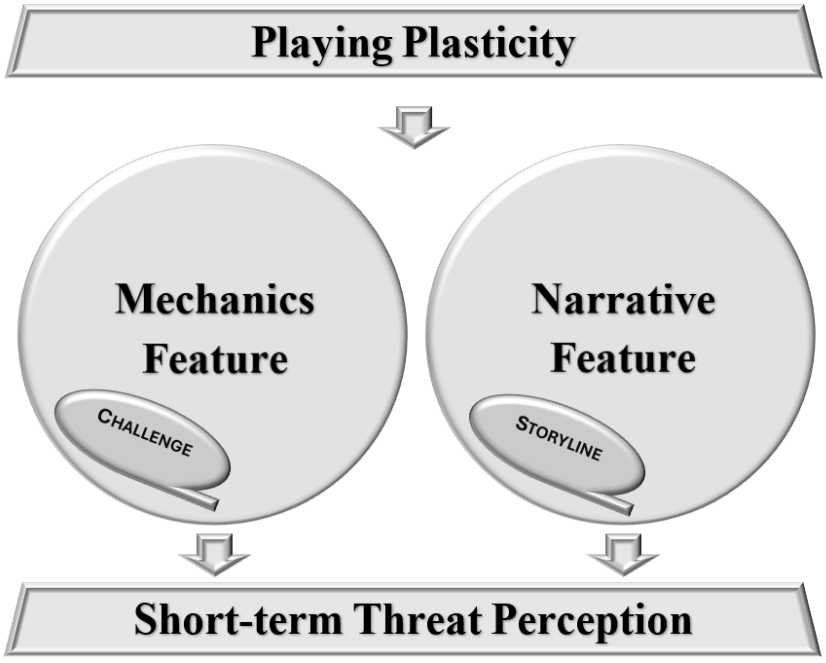


**Figure 5.3:** The aspects of Plasticity's design that predicted participants' threat perception in short-term.

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**Table 5.6:** Multiple Regression Analysis for Plasticity's Design Elements' Individual Impacts on Threat Perception (short-term)

| | | $\beta$ | t | p |
|---|---|---|---|---|
| Mechanics | Controls | .26 | 1.35 | .187 |
| | Goal-setting | -.05 | -0.22 | .826 |
| | Feedback | .20 | 1.17 | .250 |
| | Challenge | .46 | 2.91 | .007 |
| Narrative | Storyline | .56 | 2.57 | .015 |
| | Character | .24 | 1.32 | .195 |
| | Concept | -.34 | -1.55 | .132 |
| Animation | Worldbuilding | .23 | 1.10 | .279 |
| | Exploration | .11 | 0.46 | .647 |
| | Audiovisual | -.12 | -0.56 | .579 |

In the final analysis, I used a series of multiple linear regressions to explain the potential long-term effect of the game's design features (mechanics, narrative, animation) on participants' positive eco-emotion. I examined all the presumptions in advance, which were met for the analysis. None of the overall mechanics ($R^2 = .26$, $F(4,26) = 2.32$, $p = .083$), narrative ($R^2 = .17$, $F(3,27) = 1.81$, $p = .169$), or animation ($R^2 = .02$, $F(3,27) = 0.21$, $p = .890$) features were significant in explaining the participants' long-term positive eco-emotion. After checking the coefficients independently to evaluate the possible effect of each of the design elements on the long-term positive eco-emotion, I saw that concept ($\beta = -.54$, $t = -2.12$, $p = .043$) and feedback ($\beta = .54$, $t = 2.94$, $p = .007$) were the only design elements that appeared to independently relate to the outcome variable (positive eco-emotion in the long-term). Table 5.7 contains a detailed breakdown of the results (also, see Figure 5.4 for the significant results).

## 5.3 Conclusions

This project investigated the intricacies of the data through a series of quantitative approaches. The quantitative method measured the overall persuasiveness of Beyond Blue and Plasticity's message framing and assessed the extent of the persuasive potential of their mechanics, narrative, and animation design aspects. Via a series of rigorous analyses and interpretations, the research questions and exploratory goals were addressed. I used the empirical evidence from the analyses to support or refute the proposed hypotheses. The quantitative results showed that, regardless of message design, both eco-games increased players' cognitive attitudes after gameplay. I also found that Plasticity's multi-

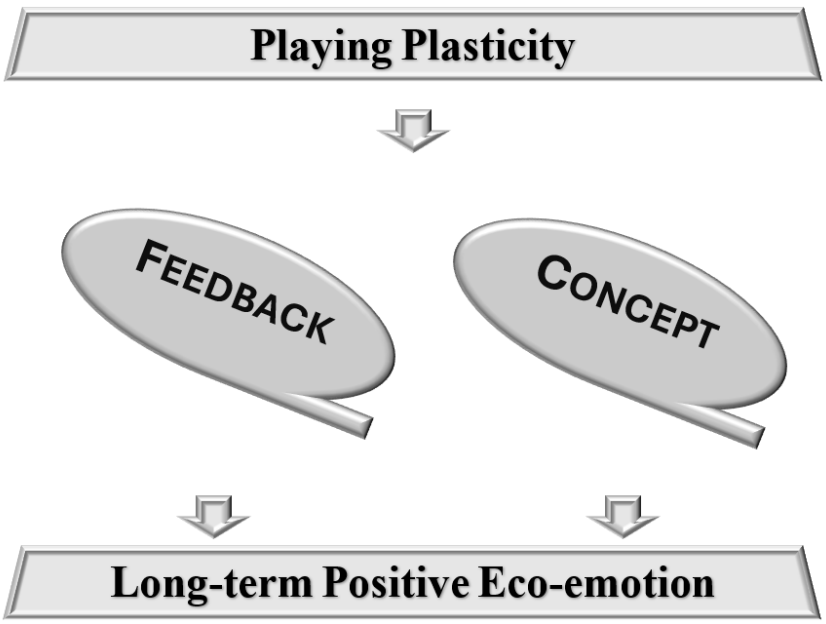


**Figure 5.4:** The aspects of Plasticity's design that predicted participants' positive eco-emotion in long-term.

**Table 5.7:** Multiple Regression Analysis for Plasticity's Design Elements' Individual Impacts on Positive Eco-emotion (long-term)

| | | $\beta$ | t | p |
|---|---|---|---|---|
| Mechanics | Controls | -.18 | -0.89 | .381 |
| | Goal-setting | -.21 | -0.99 | .331 |
| | Feedback | .54 | 2.94 | .007 |
| | Challenge | -.01 | -0.05 | .959 |
| Narrative | Storyline | .47 | 1.84 | .077 |
| | Character | .15 | 0.67 | .511 |
| | Concept | -.54 | -2.12 | .043 |
| Animation | Worldbuilding | -.16 | -0.65 | .520 |
| | Exploration | .18 | 0.69 | .496 |
| | Audiovisual | -.03 | -0.14 | .893 |

layered message design (central loss-frame with a potential hopeful ending) increased short-term awareness of the climate-change threat (threat perception) and long-term hope for dealing with the issue (positive eco-emotion), balancing fear and empowerment and emphasising the intricacies of message framing. The findings also showed that Beyond Blue's overall mechanics and narrative features were the main significant predictors of pro-environmental cognitive attitudes. Challenge design was the only significant element that predicted Beyond Blue's participants' cognitive attitudes. For Plasticity, the overall mechanics and narrative features were predictors of participants' climate threat perception, while the overall animation design predicted pro-environmental cognitive attitude. Plasticity's storyline was the only element that predicted both threat perception and cognitive attitude. Also, this game's challenge design predicted threat perception and the exploration design predicted cognitive attitudes. Plasticity's concept/meaning and feedback design significantly predicted participants' long-term positive eco-emotion. The quantitative evidence shows that different design features/elements can add to a game's persuasive capacity and be responsible for changing or reinforcing ideas. The next chapter will present the qualitative analyses and results.

Chapter 6

# Qualitative Data Analyses

The qualitative portion of the methodology involved identifying patterns and trends to produce themes as qualitative evidence to frame the expectations for effective and successful eco-design suitable for video games. The reflexive thematic analysis was used (Braun and Clarke, 2006) to explore and explain how and to what extent the interventions' design (Beyond Blue and Plasticity) contributed to climate communication and identify the advantages and shortcomings of gameful elements used in the interventions. As a versatile and multipurpose system, thematic analysis provides a customisable approach that can offer a well-organised dataset (King, 2004) as well as an elaborate and in-depth interpretation of data (Braun and Clarke, 2006; King, 2004). It is a valuable method for inspecting the viewpoints of various participants, underlining both associations and differences, and drawing interpretations (Braun and Clarke, 2006; King, 2004). This flexible approach helped to show the interventions' design capacity for communicating environmental and climate-related aspects of the message. NVivo 12 Plus was used to analyse the qualitative data. I had three sets of qualitative data:

1. Interview transcripts (primarily transcribed via Word Online (Microsoft 365) and then carefully checked and edited.)
2. Descriptive replies to the open-ended survey questions.
3. Observation and reflection notes written throughout and following collecting data.

## 6.1 Reflexive Thematic Analysis Procedure

Reflexive thematic analysis (see Figure 6.1) dynamically engages researchers in reviewing and evaluating the data to generate insights about meaningful patterns and recurring themes (Braun et al., 2019). A light data-cleaning procedure was conducted before the analysis of the qualitative data. In particular, to keep the study's focus on attitudes, questions about behavioural aspects were excluded. This decision was made to align the analysis more closely with the research objectives, which emphasise the attitudinal changes fostered by the games. The remaining data was carefully examined to ensure it

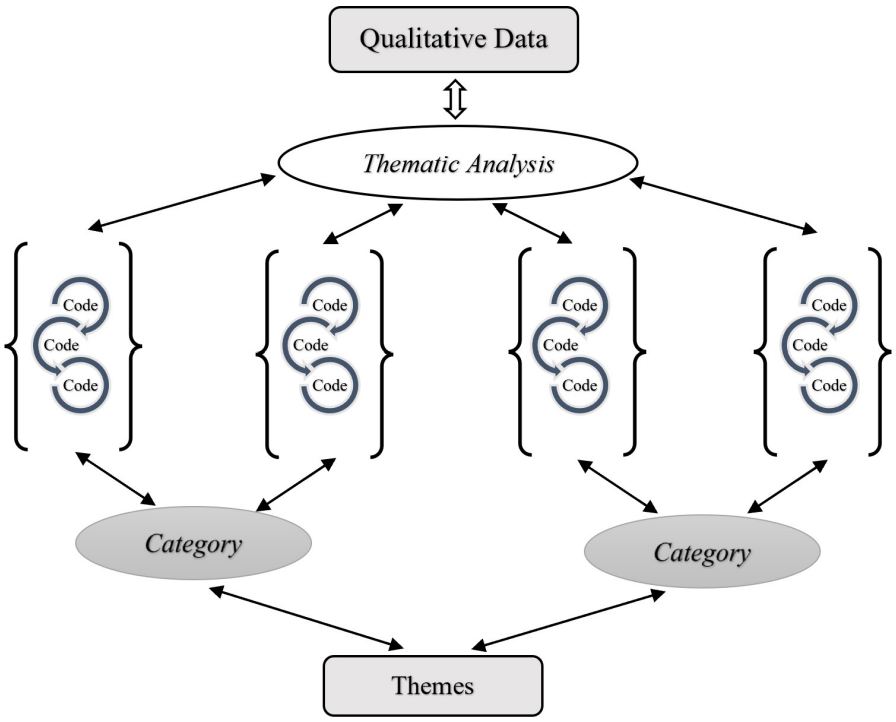


**Figure 6.1**: Reflexive Thematic Data Analysis Procedure

was directly relevant and conducive to addressing the research questions. To enhance the integrity and reliability of the findings, I used the six-phase guide by Braun and Clarke (2006) in conducting the analysis.

Phase 1- Familiarisation: This phase requires researchers to read, observe, re-read, and review the gathered data (Braun and Clarke, 2006), so I followed this process as well as taking notes and immersing myself in the collected information.

Phase 2- Initial Coding: This phase requires researchers to identify and connect codes to the data and accumulate characteristics pertinent to each code (Braun and Clarke, 2006). An initial set of design-oriented codes was derived deductively from my COPE model, helping me in generating a series of design feature-based and element-based codes. This coding system/manual had detailed descriptions of each code and examples. This variable-based strategy (Miles et al., 2019) also helped me fit the codes into a coding system, which in turn made managing, analysing, and interpreting the data easier, as well as establishing a clear and credible route that reinforced the study's trustworthiness. In line with this flexible approach, I identified and explored further codes inductively. That is, if I saw relevant additional ideas in the dataset, I assigned descriptions to them along the coding phase. Put briefly, codes were produced both deductively (through a pre-existing frame made by the COPE model's design elements, features, and processes) and inductively (directly from the data) at both the semantic and latent levels (precise

connotations delivered by participants along with inherent or abstract implications across the data). NVivo software helped to simplify the dataset arrangement and manage the elaborate coding system. While I was responsible for coding the data, the process was validated after my primary supervisor coded some parts and I compared the coding results with the initial coding. This process strengthened the reliability of the findings. This phase involved a comprehensive, repetitive, and vigilant inspection of the dataset.

Phase 3- Searching for Themes: In this phase, researchers link codes and recognise higher level arrangements (Braun and Clarke, 2006). Each excerpt of data was grouped into multiple codes depending on their implication and pertinence, and subsequently labeled. From the beginning, I assigned descriptive comments to the codes. I chronicled notes to find distinguished qualities and identify observations and perspectives that could shape the groundwork for patterns in the data. Going through the codes revealed certain shared traits among some of them. Each code's comments expanded into a more formulated and categorised bundle of themes. I created a detailed account for each theme, explaining the story expressed by them and evaluating how they each contribute to the big picture in relation to my research goals and questions.

Phase 4- Reviewing Themes: This phase requires to check themes against the dataset (Braun and Clarke, 2006). So, I meticulously re-evaluated the codes, made connections between them, and re-assessed the recurring patterns. I examined and reviewed all of the conceptualised themes and sub-themes and revisited the code descriptions to review the trail of thought that led to the creation of these patterns. Wherever the themes or sub-themes were not supported with enough data, I omitted them. I also revisited the raw data, when necessary. In other words, through an iterative procedure, I reviewed how the dataset evolved into an assembly of qualities and characteristics, which expanded into defining themes. I aimed to arrange the themes in a way that faithfully represented the dataset. So, I reorganised and restructured the themes until all facts were portrayed accurately and earnestly.

Phase 5- Defining and Naming Themes: This phase requires researchers to name each theme based on their interconnected quality (Braun and Clarke, 2006). So, I focused on ways for arranging the patterns (themes), classifying their implication in relation to improving pro-environmental attitudes and climate communication, and assigning them proper names. While reassessing the themes, I was interested in using specific language used by participants in the themes' names. This way, I included a larger portion of the participants' voices in the final report.

Phase 6- Producing the Report: This phase requires researchers to accumulate the themes with interpretations and quotations from the dataset (Braun and Clarke, 2006). So, I distinguished the relevant components of the data, integrated them into themes and sub-themes, based on the favourable and unfavourable design aspects of the interventional

experiments and wrote-up the report. I clearly and explicitly specified the approaches used to reach the results and used both brief quotations and lengthy chunk quotations escorted by an exclusive anonymous identifier to show that different participants were depicted throughout the final narrative.

## 6.2 Gameplay Experience Overview

An overview of the participants' gameplay experiences provides an outline for the key aspects of the gameful interventions. This introduction into the gameplay contextualises the qualitative process and sets the stage for subsequently presented themes and sub-themes.

### 6.2.1 Experiment 1 (Beyond Blue): Gameplay Experience Overview

Participants found Beyond Blue a pleasant place, where there is a chance to explore a less-known part of our planet. To them, the gameplay was serene, slow-paced, peaceful, and relaxing with a cool educational agenda. HM7 expressed their feeling towards the game as:

> *The first feeling that I got was relaxing and I think it was about the environment, animals, the feeling between humans and animals, which is great.*

They also enjoyed how the gameful tasks, missions, and challenges were in harmony with the overall theme and tone of the game; nature-centred, unwinding, and amicable. However, there were mentions of how this new experience could get monotonous and repetitive after running some errands as the character. GA20 said that they could see themselves *getting bored if I did play this game for a long time.*

To participants, the soundscape was also an admired and characteristic element of Beyond Blue. There were recurring mentions of how the music, sound, and noises in the game were heartening and comforting, making a deep connection to nature. PH25 mentioned how *the voice, the sounds during the game* were *lovely and calm* and *made everything so much easier.* HI19 believed the *soundtrack was very good, especially the whales and the sea creatures' sounds.* DD8 explained:

> *At the very least I felt more relaxed and I think it's because of the noises and like maybe the blue um has a calming effect. Um like animal noises, specifically the whales and stuff is calming.*

The message design and its framing were the most recurring criticism about the game. By concentrating on the positive and optimistic aspects of the environment, Beyond Blue uses a gain-frame message. In this approach, the focus is on how and why it is important to preserve the exquisiteness, tranquility, and aura of nature. So, despite the presence

of a robust environmental theme, the participants enunciated their negative views and arguments about Beyond Blue's message design. In answer to whether playing Beyond Blue made them re-evaluate how critical/urgent climate change is, participants explained that the message approach did not sufficiently highlight the gravity of the problem or how climate change and environmental issues are connected. They proposed adding more urgency to the message and refocusing on the negative and harmful aspects. MK10 believed that even though seeing and interacting with all the positive aspects such as the *fresh* and *healthy* marine wildlife made them *feel better about the environment* and the *climate*, lack of *negative things inside this game* left them unsure and unclear about the whole message. OP25 added:

> *It was a relaxing and fun experience, but in case of giving messages about reevaluating the climate change issues, I didn't see any clear connection.*

At the end of the interview (first session), participants reported that their level of environmental awareness or attitudes was only increased in parts that novel and interesting information was presented about marine wildlife. However, in answering whether Beyond Blue had motivated them to address climate change more than usual, participants expressed that in one way or another, they had been positively impacted by the game, even if it was a short-term influence. To them, the gameplay served as a reminder, highlighter, cue, or push towards the topic of environmental and climate problems, which in turn reinforced and encouraged (as opposed to transforming or reshaping) their environmental awareness, attitudes and motivation. HA12 believed that although Beyond Blue *is not a particularly invigorating game*, it *reinforced* their *sense of awareness* about *the environment* and *the ocean in particular*. WB8 expressed that playing the game made them *narrow down* their *perspective*, making them realise that they should *have a specific goal in mind* in exploring climate change activism, encouraging them to focus on oceans.

In the second session (3-5 weeks after playing the game), participants reported thinking back about the game during the past few weeks, only for very brief or intermittent periods. MC23 said that thinking about the game only occurred in *a few occasions* at which they had been by the ocean, *where that served as a memory trigger*. While BK13 described the game had *popped into [their] mind from time to time*, LK30 reported recalling the game *mostly in fleeting bits and pieces*. One of the most memorable aspects of the game was reportedly Beyond Blue's music/soundtrack. The music was remembered as calming, unique, and decent. WH12 expressed that *on the next day after playing the game*, they could *still hear the game music*. PH25 recalled how *interesting and tangible* the *whale sounds* were. And there were reports of the sound of drills as a menacing factor. Another memorable aspect of the game was participants' emotional bond with the marine wildlife. ML6 said that they remembered *being able to swim amongst all the different creatures* and how awe-struck they were with their diversity. CF24 mentioned that *swimming*

*underwater* and *scanning the different species of animals*, *specifically the whales* stayed with them, recalling the experience as *unique*. However, the delayed post-test reports showed that the participants' overall environmental motivations fueled by the game had dropped in the long term.

### 6.2.2 Experiment 2 (Plasticity): Gameplay Experience Overview

Participants described Plasticity as an interesting, simple, and linear game filled with provocative, confronting, daunting, extremist, enlightening environmental ideas that knew how to play with recipients' emotions by showing a miserable and petrifying futuristic world. NF9 called it *a smart game*, which was *beyond entertainment* and had an *obvious* message about *the climate change*, *the environment*, and *the way we deal with the climate*. MK6 added:

> *It really gives you an opener into what like the consequences of climate change is, but also other things like over-pollution, umm, like plastic in the oceans and also the effect of human society on on the natural world.*

The experience left participants with a wide range of emotions often spanning from intense frustration, anguish, and despair to determination, motivation, and hopefulness. RC3 described playing Plasticity as a shocking experience and *a real eye-opener* to the severe impact of climate change. AL11 expressed their feeling towards the game as:

> *At the beginning I was kind of confused, but then I got kind of curious to see how the game will go and at the end I was kind of like triggered and kind of like provoked about the ideas about climate change and stuff like that. But in general, I would say I liked it.*

The most praised elements of Plasticity were its engaging and relevant storyline which used several emotional triggers to create sequence and its use of saving trapped and endangered animals as gameplay challenge to make events relatable. FW8 believed *the story was memorable*. LR15 mentioned *the way the story tried to ... involve a person's emotions* and how the designers aimed to *map it to environmental issues and causes around us* inspired them to make a move towards change. To KD29 the *animals stood out* and made the game *relatable*. DI27 also believed that *the fact that you can interact with animals and remove their trash object from them*, makes the game *meaningful*. FD4 added that showing the harsh and heart-breaking aspects of the issue, including how animals were *choking on the plastic* refocused the matter and put it on *the forefront of your mind*. RO19 stated:

> *the story is very intact and very expressive and I like how the objectives of the boy is constantly changing while the story progresses.*

The most severe criticisms were directed towards two aspects: the control settings and the limited choices in Plasticity's gameplay. While control is an element of game mechanics, player's choice is a wider notion that can encompass both narrative and mechanical features. Choice has two aspects: the player's judgment and the game's feedback with consequences that could be either intense, quick, and pivotal or gentle and mild, requiring more time for players to process them (Wright and Denisova, 2024; Stokes, 2012). TA18 called Plasticity's movements *slightly janky*, explaining *it's just not quite what you would expect it to move like*. GO7 thought the controllers were *clunky* and *didn't quite behave the way* the player wanted. The difficulty in the control system made EL23 feel *stuck at certain locations*, which as a result *reduced the game experience* for them. Participants also demanded more range, possibilities, choices, and freedom in an eco-game to make the gameplay more engaging and effective. BT8 asked for *more options* and *more different parts*. TL14 was frustrated about how there were *almost no choices* that were *meaningful* and believed that the presence of *interesting choices where it's hard to know what the right answer is* makes games and their ideas influential. BG2 also criticised Plasticity and said:

> *I didn't think I was making important decisions, so I didn't think my choices really mattered and I I thought it was the the person designing the game had a very strong idea about what choice I should make.*

The most polarising views revolved around the game's message design and framing. Plasticity has a loss-framed message. Loss-framed messaging focuses on the disadvantages and negativity of environmental issues. However, the game gives players two different endings according to the decisions made throughout the journey. If enough acts of kindness are completed (e.g., releasing animals from traps or debris, picking up plastic residues, cleaning up litter) a hopeful and optimistic ending is achieved. But, if little attention is given to restoring the Earth, then a cold and hopeless finale transpires. During the 35-40-minute experimental task, I recorded how each participant experienced the gameplay and potential endings. While most participants *(N = 31)* reached to the game's ending, the majority experienced the hopeful conclusion *(N = 26)*. A small group finished the game twice *(N = 4)* during the experiment, with three of them seeing both hopeful and hopeless finales. However, they expressed that the bleak ending was compensated once they finished the second round with a hopeful ending. One of them had hopeless wind-ups in both turns of playing the game. Similarly, another participant finished with the hopeless finale, delivering two participants with the hopeless conclusion *(N = 2)*.

The complexities of a loss-framed approach mixed with a potential hopeful finale and a straight message strategy provide a multi-layered message design in Plasticity. While the majority believed the game to have a clear, confrontational, relevant, and noteworthy message, participants were polarised about how they felt concerning certain aspects and

details of the game's message. I argue that this polarisation of ideas was partly due to some challenging notions presented in the game as well as the multi-layered message design of this game. For instance, while some praised the game for its focus on individual actions in mitigating climate change, there were some with strong ideas that considered this approach a contrived and outdated method that wrongly blames individuals for climate change (rather than targeting higher establishments and administrations). KD10 who experienced a hopeless ending described the game as *a poke*, calling out the player and reminding them that *hey in a few years, which is not that far for our next generation, it's going to be a disaster if we don't act wisely.* To them, Plasticity's message was *cruelly designed* with *very clear*, *very straightforward, and scary* agendas. NF9 and LS22 who experienced a positive ending, interpreted the game's message as a way to show *hope* and *life* still exist. AM27 who played the game twice and experienced both types of endings saw the message as a request for climate action and a way to focus on individual responsibility, encapsulating the message as *it's not too late to just save our planet.* MO1 who did not reach to the game's ending summed up their view of the message as:

> *Climate change is real... [The game] knows what it's about. It has absolutely no compunctions about telling you what it's about.*

In answer to whether playing Plasticity made them re-evaluate how critical and urgent the issue is, MO1 believed that the game *galvanized the opinions I already had*, while HG11 expressed how Plasticity *reinforced the beliefs* that they already held about climate change. KD10 expressed that playing Plasticity made them compare the climate gravity to Covid-19 severe situation and how *this could happen really soon if we are not doing anything.* TA18 explained:

> *I felt like ... it wasn't very farfetched an idea. Like it could very possibly happen. Like having mountains of trash everywhere.*

At the end of the interview (first session), in response to whether the game had influenced recipients' environmental awareness, attitudes, and motivation to address climate change more than usual, the participants (interestingly, even those who had heavily criticised the game and its manipulative approach and message design) declared that they had been somehow motivated to take some positive action towards climate change and specifically using plastics after playing the game. They believed that exposure to the game acted as a harsh reminder, prompt, tip-off, warning, or intimation that moved them and improved their environmental awareness and attitudes. VD9 expressed interest in doing more research on *the plastic content in our food* and related *regulations* to see *where we are and what we need to do.*

In the second session (3-5 weeks after playing the game), participants recollected the game as illuminating, purposeful, creative, meaningful, relevant, and confronting, with a glimmer of hope. EN22 described the game as *insightful* and an attempt to help players

*grasp a future where little was done on climate change.* Participants stated that during the interval between the main experimental task (playing the game) and the delayed post-test, they recalled the game on some occasions. Understandably, VD9 cited that *dealing with garbage* reminded them of the game. BT8 also mentioned that *recycling* would activate *imagery from the game* in their mind. AM27 revealed that eating food would often cause them to think *about microplastics* since playing Plasticity. LR15 even considered *reading news on climate change* a prompt to recall the game. TA18 was still upset about how the game tried to *oversell the extent to which individuals can have an impact on climate change* and how it did not recognise *the larger roles of companies and governments in climate change.* On a positive note, SG11 remembered *some parts of the game which were about being hopeful even in a hopeless situation.* AJ24 also expressed how the experience pushed them to undergo *a journey* and *discover that they could have a positive impact on pollution.* In terms of design aspects, participants reported recollecting the game's atmosphere, eerie trash-filled graphics, and expressive music. MO1 reminisced Plasticity as a *considerate and heavily considered message intended to be conveyed through music, colours, scenery and cut scenes.* RO19 cherished *the graphical style*, as a *cartoony, low-poly style* that *stood out* as *you don't see anything similar that often.* KS7 remembered *the message, the mood of it, as something that was supposed to be passed onto* them. Moreover, MK6 said that they remained motivated especially due to *the idea of how climate affects oceans and animal life, plus how our actions now influence the reality of birds and animals fifty years in the future.* KD29 also expressed that they continued to evaluate *the meaning* behind the game as a way of sparking their environmental incentive. Overall, the participants mentioned that the experienced emotional impact from bonding with the game's narrative and their concern for the animals motivated them to make some changes (although reportedly the changes did not remain consistent).

## 6.3 Thematic Analysis Results (Themes and Sub-themes)

The qualitative themes were informed by the lessons learned from the favourable and unfavourable design aspects of both of the experimental interventions as experienced by the participants, in addition to their views on how to develop effective eco-games. The themes were developed using the reflexive thematic analysis based on the qualitative research goal that investigates how to improve eco-game design.

Based on the participants' experiences, responses, and recommendations (in both short and long term), I found four main themes and several sub-themes in the dataset regarding the potential to develop effective eco-games and improve their design. The main themes included:

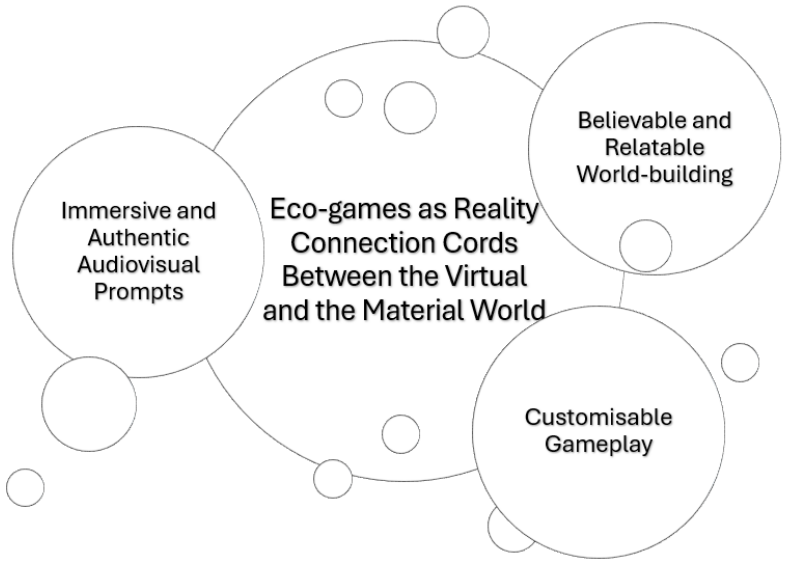


**Figure 6.2**: Theme and sub-themes drawn from the qualitative data

1. Eco-games as reality connection cords between the virtual and the material world.
2. Eco-games as risk projectors in climate communication.
3. Eco-games as climate awareness heralds in climate communication.
4. Eco-games as balanced mediators in climate communication.

### 6.3.1 Eco-games as Reality Connection Cords Between the Virtual and the Material World

The first main theme from the analysis focused on video games' capacity to link the material world to the virtual world and involves three sub-themes: 1) immersive and authentic audiovisual prompts for game-based climate communication, 2) believable and relatable world-building for game-based climate communication, and 3) customisable gameplay for creative climate communication (see Figure 6.2).

#### 6.3.1.1 Immersive and authentic audiovisual prompts for game-based climate communication

Audiovisuals in video games are sensory properties that can connect the game world to the material world. This aspect of design focuses on how gameful encounters can engage players on emotive and experiential levels (Miles, 2010). That is why creating plausible

and authentic visual and auditory cues can set the stage for more realistic and immersive gameplay (De La Hera Conde-Pumpido, 2018). For Beyond Blue, the audio design was the most praised and distinguished element by the participants. They believed the realistic ambience added value to the game. Also, the music was underlined for its calming impact while the background sound effects highlighted some nuanced environmental issues (e.g., sound of miners' drills). Participants also appreciated the game's occasion-appropriate volume levels and engaging character voices. In Plasticity's case, participants also found the audio design engaging and confirmed the importance of this aspect in creating realism. MO1 (Plasticity) found *the music* of the game *very impressive* in how it could evoke emotional responses and relatable senses towards game-depicted events. Participants from both groups admired the theme-relevant acoustic effects, background sound, and complementary scores and soundtracks. They also suggested that having engaging character voices and authentic dialogues are another way of immersing players in eco-games and their ideas. LK30 (Beyond Blue) explained that as a person whose *brain is all over the place*, because they usually are unable to concentrate, the *sound* and the *voice of the game* have a calming effect and *completely gets [their] attention.*

The visual design was also identified as a way of grabbing players' attentions. Beyond Blue was highlighted for its faithful proportions, lighting techniques, and aesthetic style. As MC23 (Beyond Blue) explained, the game made them feel immersed because *of the sensor scale that the whales brought to ... the big open blue.* This sense of realistic proportion made the participant feel *very small within the big ocean.* Plasticity was praised for its notable and eye-catching visual details and coherent lighting. Its visual design was described as simple with a minimalist style while haunting, and meaningful. EN22 (Plasticity) thought the graphics had very *confronting* images. RO19 (Plasticity) found the graphics *quite compelling* and *a good job of illustrating how bad the problem could get.* Participants of both groups expressed the importance of consistent aesthetic style, theme-relevant environment, and thought-provoking visual details to enhance eco-games' effect.

There were also mentions of some shortcomings in these games' graphics that took away from a realistic experience for the participants at some points, including flaws in the depth perception (Plasticity and Beyond Blue), frame rates (Beyond Blue), and monochromatic colour palettes (Plasticity and Beyond Blue). JI17 (Plasticity) mentioned the inconsistent color palette and how it was *quite subdued, except for splashes of red, which tended to, but didn't always indicate something that you could interact with.* SD19 (Beyond Blue) also pointed out some interesting areas for improvement:

> *It does feel like a little bit flat. Like there was not much depth to the graphics. I feel like that kind of like took me out of it a little bit. Just it doesn't feel like there was a big open sea out there. It just kind of felt like that was the edge*

*of the level.*

#### 6.3.1.2 Believable and relatable world-building for game-based climate communication

Worldbuilding is a multifaceted and creative aspect of game design, concerned with creating a new domain where a sense of presence and realism (Mckernan, 2017) is essential for an immersive experience (Shinkle, 2020). In picturing a futuristic Earth, worldbuilding enables envisaging alternative settings and human-nature relationships, serving as an analogy that can describe and form new realities through accounts of speculative prospects (Martin and Sneegas, 2020). The worldbuilding efforts of eco-games can amplify climate communication by setting up a believable and relatable environment. For Plasticity, despite its simplistic design, participants stated that experiencing issues with material-world relevance and connection made them feel like the futuristic world was believable and possible. They described it as a very emotionally evocative world. In Beyond Blue's case, although participants reported having an immersive experience and sense of presence in the ocean, they asked for more believable and relatable elements that would connect the game world to the material world. Beyond Blue's futuristic gears and its relatively limited environmental issues (compared to our present-world environmental urgency) were among recurring examples of factors that were not relatable or believable to the participants. In both groups, participants could not relate to the non-player characters and some parts of their behaviours or dialogues. NG4 (Beyond Blue) proposed adding some relatable elements to the game world such as *the big ships and stuff to like scoop up the ocean floor and how that's destroyed coral and getting a lot of other sea life trapped in it.* WH12 (Beyond Blue) also suggested avoiding a *fantasy-like world* that seems *unreal and unbelievable* while addressing real issues. KS7 (Plasticity) explained how the similarities between the game and the *real world events* made them feel uneasy and how *although it seems like a dystopian game* and *fiction*, its worldbuilding represents *where our world is headed, and that's quite scary.* To diminish the divide between the virtual and the material world, participants asked for more diversity (e.g., geography, people, wildlife), credible and reasonable timeline/history, and better interconnection and consistency between the overall game's elements to create a flowing experience and immersive world.

#### 6.3.1.3 Customisable gameplay for creative climate communication

Understanding options, decisions, and possibilities is a key step in exploring video games (Wright and Denisova, 2024; Stokes, 2012) with critical topics. That is why, in an eco-game, a customisable design can be crucial in assessing the depth and quality of risks. Implanting choices can add to a gameplay's meaningfulness, improve exploration oppor-

tunities, enhance interaction with the presented ideas (Wright and Denisova, 2024; Salen and Zimmerman, 2005; Stokes, 2012), and link the virtual to the material. While Beyond Blue's participants did not feel limited in a semi-open-world with multiple gameplay options and paths to choose, Plasticity's participants expressed a sense of restriction. They believed that increasing choices would have made their experience more relatable and meaningful, providing deeper interaction with the game's ideas and engaged them in moral decision-making to a greater extent. TL14 (Plasticity) said:

> *Do you want to do the good thing or the bad thing? That seemed to be the choices, whereas a lot of good games cause you to think about an issue by presenting you not with the good and bad option but with two bad options and then trying to make you kind of reckon with... Umm, which of these two is the least bad in your mind? And you know like a ... moral dilemma. And yeah, that to me that would have made it really way more engaging and I would have been far more interested in it because it would have made me rethink my beliefs about climate change.*

Both groups believed adding choices, options, and customised paths or characters could add value to an eco-game's experience. Creating customisable avatars and environments can contribute to building characters, developing identity, and structuring a self/social image that will, in turn, make the experience more believable and relatable.

BG2 (Plasticity) believed that if the character could go *to different places, to different countries and see different problems*, the game could become more engaging. AB15 (Plasticity) emphasised how *more freedom of choice during playing* could make the game more consequential and genuine, and RO19 (Plasticity) added that making *interesting choices where it's hard to know what the right answer is* adds realism and credibility to the game. FD4 (Plasticity) thought *the most important thing* was having *actions that have real consequences* and seeing *those consequences*. Participants from both groups suggested adding an appropriate difficulty level to match the players' skill level as a way of creating more engaging gameplay. They were also interested in exploring different choices in their character. For example, they believed having customisation options regarding their avatar's appearance, age, and name could make the game and its ideas more appealing and authentic. DD8 (Beyond Blue) believed that having avatars that are *visually similar* to players can make eco-games more engaging as they *touch people's identities* and *connection* to the matter. VD9 (Plasticity) explained that customisation would be *very helpful for the player to get into the character and get more involved to the game.* DI27 (Plasticity) thought the character was *extremely vague*, highlighting that it is *hard to relate to something that's just very vague* and found *being able to choose from multiple avatars* an interesting option, suggesting the addition of *nonhuman perspectives*. PH25 (Beyond Blue) also emphasised the importance of diversity in today's global discourse

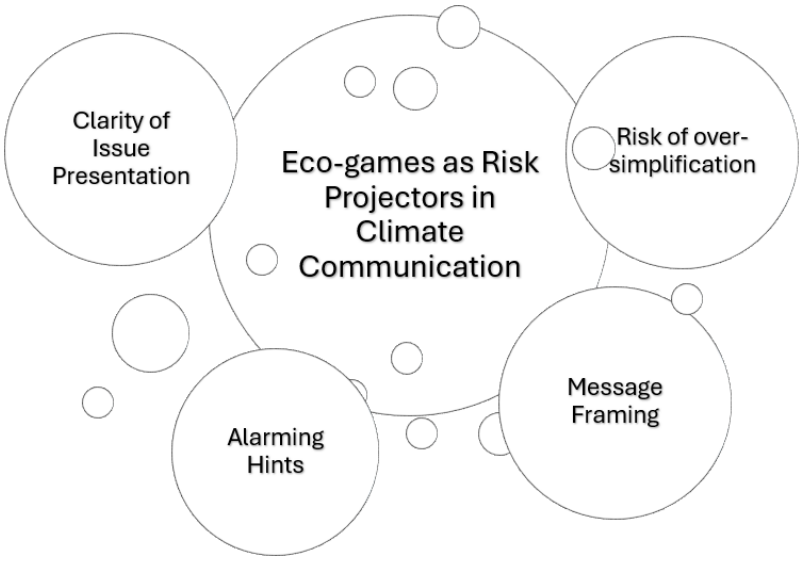


**Figure 6.3**: Theme and sub-themes drawn from the qualitative data

and how people *should have options to choose from... especially when we are talking about their own avatars.* SZ19 (Beyond Blue) believed that using customisation in eco-games should have a purpose:

> *I would give her abilities and tools like sort of knives and so that she can go and be more active in that, instead of just being an observer. And if there needs to be a certain instance where she needs to save something, you know, like you know unhook a net or do something to save or prevent a disaster from happening. And I'll give her a set of tools and powers. To do that.... to empower her not to change her physical appearance. More to give her tools to be more effective in making changes.*

### 6.3.2 Eco-games as Risk Projectors in Climate Communication

The second main theme from the analysis focuses on eco-games as a platform to represent environmental risks and involves three sub-themes: 1) clarity in the portrayal of environmental issues, 2) risk of over-simplification in climate communication, 3) message framing in assessing environmental threats, and 4) alarming hints for climate communication (see Figure 6.3).

#### 6.3.2.1 Clarity in the portrayal of environmental issues

In environmental risk and climate communication, clear and honest presentation of the issue is essential (Covello and Allen, 1988). Plasticity's participants found the message of the game to be well-defined, understandable, and illustrative of climate change's hazards. LR15 (Plasticity) believed that clear messages in eco-games are *really appealing* and *meaningful*, providing ways to *touch people who play the game*. MK6 (Plasticity) stated that the clarity of the message is what *encourages* players *to pay more attention to conservation of our environment*. On the other hand, in Beyond Blue, one of the participants' most recurring criticisms was about the indirect and unclear presentation of environmental issues. HM7 (Beyond Blue) stated how *they could put more direct messages within their game about preserving the marine environment* and how making more *direct connections with the issues that are changing ... the biomes of that part of the Earth* could be beneficial. FD25 (Beyond Blue) continued that the game's *message could have been lost* easily. WB8 (Beyond Blue) wanted eco-games to *raise the issues clearly, without sugarcoating the main problem*. RS17 (Beyond Blue) also believed that the game needed to *emphasise* the environmental issues:

> *In terms of promoting environmental issues, they didn't really go first on anything environmental. They talked about the diseased coral. They talked about the starfishes being invasive. That's about the only environmental things they raised. Apart from, you know, just subtle hints, there wasn't much to point out the bold obvious thing about the ecosystem, which is all the environmental issues that they could have raised but just didn't. It was a nice platform, a chance to bring these up properly, and they missed out on it.*

#### 6.3.2.2 Risk of over-simplification in climate communication

It is vital to simplify scientific notions to make them comprehensible and approachable for the general public. Nevertheless, this task must be managed carefully, since oversimplifying scientific ideas can aggravate and reinforce gaps in information and interpretation (Ribeiro and Soromenho-Marques, 2022). Oversimplification in communication could distort or mislead recipients' understanding of a problem, resulting in faulty deductions (Cook, 2020). Oversimplifying and misrepresenting climate change causes, processes, and solutions is a common challenge in climate communication that can misinform and misguide the public, causing people to falsely believe that complex environmental issues hold simple and straightforward resolutions (Burrows et al., 2022).

In a video game context, oversimplification of climate change could be reflected in narrative and mechanics design as well as animation design. For example, in the case of Plasticity, the narrative uses oversimplified solutions in addressing the adversity of climate change environmental spin-offs. Oversimplified solutions to big problems are one

of the typical errors in communicating risks (Cook, 2020), which seems to be a recurring issue in Plasticity. Although the message of the game is clear and direct, emphasising how immediate and real climate change is, the solution it represents is simplified to individualism and personal action, rather than targeting the heavy impact large corporations and systems have on the environment. It did not go unnoticed by the participants, who mentioned that diverting the guilt to individuals undermined the impact of the game. MO1 (Plasticity) believed that *this idea that individuals can do as much as the game suggests they could do in terms of climate change is unrealistic.* EL23 (Plasticity) mentioned that the presented solutions *didn't seem to have much range there and there wasn't much of a way to engage in that. Like I think plastic recycling is a much more complex issue than putting the the plastic or the cans in the bin.*

In Beyond Blue's case, although the participants applauded the way the game's technological gadgets put emphasis on science as a way of preserving the nature, there were concerns that these techno-solutions are not readily available and there should be more focus on how to approach climate-related issues with today's accessible methods. So, the participants criticised how using cutting-edge futuristic technology was a fast and oversimplified way of solving environmental challenges in this game. DY4 (Beyond Blue) described the easy fix impact of these technological tools as an *interesting but lazy way* that *would not teach us much* about tackling nowadays's environmental problems. ML6 (Beyond Blue) called it a *thrilling view of the potential our future has* but a *fantasy element that is unpractical and inconvenient.* JB5 (Beyond Blue) found these kinds of quick fixes during the game *passive.* This finding shows that the participants did not find techno-optimism, which is advocating for technology solving our problems (Barry, 2016; Gardezi and Arbuckle, 2020), an effective way of addressing climate change.

To avoid oversimplified solutions as a gameplay or narrative strategy in eco-games, the participants even suggested some innovative answers and resolutions. For example, TA18 (Plasticity) proposed that avoiding oversimplified explanations such as *personal blame* and diverting the critical lens to *blaming the corporations and the systems*, and as JI17 (Plasticity) added, *displaying the influence of governments and corporations on the environment*, rather than making it seem like it is people's fault, the narrative and gameplay become more engaging. AL11 (Plasticity) also elaborated on the part where children gather on Avalon Island and collect plastic rubbishes to restore the area:

> *Even though the main point is that individuals could also donate their power to the world, combating the climate change, the game greatly ignores other factors, such as how the government would decide how to deal with the climate change. Are there any technological progress that could help us? ... I think that it should have been more focused on how to solve the problems than just showing the problem.*

Oversimplification of the procedure in eco-games was also a broadly discussed subject. An oversimplified gameplay can reduce player enjoyment and engagement with the game's ideas. So, the participants believed that both games could benefit from additional action/interaction, intricate steps, and problem-solving opportunities. LR15 (Plasticity) expected *more surprising factors* and *challenging components* to highlight the risks associated with climate-relevant issues. DW21 (Beyond Blue) added how replacing the oversimplified gameplay by *different interactive occasions* and more *sophisticated goals and trials* could make the game *more fun and educational*. JB5 (Beyond Blue) expected ways to assess risks in eco-games. GF3 (Plasticity) suggested:

> *Increasing the complexity of the puzzles that were there, I thought they were all fairly simple, and while I get that sort of for general accessibility. Yeah, I don't know. I just thought it could make it more interesting and engaging.*

#### 6.3.2.3 Message framing in assessing environmental threats

Framing (Tversky and Kahneman, 1986), the notion of highlighting particular aspects of a subject in mediated communication, has been a practical approach in climate communication. The participants' most recurring criticism of Beyond Blue was about its message design and framing. Beyond Blue employs a gain-frame (Sallam et al., 2022) message technique in which it focuses on the beneficial and positive aspects of the environment to attract the audience's attention. Contrary to loss-framed messaging (Sallam et al., 2022) in Plasticity, which focuses on the disadvantages and negativity of environmental issues, gain-framing concentrates on how and why it is worth preserving the beauty, serenity, and glory of nature. So, even though a robust environmental theme was evident throughout Beyond Blue's gaming experience, the participants voiced out their opposing views regarding the game's message framing, articulating that the designers' tactic was not enough to underline and reflect pressing climate issues. CF24 (Beyond Blue) believed that designers need to highlight *the ugliness of the human impact* to make a meaningful impact. AM27 (Plasticity) believed that Plasticity's approach in portraying *a cautionary tale* where the purpose was *to picture as many bad things, like negative things of the issue as possible* had a substantial effect in showing the urgency of the situation. While AK18 (Beyond Blue) criticised not highlighting negative aspects of environmental issues:

> *Like they wanted to convey a message, but they wrapped it up in a beautiful package and just just umm ignored, and I don't know all the ugliness, like they looked the other way, and it wasn't a very effective way of of talking like addressing such a big ummm life-threatening issue.*

#### 6.3.2.4 Alarming hints for climate communication

Inducing fear has been a long-standing communication designed to generate attitude/behaviour change (Tannenbaum et al., 2015). In this approach, alarming hints and fear prompts are designed to endorse vigilant actions by provoking concern about an approaching risk (Ruiter et al., 2014). SG11 (Plasticity) believed the game had *a realistically positive message, shown in a negative style for emphasis, which may alert us about the changes in the world.* BT8 (Plasticity) thought that merging *warnings* in the message was a clever way to allow this *really important message to get across* and *show where our world is headed.* The participants suggested using elements of surprise and evidence-revealing tactics to improve eco-games' design. EN22 (Plasticity) stated how shocking elements, such as the mother's sudden death, reminded them of the *dangerous consequence of climate change.* NF9 (Plasticity) also believed showing players new information can expose them to climate change's risks. DI27 (Plasticity) added:

> *I really was just thinking of climate change in terms of global warming and uh that the weather is changing and yet this this game really highlighted that pollution in the oceans, especially plastic, and then pollution in our food, especially the plastic, is is actually quite harmful. So this was sort of like the rubbish or plastic version of climate change, which I hadn't really considered.*

Beyond Blue's participants also believed that the eco-games such as Beyond Blue could benefit from occasional surprising, exciting, alarming, confronting, or distressing elements to emphasise the environmental theme. GT9 (Beyond Blue) suggested adding colour/tone/music-changing prompts as a distress call to enhance players' sense of alarm. BH29 (Beyond Blue) also stated:

> *There wasn't anything confronting for me to see that will make me raise awareness about the urgency of the issue because it was all like swimming nicely. Yes, there was a bit of dialogue. Maybe they said that some of these species are endangered, but it wasn't anything that would prompt me or ummm highlight the urgency of the situation.*

### 6.3.3 Eco-games as Climate Awareness Heralds in Climate Communication

The third main theme from the analysis revolves around how eco-games can be conservation heralds/messengers, contributing to climate communication by raising environmental awareness. This theme includes three sub-themes: 1) designing curiosity cues for game-based climate discourse, 2) creating emotive cues for game-based climate communication, and 3) developing agency cues in game-based climate discourse (see Figure 6.4).

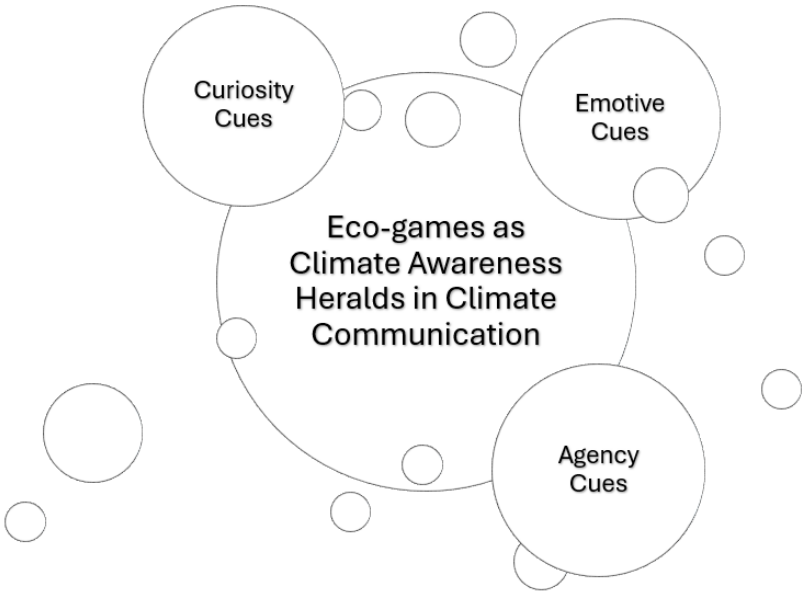


**Figure 6.4**: Theme and sub-themes drawn from the qualitative data

#### 6.3.3.1 Designing curiosity cues for game-based climate discourse

The appeal to explore gameful worlds is related to the sense of curiosity (Gómez Maureira et al., 2019). Thus, embedding components and details in the game that increases players' sense of curiosity and exploration (curiosity cues) is recommended. Curiosity cues can encourage players to navigate the game world and its environmental ideas, leading to advancing their awareness, attitudes, or motivation (Gómez Maureira and Rieffe, 2021; Gómez Maureira et al., 2019; To et al., 2016). Discovering nuances such as rare wildlife, hidden locations, unique flora and fauna, and unfamiliar environmental phenomena incentivises players to focus on the gameplay and its central theme. For Beyond Blue, although the participants noticed interesting details (e.g., sophistication of the technological gadgets, tribalistic Polynesian tattoos in the character's arm, or naming the whales), they did not seem to find enough incentives to explore the game's corners. The fault with this design aspect seemed to be with the absence of information gaps or unexpected and mysterious stimuli, as participants reported. However, it is worth mentioning that participants highlighted that the game's setting and location (ocean) by itself introduced a fresh perspective on a less-explored and isolated climate-impacted part of the planet, as the majority of media and public attention is generally focused on land-related problems. DH11 (Beyond Blue) explained how although they *wanted to see the ending*, the game did not offer enough incentives to *sell on the next one and to see what happens next.* For

Plasticity, the details were commended, although the 2.5 dimension nature of the game caused some limitations. For example, BG2 (Plasticity) expressed how they *wanted to explore a lot more than* the game allowed. Still, the overall reports did not mind this restriction and focused on the game's curiosity-focused and nuance-centered design. MK6 (Plasticity) specified how the game's *details like the wildlife animals being stuck with trash objects, like a dog or the seagull or the sea lion... and then the mountainous pile of trash... and rising sea water* motivate you to keep going in the game and *make you realise what the world can look like if nothing's changed.* EL23 (Plasticity) confirmed how inputting details and curiosity cues in eco-games could raise environmental awareness:

> *There were just so many different things, different details that addressed a whole breadth of issues like there was wildlife choking on plastic, being stuck in nets, a beach whale that was dead. Sewerage, I think or some kind of pollutant spilling out from pipes, it was just.... Obviously, the mountains of trash as well, there was a lot of it and it was.... It was so in your face about it that it would be very difficult to ignore.*

#### 6.3.3.2 Creating emotive cues for game-based climate communication

Emotions are influential and effective stimuli for human actions (Salama and Aboukoura, 2018) and essential components of the decision-making process (Lerner et al., 2015). Embedding emotive cues in climate communication can help to overcome the barriers of engagement with the abstract sides of climate change as these cues can create empathy and serve as a promising aid for designing efficient eco-feedback (Dillahunt et al., 2017). Video games have the potential to implant emotive cues in several elements. In Beyond Blue, participants reported feeling emotional in numerous situations including identifying with the character and her background story. Also, finding the main character as a female scientist was very encouraging to the female participants. They expressed how excited they were to see the main character as a female and how it made them proud and boosted their confidence, self-efficacy, and sense of identity. The participants also reported how hearing the game's music and encountering marine life was astonishing, making them feel more connected to the game and its environmental message. BK13 (Beyond Blue) explained:

> *There were moments of peace and quiet, broken up with these kinds of big moments of these emotional moments. So I thought that was, yeah, interesting how it could go from like most of your time is very relaxing and passive but they break that up with moments where you really focus and take note of what's happening like, especially when there's a new creature or something like that.*

In Plasticity's case, there were recurring reports of how the emotional connection between participants and the game raised awareness about the upcoming climate-related reality.

For instance, participants stated how Plasticity used an expressive audio design, emotive cues in the storyline (e.g., the mother's death from plastic pollution), and endangered animals as in-game challenge to provoke its players. GF3 (Plasticity) noted *the music of the game* as *very impressive*, while RO19 (Plasticity) noticed how the emotional experience of not being able to *take the bucket off the dog's head* and later on finding its dead body raised their awareness of how human activity endangers other species and triggers *environmental disasters*. AJ24 (Plasticity) stated how playing the game opened their eyes to new harsh realities:

> *I was very happy that I saved the bird and then [the game] says that by the end of the night or something like that, their belly will be filled with the rotten sea garbage and I was like, Oh my God! so... still, they're really in danger.*

#### 6.3.3.3 Developing agency cues in game-based climate discourse

Agency is an important contribution to a gaming experience and a key constituent to players' sense of autonomy and freedom (Snow et al., 2015; Jennings, 2019). Game-based factors including the controller, customisation, and in-game choices are designed to improve players' sense of agency, consequently boosting performance, motivation (Snow et al., 2013; Jackson and McNamara, 2013), and attitudes (Pekrun et al., 2010) towards presented ideas. Therefore, increasing players' agency can influence the quality of climate discourse in eco-games. In Plasticity's case, the faulty control system was the most criticised element of the game by the participants. This aspect influenced participant's sense of agency to the point that even one of the participants (LM23) interpreted this control deficiency as a way for designers to show *we don't have any freedom to change everything in climate change...we are powerless*, which negated the whole point of the game's message, showing the integral role of a healthy mechanical design (specifically the controller) to let players smoothly interact with the game's internal ideas. Participants in both studies considered inserting choice-based and customised routes/characters along with enhancing the mechanics of the game (specifically the controller) as a way to elevate their sense of agency and freedom. VD9 (Plasticity) mentioned how the *slow pace* of the game and its *sluggish controllers* prevented them from interacting with the game properly. BT8 (Plasticity) added:

> *It became... like disconnected and frustrating for me to kind of move so slowly through this space and, like, have to be lined up exactly to interact with ladders and crates and stuff.*

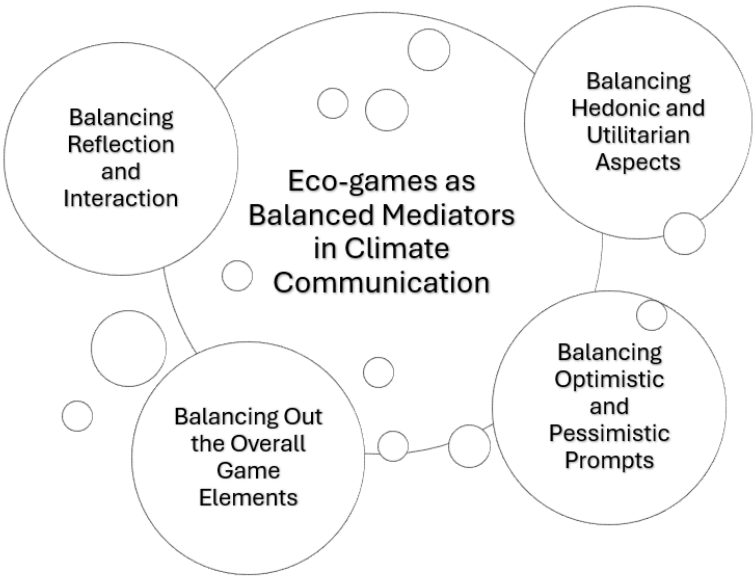


**Figure 6.5**: Theme and sub-themes drawn from the qualitative data

### 6.3.4 Eco-games as Balanced Mediators in Climate Communication

The final main theme revolves around how eco-games must strike the right balance for successful climate communication. This theme entails four sub-themes: 1) balancing reflection and interaction in game-based climate communication, 2) balancing hedonic and utilitarian aspects in game-based climate communication, 3) balancing optimistic and pessimistic prompts in game-based climate communication, and 4) balancing out the overall game elements for climate communication (see Figure 6.5).

#### 6.3.4.1 Balancing reflection and interaction in game-based climate communication

Game mechanics should be user-friendly to create fluent interactivity and be well-developed to avoid destabilising the gameplay (Tondorf and Hounsell, 2023). Meanwhile, a meaningful concept can add value to the persuasive narrative of eco-games (Hamby et al., 2018). The balance between moments of reflection and sequences of interaction with the game is key to a fluid and profound experience, which can also develop meaningful routines and patterns. The common view among participants was that this balance was off in both Plasticity and Beyond Blue. In Beyond Blue's case, participants stated that even though reflection moments were adequate, the game did not provide sufficient theme-pertinent

interactions during its gameplay, which in turn lacked adequate practical opportunities that could lead to developing internalised ideas or building routines. Similarly for Plasticity, participants found a lack of unity between moments of observation and the quality of interaction with the game world. The participants in both groups asked for more interaction and better engagement, asserting that moments of contemplation and appreciation cannot make up for limited interaction with the world. They also asked for more meaningful interactive opportunities to build routines during gameplay. Furthermore, the participants emphasised eco-games' necessity to create harmony between reflective and interactive occasions. MA25 (Beyond Blue) stated that interaction *especially with animals* was *an important missing thing* in the game. SG11 (Plasticity) suggested creating more balanced eco-games by adding teams and giving *some tasks to each of them to encourage collaboration* along with *thoughtful moments*. DI27 (Plasticity) suggested having *more characters* to *play a competitive game*, and AM27 (Plasticity) proposed adding a social aspect by making the game *online* and *play in real time*. KB31 (Beyond Blue) added:

> *I was really hoping that if I went up to the sperm whale, you could like pat it with something or you could like touch it. And unfortunately, you can't really. You just kind of stare at it and like the hit boxes just kind of collide.*

#### 6.3.4.2 Balancing hedonic and utilitarian aspects in game-based climate communication

Design considerations for games with critical topics can be tricky as the main message/goal and the entertainment part can become conflicting (Ritterfeld et al., 2009), making the appropriate balance between hedonic (pursuing pleasure and entertainment) and utilitarian (pursuing knowledge and education) aspects crucial (Hamari and Keronen, 2017). In both groups, the shared opinion was that this balance was off and that both interventions needed more hedonic and utilitarian factors in their gameplay. In Beyond Blue's case, although the educational significance of the mini-documentaries embedded in the game was recognised, the participants articulated that the way the game ignored environmental issues took away from its pedagogical agenda. Additionally, the common view was that the entertainment aspect was lacking and needed improvement. Plasticity's participants acknowledged that the game was a serious educational game, but still they thought that equalising fun and education is the best approach for an effective eco-game. They believed that a balanced mixture of these two aspects could significantly augment eco-game's environmental values. Gh3 (Beyond Blue) called the game sometimes became *boring* and added that *little play or knowledge* could be attained from it:

> *you just kind of like swim from one location to another and then just look at like fishes and stuff. Like there's a couple of moments where I was like, oh,*

*well...*

TA18 (Plasticity) categorised the game in the *beyond entertainment* genre and said:

> *Imagine if you had enough of both fun and and like environmental lessons or thoughts or ideas ummm or whatever scattered in a a fun way throughout the game, just how how powerful the game could become.*

#### 6.3.4.3 Balancing optimistic and pessimistic prompts in game-based climate communication

Climate change causes an increase in extreme weather phenomena, with dangerous consequences (Lee et al., 2023). The magnitude of such pressing environmental issues underpins how individual-level and grassroots-led actions can be inconsequential, leading to pessimistic views about climate change (Ojala, 2012, 2023). Consequently, perceived lack of ability to influence climate-related events reinforces environmental cynicism and pessimism, producing apathy and a sense of powerlessness in individuals (Kelsey, 2016). Therefore, the climate narrative can greatly benefit from hopeful and optimistic prompts as motivator for climate action (Ojala, 2012, 2023). Game design has also used some persuasive measures to convey the message of hope. Yet, entrusting optimism that is grounded on refuting the reality or gravity of a problem is unhelpful (Ojala, 2012, 2023). Therefore, it is critical to synchronise the use of optimistic and pessimistic prompts as hope catalysts and action motivators to have a balanced reaction to the issue. In Beyond Blue's case, participants criticised how the game heavily leaned towards showing optimistic aspects and expressed how the imbalance between hopeful and troublesome hints diminished the game's environmental message. Lk30 (Beyond Blue) explained this lack of balance as:

> *this is a very positive outlook on human impact on the marine life ecology, but. I'm not sure if it's the full picture of human influence, so I feel like the fact that it is a positive term sort of undermines whether or not it's a full view of the current situation.*

In Plasticity's case, while the participants endorsed the way their emotions were triggered by pessimistic prompts to highlight the climate-related urgency, there were oppositions to some of the most radical strategies, calling them manipulative, overpowering, and controlling. GO7 (Plasticity) proposed including *more achievements*, and avoid a repetition of devastating situations in the gameplay, highlighting the imbalance between negative and positive facets of the issue in the game. Hence, participants asked for a logical balance between the pessimistic and optimistic portrayal of climate-related cases. TL14 (Plasticity) thought the game's *very dark tone*, *manipulative* design, and *strong symbolism* of negative aspects of climate change could be softened by some hopefulness. HG1 (Plasticity) shared the same sentiments:

> *It was very emotionally manipulative. So getting here to play as a child, like starting with the death of your mother because she ate too much plastic... So mother dying in the 1st 5 minutes is highly emotionally manipulative. And then finding out that it was because of, you know, like if only you'd done things better when you were a kid, we could have avoided this. I thought that was very manipulative.*

#### 6.3.4.4 Balancing out the overall game elements for climate communication

Different elements in a game should complement each other and be consistent with the overall theme to create a balanced experience (Tocci, 2008). Game elements are imbalanced when players feel unsettled, uninterested, disengaged, or disoriented in the gameplay (Tondorf and Hounsell, 2023). Excessive or disproportionate components, such as very complex or effortless puzzles, extremely difficult or easy-to-defeat enemies, complicated or elementary systems, irrelevant tasks, lengthy messages or scenes create a disruptive dynamic between the game and the player, which can lead to an unbalanced gameplay (Caserman et al., 2020). It should be the designers' ultimate goal to formulate a unity between all elements and the central theme of the game. The participants' statements so far show that both Plasticity and Beyond Blue still need some fundamental improvements to create this kind of balance between their elements and the central environmental theme to reach a desirable eco-design. KD29 (Plasticity) believed what they *found missing was the link between human actions or environmental changes* and *what the landscape looked like and the impacts on health*, stating that balance in eco-games should go *beyond playability* options and incorporate the overall topic, linking the theme to all the elements. RC3 (Plasticity) emphasised the role of *fluctuation* in the gameplay, explaining how going from dark moments to bright ones is a way of creating harmony and preventing players from getting bored. YM11 (Beyond Blue) elaborated on the importance of balance, stating:

> *You could literally divide the gameplay and the story from each other and like, listen to the voice audio separate from the game and that wouldn't change anything. You wouldn't lose much.*

Participants expressed the necessity of emotionally balanced plots to make an eco-game more effective. They believed that balancing out the photo-realistic visuals and artistic choices of designers could add to the authenticity of eco-games and stated how balance of scientific and empathetic messages can make eco-games profound, thought-provoking, and engaging. They also mentioned how the balance between challenges and skills makes eco-games more accessible and user-friendly.

## 6.4 Conclusions

The qualitative component of this project investigated nuances involved in the interventions' design and identified the perks and limitations of the games as experienced by participants. My qualitative approach involved identifying patterns and trends to produce a series of themes and sub-themes as qualitative evidence to frame an effective and successful eco-design suitable for video games. The results highlighted that eco-games can be effective in illustrating and envisioning different ecological setups and futures as well as forming a link between people and the environment. They can project the environmental risks, increase awareness about the gravity of the issue, and serve as intermediaries for facilitating climate communication. The findings shed light on how enhancing the interactivity of game mechanics, persuasiveness of the narrative, immersive realism of the animation, and theme-appropriate framing can aid in conveying environmental messages. With qualitative and quantitative findings in hand, the next chapter will concentrate on explaining their implications and embedding them within the current literature.

Chapter 7

# Discussion

Creative interventions, such as video games, have been proposed to draw in and engage the public with climate change (Lee et al., 2013; Ouariachi et al., 2018a,b). Role playing a crisis through an engaging plot encourages action (Heath, 2004) and video games as interactive systems, influential storytellers, and immersive world builders have the potential for this purpose. Coupled with perspective-taking as the avatar, video games can create an engaging and persuasive setting, enabling the player to personally experience the causal nexus of actions and events (Ouariachi et al., 2018a,b; De La Hera and Raessens, 2021). However, there is limited knowledge and empirical research on how gameful features and elements can add to the players' game experience in development of persuasion to impact their attitudes (De La Hera and Raessens, 2021; Whitby et al., 2019), specifically within the context of climate change. Gaining an in-depth understanding of successful creative processes and nuances of game design aspects within an environmental framework can help game designers create effective games that can target pro-environmental attitudes and motivate greater protection of the environment. Thus, my research investigated the question: **how can we improve gameful design for effective climate communication?** This project aimed to advance understanding of the impacts of climate-themed persuasive design in video games.

To conceptualise the necessary factors and processes in effective climate communication, my research developed a Climate-Oriented Persuasive Edutainment (COPE) model, which is anchored in several underlying theories. Integrating a multidisciplinary body of theories (Prospect Theory (Kahneman and Tversky, 1979), Framing Effect (Tversky and Kahneman, 1986, 1981), Procedural Rhetoric (Bogost, 2007), Narrative Persuasion (Appel and Richter, 2010; Murphy et al., 2013), and Immersion (Mcmahan, 2003; Ryan, 2003)) informed the approach to developing the COPE model. This model explains the design considerations and player experience processes that can influence pro-environmental attitudes. It considers three main design features (mechanics, narrative, animation) and their related elements, along with message framing as an overarching theme and key factor in designing for critical situations.

Using the COPE model as a framework, I conducted two multi-stage interventional exper-

iments to measure how and to what extent the design intricacies of two climate-themed video games (Beyond Blue and Plasticity) relate to their players' pro-environmental attitudes. I collected a combination of quantitative and qualitative data. Using both explicit and implicit attitude measurements, the experiments investigated how the gameful interventions affected players' pro-environmental attitudes. For these parallel within-subjects experiments, participants were randomly assigned to play Beyond Blue in Experiment 1 ($N = 36$) or Plasticity in Experiment 2 ($N = 37$) as the intervention. These games were selected because their central message design dealt with environmental issues in different ways (gain-frame and loss-frame, respectively). Plasticity uses loss-framed messaging to depict its dystopian game world, whereas Beyond Blue employs gain-framed messaging as its primary messaging technique. Also, they had different production resources, which led to different design choices. Beyond Blue is a commercial eco-game, with a high budget in its development process, while Plasticity is an independent (indie) eco-game, with limited production budget.

The interventional experiments (Beyond Blue and Plasticity) used identical pre and post-test designs, with the delayed post-tests administered three to five weeks after the main gameplay session. In each experiment, I compared the environmental attitudes of participants before, immediately after, and three to five weeks following playing the eco-game. This repeated-measures design helped to understand how attitudes varied over each stage of the experiments and the types of impacts an interactive gameful intervention can have on players' pro-environmental attitudes. Additionally, the two types of central message strategies (gain versus loss frame) used in the interventions were explored as an initial step to understanding nuances of message framing in a gaming setting.

During the experiments, I also evaluated two levels of design considerations: 1) the feature-based design that addressed the mechanics, narrative, and animation dimensions of game development, and 2) the element-based design that categorised each feature into smaller design factors to assess how they can predict players' pro-environmental attitudes. This chapter presents the discussions around the findings, their implications, how they relate to the existing literature, and how they address the hypotheses.

## 7.1 Beyond Blue (Experiment 1)

In a near-future semi-open-world setting, Beyond Blue simulates an aquatic habitat in a gameful design to depict the greatness of the marine ecosystem. This simulation video game addresses the aquatic ecosystem by portraying the ocean and the value of its preservation as well as subtly showing how human footprints have touched even the deep and dark corners of our oceans via scattered litter and scraps. As part of the trend that connects players with other aspects of the nature with whom humans share the climate-

associated consequences (Germaine, 2023), Beyond Blue portrays the ocean, its inhabitants, and the humans as interconnected beings. The topic this eco-game chooses is important because there is evidence of how the mobilisation of mismanaged waste and microplastics via wind or tidal transport (Allen et al., 2020; Lo et al., 2020; Wang et al., 2019) is a pervasive environmental threat (Villarrubia-Gómez et al., 2018) that can penetrate the water sources (Gunaalan et al., 2020), destabilising the organic and biochemical structure of the ecosystem (Welden and Lusher, 2017; Van Sebille et al., 2020; Duarte et al., 2020; Roebroek et al., 2021).

Simulation video games are designed to mimic real-world activities in an educational setting. A simulation eco-game can offer direct training about environmental topics via a virtual self-depiction or avatar (Freeman et al., 2020). Beyond Blue's theme centres around the positive aspects and prominence of preserving the aquatic environment. Through perspective-taking and role-playing a scientist (Mirai) who live-streams her daily encounters with the marine ecosystem, the player has the chance to navigate the ocean, appreciate its grandeur, empathise with the underwater wildlife, and discover occasional ecological threats (such as noise pollution or flow of waste) as reminders of the effects of human activities on the aquatic biome and its inhabitants (e.g., coral reefs, whales). Through the game, the player not only experiences an educational overview of the ocean but also gets to explore its spectacles using some interesting futuristic technology to interact with marine life. The whole game takes about four hours to complete. The experimental task required participants to play Beyond Blue for 35-40 minutes.

Using Beyond Blue as the intervention in Experiment 1, my research provided empirical evidence concentrating on how, and to what extent, players' experiences of this simulation eco-game relate to their pro-environmental attitudes. In Experiment 1, the initial hypothesis (E1-H1) expected Beyond Blue to positively impact players' pro-environmental attitudes and estimated to see changes in participants' pro-environmental explicit attitudes in the short term (E1-H1a) while anticipating no significant change in either their long-term explicit attitudes (E1-H1b) or overall implicit attitudes (E1-H1c) after playing the game. These hypotheses were directed towards Beyond Blue's overall effect based on its eco-themed message design and how it revolved around a gain-framed tactic where the focus was on marine life preservation, with subtle remarks concerning the ramifications of climate change on aquatic ecosystems. This type of message framing is believed to be a persuasive approach, which can elicit positive thinking and motivation (Kahneman and Tversky, 1979), through appealing and non-manipulative demonstrations of issues (Reinhart et al., 2007; Witte, 1994). Additionally, earlier literature argues that this message design has exhibited improved behaviour intentions in its recipients and has been deemed valuable in problem management (Ahn et al., 2015; Gray and Harrington, 2011; Gallagher and Updegraff, 2012).

As predicted, participants who played Beyond Blue showed higher cognitive pro-environmental attitudes (an aspect of explicit attitude) after playing Beyond Blue, providing partial support for E1-H1a. The participants exposed to this type of message design showed a statistically significant increase in cognitive pro-environmental attitudes following gameplay. This finding suggests that embedding a central gain-framed environmental message accompanied by perspective-taking in a gameful intervention can significantly influence players' cognitive explicit pro-environmental attitudes in the short term. An explanation for this result is that evoking appreciation towards nature and highlighting environment preservation (gain-framed messaging) via gameplay can form propositional reasoning aligned with other propositions in one's memory and lead to attitude revision. In line with E1-H1b, the explicit pro-environmental attitude change did not persist long-term. I argue that due to the intervention's brief duration and indirect messaging strategy used to address the climate change concern, the results did not show a durable explicit pro-environmental attitude change in Beyond Blue participants.

The observations also showed that implicit attitude assessments did not change significantly from the pre-test to the post-test or from the pre-test to the delayed post-test. This pattern of findings is in line with E1-H1c, suggesting that playing Beyond Blue did not have short or long-term impacts on participants' pro-environmental implicit attitudes. To alter players' implicit views, the intervention must trigger and remodel pre-existing associative links between the presented notions in the video games and other generic ecological ideas stored in participants' memories that they see as unfavourable (e.g., collective guilt or personal sense of responsibility and remorse towards climate change). Participants' general associative evaluation of the encounter should be influenced by these revised associative links. The findings implied that exposure to Beyond Blue altered the conscious logical conclusion about the topic (i.e., explicit (cognitive) attitude), but not the involuntary affective reaction to the issue (i.e., implicit attitude), suggesting that this interventional game lacked the key qualities to elicit and modify associative evaluations of the issue at hand. It is also likely that the short (35-40 minute) game session was insufficient to generate fresh, robust, associative evaluations or enhance existing ones and therefore, had no effect on implicit attitudes. These findings are in line with the research by Alblas et al. (2018) and Kolek et al. (2021), which used video games to measure implicit attitudes. Alblas et al. (2018) used evaluative conditioning as a persuasive mechanism within the intervention to test short-term implicit attitudes about healthy nutrition and found no significant change in implicit attitudes of their experimental group. Kolek et al. (2021) assessed both short and long-term effects of a video game with a historical message and did not report any change. The former study used a 10-minute gameplay in its design, while the latter had a 50-minute play session. So far, the scientific findings on the effects of video games on implicit attitudes are limited and additional evidence is required to assess the influence of measurement on implicit attitudes, including exploring

the effects of repeated gameplay.

Since the results of the t-tests showed that playing Beyond Blue had an overall impact on participants' cognitive attitudes, I further assessed players' subjective experiences of game features (mechanics, narrative, and animation) and their specific elements to identify design choices' contributions to participants' pro-environmental cognitive attitudes. I expected Beyond Blue's overall mechanics (E1-H2), narrative (E1-H3), and animation (E1-H4) design to positively predict players' pro-environmental explicit (cognitive) attitude. Results showed that the overall narrative and mechanics features of the intervention were significant predictors of pro-environmental cognitive attitudes, indicating that these aspects in Beyond Blue are successful interactive and persuasive features in the context of climate communication. This finding could suggest that presenting ecological views and values via a simulation's narrative and mechanics design can influence attitudes through interaction (Bogost, 2007) (empowering players to interact with the game world) and narrative persuasion (Bril et al., 2018) (plausible plot-relevant ideas). I argue that this finding aligns with the proceduralism literature's premise that video games' interactivity systems can impact players' views and attitudes (Bogost, 2007; Antle et al., 2014). Also, by signifying the capacity of the narrative design aspect, this finding underpins previous literature on narrative persuasion (e.g., (Burrows and Blanton, 2016; Bilandzic and Busselle, 2012; Green, 2021)) and highlights the importance of evaluating design aspects beyond proceduralism (interactive mechanics) to understand the persuasive nuances of different gameful factors (De la Hera et al., 2017; De La Hera and Raessens, 2021; Heide Smith and Norholm Just, 2009; Evans, 2011).

Following a more detailed design evaluation, I observed that only one element (players' experiences of the challenges) in Beyond Blue was a significant predictor of participants' pro-environmental explicit (cognitive) attitudes, meaning the more participants appreciated the challenges within Beyond Blue, the higher their pro-environmental attitudes. In other words, the more participants thought the game was appropriately challenging, the higher their reported pro-environmental attitudes were. One possible explanation for this result is that those participants who were more engaged with the eco-friendly ideas presented in the gameplay adopted more pro-environmental attitudes after playing. The qualitative data offer further explanation for this finding as the participants expressed how the relation between Beyond Blue's central theme (preserving and appreciating the underwater world) and the challenges set in gameplay (e.g., dive missions for following aquatic creatures' well-being, scanning marine wildlife, and getting information about the oceanic biome in a serene setting) was integral to their understanding of the eco-centred ideas of the game. Combining the quantitative and qualitative findings shows that theme-relevant tasks/challenges strengthened the influential capacity of this element in the game. This result is in line with preceding studies that link video games to the

improvement of cognitive attitudes towards the environmental crisis (Topp et al., 2019; Janakiraman et al., 2018; Fernández Galeote et al., 2023b,a). Yet, there is limited empirical data to support any significant connection between game-based challenge design and pro-environmental cognitive attitudes. As an interactivity element of games, challenge is crucial in defining gameplay (Vahlo and Karhulahti, 2020; Salen and Zimmerman, 2005; Ryan et al., 2006). This outcome could demonstrate the importance of a successfully interactive challenge-setting scheme, its design, level, and execution in a gameful setting, where the topic of environmental preservation and climate-related matters are embedded. I argue that setting well-developed theme-oriented challenges in this game boosted engagement and interaction, reinforcing the connection between the player and the game's ideas.

It is noteworthy that, on a more detailed level, I did not find any evidence to show the individual contributions of each element of the narrative feature (storyline, character, concept/meaning) to pro-environmental attitudes. While the combined effect of these factors was significant, as individual elements, my study did not identify much potential for pro-environmental attitudes. It can be argued that enhancing these individual elements based on the main theme could have added to the pro-environmental impact of the intervention. I propose further improvement of climate-related storylines, character design, and conceptual presentations in video games. In the case of Beyond Blue's character design, for instance, a plausible explanation for the absence of attitudinal effect could be assigned to the limitations of modifying the avatar, as supported by the qualitative data. Some players would rather roleplay a character who is more similar to them (for example, choosing the gender or facial qualities). However, this element in Beyond Blue did not have the character design opportunities a simulation game is expected to provide. From a combination of the quantitative and qualitative data, I argue that the lack of inclusiveness and flexibility in the character design impeded this element from making a connection with some of the players and influencing pro-environmental attitudes.

Equally for the mechanics elements, the combined effect of Beyond Blue's controller, goal-setting, challenge, and feedback design on participants' cognitive attitudes was significant. However, as individual elements, except for the challenge element, none showed much promise for pro-environmental attitudes. Mixing this finding with the qualitative data, a possible explanation for the lack of attitudinal effect in the feedback design could be that Beyond Blue pays insufficient attention to evaluating players' actions and guiding them during gameplay. It can be speculated that the game designers wanted to increase players' sense of freedom and agency in this semi-open-world game, and this design choice undermined the guidance or feedback scheme in the game. During the interviews, several participants mentioned that having a more active feedback system could make the transmission of the game's ideas smoother and faster by guiding players and pointing

out the consequences of their actions. Also, the qualitative findings can explain why the goal-setting element did not relate to players' attitudes. The participants mentioned how Beyond Blue's goals required more clarity and direction to engage and influence players. Again, one potential explanation is that the designers have overlooked this element in favour of creating a semi-open-world game where the player is free to navigate and explore without the restrictions of following mandatory goals. I argue that strengthening these design elements could enrich players' experiences of the game's environmental ideas and increase players' pro-environmental attitudes (possibly on more attitudinal levels or even longer intervals). I propose that paying attention to details to strengthen individual mechanics elements can further promote the interactive quality of games and their persuasive impact.

Contrary to the hypothesised expectations in E1-H4, neither the overall animation feature nor its independent elements (worldbuilding, exploration, audiovisual design) were predictors of participants' pro-environmental cognitive attitudes. One potential explanation is that there are two different kinds of realism for a game to be immersive and authentic in players' views; 'graphical realism' and 'behavioural realism'. Improved graphical realism refers to the quality of a game's graphics, which is expected to increase effects, enhance player's perceived realism, and modify mental processing of views, attitudes, and behaviours (Shapiro et al., 2006; Shinkle, 2020; Lin and Wu, 2020). On the other hand, behavioural realism describes the authenticity of gameful rules and how things and characters behave compared to the same items in real life (Krcmar et al., 2011; Zendle et al., 2018). To create the illusion of a sensible and immersive setting within the game, designers need to achieve both graphical and behavioural realism and immerse the players in the game. The findings contradict E1-H4, suggesting that Beyond Blue's animation design lacked the quality to achieve this combined level of realism and fidelity. The qualitative data shed light on this aspect of the results, pointing out that some of Beyond Blue's futuristic tools, robotic character movements, or dull dialogues broke parts of the participants' sense of realism in the game. Also, the visual cues lacked the boldness to depict conspicuous climate-related issues, failing to make a connection to the current urgency of the environmental crisis. Because immersive gameplay is a core part of player experience (Abeele et al., 2020; Hafner and Jansz, 2018; Sweetser and Wyeth, 2005), I propose that strengthening the level and extent of realism, curiosity-based elements, and topic-focused audiovisual prompts can further promote the immersive value of games and encourage the portrayed themes in the game's worldbuilding, exploration, and audiovisual design. Also, because immersive gameplay can set the stage for playful enjoyment (Nacke et al., 2011), I speculate that the flaws in the animation feature could be a reason why there was a considerable attrition in the delayed post-test ($N = 22$), compared to the pre/post-test ($N = 36$). However, the animation feature needs further examination and enquiry, which exceeds the scope of this project.

## 7.2 Plasticity (Experiment 2)

Plasticity (2019) is a puzzle-platformer game set in a near-future where plastic consumption has led to a toxic condition of life. The issue this eco-game specifies is imperative because there is evidence of how plastic pollution is an ominous threat (Eriksen et al., 2014). In 2010, 32 million metric tons (Mt) of the world's plastic litter was categorised as mishandled trash (Jambeck et al., 2015). There are estimates that the mismanaged plastic waste will grow to 90 million Mt/year by 2030 (Borrelle et al., 2020). So, the world Plasticity depicts is not far-fetched. Plastics are not only a critical waste control issue (Chae and An, 2018), but they can break into microplastics and nanoplastics and penetrate the food chain (Napper and Thompson, 2020). Moreover, plastic pollution changes native landscapes and the production of plastics contributes substantially to greenhouse gas (GHG) emissions (Beaumont et al., 2019; Brouwer et al., 2017; Hamilton and Feit, 2019). Plasticity is a video game that addresses this subject.

This eco-game is imbued with climate-themed references to the detrimental effects of plastic pollution on the ecosystem (barren areas, flooded regions, dispersed litter, trapped animals, and dreary sites). Even the player's smallest decisions can make notable changes to the story and the gameplay. The message is structured in a clear and straightforward way, which is an approach to avoid overwhelming the recipient (Fernández Galeote and Hamari, 2021). Still, some less familiar information about the severity of plastic pollution (e.g., microplastics in food and the consequences of consuming them) is also set in the gameplay, which could challenge some optimistic current views on the issue. I chose this game because the intricacies of a loss-framed approach mixed with the design opportunities of an indie game give Plasticity an interestingly multifaceted theme and design.

Using Plasticity as the intervention in Experiment 2, my work produced empirical evidence on how, and to what extent, players' experiences of this eco-game pertain to their pro-environmental attitudes. The repeated-measures design (pre/post/delayed-post) of the experiment facilitated the investigation of how attitudes fluctuated at each phase of the study. My research also included examining three key design features (mechanics, narrative, and animation) and their specific elements in the intervention to detect how game design choices can influence players' pro-environmental attitudes. In Experiment 2, the initial hypothesis (E2-H1) expected Plasticity to positively impact players' pro-environmental attitudes. This hypothesis focused on Plasticity's overall effect based on its eco-themed message design and how its climate-themed message design is a central loss-framed strategy communicated in a direct manner followed by a potential hopeful twist in the ending, which could have both short and long term effects. Therefore, I hypothesised that I would observe changes in participants' pro-environmental **explicit** attitudes in both the short-term (E2-H1a) and long-term (E2-H1b). I also hypothesised

that the intervention would significantly impact **short-term implicit** pro-environmental attitudes (E2-H1c) while expecting **no** significant change in **long-term implicit** pro-environmental attitudes.

The results suggested that, similar to Experiment 1, playing Plasticity increased participants' cognitive attitudes regarding climate change in the short term. This finding indicates that both message design strategies improved an aspect of their players' explicit attitudes (cognitive pro-environmental attitudes), which partially confirms E2-H1a and underlines the importance of interactive gameplay in climate change communication. Earlier empirical works in this domain show mixed results as different studies have measured different persuasive features of video games regarding players' explicit attitude change. For example, Kampf (2015) incorporated perspective-taking as a persuasive mechanism in their game design, which supported this gameplay feature's short-term impact on attitude shift towards the ongoing tensions in the Levant region. Price et al. (2016) used diverse game elements and meaningful choices to measure the benefit of understanding human anatomy in an educational game. They also confirmed video games can change people's explicit attitudes. Additionally, Kolek et al. (2021) took perspective-taking as a persuasive method to target a historical game and recorded short-term explicit attitude changes in participants. Meanwhile, Ruggiero (2015) simulated life in poverty to assess attitudes about homelessness, using a pre-scripted economic model as a persuasive element. However, they did not find a significant explicit attitude change. Also, Pena et al. (2018) were unable to track this influence on their participants. They used perspective-taking as a persuasive feature. However, their method has been criticised as partially limited due to adding the main avatar's relatives to the consequences of the player's decisions. Previous research indicates that perspective-taking, which was also used in Plasticity, can have substantial influences on explicit attitudes.

The results also revealed that exposure to Plasticity made the recipients feel more negative affect and more aware of the urgency and threat of climate change immediately after gameplay. This finding provides further support for E2-H1a by indicating that exposure to Plasticity increased another aspect of participants' explicit pro-environmental attitudes. In other words, Plasticity players showed significantly higher threat perception towards climate change than prior to the intervention. Earlier studies identified a connection between affects and attitudes (Schwarz and Clore, 1983; Wegener et al., 1994), but these findings deepened this understanding by revealing significant correlations between reported negative affect and some aspects of explicit pro-environmental attitudes (negative eco-emotion and threat perception) immediately after a gameplay session containing a primary loss-framed messaging design. One interpretation of these findings is that a central loss framing technique in a climate-themed avatar-based game setting can effectively evoke the notion that gameplay events (drastic outcomes of neglecting the

environment) might occur in the future. Prospect Theory and perspective-taking can help explain this finding as they give a unique outlook on how avatar-based video games help individuals assess their actions' serious ramifications and determine if they would act similarly outside the simulated space (von Salm-Hoogstraeten and Müsseler, 2021). The significant pro-environmental impact of playing a game with loss-framed messaging suggests that exposure to disadvantages during gameplay can help people comprehend that such negative events could occur if humans continue neglecting the environment and delay enacting solutions for climate change.

These findings are also consistent with earlier risk-related literature, which contends that loss framing promotes message elaboration and persuasion effects. For example, some previous studies drew from research on fear appeal and argued that the loss-frame and cautionary features of a message share similar elements (O'Keefe and Jensen, 2008) and improved message processing (Slater et al., 2002; Das et al., 2003; Hale et al., 1995). Also, cognitive-motivational-relational theory (Kemper and Lazarus, 1992) argues that fear prevents danger by pushing individuals to search for and understand risk-reducing information to prepare for/respond to hazards (Das et al., 2003; Nabi, 2003). Other studies used the elaboration likelihood model (ELM) (Petty and Cacioppo, 1984) to argue that people would analyse a central loss-frame more thoroughly because it draws more attention and/or is more likely to contradict their expectations. Additionally, the results of my research advance previous findings on how perspective-taking as an emotive element can engage the public with sensitive subjects (Fernández Galeote and Hamari, 2021; Adler et al., 2016) and lead to more agreeable attitudes towards the portrayed viewpoint (Kolek et al., 2021). Approaching climate change in this way helps generate more understanding, a more profound feeling of purpose and meaning, and the opportunity to inspire action beyond limited efforts and extrinsic rewards by incorporating a mixture of personal and regional concerns with a global viewpoint (Fernández Galeote and Hamari, 2021).

Interestingly, I observed an increase in the level of positive eco-emotion in the delayed post-test results for Plasticity, which has implications for its message design's long-term effects. This finding partially supports E2-H1b, which expected the explicit pro-environmental attitude change in Plasticity's players to be long-term. The results showed that participants' positive eco-emotion rating was significantly higher three to five weeks after playing Plasticity than before and immediately after gameplay session. This finding implies that the negative feelings and sense of caution and threat embedded in this game were short-lived and replaced with a sense of positive eco-emotion after a few weeks. One way to interpret this finding is to relate it to the game ending. Plasticity has two different endings based on the choices made by players. If the player shows small acts of kindness towards life around them (e.g., saving the animals, picking up trash, or teaming up with others to clean the surroundings), the game has a positive and hopeful ending. Other-

wise, the game ends with a gloomier and darker destiny for Earth and its inhabitants than the start of the game. The majority of the participants in this experiment experienced the positive ending as documented by the researcher during gameplay sessions. It could be argued that the potential hopeful conclusion embedded in this game had a significant durable influence on the players. This result has interesting implications for the long-term effect of message framing in an interactive gameful setting. Based on climate change communication research, empowering and giving agency to people is essential in transferring climate awareness, regardless of the message framing techniques employed (O'Neill and Nicholson-Cole, 2009). Therefore, even if imagery and messages in the game provoke anxiety or stress, they should be complemented with remedial measures tied to climate change. Otherwise, the loss-framed message can lead to unproductive feelings of powerlessness and frustration (O'Neill and Nicholson-Cole, 2009; Nabi et al., 2018). I believe Plasticity had a balance of these two aspects (provoking anxiety, yet giving hope to the player through its ending), which could have helped its more durable effect (than Beyond Blue) on the participants.

There is a case for attributing the positive eco-emotional attitude shift to the gameful intervention (Plasticity), rather than the passage of time or some intervening event. This is because the increase in long-term positive emotions about climate change occurred only for Plasticity players, and not for those playing Beyond Blue, and yet participants were randomly assigned to the gameful interventions. I also carefully monitored the news cycles and found there were no climate events during the data collection period (pre-test until the delayed post-test). Studies that have explored the long-term effect of video games are scarce, but a few relevant studies can be mentioned that are aligned with this case. Kampf (2016a) assessed attitudes towards the Israeli-Palestinian conflict using perspective-taking as a persuasive mechanism, Ruggiero (2015) studied attitudes towards homelessness using a pre-scripted economic model as a persuasive technique, and Kolek et al. (2021) explored attitudes towards historical content via perspective-taking as a persuasive method. Kolek et al. (2021) and Kampf (2016a, 2015, 2016b) reported a long-term durability of explicit attitude change in their samples. Ruggiero (2015) also confirmed a long-term difference between the experimental and control groups after a gameplay intervention, but suggested further data is required for the interpretation of their finding. Earlier research indicates that the duration of the intervention might play an essential part in long-term explicit attitude transformation; nevertheless, this idea requires additional investigation. Based on this research, it is reasonable to infer that the gameplay's duration is not the exclusive element that holds lasting persuasive capacity. Message design and framing the issues portrayed in the game, in addition to perspective-taking should also be considered integral parts of the equation, particularly in addressing views towards delicate matters, as in this work.

I further argue that having conclusive endings could also influence the way a message is perceived and internalised, impacting the formation, modification, or reinforcement of views and values in recipients. In contrast to Plasticity which gave most of its players the chance to experience a finale during the experimental task time frame, Beyond Blue's lack of an ending could have impeded some components of message processing due to an absence of narrative closure and 'feeling of finality' (Carroll, 2007), limiting emotional engagement (Green and Brock, 2000) and thereby reducing the game's overall persuasiveness in cultivating and transmitting ideas (Nabi and Green, 2015). I urge future studies to delve deeper into the field of game narrative design and explore the impact of narrative endings and closure in eco-games on players' perceptions, attitudes, behaviours, motivation, engagement, and overall player experience of the environmental messages embedded in videogames.

The results also demonstrated that the intervention did not significantly impact players' implicit attitudes in either the short or long term. This finding refutes E2-H1c, which anticipated Plasticity to positively impact short-term implicit pro-environmental attitudes and simultaneously confirms E2-H1d, which expected the potential implicit pro-environmental attitudes to **not** be long-term. I interpret the pattern of findings to mean that playing Plasticity modified participants' conscious rational conclusion about the climate themes embedded in the game (explicit attitudes), but not their unconscious spontaneous reaction to the topic (implicit attitude). Provoking and activating preliminary associative links between the displayed ideas and the overall critical environmental views kept in one's mind (shared responsibility, internal remorse, or social guilt regarding climate change) are necessary to modify the implicit aspect of attitudes (Gawronski and Bodenhausen, 2014). One possible explanation for these results could be that the duration of the experiment (35-40 minutes) contributed to this null finding as it is difficult to build new or activate old associative links in the recipients' minds if the exposure to the ideas is short-lived. The limited empirical evidence on implicit attitudes in a gameful context (e.g., a 10-minute (Alblas et al., 2018) or 50-minute game experiment (Kolek et al., 2021)) also did not impact the implicit aspect of attitudes. It could be proposed that this attitudinal aspect can be better studied in an experimental design with longer and/or repeated gameplay.

The results of the t-tests revealed Plasticity to have an overall effect on participants' short-term threat perception and cognitive attitudes as well as long-term positive eco-emotion. Thus, to recognise design contributions to the above-mentioned pro-environmental attitudes, further assessments were conducted to examine players' subjective experiences of game features (mechanics, narrative, and animation) and their specific elements. This study anticipated Plasticity's overall mechanics to not predict players' pro-environmental attitudes (E2-H2) while expecting the overall narrative (E2-H3) and animation (E2-H4)

design to positively predict pro-environmental attitudes. The analysis of Plasticity's feature-based design (mechanics, narrative, animation) showed that both the overall mechanics and narrative features contributed to predicting participants' perceived threat towards climate change immediately after playing the game, suggesting that participants' experiences of these two game features attributed to greater threat perceptions. These results strengthen the importance of interactive mechanics and persuasive narratives in creating an influential game, supporting studies around the proceduralism (Bogost, 2007; Antle et al., 2014) and narrative persuasion (Burrows and Blanton, 2016; Bilandzic and Busselle, 2012; Green, 2021) theories, as well as the integration of these theories through the COPE model.

The qualitative data echoed the same sentiment as the participants specified how Plasticity's execution of its environmental ideas through interaction with its gameplay (interactive mechanics) (Bogost, 2007) and portrayal of a climate-motivated plot (persuasive narrative) (Bril et al., 2018) intensified their apprehension of potential environmental disasters (their threat perception) in an engaging way. The emotive cues embedded in the narrative (e.g., the storyline around the mother's death from plastic pollution) or the game mechanics (e.g., using endangered animals as in-game challenge to provoke players) were among recurring factors that participants reported raised their awareness of climate threats through playing this game. In relation to game mechanics, I argue that even the faulty controller of this game may have contributed to a greater sense of threat towards the depicted environmental issue. Upon combining the quantitative results with the interviewees repeated mentions of how Plasticity's sluggish and defective control system deprived them of a sense of agency in the game world, I put forth this case that the sense of low control and agency in gameplay could be linked to the participants' higher sense of threat of the environmental issues depicted in the game. Therefore, in a thought-provoking way, this element could have contributed to the participants' explicit attitudes by constraining their agency and control in gameplay.

I also found the overall animation feature to be a significant predictor of cognitive attitudes, indicating that participants' immersive experiences via this design feature were linked to more positive pro-environmental cognitive attitudes. During the interviews, there were mentions of how the world and realism created by Plasticity amplified participants' understanding and perception of environmental issues, echoing how a gameful immersive animation feature can be a valuable aid in climate communication. A major theme derived from the qualitative data is in line with the importance of the animation feature in creating realities and focus on how eco-games can be valuable communication tools by replicating climate-impacted biospheres and futures. They can do this by creating authentic graphics and immersive acoustics in believable and relatable settings, engaging players in virtual microworlds (Egenfeldt-Nielsen et al., 2008). Providing a

risk-free platform to envision and experience different ecosystems and their situations makes games unique and powerful environmental mechanisms. The interviewees highlighted the significance of game elements that create an immersive animation feature, including the audiovisual aspect, which nurtures new connections between humans and the environment. This finding is noteworthy as immersive audiovisuals offer a trajectory for prompting new experiences. Entering the virtual 'audiovisual geographies' (Hawkins and Kanngieser, 2017) of games, players are presented with experiences that can change spatial-temporal dynamics and connections (Hawkins and Kanngieser, 2017), impacting the cognitive layer of attitudes as seen in Plasticity's example. Moreover, through worldbuilding, the social, psychological, and scientific realities of climate change can merge with the media content (Harris, 2020), building an aesthetic setting that can act as a connection cord between the virtual and the material world. Games' worldbuilding design can go beyond merely visualising a climate-changed planet as it provides a setting that players can inhabit and explore, growing cognitive and emotive views that target potential solutions. As evidenced by the qualitative findings, adding a customisation option reinforces the bridge between the virtual and the material world as embedding choices within a gameplay experience contributes to its relevance, advances its exploration chances, and augments interaction with the portrayed notions (Salen and Zimmerman, 2005; Stokes, 2012; Woolbright, 2017). This theme is in line with studies that consider games as the 'backbone' of communicating the gravity of the climate change (Crookall, 2013) and as a method for adapting to climate-riddled 'futures of scarcity' (Kelly and Nardi, 2014). It also follows the research that emphasise on games' capacity to envision and simulate systems and realities with numerous factors, choices and particular consequences associated with climate change (e.g., (Makai, 2023; Ouariachi et al., 2018b; Fernández Galeote and Hamari, 2021)). This finding encourages developers to improve their game's immersion qualities, specifically through elements that can provide enhanced eco-simulated realism of different environments and futures and connect the virtual world of games to the material world. This mission can be possible by creating immersive and authentic audiovisual prompts, believable and relatable world-building, and interesting exploration within gameful designs.

My findings on the animation and narrative features highlight the importance of these two design aspects when creating persuasive games, further supporting the idea that considering design aspects beyond interactivity (mechanics design) can be advantageous in uncovering persuasion formulation in a gameful environment (De la Hera et al., 2017; De La Hera and Raessens, 2021; Heide Smith and Norholm Just, 2009; Evans, 2011). Overall, while the findings partially confirmed all the hypotheses about Plasticity's design considerations (E2-H2, E2-H3, E2-H4), there were nuances that must be stated. Plasticity's overall mechanics feature only explained a part of the total pro-environmental attitudes (threat perception) in the participants (E2-H2). The game's overall narrative design

predicted threat perception as an aspect of the participants' pro-environmental attitudes (E2-H3) whereas the overall animation feature explained one part of the participants' pro-environmental attitudes (cognitive attitudes) (E2-H4). Moreover, the results around the feature-based design reinforce the utility of combining procedural rhetoric, narrative persuasion, and immersion theories in the development of the COPE model.

On a more detailed level, the analysis of the intervention's element-based design revealed that players' experiences of the game's storyline and the exploration design were significant predictors of participants' pro-environmental cognitive attitudes. Plasticity's storyline contains some less-familiar information about the severity of plastic pollution impacts on human health (micro-plastics in food), which could defy some optimistic and simplistic knowledge on the subject, expanding the learning and cognitive prospects for players. Also, this game takes advantage of humans' innate fascination for discovery and exploration by designing an environment that is filled with mystery and darkness. A puzzle that slowly unravels to show the true gravity of the environmental situation in the near future, building up to startling encounters with endangered wildlife and declining terrain. This finding is further supported by the qualitative data because one of the major themes found in the qualitative evidence revolved around how video games can work as reminders to increase environmental awareness by embedding theme-relevant curiosity cues and emotive stimuli in their design elements. Curiosity cues matter because by embedding new, intriguing, mysterious, or unexpected stimuli (e.g., settings, landscapes, collectable objects, or clues) they can make players **explore** different paths, options, solutions, or alternatives (Gómez Maureira and Rieffe, 2021; Gómez Maureira et al., 2019), strengthening their connection to the topic. For Plasticity, presenting some less-known details about microplastics in the food chain and their detrimental consequences was an intriguing stimulus that reportedly made participants more curious about the game's theme. Emotive cues also matter because one of the most important aspects of climate communication is the assimilation of humanitarian facets (e.g., hope, trust, awareness, social/cultural contexts) (Schiavo et al., 2022) into the central story. Inducing such emotions can result in either engagement or disengagement with the topic (Salama and Aboukoura, 2018). This theme complies with previous research that affirms the relevance of employing video games to strengthen the development of raising environmental awareness among players and focuses on their advantages to the learning procedure, such as refining cognitive abilities, attention, and incentive to absorb new subjects (Barcena-Vazquez et al., 2023; Bontchev et al., 2022; Bekoum Essokolo and Robinot, 2022; Fjællingsdal and Klöckner, 2019). Developers are encouraged to improve the explorability of their games by incorporating step-by-step clues, non-linear, branching paths and narratives, or unexpected and new stimuli. I also encourage game developers to create theme-relevant and persuasive narratives that have emotionally driven stories.

Navigating Plasticity's unique setting and story motivated participants to focus on the game and its pivotal topic. Wrapped in a loss-framed message, this design makes room for more curiosity-fueled gameplay, abounding in theme-related details, which are key to a persuasive and immersive exploration design. This result aligns with previous studies that connect digital gameplay to cognitive attitude regarding climate change (Topp et al., 2019; Janakiraman et al., 2018; Fernández Galeote et al., 2023b,a; Barreto et al., 2013). However, there is limited empirical evidence specifically associating gameful storyline and exploration elements with improvements in pro-environmental cognitive attitudes. Still, this result closely corresponds with previous research that emphasises the importance of considering design elements outside the proceduralism (mechanics) to reveal more contributing persuasive influences in a game environment (Heide Smith and Norholm Just, 2009; Evans, 2011; De la Hera et al., 2017; De La Hera and Raessens, 2021).

The analyses also found two potentially important elements, storyline and the challenge design, that were significant predictors of participants' perceived threat towards climate change. Plasticity tells the story of an eco-apocalyptic world in a personal and perceptible way (e.g., the death of the character's mother is attributed to plastic pollution within the food chain). Wrapped in a loss-framed theme, the story has the right details to carry the player into the near-future eco-doom, raise the urgency of the issue, and promote story-relevant views. The game also contains a balanced level of challenge that pushes the gameplay forward through puzzle-solving. Resolving the game's environmental challenges could enhance emotional engagement with the issue, arousing empathy and a sense of personal connection to the presented problem (Rigby and Ryan, 2007). As reinforced by the qualitative data, participants' greater threat perceptions after playing Plasticity can be credited to experiencing an enhanced puzzle-riddled story-driven game presented in a loss-framed setting. While this result is in line with previous studies that show the impact of digital games on enhancing participants' climate-related risk/threat perception (van Beek et al., 2022; Fox et al., 2020; Fleming et al., 2020), there is very limited empirical data specifically linking the gameful storyline and challenge design with perceived climate change threat. The connection between these two elements and threat perceptions also aligns with the risk-related framing effect literature (e.g., (O'Keefe and Jensen, 2008; Slater et al., 2002; Das et al., 2003; Hale et al., 1995; Kemper and Lazarus, 1992; Petty and Cacioppo, 1984)), which argues that apprehensive stories and challenges can increase communication and persuasion impacts. Also, some earlier research in risk studies focus on how cautionary tales can prevent dangers by activating fear and enhancing motivation to look for risk-reducing, subject-related information (O'Keefe and Jensen, 2008; Slater et al., 2002; Das et al., 2003; Hale et al., 1995; Kemper and Lazarus, 1992). Based on these results, this research argues that designing games that can draw more attention to risk-related challenges and story-led details that override simplistic common assumptions about an issue (Petty and Cacioppo, 1984) is critical to a game-based climate

communication's success.

Expanding the wisdom from risk-related framing effect literature to a gameful setting, the presented findings emphasise how well-devised design features and elements can yield fruitful implications and conceptual persuasive results. This notion becomes even more interesting when noticing that Plasticity was designed by a group of students with limited resources. The fact that even the two-dimensional exploration design element contributed to explaining explicit pro-environmental attitudes in players goes to show how creating an interesting and curiosity-driven setting merged with the topic-related themes can potentially help persuade and direct ideas in users. A possible explanation for these results is that the extension of the loss-framed theme of the game across these elements, coupled with players' experience of transportation into the storyline (Green, 2021), interaction with theme-pertinent challenges (Bogost, 2007; Ryan et al., 2006; Hamari et al., 2016), and immersion in the game's exploration opportunities (Wilcox-Netepczuk, 2013) made way for higher pro-environmental explicit attitudes. By combining the quantitative and qualitative data, it could be argued that a successful climate-themed game needs to provide an interactive, transportative, and immersive experience and build a bridge between the main theme (e.g., loss-framed message) and the gameplay elements to create the desired effect and influence pro-environmental attitudes.

On a related note, the exploratory analysis of the intervention's element-based design showed that Plasticity's concept/meaning and feedback design were significant predictors of participants' **long-term** positive eco-emotion. This result indicates that participants' experiences of this eco-game's meaningful ideas and feedback were durable, influencing participants' positive eco-emotions towards the topic of climate change three to five weeks after gameplay. This finding could be justified by how Plasticity invites its players to reflect on environmental concepts and how its feedback system relies on interacting with the problem and evaluating its consequences. The message framing (loss-framed with a potential hopeful ending) is mirrored in both the general concept/meaning of the game and its feedback design. As previously mentioned, the game's ending varies based on players' choices, which could be influenced by the interactive feedback and reflective concepts they were receiving during gameplay. Thus, it can be argued that the mixture of a loss-framed message with a hopeful ending reflected in the games' overall concept/meaning and left a lasting positive impact (long-term positive eco-emotion) in participants. Also, I argue that the feedback loop (observing optimistic results after completing eco-friendly tasks) had a durable positive impact (long-term positive eco-emotion) through transmitting agency to participants. These findings further highlight the importance of a continuous chain of action and reaction coupled with meaningful contemplation towards the ideas presented to create a persuasive and creative setting. The qualitative data emphasised incorporating meaningful choices in an eco gameplay as a way to personally engage play-

ers with problem-solving (Stokes, 2012), making a connection between the virtual and the material world's issues. In particular, making meaningful choices is met with some sort of gameful feedback, which in turn deepens players' interaction with the game (Salen and Zimmerman, 2005). Also, a choice-driven design reinforces game-based learning and persuasion (Tilvawala et al., 2019).

Finding evidence for Plasticity's long-term explicit attitude impact (positive eco-emotion) also has implications for the potential long-term effect of game design in an environmental context. This finding resonates with preceding studies that explored the capacity of digital games in building a range of emotions towards climate change (e.g., (Fernández Galeote and Hamari, 2021; Fernández Galeote et al., 2023b; Ouariachi et al., 2018b)). This result is also in line with the literature on eco-feedback design, which makes numerous references to the importance of invoking emotions (e.g., sympathy, compassion, or responsibility for the environment) to successfully impact users' pro-environmental attitudes/behaviours via technology-based (Froehlich et al., 2010; Rasamoelina et al., 2013; Chalal et al., 2020; Bao et al., 2016) and game-based interventions (Avolicino et al., 2022; Dillahunt et al., 2017; Chalal et al., 2022). Still, there is limited empirical evidence relating the long-term effect of gameful feedback or concept/meaning-making process to recipients' eco-emotions. The data indicate that producing a successful eco-game can be facilitated through meaningful and relevant concepts that can invoke more durable contemplation and reflection upon the presented ideas. Also, shaping the way players can interact with the game through a theme-pertinent engaging feedback system can enable game-based climate communication for a longer period of time.

Although there were also several design elements in Plasticity that did not individually contribute to players' attitudes, this indie game's overall performance in predicting pro-environmental attitudes is noteworthy. The results further highlight that framing environmental messages in a video game can have significant impacts on players' affect and mindset, as well as their eco-emotional attitude, threat perception, and cognitive attitude towards climate change. Also, taking subtleties of message framing strategies into account can influence the stretch of the message's impact. It is imperative to highlight that there is no secret formula to identifying the best elements and message-framing techniques in gameful interventions (Ouariachi et al., 2018b). That said, developing more nuanced climate-themed design elements by improving identifiable characters, immersive sonic and visual prompts, realistic virtual worlds, motivating goals, and easy-to-use controllers could add to the persuasiveness of video games as creative interactive climate communication tools.

## 7.3 Gameful Interventions Matter

Going through the findings from both experiments (Beyond Blue and Plasticity) suggests that embedding climate change messages in video games, regardless of the framing strategy, has the potential to impact the persuasiveness of this interactive medium in climate change communication and raise the player's pro-environmental attitudes towards the issue. Examining the strengths and limitations of the two presented gameful interventions (Beyond Blue and Plasticity) showed how eco-games could represent environmental risks by clearly portraying ecological issues, avoiding over-simplification, using framing in presenting their messages, and employing alarming prompts to highlight the upcoming climate threat. Literature suggests that openness and clarity in communication increase recipients' trust (Abunyewah et al., 2020) as well as their motivation and intent to act (Furner and Zinko, 2017).

While Beyond Blue employs a gain-frame messaging (using positive aspects of nature to show its significance), the participants believed that to preserve the environment, avoid the spread of pollution, and avert climate change, the game design needed to refocus on the detrimental environmental aspects. To them, although showing appreciation for the marine ecosystem and the connectivity of life was admirable in the game, highlighting the environmental issues was the sensible way of generating climate intent, environmental awareness, and ecological consciousness. On the other hand, Plasticity uses a multi-layered loss-framed (using the negative or adverse consequences of failing to preserve the Earth) message design with a potential hopeful ending. Participants found the message clear, comprehensible, and motivating. Generally, the literature suggests gain-framing to be a successful approach in the initial stages of prevention, whereas loss-framing has been deemed efficient in hazardous situations (Gray and Harrington, 2011; Gallagher and Updegraff, 2012). Admittedly, we are past the early phases of climate change. Therefore, it can be argued that a loss-framed approach can create more push for revisiting attitudes and lifestyles. The literature on employing fear-based communication to effectively impact attitudes/behaviours (Tannenbaum et al., 2015) supports this finding. However, oversimplification of complex issues could misinform and mislead the lay audience (Cook, 2020), causing them to incorrectly consider elementary and effortless resolutions for multifaceted environmental risks (Burrows et al., 2022). This finding is also in line with the literature on disaster risk reduction (DRR) awareness (e.g., (Solinska-Nowak et al., 2018; Shliakhovchuk, 2024; Gampell et al., 2020; Gampell and Gaillard, 2016; Gampell et al., 2017; Rumore et al., 2016)), which considers video games as positive tools to underpin messages about risk (including climate change) by diminishing denial and intensifying empathy in players. Game developers are encouraged to improve their theme and message design by clearly presenting the issue, refraining from over-simplifying the matter, framing a thought-provoking message, and incorporating alarming hints into the

gameplay.

The results of this project also captured how a balanced player experience can contribute to effective climate communication. The symmetry between moments of reflection and interactive opportunities with the game is important to having an engaging and meaningful engagement (Tondorf and Hounsell, 2023). This finding aligns with the research on gameplay interactions aimed towards directing players' attention and providing prospects for thought and reflection, powering the flow of players' experience (Daneels et al., 2021; Marsh, 2016, 2015; Ma, 2023). Also, balancing the hedonic (playability) and utilitarian (knowledge) aspects is key (Hamari and Keronen, 2017) to improve eco-games' quality as climate communication mediators. This result complies with previous research that considers blending the fun and playful qualities of games with learning and educational values (Caserman et al., 2020; Franzwa et al., 2013; Wernbacher et al., 2012; Anastasiadis et al., 2018) to benefit from their maximum capacity in an environmental context (Hamdan et al., 2023; Speth et al., 2018). Additionally, a harmonised theme or message that encompasses a balanced dose of optimism and pessimism about climate-related futures and situations can be vital to encouraging a healthy amount of fear-based action and hope-based solutions. This finding is in line with preceding research that asks climate-related interventions to go beyond positive/negative messages and incorporate prerequisites for constructive hope/optimism (e.g., clean energy, humanitarian advancement), together with constructive apprehension/pessimism (e.g., acknowledging the climate risk) in their approach (Marlon et al., 2019; Ojala, 2023; van Zomeren et al., 2019; Hornsey and Fielding, 2016). While negative emotions (such as fear representations) alone can be ineffective and counterproductive (O'Neill and Nicholson-Cole, 2009) in climate communication, mere use of positive emotion (such as hope) can be an insufficient influence for the collective motivation (van Zomeren et al., 2019). Negative emotions (fearful depictions of climate change) complement the equation by building relationships with mitigation motivation and sense of efficacy (Hornsey and Fielding, 2016). This body of research highlights that balance matters because false hope/optimism and bleak apprehension/pessimism could cause avoidance, estrangement, indecision, and procrastination in lay audiences (Marlon et al., 2019; Ojala, 2023; van Zomeren et al., 2019; Hornsey and Fielding, 2016).

Most importantly, my findings exhibit that to have a successful eco-game, all gameful elements should be mutually complementary (Tocci, 2008). To achieve this level of balance in an eco-game, the findings suggested that every element should be in harmony with the main theme (the environmental message) and revolve around strengthening its value and importance. Thus, developers are encouraged to increase their eco-game's interactivity by enhancing the mechanics feature (controls, feedback, goals, challenge) and focusing on choice-driven design to synchronise game interactions with reflection on the

environmental theme. I also urge designers to merge and adjust the educational properties of their eco-games with entertaining factors to create harmony between the hedonic and utilitarian aspects of eco-games. Additionally, game developers can benefit from balancing optimistic and pessimistic prompts in game-based climate communication. A well-balanced eco-game can be effective in illustrating and envisioning different ecological setups, environmental risks, and futuristic cautionary tales, as well as constructing a link between people and the environment. Hence, designers are advised to customise players' gameplay experience as customisation is an effective way of creating balance by taking different types of players' needs into account (Tondorf and Hounsell, 2023).

## 7.4 Limitations

It is important to mention some of the limitations in this research, not only to identify boundaries, but to make way for the progression of future works. COVID-19 restrictions in Australia during the data collection phase shifted the intended in-person experiments to online sessions. This change meant that participants became responsible for study preparation that would have ordinarily rested with the researchers, including ensuring access to fast and reliable internet, a computer compatible with the game, a keyboard for the questionnaires, and installing the Steam app, downloading and installing the assigned game, and having familiarity with and access to Zoom or Microsoft Teams to join the session. Moreover, the assigned game could only be played by a desktop or laptop computer with at least a Microsoft Windows 10 x64 system (Mac computers were not compatible with the game at the time). The experiment requirements (the time commitment, detailed preparatory steps, and multiple phases of the study such as the pre-test, post-test, and delayed post-test mentioned in the advertisements) delayed and impeded the data collection phase, making it challenging to recruit participants and have a larger sample size. The attrition during the delayed post-test could also be a result of the above-mentioned circumstances. Among the limitations of conducting an online experiment, compared to face-to-face experiments, I could point to potential technical problems (e.g., connectivity issues, software and hardware inconsistency among participants) and reduced engagement between researchers and participants. For the recruitment phase, one of the main limitations and concerns is sampling bias which could lead to the under-representation of people who do not have access to the internet and/or computing devices.

In the face of these restrictions, there were some notable benefits in conducting the research online, including having a more organic, real, and unaffected gameplay environment, which had a better reflection of the real world's technological and ambient conditions in the final results via using home-based devices (compared to the artificial

setting of a laboratory), and having a more geographically assorted sample who could access the experiment remotely. Also, it is worth mentioning that an online experiment is more flexible, convenient, and cost-efficient compared to a face-to-face experiment. Also, with minimal interaction in an online mode, the chances of researchers swaying the participants' opinions and views decrease, hence the experimenter bias reduces too.

In terms of research design, there are also a number of limitations that need to be discussed. Although the main questions of the study revolved around **how** and **which game features/elements** impact attitudes (and **not** whether the overall gameplay experience impacted attitudes), adding a control group could bring benefits to the research such as enabling me to attribute the observed attitude changes in the participants to the gameful interventions (and not other external factors). Also, despite including a set of explicit and implicit attitude tests as well as the PANAS test to make a comprehensive way of measuring different layers of attitude, the timing of the delayed post-test (3-5 weeks after the intervention) might not reflect sustained attitude impacts in the longer-term. To remedy this limitation, I advise future researchers to have follow-up tests at numerous time intervals to evaluate the longevity of gameful attitude impacts. Also, pre-tests can expose participants to the subject and aims of the research earlier than expected and unconsciously sway their responses. Although the implicit attitude test (IAT) was used to prevent such scenarios, still social desirability bias could have caused some interviewees to strategically modify their answers to sound more socially acceptable. Therefore, interview bias is another potential limitation. Additionally, in my research, I chose only two eco-games as interventions; one game from the high-budget and one game from the low-budget end of the climate-themed game industry. However, these two games are not representative of the wide spectrum ever-developing eco-game genre, which limits the generalisability of the results. Including a greater diversity of eco-games can help researchers encapsulate a more comprehensive grasp of their influence on pro-environmental attitudes.

In terms of the COPE model, I should mention that adding a realism (behavioural and graphical) scale to measure the animation feature can test the wider potential of this aspect of game design. As I have previously mentioned, the animation feature represents how games can convey realism and project player immersion. However, in measuring this feature, I only used the immersion, curiosity, and audiovisual appeal scales. Since creating a realistic and immersive experience is a multifaceted and complex topic, I call for more research on how to measure the animation feature more comprehensively to precisely assess and capture the concept of realism in games.

Another limitation was that, even with the attempts to circulate my study advertisements widely across Australia, the sample was biased in terms of educational level. Most participants were well-educated people from large cities in Australia, with more progressive

political views. Consequently, the small sample size and left-leaning sample make generalising the quantitative findings challenging. Future works will need to increase the number and represented group diversity (especially educationally, politically, and gender-wise) of their sample. Also, the small sample size limited the ability to detect small effects and subtle differences in attitudes pre- and post-gameplay. Moreover, the fact that my study did not detect any significant evidence for some of the individual game elements' potential on participants' attitudes could be related to my limited sample. In other words, my study was not high-powered enough to detect their effects and having more participants could detect more potential nuances in those elements. Although the small sample does not allow generalisability of the quantitative results, the in-depth qualitative evaluation of the intricacies of the design opportunities, recommendations, and limitations can be usefully shared for making future climate-themed simulation games.

## 7.5 Future Work

The presented findings can be used as evidence to how improving video game design can be an essential asset in provoking the public regarding pressing issues such as climate change. Studies on persuasive communication in climate-themed video games are important in promoting pro-environmental attitudes and climate change awareness. Video games have popularity and engagement power among different age-groups to address climate concerns (Wu and Lee, 2015). With the emergence of immersive interactive technologies, it is now feasible to depict alternative futures based on action and consequence of players and take advantage of virtually experiencing the outcomes of past and present generations' environmental decisions and actions. This project contributes to the use of interactive technology in climate change communication by identifying effective persuasive features/elements in video games. There is still further to go in designing games that can target different layers of attitudes (e.g., impacting implicit attitudes), but paying attention to theoretical processes and the link between message framing and design features/elements can help designers navigate these issues more easily. The Climate-Oriented Persuasive Edutainment (COPE) model combines the theory and design aspects necessary to influence players' attitudes towards a risk-related subject (e.g., climate change).

In terms of methodology, this study calls for more studies that focus on a combination of quantitative and qualitative methods to uncover the nuances of design towards directing pro-environmental attitudes. Also, scholars should broaden their studies to not only distinguish game design dimensions that are decisive factors in the process of persuasion, but control for player incentives to better interpret this process. What is the connection between the players and the game, and how do the contextual aspects play out in this development? Investigating various persuasive aspects of games, particularly

the player characteristics (De la Hera et al., 2017), motivational agents, and the circumstantial factors in which a game is designed and played (De Grove et al., 2011) will strengthen our understanding of persuasion processes within gameful settings. This approach can support game developers in creating more appealing games that let players make wiser decisions based on the depicted issue. Given the role of narrative in shaping players' attitudes as evidenced by the findings, I call for more research on narrative theory (specifically ecocriticism and climate fiction).

Moreover, there is a gap in the literature around how and to what extent commercial games can work in a persuasive and educational context without losing the element of entertainment. I further highlight the importance of exploring the potential of more widely recognised entertainment games, which could provide rich contexts for studying ecological themes in popular games that reach a wider audience and thus have greater potential for influence. More theoretical and empirical approaches need to focus on persuasive features and elemental design in digital games in environmental frames. I also call for additional studies on the mediating factors that can further explain the link between design factors and attitudes, and interpret the process of persuasion in gameful settings. Game researchers and developers can benefit from more empirical evidence on the long-term potential of persuasive games on players' pro-environmental attitudes using a mixture of implicit and explicit attitude measures, and varying the dose of intervention (e.g., longer gameplay sessions, repeated gameplay). While this thesis underscores the importance of interdisciplinary perspectives, future research would also benefit from considering broader philosophical and ideological questions surrounding climate change communication and further engagement with networked theories of game reception and production.

## 7.6 Conclusions

The motivation to start this project was to answer the call for research on transitioning towards more participatory creative strategies in climate communication and transforming it from being reactive to proactive (Yamori, 2011; Clerveaux et al., 2008). In shifting towards more participatory approaches in climate communication, one proposed solution is edutainment methods, which are creative measures (such as video games) that can increase empathy, involvement, and urgency of climate change and environmental preservation among people (Cordero et al., 2008; Flora et al., 2014; Woolbright, 2024) and demonstrate it as a personal matter with a concrete and imminent outlook (Senbel et al., 2014; Satchwell, 2013; Ojala, 2012). There is limited knowledge about game design potential and opportunities in influencing attitudes towards climate change.

My research made progress towards this goal by 1) conceptualising a model that described

gameful features/elements and processes involved in directing attitudes and 2) empirically examining how and to what extent two eco-games (Beyond Blue, a commercial simulation with central gain-frame environmental message, and Plasticity, an indie game with a central loss-frame environmental message) influenced pro-environmental attitudes on both explicit and implicit levels, both immediately after gameplay and with a delay. As attitudes are the prerequisites of behaviour (Bohner and Dickel, 2011), designing games that can decode more aspects of attitudes towards a sensitive topic such as environmental crisis can be a promising step in climate communication. The results of this project are applicable to video game and message design effects on players' attitudes, but they also contribute to general attitude studies. More studies need to concentrate on understanding how specific gameful elements can influence pro-environmental attitudes. The next chapter will explore the design implications drawn from the empirical results.

Chapter 8

# Design Implications

As a research project progresses, some queries get resolved and some new research questions arise along the way. In the case of my experiments, and after learning the quantitative and qualitative results to my original research questions, the first question that emerged in my mind was: what is the relevance of this information? And specifically, how can these findings be of use in a design context?

The nature of case study research, and the small sample in this project, do not afford the generalisability of the findings. However, I drew several design implications from this research. I used the quantitative findings and the qualitative statements where participants shared their experiences of the assigned games, as well as their opinions on how to improve them, to evaluate a combination of the two eco-games' strong and weak design points and develop a set of design recommendations to provide guidance for prospective game designers who want to target players' attitudes, specifically regarding critical topics such as environmental issues and climate change. In this approach, my objective was to identify how to improve different game elements of the COPE model to maximise the interactivity of the mechanics, the transportation of the storyline, the identifiability of the characters, the reflectiveness of the concept, the immersion capacity of the animation aspect, and the framing influence of the message design. More importantly, I outlined a set of design directives (coined as MICROGATES) as practical steps in grasping successful persuasive game design. MICROGATES encompass a range of detailed action-based design instructions for game-makers to follow. These detail-oriented sets of recommendations and directives focus on enlightening designers on how to embed persuasion into games.

## 8.1 Towards an Effective Mechanics Design

The COPE model describes game mechanics as a feature that can facilitate learning through interacting with the game world and investigating gameful ideas by making choices to reach specific goals (Bogost, 2007; Antle et al., 2014). Using the player experience literature, the model categorises the mechanics feature into four elements: the

controller, feedback, goal-setting, and challenge. Based on the quantitative results, both interventions' mechanics design related to an aspect of the explicit attitudes, as initially hypothesised. The overall mechanics feature of Beyond Blue significantly predicted pro-environmental cognitive attitudes, and the overall mechanics feature of Plasticity significantly predicted participants' climate-related threat perception. In terms of elements, both games' challenge designs were significant predictors of an aspect of these same explicit attitudes. While Beyond Blue had no long-term impact on participants' pro-environmental attitudes, Plasticity's feedback predicted participants' positive eco-emotion in the long-term.

The qualitative data of both studies (Beyond Blue and Plasticity) allowed me to delve into the criteria for each element to understand their strengths and weaknesses. For the controllers, having accessible button combinations, customisable button mapping, or even adding a multi-sensory input were among the notable suggestions to enhance the control system. In other words, participants expected to have controllers that were intuitive and easy to operate. These expectations align with the literature, which highlights these qualities as a way to optimise the interaction between players and the game (Crick, 2011; Rigby and Ryan, 2007). Goal-setting is a strategy to increase incentive, improve performance (Locke and Latham, 2006), and enhance the sense of self-efficacy (Ryan et al., 2006) through encouraging/discouraging tactics that can induce players' motivation and, in turn, provoke their attitude/behaviour (Locke and Latham, 2006). As a way of enhancing players' interactions with the eco-game, participants wanted clear and accessible goals that were relevant to the overall theme. There were also recurring suggestions to incorporate goals that encourage meaningful choices and collaboration (teamwork).

For feedback design, the qualitative data showed that participants favoured mechanisms that would help players with decision-making, risk assessment, or advancement tracking. Plasticity's quantitative results also showed its feedback system predicted players' long-term emotional response to climate change. Indeed, playing the game presents recurring examples of how Plasticity's clear and timely positive reinforcement (rewards) and negative reinforcement (penalty) moved the participants through the game (progression feedback). Also, the game's use of sounds/music for different situations or moods was a prominent aspect of its feedback system (acoustic feedback). Feedback in video games includes an extensive variety of mechanisms that cooperatively form how players can interact with the game (Rogers, 2017). Thus, there were notable suggestions to improve both games' feedback by adding textual feedback (text-based hints or clues, on-screen notifications, or charts), visual feedback (health status points, guiding maps, level indicators, progress bars, experience points), or even haptic feedback (activate controller vibration based on different situations or moods). Overall, my findings suggest that incorporating looped feedback and meaningful repercussions for player choices could

add perceived value to this element.

Challenges are vital fundamentals of gameplay that pertain to a task, problem, obstacle, or dilemma confronting the player (Ryan et al., 2006). To overcome a challenge, players need dexterity, tactic, skill, or resourcefulness. Successful game design balances the complexity of challenges to deliver a gratifying and enjoyable level of involvement and advancement (Csikszentmihalyi, 1990; Caserman et al., 2020). An overly straightforward or simple game results in a dull or disheartening experience; equally, an extremely demanding and difficult game could feel insurmountable and leave players annoyed and demotivated (Caserman et al., 2020; Crockett, 2016). The right balance between difficulty and ease in designing challenges could create a sense of enthusiasm, achievement, and development in players (Caserman et al., 2020; Crockett, 2016). The quantitative data showed that both games' challenge designs were meaningful elements in explaining an aspect of participants' explicit pro-environmental attitudes immediately after gameplay. In Beyond Blue, challenge was the only significant element of the game that related to participants' post-gameplay cognitive attitudes. In the interviews, Beyond Blue's participants underscored how the challenges of the game were consistent with the relaxing theme and in line with the overall message of the game. Players' interest in the environmental ideas of the game was associated with their viewpoint of how the level and design of the challenges fit their expectations of a game with this calming tone and theme. Meanwhile, in Plasticity, challenge design predicted threat perception. During the interviews, participants praised how the game used saving trapped and endangered animals as a gameplay challenge to make events relatable, underlining it as an effective way to communicate its message. From the combination of these findings, I argue that designers need to tailor challenges in concert with the game's theme to effectively communicate an eco-message. Thus, it is essential to provide contextualised and thematic challenges that contain a variety of meaningful choices, learning curves, difficulty waves, and repetition opportunities (to reinforce the central theme). The challenges of an eco-game can take various gameful forms (e.g., puzzle-focused, quest-focused, skill-focused, decision-focused, combined virtual-physical) and can be relevant to different environmental topics (e.g., supply administration, adaptation, risk evaluation, time-dependent situations). Additionally, a reiterative and collaborative set of eco-related challenges not only aids in emphasising the topic but can add further playful opportunities to the challenge design.

## 8.2 Towards an Effective Narrative Design

The COPE model describes the game narrative as a feature that covers the plot-related dimension in video games design and includes elements of storyline, characters, and concepts/meaning. As an interactive form of narrative, video games can influence players'

beliefs and attitudes with narrative-consistent ideas (Bril et al., 2018) by transporting players into the story (Transportation (Green and Brock, 2000; Green, 2021)), creating identifiable characters/avatars (Identification (Cohen, 2001; de Graaf et al., 2012; Chen and Koek, 2020)), and prompting players to reflect on the game's concept/meaning (Reflection (Hamby et al., 2018; Van Laer et al., 2014)) that in turn exposes players to the persuasive ideas embedded in the game (Graesser et al., 2009; Burrows and Blanton, 2016). Based on the quantitative findings, both interventions' narrative design explained an increase in one aspect of the explicit attitudes as primarily hypothesised. Beyond Blue's overall narrative feature was a significant predictor of participants' pro-environmental cognitive attitudes. However, none of the elements explained this pro-environmental attitude independently. For Plasticity, the overall narrative feature significantly predicted participants' climate-related threat perception. In terms of specific elements, Plasticity's storyline was the only element that predicted both threat perception and cognitive attitude and its concept/meaning was the only narrative element that explained the positive eco-emotion in the long-term.

The qualitative findings enabled me to assess the criteria needed in each element to reveal the games' strengths and limitations. For the storyline, this study drew from the participants' approvals and ideas to further improve this game element. One of the recurring requests was for eco-games to have a meaningful and relatable plot, as well as a consistent and easy-to-follow storytelling approach to engage players with the story. Also having a well-paced plot that honoured a rational, believable, and understandable narration with coherent and convincing changes in the story was important to transport the recipients into the narrative journey. Moreover, the participants wanted eco-games to have a thought-provoking plot relevant to the overall theme that would emotionally incite them to a certain degree, though not so much that they would feel manipulated, indicating the careful balance that game designers must negotiate when using emotional content. Another interesting aspect was the participants' emphasis on a type of story arc that not only highlights environmental problems, but presents answers and encourages thinking towards solutions. Besides, the participants' responses urged weaving storytelling devices such as moral dilemma, symbolism, or foreshadowing into the story. Other qualities that would reportedly draw the participants' attention and plunge them into the heart of the story were the existence of surprising developments, information-revealing moments, choice-driven/branching narration, and multiple ending opportunities that lead to an entertaining and memorable plot. Simply put, participants expected to have storylines that could optimise their transportation into the game and its environmental ideas. These suggestions are in line with the literature that uses stories to transport the audience into the narrative (Green and Brock, 2000; Green, 2021) and engage them (Bilandzic and Busselle, 2012) with ideas and opinions.

For character design, the literature states that identifying with the character opens opportunities to improve the player's sense of identity, control, and agency as well as a chance for self-insertion into the narrative and perspective-taking (Cohen, 2001). The findings showed that participants preferred characters with distinctive qualities with whom they could identify. Participants mentioned that having customisation opportunities that consider cultural/gender representation options and theme-pertinent roles/skills were very important aspects that could contribute to the value of the character. In terms of appearance, participants wanted the chance to build aesthetically pleasing avatars that could complement the theme and goal of the game (e.g., based on the role of the character). In terms of personality, they wanted their avatar to feel authentic with an empathetic backstory with whom they could share common ground. Having lifelike and fluid movements as well as fitting voice/dialogues were also reportedly imperative in building a connection with the avatar.

For developing the game concept and meaning-making properties, the focus should be on how to represent ideas (Hamby et al., 2017). The participants unravelled the importance of embracing universal motifs and shared human experiences that highlight the material-world relevance of the game ideas as a way of adding meaning to the content. Also, having consequential choices, contradicting normalised biases/stereotypes, presenting thought-provoking questions/dilemmas, and displaying confronting topics were encouraged as a way of facilitating critical thinking, introspection, and contemplation that could promote self-reflection and lead to re-evaluating attitudes or behaviours towards environmental ideas of the game.

## 8.3 Towards an Effective Animation Design

The C.O.P.E model uses the term 'animation' to address the design factors that can build an immersive and hypnotic experience that brings the game world to life (animate). Using the player experience literature, the model relates this feature to three prominent elements in game design: worldbuilding, exploration, and audiovisual design. The quantitative data showed that, contrary to the initial hypothesis, Beyond Blue's animation design did not have a meaningful influence on the participants. However, Plasticity's overall animation design related to an aspect of participants' pro-environmental explicit attitudes (**cognitive attitudes**) as primarily hypothesised. In terms of elements, Plasticity's exploration design was the only significant predictor of participants' pro-environmental **cognitive attitudes**.

The qualitative data focused on the weak and strong points of the elements experienced by the participants. In terms of animation elements, when speaking about world-building design for games, it is noteworthy to reference the 'cli-fi' genre (Svoboda, 2016; Tuhus-

Dubrow, 2013), where climate change is portrayed in the near-future. This genre shows the importance of creating potential futuristic worlds in the face of this ecological catastrophe. Cli-fi genre creates worlds that enable the audience to visualise the future and navigate the socio-political dynamics and ramifications of a climate change-ridden Earth (Svoboda, 2016; Tuhus-Dubrow, 2013). World-building also produces socio-culturally contingent understandings of possible worlds (Martin and Sneegas, 2020). While climate science speculates about potential futures, world-building can be an asset in picturing those environmental speculations and enacting different realities or catastrophic instances of climate change in gameful risk-free frames (Harris, 2020). For the world-building, given its broad definition, I identified a wide range of suggestions and expectations. First and foremost, the participants expected to see diversity (geography, people, culture, folklore, environment, social structures, etc.) in a realistic and immersive gameful world. They also believed that having logical systems/structures (social, economic, cultural, architectural, environmental, etc.), coherent laws/limitations (natural, physics, societal, judiciary, etc.) and different types of equipment/technologies, consistent with the overall theme, could help eco-games become more real and believable. Attention to detail such as incorporating credible and reasonable timeline, history, and chronology as well as having sensible and realistic non-player-character (NPC) behaviours were also recurring qualities mentioned by the participants that could help the credibility of the game world (Krcmar et al., 2011; Zendle et al., 2018). To build an immersive game world, another important aspect was shown to be interconnection, balance, and consistency among the game's overall elements. Overall, making connections between the virtual and the material world was considered a vital aspect of creating immersive and believable game worlds.

For exploration, designers use a range of gameful factors to invoke players' curiosity and sense of uncertainty to encourage them to navigate the game (Lazzaro, 2009; Wouters et al., 2011; Costikyan, 2013). The literature has associated curiosity with fun (Hunicke et al., 2004; Lazzaro, 2009) and seen it as a precursor of flow that can provide an immersive experience through knowledge-seeking behaviours, discovery incentives, and exploration (Garris et al., 2002; Jirout and Klahr, 2012). Exploration was a significant variable in this research as it was the only element of Plasticity's animation feature to explain pro-environmental cognitive attitudes. The participants' compliments and endorsements for improving gameful exploration focused on topic-related or theme-consistent novelty, ambiguity, and unpredictability to encourage exploration. Thus, they wanted new, mysterious, and surprising stimuli (settings, landscapes, collectable objects, or ideas). Other interesting points included adding information gaps (e.g., hide details, hide vital areas, hide items), using step-by-step clues (riddles or easter eggs), and developing non-linear pathways/experiences in the game.

For audiovisual design, participants proposed some detailed and informative suggestions

that are consistent with the literature that considers game graphics and acoustic design as a way of increasing gameful immersion, sense of realism, and emotional impact (De La Hera Conde-Pumpido, 2018; Evans, 2011; Kjeldsen, 2012; Collins, 2008). As suggestions to improve the graphics of the interventions and develop immersive eco-games, participants proposed elevating the games' textures and details, augmenting depth perception, applying high-quality lighting techniques, and using colour palettes that can evoke emotions and highlight important factors in the game. They also suggested realistic proportions and dimensions coupled with a complementary aesthetic style, relevant to the eco-theme. Paying attention to frame rates, physics simulation, and enhancing visuals was also considered key to creating engaging graphics. Interestingly, there were mentions of how Plasticity's design in balancing out the photo-realistic visuals and artistic choices was an important factor in creating immersive graphics for such a simple and less sophisticated game. For audio design, participants suggested adding realistic ambience, music, and background sound. There were also mentions of how applying event-appropriate volume levels, harmonising sonic and auditory effects, theme-relevant acoustic effects and spatial audio, and complementary scores and soundtracks can be necessary to create an immersive acoustic experience. On top of that, using authentic, representational, and engaging character voices were mentioned as a crucial addition to the audio design.

## 8.4 Towards an Effective Message Design

The COPE model considers message design and framing an integral part of climate communication that can even influence other design features (mechanics, narrative, animation). Messages of risk enable individuals to make informed choices, influencing lay audiences' vision and reaction towards various hazards (Renn, 2020). The literature has highlighted the use of creative, interactive, and recipient-focused approaches in conveying risk/climate messages (Covello and Allen, 1988; Covello and Sandman, 2001; Schroth et al., 2014; Walsh, 2015) such as story-based (Miller et al., 2015; Moezzi et al., 2017; Veland et al., 2018) and game-oriented tools (van Beek et al., 2022; Vervoort et al., 2022; Galeote et al., 2021; Rooney-Varga et al., 2018; Lee et al., 2013; Rooney-Varga et al., 2020; Rumore et al., 2016).

Understanding the message and its design matter as the clarity of communication can serve as a motivator for action, nurturing the recipients' need to efficiently use the presented knowledge (Bolkan et al., 2016; Furner and Zinko, 2017). The participants wanted eco-games that show the urgency of the environmental issues through credible sources, with accessible and inclusive messages. They pointed out message clarity as one of the most important aspects of what they expected to see in an eco-game. They wanted the environmental messages to be straightforward, honest, open, and well-defined, with

clear outside-world implications to build empathetic bonds. Further research suggests that conveying simple and clear risk-related information improves recipients' trust and their preparedness intentions (Curnin et al., 2015; Schrodt et al., 2009). Despite their emphasis on clarity, the participants did not want the message to include over-simplified ideas and solutions. For example, the majority of participants considered putting the climate change blame on individuals as a superficial and negligent strategy. They instead encouraged game narratives that shift towards a mixture of collective and administrative accountability towards environmental issues. This viewpoint mirrors recent discourse about locating the drivers of environmental issues at the system level, rather than attributing blame solely to individuals (Hormio, 2023; Voulvoulis et al., 2022; Ganguly et al., 2018). Moreover, they underscored action-approaching messages in empowering formats that were thoughtfully framed.

From a design viewpoint, the COPE model considers message framing a dominant feature that can influence the rest of the design features and impact the overall theme, tone, and the mood of the game as a whole experience, determining the overall effect of a game. Based on the quantitative results, both interventions increased participants' cognitive attitudes immediately after gameplay (short-term). Additionally, Plasticity's participants showed higher climate-related threat perception in the short-term and a significant increase in positive eco-emotion rating in the long-term. The qualitative data looked into the criteria for message framing, underscoring the strong and weak points of this element. In exploring message framing, although the selected interventions had a gain-frame (Beyond Blue) versus loss-frame (Plasticity) messaging technique, the participants' opinions of an effective eco-game frame incorporated aspects beyond the gain-loss framing. For example, the participants mentioned that framing eco-messages based on specific cultural interests, values, and identities could make messages engaging and persuasive. They also believed that focusing on local and community-based needs can draw specific groups' attentions. The literature also shows that environmental framing is most effective when focusing on present matters, local capacities, and cultural values, as people prefer to prioritise their understanding of immediate time, and localised standards (Degeling and Koolen, 2022; Jarreau et al., 2017). They also asked for a balance between optimism and pessimism and a balance between scientific and emotional contents for framing environmental messages. Other interesting suggestions included time-sensitive and solution-focused framing that could capture the necessity of action-oriented approaches and underscore the urgency of the climate issue. These design endorsements echo the preceding studies that considered problem-focused frames as a strategy to generate a sense of urgency for tackling environmental threats and saw solution-focused frames as a way to push the importance of pro-environmental views and lifestyles (Baden, 2019; Jarreau et al., 2017; Sheppard, 2012).

## 8.5 Introducing MICROGATES Design Directives

Persuasion studies emphasises two different layers of persuasion to define various levels at which persuasive methods are applied (Fogg et al., 2007). First, **macro persuasion** focuses on large-scale approaches that form the overall user experience and engagement (Fogg et al., 2007). Second, **micro persuasion** functions at a lower level via specific prompts and patterns to influence users' actions and decisions (Fogg et al., 2007). Speaking from a persuasive angle, the steps the COPE model presents are macro strategies for changing attitudes. This model explains how implanting message framing as the umbrella design aspect sets the overall tone of the game experience and determines the effectiveness of the theme presentation. The COPE model also explains the relevance of three main design features (mechanics, narrative, animation) and their elements, interpreting how they can be tied to attitudes through building an experience that is **interactive** (via game mechanics: controller, goals, feedback, challenge), **transportative** (via game narrative: storyline), **identifiable** (via game narrative: character design), **reflective** (via game narrative: concept/meaning), and **immersive** (via game animation: worldbuilding, exploration, audiovisual design). Simply put, this model provides the big picture for successful persuasive design for critical issues and does not provide specified action-based design instructions for game-makers to follow.

Hence, the next critical phase was finding more practical steps to achieve effective persuasive game design. Thus, I aimed to outline the detailed directions needed to complement the big picture and fulfil the persuasive objectives. To do so, I first reviewed the persuasion literature, specifically Fogg's persuasive technological tools/strategies (Fogg, 1998, 2003b; Fogg et al., 2007) and Cialdini's principles of persuasion/influence (Cialdini, 2001, 2007, 2009), which have been extensively established and validated in various fields. Fogg developed several key technological tools/strategies that could make the process of persuasion simple (**reduction** technology), step-by-step (**tunnelling** technology) personalised and pertinent (**tailoring** technology), opportune (**suggestion** technology), clear (**self-monitoring** and **surveillance** technology), and rewarding (**conditioning** technology) (Fogg, 2003c). Cialdini also outlined several persuasive and influential principles, including **reciprocity** (the sense of obligation to repay favours), **consistency** (the endeavour to remain consistent with one's active, public, and voluntary commitments), **social proof** (the urge to follow counterparts'/peers' actions or cases), **authority** (the urge to obey authoritative and capable figures), **liking** (the drive to follow likeable figures), **scarcity** (the desire for unique and exclusive information/items/situations), and **unity** (the sense of belonging and identity implanted in the target audience through uniting them with the persuader or the presented idea) (Cialdini, 2001, 2007, 2009).

Next, I revisited my data and realised that some of the insights and concepts outlined in my results can be synthesised with the strategies/principles recorded by Fogg and Cial-

dini to establish a set of design directives adaptable to persuasive gameplay. So, I cross-referenced these insights/concepts with Fogg's persuasive technological tools/strategies (Fogg, 1998, 2003b; Fogg et al., 2007) and Cialdini's principles of influence (Cialdini, 2001, 2007, 2009) and mapped the insights/concepts to the related strategies/principles accordingly, ensuring that each step in the design directives corresponded with these established persuasive approaches. Next, I combined the overlaying insights/concepts and formed action-oriented and relevant steps to game design. I repeated the procedure of refining and validating with the related literature and my data until ten steps that cover the crucial facets of persuasive gameplay were identified. The proposed set of design directives includes manifesting identity, integrating triggers, contextualising the experience, reiterating the idea, optimising the playability, guiding the path, applying patterns, transmitting agency, establishing urgency, and setting up parallels (see tables8.1, 8.2, and 8.3). The first letter of the proposed steps were combined to coin the term **MICROGATES**. Next, I will explain each step and present examples of how they can be applied to gameful elements.

**Table 8.1**: Mapping MICROGATES design directives.

| **MICROGATES Design Directives** | **Fogg's Persuasive Strategies** | **Cialdini's Principles of Influence** |
|---|---|---|
| Manifest identity | Tailoring + Self-monitoring | Unity |
| Integrate triggers | Suggestion | Social proof + Consistency |
| Contextualise the experience | Tailoring + Tunnelling | Consistency |
| Reiterate the idea | Conditioning + Self-monitoring | Consistency + Scarcity |
| Optimise the playability | Reduction + Tailoring | Liking + Social Proof + Consistency |
| Guide the path | Tunneling + Suggestion | Authority + Social Proof |
| Apply patterns | Conditioning + Self-monitoring | Consistency + Reciprocity |
| Transmit agency | Tailoring + Suggestion | Consistency |
| Establish urgency | Suggestion + Conditioning + Self-Monitoring | Scarcity + Authority |
| Setup parallels | Tailoring + Suggestion | Social Proof + Liking |

**Table 8.2**: MICROGATES design directives

| MICROGATES Design Directives | Definition | Example of Implementation |
|---|---|---|
| **Manifest identity** | Aligning games with players' identities to enhance personal bonds with the game, self-manifestation, and meaningful contributions. | Creating customisation opportunities to reflect the player's preferences and identities. Setting goals that align with players' choices and personal values |
| **Integrate triggers** | Embedding an event, case, signal, or mechanism in the game that can stimulate players and initiate a chain of actions and reactions. | Hints or prompts that direct players towards goals. Environmental feedback and clues that steer exploration. Emphasising other players'/characters' popular actions and decisions as examples and hints. |
| **Contextualise the experience** | Situating an idea, message, or issue in a suitable context to improve the interpretation, relevance, and meaning of gameful ideas | Having branching narratives, customisable characters, different difficulty levels, or modifiable environments in response to the player's choices, interests, progression quality, and preferences. |
| **Reiterate the idea** | Repetition is a strategic approach to augment player understanding, engagement, enjoyment, and overall experience | Developing multiple plots that repeatedly mention the significance of an idea in different ways. Each mission, challenge, or quest could tackle a different aspect of the idea. Reiterate ideas through non-player characters' (NPC) dialogues and actions. |
| **Optimise the playability** | Packaging a complex process into an intuitive, immersive, playful, and enjoyable procedure | A smooth and responsive control system. High-quality voice acting and cut scenes. Increasing the playful component of tasks and challenges to enhance players' fun and satisfaction. |
| **Guide the path** | Providing players with step-by-step directions towards an intended plan through a set of activities or occasions. | Quest-based guidance, progress bars, in-game metrics, rewards, or milestone unlocks to keep players focused on goals and gradually guide them towards them. |

**Table 8.3**: MICROGATES design directives

| MICROGATES Design Directives | Definition | Example of Implementation |
|---|---|---|
| **Apply patterns** | Training the mind and body through procedures and routines to internalise new views/values and practice them regularly. | Integrating recurring (yet diverse) gameful tasks and challenges. Presenting narratives that promote solution-driven, action-oriented strategies and a curious character that invites exploration and adventure. Reinforcing ideas and practising new routines via mini-games incorporated throughout the game. Incorporating side stories and different character interactions into tasks to add new conversations and narrative pathways. |
| **Transmit agency** | Agency represents having control and autonomy over a situation that can instil motivation and a sense of freedom. | Designing an intuitive controller, proper game challenges (in line with players' skill levels), moral dilemmas/choices/consequences, customised exploration options/routes and characters, choice-driven goals or narrative evolution to give players freedom and boost their sense of agency. |
| **Establish urgency** | Changing the status quo by provoking a sense of apprehension and anxiety through push strategies, cautionary tales, and fear prompts. | The game world should react evidently and appropriately to players' delayed actions or negative decisions. Having side characters and NPCs that engage players' attention to the urgency of issues through occasional and timely dialogues. Incorporating goals that show the outside world's environmental deadlines and time frames. Using time-sensitive plots where immediate actions are required. |
| **Set up parallels** | Building similarities between items/situations in the game world and the material world to make them relatable, empathetic, and understandable. | Embedding universal motifs and shared human experiences in gameful content to emphasise the physical-world relevance of a message. Using historical records as a game device (storyline and challenge design inspirations). Creating appearance similarities in the overall worldbuilding (gameplay locations/wildlife/cultures). |

### 8.5.1 Manifest identity

Aligning games with players' identities (who they are and who they aspire to become) creates design opportunities that can represent players' personal and social experiences (Heath and Heath, 2010). In the qualitative results (themes), the participants' emphasis on identity was evident in both building reality connection cords between the virtual and the material world and incorporating identities as emotive cues to increase climate awareness. They highlighted the importance of weaving identities into a gameplay experience to add to eco-games' persuasive capacity. The persuasion literature supports this finding as Cialdini's principle of **unity** (Cialdini, 2007, 2009) also underlines the role of belonging and shared identity as an effective persuasive method. Cialdini believes that building intrinsic bonds and creating a sense of unity make it easier to approach and influence people (Cialdini, 2007, 2009). Fogg's **self-monitoring** is also a persuasive strategy that focuses on offering players ways to track their development and reflect on their personal achievements and goals to create or reinforce identities (Fogg, 2003a). **Tailoring** is another strategy that entails customising and personalising the game experience as a persuasive way to mirror players' individuality and preferences, reflecting their identity in a virtual setting (Fogg, 2003a). For example, character/environment customisation is a way of incorporating a part of the player into the game and make deeper bonds with its world. In this way, identifying with the character and the environment opens opportunities to improve the players' sense of identity, try on other identities, and have a chance for self-insertion into the narrative and perspective-taking (Cohen, 2001).

Manifesting identity in game design can be a crucial factor in conveying environmental ideas because game characters can symbolise and reflect the human facets of climate change (Fernández Galeote et al., 2022; Ouariachi et al., 2018b). Identity is a crucial part of climate communication that builds on individual attachments and affections (Milfont et al., 2020; Schmitt et al., 2019). Therefore, in an eco-game, it is vital to design characters with unique traits, incentives, inspirations and trajectories tied to nature advocacy with whom players could establish sentimental bonds and personal/social connections. For example, having characters with backgrounds, occupations, and characteristics tied to environmentalism (a park ranger with great ties to sustainable practices and preserving natural resources or a former Petroleum company owner who now invests in sustainable projects and looks for green energy). I argue that choosing characters, tasks, objectives, or story arcs that embody environmental stewardship and encourage players to see themselves as an integral part of climate communication is a persuasive way of tying games to players' identities. Another way of playing with identities is to create customisable avatars to increase the personal connection between players and their chosen characters. For instance, the incorporation of cultural icons, clothing, and relics in the game's story, visuals, or character design (Indigenous tattoos of waves, rivers, or trees). Also, mak-

ing personalised narratives with meaningful choices and branching stories that change based on players' decisions and in response to their consequences (e.g., choosing to do eco-friendly tasks such as saving an animal, having organic produce, or conserving water with short or long-term consequences to the game's world or NPC behaviours) can help to shape players' values and identities. Moreover, a thought-provoking approach is to assign non-human identities to players to provide empathetic and role-swapping opportunities to them (Woolbright, 2017).

Goal-setting is another element that can be tied to identity formation in games. Goals often involve personal and social factors, nurturing a sense of belonging and identity (Pilarska, 2020; Dominick and Cole, 2020). Designers can set goals that appeal to players' personalities (based on the character they have chosen or the audience's expectations) and serve as a gateway to express, expand, and endorse their values, interests, self-perception, and social image. Additionally, challenge design can be linked to identity development in players as overcoming challenges builds a growth mindset that can further foster self-awareness and personality development (Dweck and Leggett, 1988; Yeager and Dweck, 2020). For example, in an eco-game, the character can show personal growth after accomplishing environmental challenges that are compatible with the player's selected identity (e.g., if the player selects an environmental lawyer, the related tasks/challenges are advocating for clean technology and fighting oil companies). Moreover, by integrating personalised and localised matters (e.g., environmental issues) into game world-building, designers can target players' personal connections and identities to geographies, problems, potential solutions, and opportunities. For example, by having multiple game locations under climate-related calamities (e.g., bushfire, drought, flood, air pollution), players can choose the regions they are more interested in and feel more personally attached to (e,g., an ancestral land). Some more eco-examples in this regard are the inclusion of worldbuilding or exploration opportunities that showcase how different communities are impacted by and reacting to climate-related events. Another eco-example of this step is having interrelated storylines and gameful challenges that focus on localised environmental problems, highlighting their diverse mitigation or adaptation strategies and worldwide collaboration to overcome climate change. These strategies can evoke players' emotions and appeal to the different layers of their identities (e.g., cultural, racial, local, social, or personal).

### 8.5.2 Integrate triggers

A trigger pertains to an event, case, signal, or mechanism in the game that can stimulate players and initiate a chain of actions and reactions, generating dynamic and engaging gameplay (Sales et al., 2013). Both qualitative and quantitative findings emphasised using different types of gameful triggers, prompts, or feedback to influence players. From

a persuasion angle, Cialdini's principle of **consistency** is in line with this finding as it highlights the role of consistent challenges and consequences as persuasive hints and prompts. Also, the principle of **social proof** can be connected to this step as it explains how triggering players by showing other players'/ characters' choices and actions and making comparisons can influence people (Cialdini, 2009, 2007). Fogg's **suggestion** technology (Fogg, 2003a) can relate to embedding triggers and stimuli at the right time to influence users. Inspired by the ancient Greek concept of 'kairos', which means realising the appropriate timing to put forward one's idea (Kinneavy and Catherine R. Eskin, 2000), Fogg developed suggestion technology as a persuasive tool, stating that, when designing a computer-based persuasive technology, if a suggestion is made at an opportune time, it can hold persuasive abilities over recipients by making them think critically (Fogg, 2003a). In a video game, suggestions can come in the form of opportune triggers.

In search of what opportune moments constitute, researchers have found that people are more receptive to persuasive techniques and more willing to adopt new opinions and ideas when they are in an optimistic state of mind (Griskevicius et al., 2010; Hamby and Jones, 2022), in moments of doubt and uncertainty (van Horen et al., 2023; Tormala, 2016), their views have been disputed (Whitaker et al., 2022; Carpenter, 2019) (e.g., by new evidence), or they feel duty-bound (e.g., because of a favour (Cialdini, 2001, 2009; Guadagno et al., 2024)). The key is to choose opportune moments and appropriate prompts that do not disrupt the gameplay experience. Therefore, it is important to integrate triggers within different game elements (e.g., the game's world, story, character, goals, or challenges). In a gameful design, integrating triggers in the form of feedback, dialogue, narrative concepts, or audiovisual prompts can suggest directions, ideas, or solutions at an opportune time to persuade players to change their attitudes about a certain topic.

Some eco-examples for this persuasive step include sending timely and related reminders, announcements, or warnings for undertaking/not undertaking eco-related tasks. More specifically, the game can track the player's unfinished eco-tasks and send subtle prompts, visual markers, or hints reminding them of their benefits (these reminders can be in the form of notifications or other characters' dialogues and NPC reactions). After finishing a task, the game can suggest more eco-friendly tasks (in the form of setting goals or challenges). In this persuasive step, It is important to make each trigger as clear, specific, and well-defined as possible to reach the desired eco-objectives.

### 8.5.3 Contextualise the experience

Contextualising pertains to the process of situating an idea, message, or issue in a suitable context to improve interpretation, relevance, and meaning (Jenkins Ichikawa, 2017). The qualitative data showed that having a believable and relatable game world that highlights the connection between different elements of the game as well as framing the ideas in a

way that can make sense to players are important. The persuasive literature echoes the same sentiment. Using **tailoring** from Fogg's persuasive tools (Fogg, 2003a) can aid players in customising and personalising the context of their gameplay, adding to its relevance, which is one of the most prominent variables in augmenting the persuasiveness of systems (Orji et al., 2019b). However, contextualising is a persuasive concept that goes beyond tailoring (Fogg, 2003a). While tailoring considers the personal relevance to the user (player), contextualising refers to a broader setting, conditions, and factors that influence the user experience (Fogg, 2003a). Hence, Fogg's **tunnelling** technology (Fogg, 2003a) can also add to a gameplay context by helping direct players through a more credible and relatable setting. Additionally, Cialdini's principle of **consistency** (Cialdini, 2007, 2009) aligns with contextualising a gameful experience as creating context through meaningful choices and consistent consequences can help build an engaging and credible virtual world.

Contextualising a video game involves outlining the message and orienting the game elements based on the context in which the game will be played, including its local, global, personal, and shared relevance or cultural, social, situational, and economic factors. Thus, contextualising can be shown as customisation options or message-framing techniques used in game design. In creating a contextualised gameful experience, framing is essential because it is a way to show how the same information can have different impressions on the audience depending on how it is portrayed (Tversky and Kahneman, 1986; Gallagher and Updegraff, 2012). In a gameful design, embedding contextualised goals or challenges that are in harmony with the overall theme of the game (e.g., saving trapped and endangered animals) and in line with players' skills and expectations can influence views and attitudes (as in the case of Beyond Blue shown in Experiment 1). Also, having branching narratives or customisable characters that give players a range of options (e.g., cultural/gender representation options and theme-pertinent roles/skills) can have a persuasive effect on players. Contextualising gameful elements provides a variety of critical options, meaningful decision-makings, rehearsal chances, learning curves, and difficulty levels that are suitable for unravelling critical issues such as climate change. Designers can employ this persuasive step by developing a diverse set of gameful situations and accordingly adapting the game's goals, challenges, story arcs, and exploration paths to the current condition of the player. This way, the game elements can contain contextual information and content relevant to the player's present situation. An example is designing modifiable environments in response to the player's decisions and actions. For instance, if a player collects trash as an eco-task, the game environment should reflect this decision and become cleaner and brighter. Designers should embed player-focused prompts that have been tailored based on the player's choices, interests, progression, and preferences. For example, if a player concentrates on recycling activities, the game should provide more opportunities to navigate this eco-interest by creating more missions, chal-

lenges, goals, or character engagements with this topic. Also, the game should present multiple environmental tasks and pathways, while providing instruments and resources for each approach. This way, players can have a contextualised experience by prioritising tasks based on their evaluation of the region's demands or their chosen strategies.

### 8.5.4 Reiterate the idea

Repeating an idea in a game is a strategic approach to augment player understanding, engagement, enjoyment, and overall experience (Hanson, 2014; Lozano, 2018). The qualitative findings highlighted how repeating prompts and clues (e.g., alarming hints, curiosity cues) within the game can push players towards the game's main themes and ideas. Also, I discussed how repetitive gameplay could potentially improve the gameplay effects on attitudes (specifically the null results around the long-term effects (in Beyond Blue) and implicit attitudes (in both Plasticity and Beyond Blue). By meticulously embedding messages within different elements and timelines of the game, designers can substantially influence players' views and attitudes by improving abilities such as memory retention, skill learning, and routine reinforcement (Schimanke et al., 2017, 2014; Martí-Parreño et al., 2017). In mapping the persuasion literature to this concept, Cialdini's principle of **consistency** (Cialdini, 2007, 2009) can offer the importance of recurring gameful ideas to reinforce the main message and make users commit to the theme. Also, the principle of **scarcity** (Cialdini, 2007, 2009) can relate to how employing exclusive and time-critical tasks, challenges, rewards, or events can enhance repeated player engagement. Fogg's **conditioning** technology (Fogg, 2003a) is another persuasive strategy that can align with the step of reiterating the ideas by offering recurrent activities to reinforce the intended designers' ideas. Moreover, Fogg's **self-monitoring** (Fogg, 2003a) is another persuasive strategy that encourages players to keep interacting with repeated ventures by allowing them to track their development and feats over time.

I argue that, in a climate-themed design, a reiterative set of eco-related challenges not only aids in emphasising the topic but can add further playful opportunities to the challenge design. Also, repeating ideas in a gameful setting in different formats and times can help players contemplate and reflect on the presented topics and re-evaluate their views and ideas. Some eco-examples for this persuasive step include developing multiple plots that repeatedly mention the significance of sustainable lifestyles in different ways (each mission, challenge, or quest could tackle a different environmental task, including loss of biodiversity, ocean health, overpopulation, energy use, pollution). Also, having recurring characters with sustainable motivations can help to reiterate environmental ideas through their dialogues and actions. Other types of elements such as audiovisual cues, informational feedback, or gameful goals can be used to continuously reinforce the game's central eco-message. Designers should embed environmental ideas within a range of elements for

recurring and increased lasting effects. Every quest, goal, dialogue, location, and character interaction should highlight and reiterate a **balanced dose** of the significance of climate change in an inherent way. Video games' prearranged and regulated environments can provide effective climate-related situations and scenarios, where it is easy to repeat rounds and mistakes, making understanding complex ideas easier (Toh and Kirschner, 2020; Tussyadiah et al., 2018; Baranowski et al., 2008), affecting theme-relevant beliefs and views (De La Hera and Conde-Pumpido, 2013; De La Hera and Raessens, 2021). However, this step should be implemented with cautious and the understanding that too much emphasis and repetition can lead to the audience frustration with the topic.

### 8.5.5 Optimise the playability

Playability has been defined as a design attribute that adds to a game's functionality, usability, and gameplay (Paavilainen, 2020) Optimising a game's playability is a way of packaging a complex process into an intuitive, unobtrusive, immersive and enjoyable procedure (Korhonen, 2016) and help players feel effective and competent in fulfilling the gameful tasks and achieving the specified goals (Sánchez et al., 2012). Being in a playful state matters because it helps us to deal with tricky situations (Kelly and Nardi, 2014). Optimising the playability increases players' intentions and motivations by making the game experience more engaging, entertaining, and accessible (Sánchez et al., 2012). The qualitative and quantitative findings underlined how paying attention to maintaining certain qualities, such as an intuitive and easy-to-use controller, or fluid movements in characters, is key to optimising gameplay. The qualitative data also revealed that having a balance between the playability aspect and the knowledge aspect of the game could convey critical messages such as environmental ideas more flexibly, making it easier to accept and implement to the daily tasks. Also, cohesive and believable stories that would optimise players' transportation into the game, balanced-out and theme-pertinent goals/challenges, appealing audiovisuals, or adventurous exploration opportunities were considered important design points that could optimise game playability.

The persuasive literature supports this concept as Fogg's **reduction** strategy (Fogg, 2003a) emphasises simplifying procedures to facilitate an experience, making the transmission of ideas smoother. This strategy can be specifically translated to a game control system, emphasising how an easy-to-use and intuitive controller can optimise the gameplay. Fogg's **tailoring** strategy (Fogg, 2003a) also revolves around the power of customising the gameful experience to make it more playful and entertaining. On the same note, Cialdini's principle of **liking** can be translated to this step as it also focuses on how making an enjoyable and appealing experience can influence people (Cialdini, 2009, 2007). The **social proof** principle underpins how showing peer achievements and popular features can motivate further engagement (Cialdini, 2009, 2007). Also, the **con-**

**sistency** principle centres on how having consistency and balance can make an experience fluent, improving recipients' engagement and links to the presented ideas (Cialdini, 2009, 2007).

In translating these notions into games and eco-design, I can refer to how improving the graphics makes a game more likeable and guarantees a smooth exploration experience in the flora and fauna environment (e.g., a jungle, ocean, desert), helping to engage the player with nature. Also, how players' eco-activities can be more natural, fluid, and rewarding with a smooth and responsive control system. High-quality voice acting and cut scenes can also make the eco-message more engaging. Moreover, increasing the playful component of tasks and challenges can enhance players' fun and satisfaction.

### 8.5.6 Guide the path

Guiding the game's path can lead players to the designer's intended plan by directing them through a set of activities or occasions. In persuasion literature, Fogg's **tunnelling** strategy (Fogg, 2003a) can be translated to this concept in game design by focusing on a series of well-defined, clear, and consecutive paths (e.g., via storylines, characters, goals) that can push players towards the prearranged directions. This step is a kind of guided gradual persuasion that involves leading users to reach a planned conclusion through an organised process (Fogg, 2003c). In this approach, designers split the persuasion process into feasible steps and focus on the journey to convey their ideas by decreasing users' resistance to the main idea (Fogg, 2003a). This step can also be related to Fogg's **suggestion** strategy as in this approach, providing implications and tips is a persuasive way of swaying users towards appropriate actions, decisions, and paths. Moreover, this step can relate to Cialdini's principles of **authority** and **social proof** (Cialdini, 2009, 2007) as providing authoritative direction/supervision (e.g., via a character) and peer-focused comparisons (e.g., via goals or exploration paths) can influence players. This step values the players' autonomy and freedom of choice and persuades them by encouraging the navigation of the game world. While the qualitative data implied the importance of having curiosity cues throughout the game to lead the way, the quantitative evidence from Experiment 2 (Plasticity) showed the benefits of a curiosity-filled exploration design on cognitive attitudes and the significant and long-term persuasive effect of feedback design on players.

I argue that, in a gameful setting, various elements can aid in subtly directing players towards pre-arranged actions and decisions. For example, this strategy can be conveyed through elements such as feedback, goal-setting, storyline, or exploration design. In an eco-design following this step, the game should start with basic eco-tasks and then as players progress, the environmental issues and their potential solutions should get more complicated, requiring more sophisticated approaches and activities. Some eco-

examples for this persuasive step include the incorporation of quest-based guidance, which includes setting an eco-goal and then providing step-by-step directions on how to move towards that environmental task. Progress bars, in-game metrics, rewards, or milestone unlocks are ways to keep players focused on goals and guide them towards attaining them. In a scenario where the goal is to clean an area of the landscape from waste, the game should introduce and provide specific gear and tools for different kinds of litter, guiding players through the sanitation and cleaning procedure with tutorials, visual indicators, and instructions in small stages. Also, using nudges is another way to steer the player. For instance, if the player makes a wrong eco-decision, the game's visuals should reflect subtle or evident impacts (depending on the level of the wrongdoing) on the environment. Another example is using NPCs or in-game characters (e.g., an expert or even an animal that is integral to the environment or might be at risk of extinction or losing its natural habitat) to provide insight, knowledge, and guidance, driving players toward environmentally-friendly choices.

### 8.5.7 Apply patterns

Applying patterns is a way of training the mind and body through procedures and routines (Lazaric, 2000). The participants emphasised the importance of interactivity in video games and their intrinsic capacity to let players have first-hand experiments with ideas and developing routines. The qualitative data underlined how a balance between reflective and interactive aspects of games could create opportunities for practising patterns and implementing routines. Our mind ranks experiential training and practical learning higher than theoretical learning (van der Linden et al., 2015). Therefore, setting up practical procedures and routines in a gameful situation can empower individuals to internalise new ideas and adopt new views and attitudes (Oinas-Kukkonen and Harjumaa, 2009). Relating these concepts to the persuasion literature brings Cialdini's **reciprocity** and **consistency** principles to mind as these two persuasive approaches consider establishing a systematic pattern and consistent commitments as effective ways of influencing the audience (Cialdini, 2009, 2007). Also, Fogg's **conditioning** and **self-monitoring** strategies can be related to this step by establishing routines and tracking one's progress (Fogg, 2003a), strengthening players' patterns and continuous engagement in an experiential setting.

In an ecological context, this step matters because gameplay can provide an experiential platform to illustrate the gravity of the environmental situation. It provides active learning as players can directly take part in the game scenario through a virtual avatar, role-playing, perspective-taking, and simulation strategies in a mediated setting dealing with various situations that might not be possible in the present physical world (Toh and Kirschner, 2020; Tussyadiah et al., 2018; Baranowski et al., 2008). Experience is a

vital instructor to humans, promoting understanding of our surroundings, and eliciting a variety of emotions such as fear, frustration, concern, and hope, which drive us towards taking action (Rooney-Varga et al., 2018). Humans tend to appraise and adjust their opinions, impressions, and perceptions by getting involved in experimental, participatory, and action-led learning approaches (Bentz and O'Brien, 2019). However, setting a material stage for environmental events is costly, unfeasible, and unmanageable. With the inherent and technical aspects that allow people to have their own experience in a virtual simulated environment, video games can give compelling learning experiences to direct ways and shape players' perspectives (Ouariachi et al., 2018b,a). Video games provide risk-free practical situations and allow players to learn by reflecting on problems and their potential solutions (Wu and Lee, 2015).

I argue that, by integrating recurrent (yet diverse) gameful tasks and challenges, presenting storylines that promote solution-driven and action-oriented strategies, and a curious character that invites exploration and adventure, designers can setup patterns and encourage players towards the presented ideas. Some approaches for this persuasive step incorporate the inclusion of engaging eco-scenarios, recurring mini-games with eco-goals, environmental challenges with gradual learning paths, or collaborative eco-quests, which allow for continuous interaction and rehearsal to master certain patterns. Repetition is the key to this persuasive step. However, repeating should not lead to tedium and monotony. Thus, while designers should create challenges that require repetition and skill development to create patterns, they should make the elements engaging and varied (e.g., storylines, characters, challenges, and goals) to hold players' interest. Therefore, designers should be creative and playful while turning ideas into habitual patterns. For example, in an eco-game, the gameplay should concentrate on providing practical opportunities for mitigation, management, and control techniques. However, to avoid repetition of eco-tasks, designers should integrate multiple goals, branching options, and a range of short-term or long-term rewards that lead to different consequences and scenarios, making each round of gameplay unique and engaging. It is also a good idea to put an eco-task (e.g., waste segregation, trash collection, planting trees, saving injured animals) in different practical situations and various scenarios/locations. Also, incorporating side stories and different character interactions into eco-tasks can add new conversations and narrative pathways in the game, reducing the chance of boredom in repeating patterns. Another way of making eco-tasks and patterns less repetitive is through event-focused goals. In this way, designers can integrate special environmental events or dates as in-game incentives to arrange eco-activities and apply interesting habitual patterns.

### 8.5.8 Transmit agency

Humans desire control because having control represents agency and autonomy, which in turn increase motivation, promote self-efficacy, and provide a sense of liberation and empowerment (Snow et al., 2013; Jackson and McNamara, 2013; Ryan et al., 2006). Thus, giving agency to players is an integral part of game design. The qualitative data also echoed the importance of agency in building effective and persuasive games that can target players' eco-awareness. The data further implied that employing virtual self-representation and perspective-taking mechanics in video games helps players become active agents who can feel the consequences of their decisions and learn from them (Freeman et al., 2020; Li et al., 2022; Song et al., 2013; Kim et al., 2022). Conveying agency through perspective-taking allows players to have firsthand encounters with the cycle of actions and reactions in a virtual setting (Ouariachi et al., 2018a,b; De La Hera and Raessens, 2021). Effective crisis communication requires recreating and reenacting situations through a dynamic agent (Heath, 2004) and digital gameplay can satisfy this objective.

The necessity of transmitting agency can align with Cialdini's **consistency** principle as it translates to game design by encouraging players to make choices that are supported by their previous actions, emphasising their sense of agency during gameplay. Fogg's **tailoring** and **suggestion** strategies are also in line with transmitting agency as they can offer personalised/customised and supplementary/optional gameplay (Fogg, 2003c).

Adding agency cues in game-based climate discourse matters because giving players a sense of agency adds to their experience by enhancing their autonomy and freedom (Snow et al., 2015; Jennings, 2019), improves their motivation (Snow et al., 2013; Jackson and McNamara, 2013), and influences their attitudes (Pekrun et al., 2010) towards portrayed ideas, which in turn enhances their environmental awareness. An intuitive controller is a primary step to project a sense of agency in games (Crick, 2011). Also, designing balanced game challenges, in line with players' skill levels, can boost their sense of mastery in the game and consequently add to their agency (Vahlo and Karhulahti, 2020; Ryan et al., 2006). Another way of elevating agency in games is through character design. Giving players the option to customise avatars is a way of injecting autonomy into the gameplay (Cuthbert et al., 2019; Bódi, 2023). Also, having customised exploration options and routes is another way to give players freedom and boost their agency (Gómez Maureira et al., 2019; Xu et al., 2023; Zhan et al., 2018). Some eco-examples for this persuasive step include giving players the chance to create and manage an eco-friendly community. Another example is providing the layout for players to set and pursue personal objectives and examine different predictive or mitigation tools/techniques in tackling environmental issues, monitoring how their goals and choices can impact living conditions and the environment with the passage of time.

I argue that transmitting player agency is impactful through designing customisable environments, choice-driven goals, or narrative evolution. Also, creating scenarios where there are opportunities for adapting to new situations will help develop the player's sense of autonomy and agency. However, designers' emphasis should be on creating **meaningful** choices (Woolbright, 2017), where players are facing moral dilemmas that lead to reflection and critical thinking. Also having **clear**, **audible**, and **visible** consequences that link causes and effects is integral to implementing agency as a persuasive strategy. Because without comprehending the consequences of their actions and decisions, players can not refer to themselves as agents of change (either positive or negative).

### 8.5.9 Establish urgency

Establishing urgency through cautionary tales and fear prompts is a deep-rooted approach to influence attitudes or behaviours (Tannenbaum et al., 2015). This persuasive strategy works by provoking a sense of apprehension and anxiety (Ruiter et al., 2014). The qualitative data highlighted the importance of alarming hints and fear prompts in games as a way of adding to the urgency of eco-related topics. The persuasion literature supports this finding as Cialdini's principle of **scarcity** can show how resource limitation and tight supply can influence the audience by creating an urgency mindset (Cialdini, 2007, 2009). Also, the **authority** principle leverages valued characters or entities in the game to accentuate the gravity of a situation (Cialdini, 2007, 2009). Moreover, Fogg's **conditioning**, **suggestion**, and **self-monitoring** strategies are in line with establishing urgency by stressing the severity of a situation through tracking the progression of urgent tasks/goals and provoking users to act promptly (Fogg, 2003a).

I argue that, in a gameful design, urgency can be transmitted through the central message and ingrained in elements such as audiovisual, worldbuilding, exploration, feedback, challenge, storyline, or concept. For this persuasive step, designers should make sure the game world reacts evidently and appropriately to players' delayed actions or negative decisions. Also, having side characters and non-player characters (NPCs) that engage players' attention to the urgency of issues through occasional and timely dialogues can be a subtle way of weaving the concept of urgency into the game world. Urgency could also be created through embedding real-time ecological changes as part of the feedback loop, using time-sensitive plots where immediate actions are required to remedy the eco-tasks and challenges, incorporating goals that echo the outside world's environmental deadlines and time frames, reflecting the time critical nature of addressing our current environmental crises. For example, in an eco-game with a wildfire management focus, using countdowns in game quests (e.g., checking dry areas and locating campfires) can highlight the urgency in tackling disasters. Embedding urgency in a climate change setting is important because it can add value to the significance of the issue and motivate

empathetic and engaging action (Cordero et al., 2008; Flora et al., 2014).

### 8.5.10 Set up parallels

Setting up parallels is a way of constructing similarities between two points. This step can be persuasive by building a relatable link between two items, locations, or situations (Oinas-Kukkonen and Harjumaa, 2009). Therefore, connecting the physical world to the virtual world of a game can be a key factor in making believable, credible, and persuasive games. This concept was one of the main themes of the qualitative results, highlighting the importance of forming similarities between the virtual and the material world. By using analogical techniques and drawing parallels, designers employ familiar situations to make players comprehend and grasp different or new circumstances (Oinas-Kukkonen and Harjumaa, 2009). Cialdini's principle of **liking** is related to the concept of setting parallels as it focuses on building characters, settings, and experiences that are familiar and attractive (Cialdini, 2007, 2009), which helps to make the game world more relatable. The principle of **social proof** can also be connected to this step as it can reflect material-world activities, cultures, and people (Cialdini, 2007, 2009). Besides, Fogg's **tailoring** strategy is a persuasive approach that can be linked to this step as it can provide personalised options to mirror the material world (Fogg, 2003a). Furthermore, the **suggestion** strategy can guide players towards acknowledging the material world counterparts (Fogg, 2003a) during gameplay.

In this step, I argue that by modelling the physical-world climate issues in a gameful setting, designers enhance players' links to the topic (e.g. by making what happens in the game world more personally relevant). Applying parallels can go beyond appearance similarities and include embedding universal motifs and shared human experiences in gameful content to emphasise the physical-world relevance of a game. Some eco-design examples representing this persuasive step include storyline and challenge design inspirations from physical-world environmental disasters. For instance, by incorporating real data from locations at the risk of bushfires or floods in the gameplay, designers can create scenarios where players should implement urban development tools and procedures required to prevent or manage such catastrophes. Also using historical records on the weather patterns as a game device can help create narratives where players need to plan, forecast, or alleviate climate-related events. Another example of applying parallels is in the game's storylines. In a choice-oriented scenario, if a player chooses sustainable packaging for their business, the game can integrate reports of local businesses that have used localised packaging methods resulting in profits as side stories or dialogues in the game. Another example is merging authentic biomes and realistic ecosystems as gameplay locations or using wildlife as a game quest and challenge (e.g., monitoring animal communications or phases of growth in flora and fauna) to help mirror nature and its wonders in a gameful

setting. On top of that, by showcasing explicit environmental problems in the game's visuals or incorporating the gravity of some issues into stories, dialogues, gameful tasks, and overall worldbuilding, games draw parallels between the physical and virtual settings and increase their persuasive potential.

## 8.6 Conclusions

The insights gained from the quantitative and qualitative findings of this project offered practical implications for game design opportunities as a creative pathway in climate communication, advancing the knowledge in gameful persuasive design, attitude studies, and climate change communication fields, as well as offering avenues for future research. In this chapter, I gave an overview of how merging the strengths and limitations of game design observed in both interventions could provide lessons and recommendations towards effective game mechanics, narrative, animation, and message design. Furthermore, I combined the practical insights from my findings with the established literature on persuasion and developed a set of 10 design directives (MICROGATES) that is pertinent to game design and based on persuasive tools/principles. The MICROGATES directives describe design steps that can aid with gameful persuasion. This set of directives works as a blueprint with multiple micro strategies to facilitate the processes of persuasion (attitude change). The ten steps of the MICROGATES can be used as design directives for the development of games that target players' attitudes towards critical issues such as climate change. Design implications are valuable because they serve as principles to develop coherent, engaging, meaningful, and entertaining games (Egenfeldt-Nielsen et al., 2008).

Chapter 9

# Concluding Thoughts

Playing video games has been likened to entering a 'magic circle' (Huizinga, 1949), which encapsulates why researchers have been intrigued to study player experience and use games as persuasive tools to shape, change, and reinforce views, attitudes, or behaviours towards critical matters. Digital games represent a pioneering approach for interactive, creativity-focused, edutainment methods (Kolenatý et al., 2022) in climate communication. Using edutainment schemes as a substitute for conventional knowledge transfer methods has been shown to boost public engagement and commitment in tackling environmental issues (Flora et al., 2014; Cordero et al., 2008) by presenting climate change as a personal and tangible problem (Senbel et al., 2014; Satchwell, 2013; Ojala, 2012). Video games have caught the attention of researchers in environmental risk studies as a suitable and persuasive tool that can combine learning opportunities with entertainment and engagement (Toh and Kirschner, 2020; Baranowski et al., 2008). However, there has been limited understanding of how eco-game design can be improved to fulfill an ideal environmental objective. This research made attempts to address this literature gap.

In answering my first research question (**RQ1**: How can game design and player experience processes impact pro-environmental attitudes?), I conceptualised a comprehensive model (Climate-Oriented Persuasive Edutainment: COPE) that described the contributing design features/elements as well as the theoretical processes involved in impacting players' attitudes. Informed by an integration of established theories (Prospect Theory, Framing Effect, Procedural Rhetoric, Narrative Persuasion, Immersion), the COPE model incorporates message framing, mechanics, narrative, and animation of game design in explaining attitude change. In this project, I both presented this model and two case studies of its use, examining the persuasive potential of playing Beyond Blue and Plasticity on pro-environmental attitudes. The COPE model elucidates how enhancing the interactivity of game mechanics, persuasiveness of the narrative, immersive realism of the animation feature, and theme-appropriate framing, can aid in conveying environmental ideas and impacting players' attitudes. I argued that integrating framing effects into design features and elements in a risk-related context is integral as it can add to the

urgency and persuasiveness of the experience.

This research expands the literature by adding theoretical and empirical evidence to explain the effects of two avatar-based eco-games on players' pro-environmental attitudes, studying their overall persuasiveness and specific design considerations in climate communication. By encompassing a combination of both explicit and implicit attitude layers as well as both short and long-term implications of attitudes, I sought to answer my second and third research questions (**RQ2**: To what extent can a climate-themed gameful intervention effect pro-environmental attitudes? and **RQ3**: On what attitudinal levels can persuasive climate-themed games influence players?). Examining both explicit and implicit attitudes in the short and long-term advances the methodological design in video games attitudinal studies and broadens knowledge on the extent to which eco-game design can impact pro-environmental attitudes. Through these games, I examined the implications of virtual gameplay settings with message designs embedded in worlds where either drastic outcomes of an environmental downfall (loss-frame) or rewarding outcomes of environmental preservation (gain-frame) were central to the gameplay. The mechanism of perspective-taking was observed in two multi-stage experiments to assess players' pro-environmental attitudes.

As an initial step, I explored the two types of primary message techniques (loss versus gain frame) employed in the interventions and assessed that more quantitative data is needed to determine which message design can be a more effective climate change communication technique in gameful designs. However, comparing the results from before, following, and three to five weeks after the gameful interventions enabled me to understand how attitudes changed throughout each step of the experiments and the varieties of effects an interactive game can have on players' attitudes. I observed that participants' pro-environmental cognitive attitude was impacted by both interventions with two different message design strategies, while the intervention containing a mixture of a central loss-framed message and potential hopeful conclusion (Plasticity/ Experiment 2) impacted threat perception in the short-term and positive eco-emotional attitude in the long-term. This kind of multi-layered message design might be the key to creating a more robust and effective climate change message in a gameful context by balancing generating fear and empowering the player, which further underlines the complexities of message framing. Additionally, the qualitative data implied that having alarming hints, fear prompts, and urgency cues were integral factors in an effective eco-game.

In the response to my fourth research question (**RQ4**: Which gameful features and elements can predict pro-environmental attitudes?), the results of the first experiment implied that Beyond Blue's overall mechanics and narrative features were the main significant predictors of pro-environmental cognitive attitudes. Challenge design was the only significant element that predicted participants' cognitive attitudes. The data demon-

strated that climate communication can benefit from a carefully designed theme-oriented video game as an effective creative tool. The results from the second experiment suggested that Plasticity's overall mechanics and narrative features were predictors of participants' climate threat perception, while the overall animation design predicted pro-environmental cognitive attitude. The storyline was the only element that predicted both threat perception and cognitive attitude. The challenge design predicted threat perception and the exploration design predicted cognitive attitudes. The game concept/meaning and feedback design were the only significant predictors of participants' long-term positive eco-emotion. These results indicated that a theme-aligned, detail-centred game design can be effective in enhancing climate communication.

In further understanding the interventions' design nuances and potentials for climate communication, the qualitative results signified that a detail-oriented design can make eco-games unique persuasive tools for climate communication. The findings suggested that eco-games can be successful in exemplifying and envisaging futures and ecosystems as well as building a connection between people and mother Earth. The data also identified that videogames look optimistic and can be effective as environmental tools if they integrate believable and relatable microworlds with immersive audio and visual prompts into their design. Also, adding clearly-framed messages that avoid oversimplification of the matter and incorporating a balanced mixture of hope, fear prompts, curiosity cues, emotional stimuli, scientific knowledge, and playfulness add to their persuasive capacity. The empirical evidence further underlined how choice-driven and customisable gameplay that provides players unique opportunities to foster their identity, agency, and sense of empowerment can augment eco-games design, highlighting the function of perspective-taking and identification as persuasive devices. The combined findings unveiled videogames' potential for designing mechanics, narrative, animation, and messages that can be highly interactive, persuasive, immersive, and influential assets for climate communication.

My research contributed to the interdisciplinary field of games design, persuasion, attitude, and climate communication by conceptualising a model (COPE), developing a set of design directives for persuasive games (MICROGATES), and providing quantitative and qualitative evidence that suggest the persuasive potential of eco-games on players' pro-environmental attitudes. To the best of my knowledge, there is no other equivalent study that provides a combination of theoretical insights and empirical data on the impact of video games on both explicit and implicit attitudes over time (both short-term and long-term) related to climate change. To broaden this field, I recommend additional research to analyse mediating processes and potential moderators to better understand persuasive design in playful contexts and develop more efficient climate-themed video games. Also, more empirical evidence on the influence of gamified climate-themed mes-

sage designs on player attitudes should be collected in future studies. We know relatively little about the impacts of different video game genres and message designs on players' pro-environmental attitudes, and further research should be conducted to focus on the effects of specific message frames on larger samples. Replicating this work with a new research sample and other game-based interventions could yield further useful findings in this field. To advance the methodology, future researchers could manipulate gameful interventions and make video games that are identical in all respects other than one (the dependent variable). By isolating the effects of each design aspect through game modifications, scenario adjustments, or gameplay tuning, researchers could test the effects of each design feature and element individually. I also stress the need for empirical research on MICROGATES set of design directives, its design capacity, application, and limitations.

A mixture of quantitative and qualitative evidence showed how nuanced gameful design choices can achieve promising persuasive outcomes in climate communication. The findings echo the prominence of creative and innovative approaches in tackling climate change. The positive environmental attitudes achieved via both games, despite several design shortcomings, show promise in using gameplay as a successful climate communication tool, highlighting the prospect for further research on game design to maximise the benefits associated with this domain. Understanding the details and processes of creative design in an environmental context can help designers develop games that motivate their audiences to hold pro-environmental attitudes. This research came to this conclusion that manifesting identity, integrating triggers, contextualising the experience, reiterating the idea, optimising the playability, guiding the path, applying patterns, transmitting agency, establishing urgency, and setting up parallels between the physical and virtual world can be beneficial design steps to produce a persuasive game. The widespread popularity of video games provides a unique and inventive channel for environmental communication. This project added to our understanding of the effects persuasive game design features/elements and framing of climate-themed messages have in a playful setting.

To assist designers in creating effective and influential climate-themed games, I recommend using the COPE model and the MICROGATES set of design directives as a framework and blueprint to create and evaluate persuasion in games. The COPE model helps by giving a big picture of how each design feature/element can contribute to the determining theoretical processes and factors that provide an interactive, transportative, and immersive gameplay experience. The set of MICROGATES directives can also help by providing ten practical design steps to enhance the persuasiveness of games. My research emphasises that although experience-based and creative-centred support should be an indispensable part of climate communication, the design should not be applied in a pre-

scriptive format, but in a flexible, adaptable, decision-based, and option-driven fashion. That is why customisation must be a central part of a gameful design to enhance climate communication. A customised game empowers players to select viable options that can tailor and contextualise the experience based on the user's needs. In implementing the COPE model and the MICROGATES design directives, paying particular attention to the genre and target audience expectations can help make a more effective and persuasive game. It is also essential to highlight that interpreting the results based on the COPE model must be done together with an investigation of the particular design choices for the specific game being studied. I conclude that, with a detail-oriented and theme-directed design, eco-games can offer ample opportunities to catalyse climate awareness, environmental attitudes, and eco-friendly motivation.

# Appendix

## 9.1 Anonymous identifier

**We would like to use this code to link responses to the pre- and post-surveys while maintaining participants' anonymity:**

- What is the first letter of your mother/guardian's first name? (e.g. "J" for Julie)
- What is the first letter of the street where you live? (e.g., "P" for Pleasant Street)
- What day of the month were you born on? (e.g., 4, 18, 31)

## 9.2 Positive and Negative Affect Schedule (PANAS)

**Indicate the extent you have felt this way over the past week.**

| Item | Affect | Very slightly or not at all | A little | Moderately | Quite a bit | Extremely |
|---|---|---|---|---|---|---|
| 1 | Interested | | | | | |
| 2 | Distressed | | | | | |
| 3 | Excited | | | | | |
| 4 | Upset | | | | | |
| 5 | Strong | | | | | |
| 6 | Guilty | | | | | |
| 7 | Scared | | | | | |
| 8 | Hostile | | | | | |
| 9 | Enthusiastic | | | | | |
| 10 | Proud | | | | | |
| 11 | Irritable | | | | | |
| 12 | Alert | | | | | |
| 13 | Ashamed | | | | | |
| 14 | Inspired | | | | | |
| 15 | Nervous | | | | | |
| 16 | Determined | | | | | |

| Item | Affect | Very slightly or not at all | A little | Moderately | Quite a bit | Extremely |
|---|---|---|---|---|---|---|
| 17 | Attentive | | | | | |
| 18 | Jittery | | | | | |
| 19 | Active | | | | | |
| 20 | Afraid | | | | | |

## 9.3 Implicit Attitude Test (IAT)

For the questionnaire structure, refer to the sustainability IAT by Steiner et al. (2018). To conduct the test, refer to the supplementary tool developed by Carpenter et al. (2019).

## 9.4 Cognitive Attitude scale (Explicit Attitude Test)

**Please, indicate how much you agree or disagree with the following statements**
*Use the following scale:* 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

| Item | Statement | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 1 | Realistically, nothing will be done about climate change until it's too late. | | | | | |
| 2 | The impacts of climate change are really beyond my control. | | | | | |
| 3 | Individuals can make a difference to climate change. | | | | | |
| 4 | I feel it is my ethical responsibility to change my individual behaviour to combat climate change. | | | | | |
| 5 | The impacts of climate change are inevitable now so there's not much point worrying about it. | | | | | |

| Item | Statement | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 6 | There's nothing Australia can do about climate change that will make a meaningful difference. | | | | | |
| 7 | There are meaningful things I can do to reduce the impact of climate change. | | | | | |
| 8 | Individuals working together can make a difference to climate change. | | | | | |
| 9 | I feel a moral duty to do something about climate change. | | | | | |
| 10 | Ultimately, I am confident that the world community can find a solution to the problems posed by climate change. | | | | | |
| 11 | If we act collectively, we will be able to minimise the consequences of climate change. | | | | | |

## 9.5 Threat Perception scale (Explicit Attitude Test)

**Using the scale below, indicate how much you think climate change will harm the following groups.** *Use the following scale:* 1 = Not at all, 2 = Only a little, 3 = A moderate amount, 4 = A great deal, 5 = Don't know

| Group | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| You personally | | | | | |
| Your family | | | | | |
| People in your neighborhood | | | | | |
| People in your country | | | | | |
| People in poor, developing countries | | | | | |
| People around the world | | | | | |

## 9.6 Positive & Negative Eco-Emotion scale (Explicit Attitude Test)

**Using the scale below, please indicate how much you agree or disagree with the following emotions regarding climate change.**

| Item | Emotion | Strongly Disagree | Disagree | Neither disagree nor agree | Agree | Strongly agree |
|---|---|---|---|---|---|---|
| 1 | Angry | | | | | |
| 2 | Fearful | | | | | |
| 3 | Irritated | | | | | |
| 4 | Guilty | | | | | |
| 5 | Ashamed | | | | | |
| 6 | Excited | | | | | |
| 7 | Hopeful | | | | | |
| 8 | Joyful | | | | | |

## 9.7 Player Experience Inventory (PXI)

**Indicate the extent to which you agree with the following statements.** *Use the following scale:* 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neutral, 5 = Somewhat Agree, 6 = Agree, 7 = Strongly Agree

| Item | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1 | Playing the game was meaningful to me. | | | | | | | |
| 2 | The game felt relevant to me. | | | | | | | |
| 3 | Playing this game was valuable to me. | | | | | | | |
| 4 | I felt capable while playing the game. | | | | | | | |
| 5 | I felt I was good at playing this game. | | | | | | | |
| 6 | I felt a sense of mastery playing this game. | | | | | | | |
| 7 | I was no longer aware of my surroundings while I was playing. | | | | | | | |
| 8 | I was immersed in the game. | | | | | | | |

| Item | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 9 | I was fully focused on the game. | | | | | | | |
| 10 | I felt a sense of freedom about how I wanted to play this game. | | | | | | | |
| 11 | I felt free to play the game in my own way. | | | | | | | |
| 12 | I felt like I had choices regarding how I wanted to play this game. | | | | | | | |
| 13 | I felt eager to discover how the game continued. | | | | | | | |
| 14 | I wanted to explore how the game evolved. | | | | | | | |
| 15 | I wanted to find out how the game progressed. | | | | | | | |
| 16 | I thought the game was easy to control. | | | | | | | |
| 17 | The actions to control the game were clear to me. | | | | | | | |
| 18 | It was easy to know how to perform actions in the game. | | | | | | | |
| 19 | The game was challenging but not too challenging. | | | | | | | |
| 20 | The game was not too easy and not too hard to play. | | | | | | | |
| 21 | The challenges in the game were at the right level of difficulty for me. | | | | | | | |
| 22 | The game gave clear feedback on my progress towards the goals. | | | | | | | |
| 23 | I could easily assess how I was performing in the game. | | | | | | | |
| 24 | The game informed me of my progress in the game. | | | | | | | |
| 25 | I enjoyed the way the game was styled. | | | | | | | |
| 26 | I liked the look and feel of the game. | | | | | | | |
| 27 | I appreciated the aesthetics of the game. | | | | | | | |
| 28 | The goals of the game were clear to me. | | | | | | | |
| 29 | I grasped the overall goal of the game. | | | | | | | |
| 30 | I understood the objectives of the game. | | | | | | | |

## 9.8 Player Experience of Needs Satisfaction (PENS)

**Reflect on your play experience and rate your agreement with the following statements:** *Use the following scale:* 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neutral, 5 = Somewhat Agree, 6 = Agree, 7 = Strongly Agree

| Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| I feel competent at the game. | | | | | | | |

| **Statement** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|---|
| I feel very capable and effective when playing. | | | | | | | |
| My ability to play the game is well matched with the game's challenges. | | | | | | | |
| The game provides me with interesting options and choices. | | | | | | | |
| The game lets you do interesting things. | | | | | | | |
| I experienced a lot of freedom in the game. | | | | | | | |
| I find the relationships I form in this game fulfilling. | | | | | | | |
| I find the relationships I form in this game important. | | | | | | | |
| I don't feel close to other players.(-) | | | | | | | |
| When playing the game, I feel transported to another time and place. | | | | | | | |
| Exploring the game world feels like taking an actual trip to a new place. | | | | | | | |
| When moving through the game world I feel as if I am actually there. | | | | | | | |
| I am not impacted emotionally by events in the game.(-) | | | | | | | |
| The game was emotionally engaging. | | | | | | | |
| I experience feelings as deeply in the game as I have in real life. | | | | | | | |
| When playing the game I feel as if I was part of the story. | | | | | | | |
| When I accomplished something in the game I experienced genuine pride. | | | | | | | |
| I had reactions to events and characters in the game as if they were real. | | | | | | | |
| Learning the game controls was easy. | | | | | | | |
| The game controls are intuitive. | | | | | | | |
| When I wanted to do something in the game, it was easy to remember the corresponding control. | | | | | | | |

## 9.9 Transportation Scale

**Indicate the extent to which you agree with the following statements about your experience with the video game.** *Use the following scale:* 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neutral, 5 = Somewhat Agree, 6 = Agree, 7 = Strongly

Agree

| Item | Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| T1 | While I was playing the video game, I could easily picture the events in it taking place. | | | | | | | |
| T2 | While I was playing the video game, activity going on in the room around me was on my mind. | | | | | | | |
| T3 | I could picture myself in the events of the video game. | | | | | | | |
| T4 | I was mentally involved in the video game while playing it. | | | | | | | |
| T5 | After finishing the video game, it was easy to put it out of my mind. | | | | | | | |
| T6 | I wanted to learn how the video game ended. | | | | | | | |
| T7 | The video game affected me emotionally. | | | | | | | |
| T8 | I found myself thinking of ways that the video game could have ended differently. | | | | | | | |
| T9 | I found my mind wandering while I was playing the video game. | | | | | | | |
| T10 | The events in the video game are relevant to my daily life. | | | | | | | |
| T11 | The events in the video game have changed my life. | | | | | | | |

## 9.10 Avatar Identification scale

**To what extent do you agree with these statements?** *Use the following scale:* 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

| Statement | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| My character is like me in many ways. | | | | | |
| My character resembles me. | | | | | |
| I identify with my character. | | | | | |
| My character is an extension of myself. | | | | | |
| My character is similar to me. | | | | | |
| I resemble my character. | | | | | |
| When I am playing, it feels as if I am my character. | | | | | |
| I feel like I am inside my character when playing. | | | | | |

| **Statement** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| In the game, it is as if I become one with my character. | | | | | |
| When I am playing, I am transported into my character. | | | | | |
| When playing, it feels as if my character's body becomes my own. | | | | | |
| In the game, it is as if I act directly through my character. | | | | | |
| If I could become like my character, I would. | | | | | |
| My character is an example to me. | | | | | |
| My character is a better me. | | | | | |
| My character has characteristics that I would like to have. | | | | | |
| I would like to be more like my character. | | | | | |

## 9.11 Demographics Questions

**We would like to ask you a few questions about yourself.**

1. **How much experience do you have playing avatar-based video games?**
   - A great deal
   - Much
   - Somewhat
   - Little
   - None
2. **What part of Australia is your home located?**
   - Australian Capital Territory
   - New South Wales
   - Northern Territory
   - Queensland
   - South Australia
   - Tasmania
   - Victoria
   - Western Australia
3. **How would you describe where you live?**

- Major city
- Inner regional
- Outer regional
- Remote
- Very remote

4. **What gender do you identify as?**
   - Male
   - Female
   - Non-binary / gender variant / gender queer / non-conforming
   - Intersex / indeterminate
   - Prefer not to answer
   - Other: _____

5. **Are you currently an Australian National University (ANU) student?**
   - Yes
   - No

6. **What is your current study level at ANU? (If applicable)**
   - Undergraduate
   - Postgraduate (Masters)
   - Postgraduate (PhD)

7. **What is the highest degree or level of education you have completed?**
   - Some of primary school
   - Completed primary school
   - Some of high school / tertiary school
   - Completed tertiary school
   - Some of trade / TAFE qualification
   - Completed trade / TAFE qualification
   - Some of undergraduate degree
   - Completed undergraduate degree
   - Some of postgraduate qualification
   - Completed postgraduate qualification

8. **How would you describe your political view?**
   - Very Progressive

- Progressive
- Slightly Progressive
- Neutral
- Slightly Conservative
- Conservative
- Very Conservative

9. **What race/ethnicity do you identify as?**
   - Aboriginal / Torres Strait Islander
   - African
   - Asian
   - Hispanic or Latino
   - Middle Eastern
   - White or Caucasian
   - Multiracial or Biracial
   - A race/ethnicity not listed here
10. **What is your religion?**
   - Buddhism
   - Catholic
   - Hinduism
   - Islam
   - Jewish
   - Protestant
   - No religion
   - A religion not listed here
11. **Growing up, what was your family's socioeconomic status?**
   - Poor
   - Below average
   - Average
   - Above average
   - Wealthy

## 9.12 Descriptive Questions

**Next, we will ask some descriptive/ open-ended questions about various aspects of your gameplay experience and your feedback. Your answers are important as they will provide insights into several aspects of this research. So, in answering these questions, please explain as much and as clearly as you can. Thank you!**

- How would you describe the game you played for this study a few weeks ago? (You can use sentence(s) or just word(s) to describe it.)
- Have you found yourself thinking about the game you played for this study during these past few weeks? If so, how much and in what ways? (Please, explain as much as you can).
- What part/ aspect/ element of the game do you remember most after these few weeks? Why do you think that part/aspect/ element stood out? (Please, explain as much as you can).
- After you played the game in this study (a few weeks ago), were you motivated to know more about environmental issues? Would you explain why yes or why not?
- Did playing the game in this study motivate you to revise or improve your ideas/views about sustainability and/or environmental issues in any way?
- What do you think the overall impact of the game was on you, if any? (Please, explain as much as you can).
- If you have any other comment(s) to make about the videogame, please enter them below.

## 9.13 Interview Questions

- Could you tell me a little bit about yourself?
- What prompted you to sign up for this study?
- What did you think of the game?
- How did playing the game make you feel?
- What did you think about the message of the game?
- What did you think about the overall tone and mood of the game?
- This item was **only for the Beyond Blue study**: Do you think playing the game made you build a stronger connection with nature (in this case ocean) and its inhabitants? If so, do you think making this connection made you re-evaluate your existing environmental issues in any way?

- This item was **only for the Plasticity study**: Did you finish the game (get to the ending)? Only once or more? If so, what did you think and feel about how it ended?
- How do you think the game did in raising awareness about environmental issues?
- How do you think the designers could improve the game in raising environmental issues?
- How do you feel about the interview so far?
- How much do you agree with this statement and why? "Playing this game made me re-evaluate how critical and urgent the climate change issue is."
- Did playing this game affect your thoughts and beliefs about environmental issues?
- Was there anything about the game that surprised you?
- What do you think you took away from the experience of playing the game?
- Were there any aspect(s) / element(s) in the game that stood out to you in terms of promoting environmental issues?
- In general, what kind of adjustments/ improvements would you want to make to this game?
- What did you think and feel about your avatar?
- Some games let players customise their avatars. Is this something you would have liked to do in this game?
- If so, how much did you like to customise your character/ avatar in this game?
- Has playing this game affected how motivated you are to address climate change and environmental issues in any way more than usual?
- Do you have any other feedback you would like to share?
- Do you have something more that you wish to share?
- Do you have any questions related to this topic or this study?
- Final Note: Many thanks again for your time and participation. Please, Do NOT play this game anywhere in the next few weeks (until the second part).

# Bibliography


Vero Vanden Abeele, Katta Spiel, Lennart Nacke, Daniel Johnson, and Kathrin Gerling. Development and validation of the player experience inventory: A scale to measure player experiences at the level of functional and psychosocial consequences. *International Journal of Human Computer Studies*, 135(June 2019):102370, 2020. ISSN 10959300. doi: 10.1016/j.ijhcs.2019.102370. URL https://doi.org/10.1016/j.ijhcs.2019.102370.

Benjamin Abraham and Darshana Jayemanne. Where are all the climate change games? Locating digital games' response to climate change. *Transformations*, 30(1):74–94, 2017. URL www.transformationsjournal.org.

Matthew Abunyewah, Thayaparan Gajendran, Kim Maund, and Seth Asare Okyere. Linking information provision to behavioural intentions: Moderating and mediating effects of message clarity and source credibility. *International Journal of Disaster Resilience in the Built Environment*, 11(1):100–118, 1 2020. ISSN 17595916. doi: 10.1108/IJDRBE-08-2019-0059.

Matthew Adams. Critical psychologies and climate change. *Current Opinion in Psychology*, 42: 13–18, 2021. ISSN 2352250X. doi: 10.1016/j.copsyc.2021.01.007. URL https://doi.org/10.1016/j.copsyc.2021.01.007.

Rachel F. Adler, Francisco Iacobelli, and Yehuda Gutstein. Are you convinced? A Wizard of Oz study to test emotional vs. Rational persuasion strategies in dialogues. *Computers in Human Behavior*, 57:75–81, 2016. ISSN 07475632. doi: 10.1016/j.chb.2015.12.011. URL http://dx.doi.org/10.1016/j.chb.2015.12.011.

Sun Joo (Grace) Ahn, Jesse Fox, Katherine R. Dale, and J. Adam Avant. Framing Virtual Experiences: Effects on Environmental Efficacy and Behavior Over Time. *Communication Research*, 42(6):839–863, 2015. URL https://doi.org/10.1177/0093650214534973%0A.

Eva E. Alblas, Frans Folkvord, Doeschka J. Anschütz, Jonathan van 't Riet, Isabela Granic, Paul Ketelaar, and Moniek Buijzen. Investigating the impact of a health game on implicit attitudes towards food and food choice behaviour of young adults. *Appetite*, 128(April):294–302, 2018. ISSN 10958304. doi: 10.1016/j.appet.2018.05.141. URL https://doi.org/10.1016/j.appet.2018.05.141.

Noora Aldenaini, Felwah Alqahtani, Rita Orji, and Srinivas Sampalli. Trends in Persuasive Technologies for Physical Activity and Sedentary Behavior: A Systematic Review, 4 2020. ISSN 26248212.

Amanda Alencar and Teresa De la Hera Conde-Pumpido. Gaming in Multicultural Classrooms:

The Potential of Collaborative Digital Games to Foster Intercultural Interaction. *Social Interactions in Virtual Worlds*, pages 288–310, 2018. doi: 10.1017/9781316422823.012.

Saleem Alhabash and Kevin Wise. Playing their game: Changing stereotypes of Palestinians and Israelis through videogame play. *New Media and Society*, 17(8):1358–1376, 2015. ISSN 14617315. doi: 10.1177/1461444814525010. URL https://doi.org/10.1177/1461444814525010.

Steve Allen, Deonie Allen, Kerry Moss, Gaël Le Roux, Vernon R. Phoenix, and Jeroen E. Sonke. Examination of the ocean as a source for atmospheric microplastics. *PLoS ONE*, 15(5), 5 2020. ISSN 19326203. doi: 10.1371/journal.pone.0232746.

Fill Alwin and Hermine Penz. *The Routledge Handbook of Ecolinguistics*. Routledge, New York, 2018. URL www.routledge.com/series/RHIL.

Theofylaktos Anastasiadis, Georgios Lampropoulos, and Kerstin Siakas. Digital Game-based Learning and Serious Games in Education. *International Journal of Advances in Scientific Research and Engineering*, 4(12):139–144, 2018. doi: 10.31695/ijasre.2018.33016.

Bruno de Andrade. CLIMATE GEOGAMES: A NEW PARADIGM TO GAMES AS CIVIC ENGAGEMENT TOOLS FOR URBAN HERITAGE SUSTAINABILITY. *International Journal of Environmental Resilience Research and Science*, 2(1), 6 2020. ISSN 2675-3456. doi: 10.48075/IJERRS.V2I1.26003. URL https://e-revista.unioeste.br/index.php/ijerrs/article/view/26003.

Jeannette Angel, Alicia LaValle, Deepti Mathew Iype, Stephen Sheppard, and Aleksandra Dulic. Future Delta 2.0: An experiential learning context for a serious game about local climate change. In *SIGGRAPH Asia 2015 Symposium on Education, SA 2015*. Association for Computing Machinery, Inc, 11 2015. ISBN 9781450339278. doi: 10.1145/2818498.2818512. URL https://dl.acm.org/doi/10.1145/2818498.2818512.

Jeannette Anniés, Chrysoula Papathanasiou, Selby Knudsen, Pietro De Vito, Orestis Sampson, Panagiotis Michalis, Lazaros Karagiannidis, Angelos Amditis, Marco Barbagelata, Eva Mandri, Gianluca Ilengo, Daniele Ravizza, and Fatmanur Karaca. Participative Technology Development of ICT tools for Risk Communication and Disaster Management. In *Proceedings of Mensch und Computer*, pages 564–567. Association for Computing Machinery, 9 2023. ISBN 9798400707711. doi: 10.1145/3603555.3609428.

Alissa N. Antle, Joshua Tanenbaum, Anna Macaranas, and John Robinson. Games for Change: Looking at Models of Persuasion Through the Lens of Design. *Playful User Interfaces*, pages 163–184, 2014. doi: 10.1007/978-981-4560-96-2. URL http://link.springer.com/10.1007/978-981-4560-96-2.

Markus Appel and Tobias Richter. Transportation and need for affect in narrative persuasion: A mediated moderation model. *Media Psychology*, 13(2):101–135, 2010. ISSN 15213269. doi: 10.1080/15213261003799847.

Jens B. Asendorpf, Rainer Banse, and Daniel Mücke. Double dissociation between implicit and explicit personality self-concept: The case of shy behavior. *Journal of Personality and Social Psychology*, 83(2):380–393, 2002. ISSN 00223514. doi: 10.1037/0022-3514.83.2.380.

M R Ashmore and J N B Bell. The Role of Ozone in Global Change. *Annals of Botany*, 67: 39–48, 1991. URL `https://about.jstor.org/terms`.

Cynthia J. Atman, Ann Bostrom, Baruch Fischhoff, and M. Granger Morgan. Designing risk communications: completing and correcting mental models of hazardous processes, Part I. *Risk Analysis*, 14(5):779–488, 1994.

Simone Avolicino, Marianna Di Gregorio, Marco Romano, Monica Sebillo, Genoveffa Tortora, and Giuliana Vitiello. EcoGO: Combining eco-feedback and gamification to improve the sustainability of driving style. In *International Conference on Advanced Visual Interfaces*, pages 1–5, 2022. ISBN 9781450397193. doi: 10.1145/3531073.3531127. URL `https://doi.org/10.1145/3531073.3531127`.

Denise Baden. Solution-Focused Stories Are More Effective Than Catastrophic Stories in Motivating Proenvironmental Intentions. *Ecopsychology*, 11(4):254–263, 12 2019. ISSN 19429347. doi: 10.1089/ECO.2019.0023. URL `https://www.liebertpub.com/doi/10.1089/eco.2019.0023`.

Paul G. Bain, Taciano L. Milfont, Yoshihisa Kashima, Michal Bilewicz, Guy Doron, Ragna B. Garoarsdóttir, Valdiney V. Gouveia, Yanjun Guan, Lars Olof Johansson, Carlota Pasquali, Victor Corral-Verdugo, Juan Ignacio Aragones, Akira Utsugi, Christophe Demarque, Siegmar Otto, Joonha Park, Martin Soland, Linda Steg, Roberto González, Nadezhda Lebedeva, Ole Jacob Madsen, Claire Wagner, Charity S. Akotia, Tim Kurz, José L. Saiz, P. Wesley Schultz, Gró Einarsdóttir, and Nina M. Saviolidis. Co-benefits of addressing climate change can motivate action around the world. *Nature Climate Change*, 6(2):154–157, 1 2016. ISSN 17586798. doi: 10.1038/nclimate2814.

Anne Gammelgaard Ballantyne, Victoria Wibeck, and Tina Simone Neset. Images of climate change – a pilot study of young people's perceptions of ICT-based climate visualization. *Climatic Change*, 134(1-2):73–85, 1 2016. ISSN 15731480. doi: 10.1007/s10584-015-1533-9.

Dominic Balog-Way, Katherine McComas, and John Besley. The Evolving Field of Risk Communication. *Risk Analysis*, 40:2240–2262, 11 2020. ISSN 15396924. doi: 10.1111/risa.13615.

Sebastian Bamberg and Guido Möser. Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, 27(1):14–25, 2007. ISSN 02724944. doi: 10.1016/j.jenvp.2006.12.002.

Mahzarin R. Banaji and Anthony G. Greenwald. *Blindspot: Hidden Biases Of Good People*. Bantam, 2013.

Rainer Banse. Implicit attitudes towards homosexuality: Reliability, validity, and controllability

of the IAT. *Experimental Psychology*, 48(2):145–160, 2001. ISSN 16183169. doi: 10.1026//0949-3946.48.2.145.

Qifang Bao, Mian Mobeen Shaukat, Asmaa Elantary, and Maria C. Yang. Eco-Feedback Designs: A Balance Between the Quantitative and the Emotional. In *International Conference on Design Theory and Methodology*. American Society of Mechanical Engineers Digital Collection, 12 2016. doi: 10.1115/DETC2016-59376. URL https://dx.doi.org/10.1115/DETC2016-59376.

Tom Baranowski, Richard Buday, Debbe I. Thompson, and Janice Baranowski. Playing for Real. Video Games and Stories for Health-Related Behavior Change, 2008. ISSN 07493797.

Jorge Barcena-Vazquez, Karina Caro, Karina Bermudez, and Hector Zatarain-Aceves. Designing and evaluating Reto Global, a serious video game for supporting global warming awareness. *International Journal of Human Computer Studies*, 177, 9 2023. ISSN 10959300. doi: 10.1016/j.ijhcs.2023.103080.

Matthew Barr. Video games can develop graduate skills in higher education students: A randomised trial. *Computers and Education*, 113:86–97, 2017. ISSN 03601315. doi: 10.1016/j.compedu.2017.05.016. URL http://dx.doi.org/10.1016/j.compedu.2017.05.016.

Mary Barreto, Michelle Scott, Ian Oakley, Evangelos Karapanos, Nuno J Nunes, and Joana Gomes. Playing for the Planet: Designing Toys that Foster Sustainable Values. In *Proceedings of the 31st European Conference on Cognitive Ergonomics*, pages 1–6, 2013.

John Barry. Bio-fuelling the Hummer?: transdisciplinary thoughts on techno-optimism and innovation in the transition from unsustainability. In *Transdisciplinary perspectives on transitions to sustainability*, pages 106–123. Routledge, 2016.

Michael Lewis Barthel. PRESIDENT FOR A DAY: Video games as youth civic education. *Information Communication and Society*, 16(1):28–42, 2013. ISSN 1369118X. doi: 10.1080/1369118X.2011.627176.

Donna Barwood, Sandra Smith, Margaret Miller, Julie Boston, Martin Masek, and Amanda Devine. Transformational game trial in nutrition education. *Australian Journal of Teacher Education (Online)*, 45(4), 4 2020. URL https://search.informit.org/doi/abs/10.3316/INFORMIT.270904787749422.

John N Bassili and Rick D Brown. Implicit and explicit attitudes: research, challenges, and theory. In D. Albarracín, B. T. Johnson, and M. P. Zanna, editors, *The handbook of attitudes*, page 543–574. Lawrence Erlbaum Associates Publishers, 2005.

C. Daniel Batson, Shannon Early, and Giovanni Salvarani. Perspective Taking: Imagining How Another Feels Versus Imaging How You Would Feel. *Personality and Social Psychology Bulletin*, 23(7):751–758, 1997. URL https://doi.org/10.1177/0146167297237008.

Geoffrey Beattie and Laura McGuire. Harnessing the unconscious mind of the consumer: How

implicit attitudes predict pre-conscious visual attention to carbon footprint information on products. *Semiotica*, 2015(204):253–290, 2015. ISSN 16133692. doi: 10.1515/sem-2014-0079.

Nicola J. Beaumont, Margrethe Aanesen, Melanie C. Austen, Tobias Börger, James R. Clark, Matthew Cole, Tara Hooper, Penelope K. Lindeque, Christine Pascoe, and Kayleigh J. Wyles. Global ecological, social and economic impacts of marine plastic. *Marine Pollution Bulletin*, 142:189–195, 5 2019. ISSN 18793363. doi: 10.1016/j.marpolbul.2019.03.022.

Vicky Lauren Bekoum Essokolo and Elisabeth Robinot. «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(10), 5 2022. ISSN 20711050. doi: 10.3390/su14105774.

Julia Bentz and Karen O'Brien. ART for CHANGE: Transformative learning and youth empowerment in a changing climate. *Elementa*, 7(1), 2019. ISSN 23251026. doi: 10.1525/elementa.390.

Pawan Kumar Bhartia and Richard D. McPeters. The discovery of the Antarctic Ozone Hole. *Comptes Rendus - Geoscience*, 350(7):335–340, 11 2018. ISSN 16310713. doi: 10.1016/j.crte.2018.04.006.

Helena Bilandzic and Rick Busselle. Narrative persuasion. *The SAGE Handbook of Persuasion: Developments in Theory and Practice*, pages 200–219, 2012. ISSN 0161-5289. doi: 10.4135/9781452218410.n13.

Helena Bilandzic, Anja Kalch, and Jens Soentgen. Effects of Goal Framing and Emotions on Perceived Threat and Willingness to Sacrifice for Climate Change. *Science Communication*, 39(4):466–491, 8 2017. ISSN 15528545. doi: 10.1177/1075547017718553.

Bettina Bódi. *Videogames and Agency*. Routledge, New York, NY, 2023. doi: 10.4324/9781003298786.

Ian Bogost. *Persuasive Games The Expressive Power of Videogames*, volume 1. The MIT Press, Cambridge, Massachusetts London, England, 2007. ISBN 978-0-262-02614-7.

Gerd Bohner and Nina Dickel. Attitudes and attitude change. *Annual Review of Psychology*, 62:391–417, 2011. ISSN 00664308. doi: 10.1146/annurev.psych.121208.131609.

Åsa Boholm. Speaking of Risk: Matters of Context. *Environmental Communication*, 3(3):335–354, 11 2009. ISSN 1752-4032. doi: 10.1080/17524030903230132.

San Bolkan, Alan K. Goodboy, and Dawn M. Kelsey. Instructor Clarity and Student Motivation: Academic Performance as A Product of Students' Ability and Motivation to Process Instructional Material. *Communication Education*, 65(2):129–148, 4 2016. ISSN 14795795. doi: 10.1080/03634523.2015.1079329. URL `https://www.tandfonline.com/doi/abs/10.1080/03634523.2015.1079329`.

Boyan Bontchev, Albena Antonova, Valentina Terzieva, and Yavor Dankov. "Let Us Save

Venice"—An Educational Online Maze Game for Climate Resilience. *Sustainability*, 14(1), 1 2022. ISSN 20711050. doi: 10.3390/su14010007.

Stephanie B Borrelle, Jeremy Ringma, Kara Lavender Law, Cole C Monnahan, Laurent Lebreton, Alexis Mcgivern, Erin Murphy, Jenna Jambeck, George H Leonard, Michelle A Hilleary, Marcus Eriksen, Hugh P Possingham, Hannah De Frond, Leah R Gerber, Beth Polidoro, Akbar Tahir, Miranda Bernard, Nicholas Mallos, Megan Barnes, and Chelsea M Rochman. Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *Science*, 369 (6510):1515–1518, 2020. URL `https://www.`

Ann Bostrom, Cynthia J Atman, Baruch Fischhoff, and M Granger. Evaluating Risk Communications: Completing and Correcting Mental Models of Hazardous Processes, Part II. *Risk Analysis*, 14(5):789–798, 1994.

Ann Bostrom, Gisela Böhm, and Robert E. O'Connor. Targeting and tailoring climate change communications. *Wiley Interdisciplinary Reviews: Climate Change*, 4(5):447–455, 2013. ISSN 17577799. doi: 10.1002/wcc.234.

Benjamin Bowman and Chloé Germaine. Sustaining the old world, or imagining a new one? The transformative literacies of the climate strikes. *Australian Journal of Environmental Education*, 38(1):70–84, 2022. ISSN 2049775X. doi: 10.1017/aee.2022.3.

Benjamin Bowman, Chloe Germaine, Pooja Kishinani, and Charlie Balchin. The Climate Imaginary:
} Reading Fiction to Make Sense of the Climate Crisis. In Jennifer Atkinson and Sarah Jaquette Ray, editors, *Existential Toolkit for Climate Justice Educators: How to Teach in a Burning World*. University of California Press, first edition edition, 2024.

Elizabeth A. Boyle, Thomas Hainey, Thomas M. Connolly, Grant Gray, Jeffrey Earp, Michela Ott, Theodore Lim, Manuel Ninaus, Claudia Ribeiro, and João Pereira. An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers and Education*, 94:178–192, 3 2016. ISSN 03601315. doi: 10.1016/j.compedu.2015.11.003.

Antoine C. Braet. Ethos, pathos and logos in Aristotle's Rhetoric: A re-examination. *Argumentation*, 6(3):307–320, 8 1992. ISSN 0920427X. doi: 10.1007/BF00154696/METRICS. URL `https://link.springer.com/article/10.1007/BF00154696`.

Virginia Braun and Victoria Clarke. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2):77–101, 2006. doi: 10.1191/1478088706qp063oa. URL `https://www.tandfonline.com/action/journalInformation?journalCode=uqrp20`.

Virginia Braun, Victoria Clarke, Nikki Hayfeld, and Gareth Terry. Thematic Analysis. In Pranee Liamputtong, editor, *Handbook of Research Methods in Health Social Sciences*, pages 843–860. Springer Singapore, 2019. ISBN 9789811052514. doi: 10.1007/978-981-10-5251-4. URL `https://philpapers.org/rec/LIAHOR`.

Steven R. Brechin. Public opinion: a cross-national view. In Constance Lever-Tracy, editor, *Routledge Handbook of Climate Change and Society*, pages 179–209. Routledge., 2010.

Steve Breslin. The History and Theory of Sandbox Gameplay, 7 2009. URL `https://www.gamedeveloper.com/design/the-history-and-theory-of-sandbox-gameplay`.

Cameron Brick, Anna Bosshard, and Lorraine Whitmarsh. Motivation and climate change: A review, 12 2021. ISSN 2352250X.

Ivo Bril, Nick Degens, and Jef Folkerts. Exploring design decisions in interactive narrative games for behaviour change: A case study. In *International Conference on Games and Learning Alliance,*, volume 11385 LNCS, pages 49–59. Cham: Springer International Publishing, 2018. URL `https://link.springer.com/chapter/10.1007/978-3-030-11548-7_5`.

Roy Brouwer, Dariya Hadzhiyska, Christos Ioakeimidis, and Hugo Ouderdorp. The social costs of marine litter along European coasts. *Ocean and Coastal Management*, 138:38–49, 3 2017. ISSN 09645691. doi: 10.1016/j.ocecoaman.2017.01.011.

Christopher N. Burrows and Hart Blanton. Real-World Persuasion From Virtual-World Campaigns: How Transportation Into Virtual Worlds Moderates In-Game Influence. *Communication Research*, 43(4):542–570, 2016. ISSN 15523810. doi: 10.1177/0093650215619215. URL `https://doi.org/10.1177/0093650215619215`.

Stephen Burrows, Rebecca Olive, Stacey O'Brien, and Tamara Galloway. Connection is key when there's no planet B: The need to innovate environmental science communication with transdisciplinary approaches, 12 2022. ISSN 18791026.

K. C. Busch, Nicole Ardoin, Daniel Gruehn, and Kathryn Stevenson. Exploring a theoretical model of climate change action for youth. *International Journal of Science Education*, 41 (17):2389–2409, 11 2019. ISSN 14645289. doi: 10.1080/09500693.2019.1680903.

Rick Busselle and Helena Bilandzic. Fictionality and perceived realism in experiencing stories: A model of narrative comprehension and engagement. *Communication Theory*, 18(2):255–280, 2008. ISSN 10503293. doi: 10.1111/j.1468-2885.2008.00322.x.

Paul Cairns, Anna Cox, and Imran Nordin. Immersion in digital games: review of gaming experience research. In *Handbook of digital games*, pages 337–361. John Wiley & Sons, Inc., Hoboken, New Jersey, 2014.

Adolfo J. Cangas, Noelia Navarro, José M.A. Parra, Juan J. Ojeda, Diego Cangas, Jose A. Piedra, and Jose Gallego. Stigma-Stop: A serious game against the stigma toward mental health in educational Settings. *Frontiers in Psychology*, 8(AUG), 8 2017. ISSN 16641078. doi: 10.3389/FPSYG.2017.01385/BIBTEX. URL `http://stigmastop.net/.`

Kriston Capps. What Sid Meier's Civilization VI Gets Wrong, 2016. URL `https://www.bloomberg.com/news/articles/2016-10-20/what-sid-meier-s-civilization-vi-gets-wrong`.

Stuart Bryce Capstick and Nicholas Frank Pidgeon. What is climate change scepticism? Examination of the concept using a mixed methods study of the UK public. *Global Environmental Change*, 24(1):389–401, 2014. ISSN 09593780. doi: 10.1016/j.gloenvcha.2013.08.012.

Christopher J. Carpenter. Cognitive dissonance, ego-involvement, and motivated reasoning. *Annals of the International Communication Association*, 43(1):1–23, 2019. ISSN 23808977. doi: 10.1080/23808985.2018.1564881. URL https://www.tandfonline.com/doi/abs/10.1080/23808985.2018.1564881.

Thomas P. Carpenter, Ruth Pogacar, Chris Pullig, Michal Kouril, Stephen Aguilar, Jordan LaBouff, Naomi Isenberg, and Alek Chakroff. Survey-software implicit association tests: A methodological and empirical analysis. *Behavior Research Methods*, 51(5):2194–2208, 2019. ISSN 15543528. doi: 10.3758/s13428-019-01293-3.

Noël Carroll. Narrative closure. *Philosophical Studies*, 135(1):1–15, 8 2007. ISSN 00318116. doi: 10.1007/S11098-007-9097-9.

Donald. O Case and M Given, Lisa. *Looking for information: A survey of research on information seeking, needs, and behavior*. Emerald Group Publishing Limited, 4th ed. edition, 2016.

Polona Caserman, Katrin Hoffmann, Philipp Müller, Marcel Schaub, Katharina Straßburg, Josef Wiemeyer, Regina Bruder, and Stefan Göbel. Quality Criteria for Serious Games: Serious Part, Game Part, and Balance. *JMIR serious games*, 8(3):e19037, 7 2020. ISSN 2291-9279. doi: 10.2196/19037. URL http://www.ncbi.nlm.nih.gov/pubmed/32706669http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC7414398.

Catherine Cassell. Creating the interviewer: identity work in the management research process. *http://dx.doi.org/10.1177/1468794105050833*, 5(2):167–179, 2005. ISSN 14687941. doi: 10.1177/1468794105050833. URL https://journals.sagepub.com/doi/abs/10.1177/1468794105050833.

Amy E. Chadwick. Toward a Theory of Persuasive Hope: Effects of Cognitive Appraisals, Hope Appeals, and Hope in the Context of Climate Change. *Health Communication*, 30(6):598–611, 6 2015. ISSN 15327027. doi: 10.1080/10410236.2014.916777.

Yooeun Chae and Youn Joo An. Current research trends on plastic pollution and ecological impacts on the soil ecosystem: A review, 9 2018. ISSN 18736424.

M. L. Chalal, B. Medjdoub, N. Bezai, R. Bull, and M. Zune. Visualisation in energy eco-feedback systems: A systematic review of good practice. *Renewable and Sustainable Energy Reviews*, 162:112447, 7 2022. ISSN 1364-0321. doi: 10.1016/J.RSER.2022.112447.

Moulay Larbi Chalal, Benachir Medjdoub, Richard Bull, Raid Shrahily, Nacer Bezai, and Miranda Cumberbatch. From discovering to delivering: A critical reflection on eco-feedback, application design, and participatory research in the United Kingdom. *Energy Research & Social Science*, 68:101535, 10 2020. ISSN 2214-6296. doi: 10.1016/J.ERSS.2020.101535.

Alenda Y Chang. *Playing nature: Ecology in video games.* , volume 58. U of Minnesota Press, 2019.

Jenova Chen and Kellee Santiago. Flower, 2007, video game for SONY PS3, color, sound, Smithsonian American Art Museum, Gift of thatgamecompany, 2013. URL `https://americanart.si.edu/artwork/flower-86512`.

Tianying Chen, Margot Stewart, Zhiyu Bai, Eileen Chen, Laura Dabbish, and Jessica Hammer. Hacked time: Design and evaluation of a self-efficacy based cybersecurity game. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, pages 1737–1749. Association for Computing Machinery, Inc, 7 2020. ISBN 9781450369749. doi: 10.1145/3357236.3395522. URL `https://dl.acm.org/doi/10.1145/3357236.3395522`.

Vivian Hsueh Hua Chen and Wei Jie Dominic Koek. Understanding Flow, Identification with Game Characters and Players' Attitudes. *ACM International Conference Proceeding Series*, 2020. doi: 10.1145/3402942.3409784.

Hyunyi Cho and Franklin J. Boster. Effects of Gain versus Loss Frame Antidrug Ads on Adolescents. *Journal of Communication*, 58(3):428–446, 2008. URL `https://doi.org/10.1111/j.1460-2466.2008.00393.x`.

Robert B Cialdini. Harnessing the Science of Persuasion. *Scientific American*, 284(2):76–81, 2001.

Robert B. Cialdini. *Influence: The Psychology of Persuasion*, volume 55. Collins, New York, 2007.

Robert B. Cialdini. *Influence: Science and practice*, volume 4. Pearson education, Boston, 2009.

Virginia Clerveaux, Balfour Spence, and Toshitaka Katada. Using Game Technique as a Strategy in Promoting Disaster Awareness in Caribbean Multicultural Societies: The Disaster Awareness Game. *Journal of Disaster Research*, 3(5):1–13, 2008.

Jonathan Cohen. Defining Identification: A Theoretical Look at the Identification of Audiences With Media Characters. *Mass Communication and Society*, 4(3):245–264, 8 2001. ISSN 1520-5436. doi: 10.1207/S15327825MCS0403{_}01. URL `http://www.tandfonline.com/doi/abs/10.1207/S15327825MCS0403_01`.

Karen Collins. *Game sound: an introduction to the history, theory, and practice of video game music and sound design.* MiT Press, 2008.

Thomas M. Connolly, Elizabeth A. Boyle, Ewan MacArthur, Thomas Hainey, and James M. Boyle. A systematic literature review of empirical evidence on computer games and serious games. *Computers and Education*, 59(2):661–686, 2012. ISSN 03601315. doi: 10.1016/j.compedu.2012.03.004.

John Cook. Deconstructing Climate Science Denial. In David C. Holmes and Lucy M. Richardson, editors, *Research Handbook in Communicating Climate Change*, pages 62–78. Elgar Online, 2020.

Eugene C. Cordero, Anne Marie Todd, and Diana Abellera. Climate change education and the ecological footprint. *Bulletin of the American Meteorological Society*, 89(6):865–872, 6 2008. ISSN 00030007. doi: 10.1175/2007BAMS2432.1.

Greg Costikyan. *Uncertainty in Games (Playful Thinking series)* . Playful Thinking series. The MIT Press, 2013. ISBN 0262018969. URL https://books.google.com/books/about/Uncertainty_in_Games.html?id=5fVuf0pRK6sC.

Vincent T. Covello and Fredrick W. Allen. Seven Cardinal Rules of Risk Communication. Technical report, Records of the U.S. Environmental Protection Agency [EPA], 1988. URL https://nepis.epa.gov/Exe/ZyNET.exe/P10072T6.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2000+Thru+2005&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C00thru05%5CTxt%5C00000023%5CP10072T6.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL.

Vincent T. Covello and Peter M. Sandman. Risk communication: Evolution and Revolution. In Anthony Wolbarst, editor, *Solutions to an Environment in Peril*, pages 164–178. John Hopkins University Press, Baltimore, 2001.

William D. Crano and Radmila Prislin. Attitudes and persuasion. *Annual Review of Psychology*, 57:345–374, 2006. ISSN 00664308. doi: 10.1146/annurev.psych.57.102904.190034.

John W. Creswell and Vicki L. Plano Clark. *Designing and conducting mixed methods research.* Sage publications, Los Angeles, 2007. URL https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Creswell%2C+J.%2C+%26+Clark%2C+V.+%282007%29.+Designing+and+conducting+mixed+methods+research.+Los+Angeles%3A+SAGE+Publications.&btnG=.

Timothy Crick. The game body: Toward a phenomenology of contemporary video gaming. *Games and Culture*, 6(3):259–269, 2011.

Larry J. Crockett. Easy to Learn, Difficult to Master: Accessible Front-Ends to Challenging Science Assignments. In *European Conference on Games Based Learning*, page 144. Academic Conferences International Limited, 2016.

Tom Crompton and Shanna Lennon. Values as a Route to Widening Public Concern About Climate Change. In *Handbook of Climate Change Communication: Theory of Climate Change Communication*, volume 1, pages 385–397. Springer, 2018. URL http://www.springer.com/series/8740.

David Crookall. Climate Change and Simulation/Gaming: Learning for Survival. *Simulation and Gaming*, 44(2-3):195–228, 4 2013. ISSN 10468781. doi: 10.1177/1046878113497781.

Mihaly Csikszentmihalyi. *FLOW: The Psychology of Optimal Experience*, volume 1990. Harper & Row, New York, 1990.

C. Esra Cuhadar and Ronit Kampf. Does Conflict Content Affect Learning from Simulations? A Cross-National Inquiry into the Israeli-Palestinian and Guatemalan Conflict Scenarios. *Negotiation and Conflict Management Research*, 8(4):243–260, 2015. ISSN 17504716. doi: 10.1111/ncmr.12062.

Esra Cuhadar and Ronit Kampf. Learning about Conflict and Negotiations through Computer Simulations: The Case of PeaceMaker. *International Studies Perspectives*, 15(4):509–524, 2014. ISSN 15283585. doi: 10.1111/insp.12076.

Geoff Cumming. Inference by eye: Reading the overlap of independent confidence intervals. *Statistics in medicine*, 28(2):205–220, 2009.

Steven Curnin, Christine Owen, Douglas Paton, Cain Trist, and David Parsons. Role Clarity, Swift Trust and Multi-Agency Coordination. *Journal of Contingencies and Crisis Management*, 23(1):29–35, 3 2015. ISSN 1468-5973. doi: 10.1111/1468-5973.12072.

Robert Cuthbert, Selen Turkay, and Ross Brown. The effects of customisation on player experiences and motivation in a virtual reality game. In *OzCHI '19: Proceedings of the 31st Australian Conference on Human-Computer-Interaction*, pages 221–232. Association for Computing Machinery, 2019. ISBN 9781450376969. doi: 10.1145/3369457.3369475. URL `https://dl.acm.org/doi/10.1145/3369457.3369475`.

João Raphael da Silva. The Eco-Terrorist Wave. *Behavioral Sciences of Terrorism and Political Aggression*, 12(3):203–216, 7 2020. ISSN 19434480. doi: 10.1080/19434472.2019.1680725.

Sonya Dal Cin, Mark P. Zanna, and Geoffrey T. Fong. Narrative persuasion and overcoming resistance. In Eric S Knowles and Jay A Linn, editors, *Resistance and Persuasion*, pages 175–191. Lawrence Erlbaum Associates., Mahwah, N.J., 2004. ISBN 0805844864.

Rowan Daneels, Steven Malliet, Lieven Geerts, Natalie Denayer, Michel Walrave, and Heidi Vandebosch. Assassins, gods, and androids: How narratives and game mechanics shape eudaimonic game experiences. *Media and Communication*, 9(1):49–61, 2021. ISSN 21832439. doi: 10.17645/MAC.V9I1.3205.

Paul Darvasi. An Indie Education: Gone Home and Why Independent Games Belong in Classrooms, 2014. URL `https://www.ludiclearning.org/2014/03/19/an-indie-education-gone-home-and-why-independent-games-belong-in-the-classroom/`.

Enny H.H.J. Das, John B.F. De Wit, and Wolfgang Stroebe. Fear appeals motivate acceptance of action recommendations: Evidence for a positive bias in the processing of persuasive

messages. *Personality and Social Psychology Bulletin*, 29(5):650–664, 2003. ISSN 01461672. doi: 10.1177/0146167203029005009.

Michael A. Davis. An Overview of Environmental Themes in the Video Game Industry. *The Geographical Bulletin*, 63(2):97–108, 2022.

Anneke de Graaf, Hans Hoeken, José Sanders, and Johannes W.J. Beentjes. Identification as a Mechanism of Narrative Persuasion. *Communication Research*, 39(6):802–823, 2012. ISSN 00936502. doi: 10.1177/0093650211408594.

Frederik De Grove, Jan Van Looy, Joyce Neys, and Jeroen Jansz. Playing in school or at home? An exploration of the effects of context on educational game experience. In *In Proceedings of the 7th European Conference on Management Leadership and Governance: ECGBL 2011*, pages 137–144, 2011.

Natascha De Hoog, Wolfgang Stroebe, and John B.F. De Wit. The processing of fear-arousing communications: How biased processing leads to persuasion. *Social Influence*, 3(2):84–113, 2008. ISSN 15534510. doi: 10.1080/15534510802185836.

Teresa De La Hera and Hera Conde-Pumpido. A Conceptual Model for the Study of Persuasive Games. In *Proceedings of DiGRA 2013: DeFragging Game Studies.*, 2013.

Teresa De La Hera and Joost Raessens. Looking Beyond Persuasion Through Rule-Based Representations in Digital Games: Designing Games to Shape, Reinforce, or Change Attitudes. In Teresa De La Hera, Jeroen Jansz, Joost Raessens, and Ben Schouten, editors, *Persuasive Gaming in Context*, chapter 4, pages 57–72. Amsterdam University Press, Amsterdam, 2021. ISBN 9789463728805. doi: 10.5117/9789463728805.

Teresa De la Hera, Eugène Loos, Monique Simons, and Joleen Blom. Benefits and factors influencing the design of intergenerational digital games: A systematic literature review. *Societies*, 7(3), 2017. ISSN 20754698. doi: 10.3390/soc7030018.

Teresa De la Hera Conde-Pumpido. Persuasive Gaming: Identifying the different types of persuasion through games. *International Journal of Serious Games*, 4(1), 3 2017. doi: 10.17083/ijsg.v4i1.140.

Teresa De La Hera Conde-Pumpido. The persuasive roles of digital games: The case of cancer games. *Media and Communication*, 6(2):103–111, 2018. ISSN 21832439. doi: 10.17645/mac.v6i2.1336.

Dylan Degeling and Ruud Koolen. Communicating Climate Change to a Local but Diverse Audience: On the Positive Impact of Locality Framing. *Environmental Communication*, 16 (2):243–261, 2022. doi: 10.1080/17524032.2021.1998177. URL `https://www.tandfonline.com/action/journalInformation?journalCode=renc20`.

Dagomar Degroot. Climate change and society in the 15th to 18th centuries. *Wiley Interdisciplinary Reviews: Climate Change*, 9(3), 5 2018. ISSN 17577799. doi: 10.1002/wcc.518.

Kathleen deMarrais. Qualitative Interview Studies: Learning Through Experience. In *Foundations for Research Methods of Inquiry in Education and the Social Sciences*, pages 67–84. Routledge, 2004.

Kenneth G. DeMarree, Cory J. Clark, S. Christian Wheeler, Pablo Briñol, and Richard E. Petty. On the pursuit of desired attitudes: Wanting a different attitude affects information processing and behavior. *Journal of Experimental Social Psychology*, 70:129–142, 5 2017. ISSN 10960465. doi: 10.1016/j.jesp.2017.01.003.

Ann DeSmet, Dimitri Van Ryckeghem, Sofie Compernolle, Tom Baranowski, Debbe Thompson, Geert Crombez, Karolien Poels, Wendy Van Lippevelde, Sara Bastiaensens, Katrien Van Cleemput, Heidi Vandebosch, and Ilse De Bourdeaudhuij. A meta-analysis of serious digital games for healthy lifestyle promotion. *Preventive Medicine*, 69:95–107, 2014. ISSN 10960260. doi: 10.1016/j.ypmed.2014.08.026.

Petra Dickmann, Amanda McClelland, Gaya M. Gamhewage, Patricia Portela de Souza, and Franklin Apfel. Making sense of communication interventions in public health emergencies – an evaluation framework for risk communication. *Journal of Communication in Healthcare*, 8(3):233–240, 1 2015. ISSN 17538076. doi: 10.1080/17538068.2015.1101962.

Tawanna Dillahunt, Olga Lyra, Mary L Barreto, and Evangelos Karapanos. Reducing children's psychological distance from climate change via eco-feedback technologies. *International Journal of Child-Computer Interaction*, 13:19–28, 2017. doi: 10.1016/j.ijcci.2017.05.002. URL `http://dx.doi.org/10.1016/j.ijcci.2017.05.002`.

Alysson Diniz Dos Santos, Francesco Strada, and Andrea Bottino. Approaching Sustainability Learning Via Digital Serious Games. *IEEE Transactions on Learning Technologies*, 12(3): 303–320, 7 2019. ISSN 19391382. doi: 10.1109/TLT.2018.2858770.

Gideon Dishon and Yasmin B. Kafai. Connected civic gaming: rethinking the role of video games in civic education. *Interactive Learning Environments*, 30(6):999–1010, 2022. ISSN 17445191. doi: 10.1080/10494820.2019.1704791. URL `https://doi.org/10.1080/10494820.2019.1704791`.

Janna K. Dominick and Shana Cole. Goals as identities: Boosting perceptions of healthy-eater identity for easier goal pursuit. *Motivation and Emotion*, 44:410–426, 6 2020. ISSN 15736644. doi: 10.1007/s11031-020-09824-8.

Tristan Donovan. *It's All a Game: A Short History of Board Games.* Atlantic Books, 2018.

John S.. Dryzek, Richard B.. Norgaard, and David. Schlosberg. *Oxford handbook of climate change and society.* Oxford University Press, 2011. ISBN 9780199566600.

Carlos M Duarte, Susana Agusti, Edward Barbier, Gregory L Britten, Juan Carlos Castilla, Jean-Pierre Gattuso, Robinson W Fulweiler, Terry P Hughes, Nancy Knowlton, and Catherine E Lovelock. Rebuilding marine life. *Nature*, 580(7801):39–51, 2020. URL `https://www.nature.com/articles/s41586-020-2146-7`.

Riley E. Dunlap, Kent D. Van Liere, Angela G. Mertig, and Robert Emmet Jones. Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues*, 56(3):425–442, 2000. ISSN 00224537. doi: 10.1111/0022-4537.00176.

Carol S. Dweck and Ellen L. Leggett. A Social-Cognitive Approach to Motivation and Personality. *Psychological Review*, 95(2):256–273, 1988. ISSN 0033295X. doi: 10.1037/0033-295X.95.2.256.

Alice H. Eagly and Shelly Chaiken. The Advantages of an Inclusive Definition of Attitude. *Social Cognition*, 25(5):582–602, 2007. doi: https://doi.org/10.1521/soco.2007.25.5.582.

Simon Egenfeldt-Nielsen, Jonas Heide Smith, and Susana Pajares Tosca. *Understanding video games: The essential introduction*. Routledge, 2008.

John R Emery. MORAL CHOICES WITHOUT MORAL LANGUAGE: 1950S POLITICAL-MILITARY WARGAMING AT THE RAND CORPORATION. *Texas National Security Review*, 4(4), 2021. ISSN 2576-1153. URL `https://www.rand.org/pubs/papers/P1472.html`.

Emma Engdahl and Rolf Lidskog. Risk, communication and trust: Towards an emotional understanding of trust. *Public Understanding of Science*, 23(6):703–717, 2014. ISSN 13616609. doi: 10.1177/0963662512460953.

Marcus Eriksen, Laurent C.M. Lebreton, Henry S. Carson, Martin Thiel, Charles J. Moore, Jose C. Borerro, Francois Galgani, Peter G. Ryan, and Julia Reisser. Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. *PLoS ONE*, 9(12), 12 2014. ISSN 19326203. doi: 10.1371/journal.pone.0111913.

Michael A Evans. Procedural ethos: Confirming the persuasive in serious games . *International Journal of Gaming and Computer-Mediated Simulations (IJGCMS)*, 3(4):70–80, 2011.

Carlo Fabricatore and Ximena López. A Model to Identify Affordances for Game-Based Sustainability Learning. In *8th European Conference on Game Based Learning*, pages 99–109. Academic Conferences and Publishing International Limited, 2014. ISBN ISBN 978- 1-910309-55-1.

Justin Farrell. Network structure and influence of the climate change counter-movement. *Nature Climate Change*, 6(4):370–374, 4 2016. ISSN 17586798. doi: 10.1038/nclimate2875.

Russell H. Fazio. Multiple processes by which attitudes guide behavior: The mode model as an integrative framework. *Advances in Experimental Social Psychology*, 23(C):75–109, 1990. ISSN 00652601. doi: 10.1016/S0065-2601(08)60318-4.

Russell H. Fazio. Attitudes as Object–Evaluation Associations of Varying Strength. *Social Cognition*, 25(5):603–637, 2007. doi: https://doi.org/10.1521/soco.2007.25.5.603.

Theodore S. Feldman. Climate and history in the late 18th and early 19th centuries. *Eos,*

*Transactions American Geophysical Union*, 73(1):1–8, 1992. ISSN 23249250. doi: 10.1029/91EO00001.

Daniel Fernández Galeote and Juho Hamari. Game-based Climate Change Engagement: Analyzing the Potential of Entertainment and Serious Games. *Proceedings of the ACM on Human-Computer Interaction*, 5(CHIPLAY), 2021. ISSN 25730142. doi: 10.1145/3474653.

Daniel Fernández Galeote, Nikoletta Zampeta Legaki, and Juho Hamari. Avatar Identities and Climate Change Action in Video Games: Analysis of Mitigation and Adaptation Practices. In *Conference on Human Factors in Computing Systems - Proceedings*. Association for Computing Machinery, 4 2022. ISBN 9781450391573. doi: 10.1145/3491102.3517438.

Daniel Fernández Galeote, Nikoletta Zampeta Legaki, and Juho Hamari. Climate Connected: An Immersive VR and PC Game for Climate Change Engagement. In *CHI PLAY 2023 - Companion Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, pages 266–273. Association for Computing Machinery, Inc, 10 2023a. ISBN 9798400700293. doi: 10.1145/3573382.3616053.

Daniel Fernández Galeote, Nikoletta Zampeta Legaki, and Juho Hamari. Text- and game-based communication for climate change attitude, self-efficacy, and behavior: A controlled experiment. *Computers in Human Behavior*, 149, 12 2023b. ISSN 07475632. doi: 10.1016/j.chb.2023.107930.

L Festinger. The motivating effect of cognitive dissonance. In Lindzey Gardner, editor, *Assessment of human motives.*, pages 65–86. Rinehart, 1958.

Melissa L. Finucane and Joan L. Holup. Risk as value: Combining affect and analysis in risk judgments. *Journal of Risk Research*, 9(2):141–164, 3 2006. ISSN 13669877. doi: 10.1080/13669870500166930.

Walter R. Fisher. Narration as a Human Communication Paradigm: The case of public moral argument. *Communications Monographs*, 51(1):1–22, 1984.

Kristoffer S. Fjællingsdal and Christian A. Klöckner. ENED-GEM: A conceptual framework model for psychological enjoyment factors and learning mechanisms in educational games about the environment. *Frontiers in Psychology*, 8(JUN):1–17, 2017. ISSN 16641078. doi: 10.3389/fpsyg.2017.01085.

Kristoffer S. Fjællingsdal and Christian A. Klöckner. Gaming Green: The Educational Potential of Eco – A Digital Simulated Ecosystem. *Frontiers in Psychology*, 10, 12 2019. ISSN 16641078. doi: 10.3389/fpsyg.2019.02846.

M. Flanagan and H. Nissenbaum. *Values at play in digital games.* MIT Press, Cambridge, 2014. doi: https://doi.org/10.1177/1461444816631742.

Mary Flanagan. *Critical play: Radical game design.* MIT press, Cambridge,, 2009.

K. Fleming, J. Abad, L. Booth, L. Schueller, A. Baills, A. Scolobig, B. Petrovic, G. Zuccaro, and

M. F. Leone. The use of serious games in engaging stakeholders for disaster risk reduction, management and climate change adaption information elicitation. *International Journal of Disaster Risk Reduction*, 49, 10 2020. ISSN 22124209. doi: 10.1016/j.ijdrr.2020.101669.

Stephen Flood, Nicholas A. Cradock-Henry, Paula Blackett, and Peter Edwards. Adaptive and interactive climate futures: Systematic review of 'serious games' for engagement and decision-making. *Environmental Research Letters*, 13(6):063005, 6 2018. ISSN 17489326. doi: 10.1088/1748-9326/aac1c6.

June A. Flora, Melissa Saphir, Matt Lappé, Connie Roser-Renouf, Edward W. Maibach, and Anthony A. Leiserowitz. Evaluation of a national high school entertainment education program: The Alliance for Climate Education. *Climatic Change*, 127(3-4):419–434, 11 2014. ISSN 15731480. doi: 10.1007/s10584-014-1274-1.

Brian J. Fogg. Persuasive computers: perspectives and research directions. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 225–232, 1998.

Brian J. Fogg. Computers as persuasive tools. In *Persuasive Technology Using Computers to Change What We Think and Do*, pages 31–59. Morgan Kaufmann, 1st edition edition, 2003a.

Brian J. Fogg. Overview of captology. In *Persuasive Technology Using Computers to Change What We Think and Do*, pages 15–20. Morgan Kaufmann, 1st edition edition, 2003b.

Brian J. Fogg. *Persuasive Technology Using Computers to Change What We Think and Do*. Morgan Kaufmann, 1st edition edition, 2003c.

Brian J. Fogg. The functional triad: computers in persuasive roles. In *Persuasive Technology Using Computers to Change What We Think and Do*, pages 23–29. Morgan Kaufmann, 1st edition edition, 2003d.

Brian Jeffrey Fogg, Gregory Cueller, and David Danielson. Motivating, influencing, and persuading users: An introduction to captology. In *The human-computer interaction handbook*, pages 159–172. CRC press, 2007.

Jesse Fox and Jeremy N. Bailenson. Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors. *Media Psychology*, 12(1):1–25, 1 2009. ISSN 15213269. doi: 10.1080/15213260802669474.

Jesse Fox, Jessica McKnight, Yilu Sun, David Maung, and Roger Crawfis. Using a serious game to communicate risk and minimize psychological distance regarding environmental pollution. *Telematics and Informatics*, 46, 3 2020. ISSN 07365853. doi: 10.1016/j.tele.2019.101320.

Christopher Franzwa, Ying Tang, and Aaron Johnson. Serious game design: Motivating students through a balance of fun and learning. *5th International Conference on Games and Virtual Worlds for Serious Applications, VS-GAMES*, 2013. doi: 10.1109/VS-GAMES.2013.6624239.

Guo Freeman, Samaneh Zamanifard, Divine Maloney, and Alexandra Adkins. My body, my avatar: How people perceive their avatars in social virtual reality. In *Conference on Human*

*Factors in Computing Systems - Proceedings*. Association for Computing Machinery, 4 2020. ISBN 9781450368193. doi: 10.1145/3334480.3382923.

Lynn Frewer. The public and effective risk communication. In *Toxicology Letters*, volume 149, pages 391–397, 2004. doi: 10.1016/j.toxlet.2003.12.049.

Jon Froehlich, Leah Findlater, and James Landay. The Design of Eco-Feedback Technology. In *Proceedings of the SIGCHI conference on human factors in computing systems*, pages 1999–2008, 2010. ISBN 9781605589299.

Thomas Frohlich, Dmitry Alexandrovsky, Timo Stabbert, Tanja Döring, and Rainer Malaka. Vrbox: A virtual reality augmented sandbox for immersive playfulness, creativity and exploration. In *CHI PLAY 2018 - Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play*, pages 163–171. Association for Computing Machinery, Inc, 10 2018. ISBN 9781450356244. doi: 10.1145/3242671.3242697.

Christopher P. Furner and Robert A. Zinko. The influence of information overload on the development of trust and purchase intention based on online product reviews in a mobile vs. web environment: an empirical investigation. *Electronic Markets*, 27(3):211–224, 8 2017. ISSN 14228890. doi: 10.1007/S12525-016-0233-2/METRICS. URL `https://link.springer.com/article/10.1007/s12525-016-0233-2`.

Daniel Fernández Galeote, Mikko Rajanen, Dorina Rajanen, Nikoletta Zampeta Legaki, David J. Langley, and Juho Hamari. Gamification for climate change engagement: Review of corpus and future agenda. *Environmental Research Letters*, 16(6):063004, 2021. ISSN 17489326. doi: 10.1088/1748-9326/abec05.

Kristel M Gallagher and John A Updegraff. Health Message Framing Effects on Attitudes, Intentions, and Behavior. *Annals of Behavioral Medicine*, 43(1):101–116, 2012. doi: https://doi.org/10.1007/s12160-011-9308-7.

Anthony Gampell, JC Gaillard, Meg Parsons, and Loïc Le Dé. Fostering student
}participation in disaster
}risk reduction through
}disaster video games. *Australian Journal of Emergency Management*, 35(2), 2020.

Anthony Viennaminovich Gampell and JC Gaillard. Stop Disasters 2.0: Video Games as Tools for Disaster Risk Reduction. *International Journal of Mass Emergencies & Disasters*, 34(2): 283–316, 8 2016. ISSN 0280-7270. doi: 10.1177/028072701603400205.

Anthony Viennaminovich Gampell, J. C. Gaillard, Meg Parsons, and Karen Fisher. Beyond Stop Disasters 2.0: an agenda for exploring the contribution of video games to learning about disasters. *Environmental Hazards*, 16(2):180–191, 4 2017. ISSN 18780059. doi: 10.1080/17477891.2016.1275502. URL `https://www.tandfonline.com/doi/abs/10.1080/17477891.2016.1275502`.

Geetanjali Ganguly, Joana Setzer, and Veerle Heyvaert. If at first you don't succeed: Suing

corporations for climate change. *Oxford Journal of Legal Studies*, 38(4):841–868, 2018. ISSN 14643820. doi: 10.1093/ojls/gqy029.

Maaz Gardezi and J. Gordon Arbuckle. Techno-Optimism and Farmers' Attitudes Toward Climate Change Adaptation. *Environment and Behavior*, 52(1):82–105, 1 2020. ISSN 1552390X. doi: 10.1177/0013916518793482.

Rosemary Garris, Robert Ahlers, and James E. Driskell. Games, motivation, and learning: A research and practice model. *Simulation and Gaming*, 33(4):441–467, 12 2002. ISSN 10468781. doi: 10.1177/1046878102238607.

Bertram Gawronski. Attitudes can be measured! But what is an attitude? *Social Cognition*, 25(5):573–581, 2007. ISSN 0278016X. doi: 10.1521/soco.2007.25.5.573.

Bertram Gawronski and Galen V. Bodenhausen. Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change, 9 2006. ISSN 00332909.

Bertram Gawronski and Galen V Bodenhausen. Unraveling the processes }underlying evaluation: Attitudes from the perspective of the APE }model. *Social Cognition*, 25(5):687–717, 2007. doi: https://doi.org/10.1521/soco.2007.25.5.687.

Bertram Gawronski and Galen V. Bodenhausen. Implicit and explicit evaluation: A brief review of the associative-propositional evaluation model. *Social and Personality Psychology Compass*, 8(8):448–462, 2014. ISSN 17519004. doi: 10.1111/spc3.12124.

Bertram Gawronski and Skylar M Brannon. Attitudes and the Implicit-Explicit Dualism. In Dolores Albarracin and Blair T. Johnson, editors, *The Handbook of Attitudes, Volume 1: Basic Principles*, volume 1, 2nd ed, pages 158–196. Routledge, 2019. ISBN ISBN 9781138648265.

Bertram Gawronski and B. Keith Payne. *Handbook of Implicit Social Cognition Measurement, Theory, and Applications*. Guilford Press, 2010. ISBN ISBN 9781606236734.

Andreas Gerber, Markus Ulrich, and Patrick Wäger. Review of haptic and computerized (simulation) games on climate change. In Marcin Wardaszko, Sebastiaan Meijer, Heide Lukosch, Hidehiko Kanegae, Willy Christian Kriz, and Mariola Grzybowska-Brzezińska, editors, *The International Simulation and Gaming Association Conference, ISAGA*, volume 11988 of *Lecture Notes in Computer Science*, pages 275–289, Cham, 2019. Springer International Publishing. ISBN 978-3-030-72131-2. doi: 10.1007/978-3-030-72132-9. URL `http://link.springer.com/10.1007/978-3-030-72132-9`.

KM Gerling, RL Mandryk, MV Birk, and M Miller ... The Effects of Embodied Persuasive Games on Player Attitudes Toward People Using Wheelchairs. In *CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, page 3413–3422, 2014. doi: https://doi.org/10.1145/2556288.2556962. URL `https://doi.org/10.1145/2556288.2556962`.

Chloé Germaine. 'Nature' games in a time of climate crisis. In *Material Game Studies: A Philosophy of Analogue Play*, pages 143–162. Bloomsbury Publishing Plc., 1 2023. ISBN 9781350202733. doi: 10.5040/9781350202757.0017.

John Fitz Gibbon and Kenneth O. Mensah. Climate change as a wicked problem: An evaluation of the institutional context for rural water management in ghana. *SAGE Open*, 2(2):1–14, 4 2012. ISSN 21582440. doi: 10.1177/2158244012448487.

Laura R. Glasman and Dolores Albarracín. Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. *Psychological Bulletin*, 132(5):778–822, 9 2006. ISSN 00332909. doi: 10.1037/0033-2909.132.5.778.

Matthew H. Goldberg, Abel Gustafson, and Sander van der Linden. Leveraging Social Science to Generate Lasting Engagement with Climate Change Solutions, 9 2020. ISSN 25903322.

Marcello A Gómez Maureira and Carolien Rieffe. Level Design Patterns That Invoke Curiosity-Driven Exploration: An Empirical Study Across Multiple Conditions. In *Proc. ACM Hum.-Comput. Interact. CHI PLAY*, volume 5, 2021. doi: 10.1145/3474698. URL `https://doi.org/10.1145/3474698`.

Marcello A. Gómez Maureira, Isabelle Kniestedt, Max J. Van Duijn, Carolien Rieffe, and Aske Plaat. Shinobi Valley: Studying curiosity for virtual spatial exploration through a video game. In *CHI PLAY 2019 - Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play*, pages 421–428. Association for Computing Machinery, Inc, 10 2019. ISBN 9781450368711. doi: 10.1145/3341215.3356276.

Arthur Graesser, Patrick Chipman, and Frank Leeming. Deep learning and emotion in serious games. In *Serious games*, pages 105–124. Routledge, 2009.

Jennifer B. Gray and Nancy G. Harrington. Narrative and Framing: A Test of an Integrated Message Strategy in the Exercise Context. *Journal of Health Communication*, 16(3):264–281, 2011. doi: 10.1080/10810730.2010.529490.

Melanie C. Green. Transportation into Narrative Worlds. In Lauren B. Frank and Paul Falzone, editors, *Entertainment-Education Behind the Scenes: Case Studies for Theory and Practice*, pages 87– 103. Palgrave Macmillan, Brooklyn, NY, 2021. ISBN 9783030636135.

Melanie C. Green and Timothy C. Brock. The role of transportation in the persuasiveness of public narratives. *Journal of personality and social psychology*, 79(5):701, 2000.

Melanie C. Green, Timothy C. Brock, and Geoff F. Kaufman. Understanding media enjoyment: The role of transportation into narrative worlds. *Communication Theory*, 14(4):311–327, 2004. ISSN 10503293. doi: 10.1111/j.1468-2885.2004.tb00317.x.

Anthony G. Greenwald, Debbie E. McGhee, and Jordan LK Schwartz. Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology*, 74(6):1464, 1998.

Anthony G Greenwald, Brian A. Nosek, and Mahzarin R. Banaji. Understanding and using the implicit association test: I. An improved scoring algorithm. *Journal of personality and social psychology*, 85(2):197, 2003.

Mary Greer, Lijia Lin, and Robert K. Atkinson. Using a computer game to teach school-aged children about asthma. *Interactive Learning Environments*, 25(4):431–438, 5 2017. ISSN 17445191. doi: 10.1080/10494820.2015.1135469. URL `https://www.tandfonline.com/doi/abs/10.1080/10494820.2015.1135469`.

Mark D. Griffiths, Daria J. Kuss, and Angelica B. Ortiz de Gortari. Videogames as Therapy. *International Journal of Privacy and Health Information Management*, 5(2):71–96, 2017. ISSN 2155-5621. doi: 10.4018/ijphim.2017070105.

Vladas Griskevicius, Michelle N. Shiota, and Samantha L. Neufeld. Influence of different positive emotions on persuasion processing: a functional evolutionary approach. *Emotion (Washington, D.C.)*, 10(2):190–206, 2010. ISSN 1931-1516. doi: 10.1037/A0018421. URL `https://pubmed.ncbi.nlm.nih.gov/20364895/`.

Rosanna E. Guadagno, Amanda Sardos, and Amanda M. Kimbrough. If you reply to me, I will buy from you: A social influence examination of reciprocity on Twitter. In *12th International Workshop on Behavior Change Support Systems (BCSS 2024)*. R. Piskac c/o Redaktion Sun SITE, Informatik V, RWTH Aachen, 2024. URL `https://oulurepo.oulu.fi/handle/10024/49076`.

Kuddithamby Gunaalan, Elena Fabbri, and Marco Capolupo. The hidden threat of plastic leachates: A critical review on their impacts on aquatic organisms. *Water Research*, 184, 10 2020. ISSN 18792448. doi: 10.1016/j.watres.2020.116170.

Zamira Gurabardhi, Jan M. Gutteling, and Margôt Kuttschreuter. The development of risk communication: An empirical analysis of the literature in the field. *Science Communication*, 25(4):323–349, 6 2004. ISSN 10755470. doi: 10.1177/1075547004265148.

Abel Gustafson and Ronald E. Rice. Cumulative Advantage in Sustainability Communication: Unintended Implications of the Knowledge Deficit Model. *Science Communication*, 38(6): 800–811, 2016. ISSN 15528545. doi: 10.1177/1075547016674320.

Belinda Gutierrez, Anna Kaatz, Sarah Chu, Dennis Ramirez, Clem Samson-Samuel, and Molly Carnes. "fair Play": A Videogame Designed to Address Implicit Race Bias Through Active Perspective Taking, 12 2014. ISSN 21617856.

Manuela Hafner and Jeroen Jansz. The Players‘ Experience of Immersion in Persuasive Games. *International Journal of Serious Games*, 5(4):63–79, 12 2018. doi: 10.17083/ijsg.v5i4.263.

Jerold L. Hale, Robert Lemieux, and Paul A. Mongeau. Cognitive Processing of Fear-Arousing Message Content. *Communication Research*, 22(4):459–474, 1995. ISSN 15523810. doi: 10.1177/009365095022004004.

Kristin Haltinner and Dilshani Sarathchandra. Considering attitudinal uncertainty in the climate change skepticism continuum. *Global Environmental Change*, 68, 5 2021. ISSN 09593780. doi: 10.1016/j.gloenvcha.2021.102243.

Juho Hamari and Lauri Keronen. Why do people play games? A meta-analysis. *International Journal of Information Management*, 37(3):125–141, 6 2017. ISSN 0268-4012. doi: 10.1016/J.IJINFOMGT.2017.01.006.

Juho Hamari, David J. Shernoff, Elizabeth Rowe, Brianno Coller, Jodi Asbell-Clarke, and Teon Edwards. Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, 54:170–179, 1 2016. ISSN 07475632. doi: 10.1016/j.chb.2015.07.045. URL `https://www.sciencedirect.com/science/article/pii/S074756321530056X`.

Anne Hamby and Niusha Jones. The Effect of Affect: An Appraisal Theory Perspective on Emotional Engagement in Narrative Persuasion. *Journal of Advertising*, 51(1):116–131, 2022. ISSN 00913367. doi: 10.1080/00913367.2021.1981498. URL `https://www.tandfonline.com/doi/abs/10.1080/00913367.2021.1981498`.

Anne Hamby, David Brinberg, and Kim Daniloski. Reflecting on the journey: Mechanisms in narrative persuasion. *Journal of Consumer Psychology*, 27(1):11–22, 2017.

Anne Hamby, David Brinberg, and James Jaccard. A Conceptual Framework of Narrative Persuasion. *Journal of Media Psychology*, 30(3):113–124, 2018. ISSN 21512388. doi: 10.1027/1864-1105/a000187.

Farid A. Hamdan, Amador J. Lara-Sánchez, and Víctor Arufe-Giráldez. Critical thinking in environmental education through digital games among students. *Environment and Social Psychology*, 8(2), 2023. ISSN 24248975. doi: 10.54517/esp.v8i2.1725.

Lisa Anne Hamilton and Steven Feit. Plastic & Climate: The hidden costs of a plastic planet. Technical report, CIEL. Switzerland. Retrieved from https://policycommons.net/artifacts/2485040/untitled/3507468/ on 25 July 2023. CID: 20.500.12592/qctxbd., 2019.

Christopher Hanson. Repetition. In Mark J. P. Wolf and Bernard Perron, editors, *The Routledge Companion to Video Game Studies*, pages 204–2010. Routledge, New York, NY, 2014.

Stephen W Harmon. Virtual Worlds as a Trigger for Transformative Learning. *Technology*, 51 (2):28–32, 2011. URL `https://www.jstor.org/stable/44429914`.

Blake J. Harris. *Console wars : Sega, Nintendo, and the battle that defined a generation.* Atlantic Books Ltd„ 2014. ISBN 9781782395287.

Dylan M Harris. Expanding Climate Science: Using Science Fiction's Worldbuilding to Imagine a Climate Changed Southwestern U.S. *Literary Geographies*, 6(1):59–76, 2020.

Marna Hauk. Dreams of earth: Earth dreaming as eco-resilience practice for the long emergency.

In *Ecopsychology*, volume 7, pages 258–265. Mary Ann Liebert Inc., 2015. doi: 10.1089/eco.2015.0039.

Lucy J. Hawcroft and Taciano L. Milfont. The use (and abuse) of the new environmental paradigm scale over the last 30 years: A meta-analysis. *Journal of Environmental Psychology*, 30(2):143–158, 2010. ISSN 02724944. doi: 10.1016/j.jenvp.2009.10.003. URL `http://dx.doi.org/10.1016/j.jenvp.2009.10.003`.

Harriet Hawkins and Anja Kanngieser. Artful climate change communication: overcoming abstractions, insensibilities, and distances. *Wiley Interdisciplinary Reviews: Climate Change*, 8(5):1–12, 9 2017. ISSN 17577799. doi: 10.1002/wcc.472.

Roxanne D. Hawkins, Gilly A.R.Mendes Ferreira, and Joanne M. Williams. The development and evaluation of 'farm animal welfare': An educational computer game for children. *Animals*, 9(3), 2019. ISSN 20762615. doi: 10.3390/ani9030091.

Helen Ai He, Saul Greenberg, and Elaine M. Huang. One Size Does Not Fit All: Applying the Transtheoretical
}Model to Energy Feedback Technology Design. In *(HCI) ACM Conference on Human Factors in Computing Systems, Atlanta, Ga, USA, April 10-15*, pages 927–936. Association for Computing Machinery, 2010.

Theresa (Huan) He. *The Art of Persuasion: Self-Esteem, Message Framing, and the Persuasiveness of Prosocial Messages*. PhD thesis, University of Victoria, 2015. URL `http://hdl.handle.net/1828/6998`.

Chip Heath and Dan Heath. *Switch: How to Change Things When Change Is Hard*. Currency, 2010.

R. L Heath. Telling a story: A narrative approach to communication during crisis. . In *Responding to crisis*, pages 167–187. Routledge, 2004.

Robert L. Heath and H. Dan O'Hair. The significance of risk and crisis communication. In Robert L. Heath and H. Dan O'Hair, editors, *Handbook of Risk and Crisis Communication*, pages 5–30. Routledge, New York, 2010. doi: 10.4324/9781003070726.

Robert.L Heath and Kathy. Nathan. Public relations' role in risk communication: Information, rhetoric, and power. *Public Relations Quarterly*, 35(4):15–22, 1990.

Jonas Heide Smith and Sine Norholm Just. Playful Persuasion The Rhetorical Potential of Advergames. *Nordicom Review*, 30:53–68, 2009.

Stephen Hilgartner. The dominant view of popularization: Conceptual problems, political uses. *Social studies of science*, 20(3):519–539, 1990.

Aggie Hirst. Wargames Resurgent: The Hyperrealities of Military Gaming from Recruitment to Rehabilitation. *International Studies Quarterly*, 66(3), 9 2022. ISSN 14682478. doi: 10.1093/isq/sqac021.

Rob W Holland, Ree M. Meertens, and Mark Van Vugt. Dissonance on the Road: Self-Esteem as a Moderator of Internal and External Self-Justification Strategies. *Personality and Social Psychology Bulletin*, 28(12):13–24, 2002. URL https://doi.org/10.1177/014616702237652.

Corina Höppner, Rebecca Whittle, Michael Bründl, and Matthias Buchecker. Linking social capacities and risk communication in Europe: A gap between theory and practice? *Natural Hazards*, 64(2):1753–1778, 10 2012. ISSN 0921030X. doi: 10.1007/s11069-012-0356-5.

Säde Hormio. Collective responsibility for climate change. *Wiley Interdisciplinary Reviews: Climate Change*, 14(4), 2023. ISSN 1757-7799. doi: 10.1002/WCC.830. URL https://onlinelibrary.wiley.com/doi/full/10.1002/wcc.830https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.830https://wires.onlinelibrary.wiley.com/doi/10.1002/wcc.830.

Matthew J. Hornsey and Kelly S. Fielding. A cautionary note about messages of hope: Focusing on progress in reducing carbon emissions weakens mitigation motivation. *Global Environmental Change*, 39:26–34, 7 2016. ISSN 09593780. doi: 10.1016/j.gloenvcha.2016.04.003.

Rachel A. Howell. It's not (just) "the environment, stupid!" Values, motivations, and routes to engagement of people adopting lower-carbon lifestyles. *Global Environmental Change*, 23(1): 281–290, 2 2013. ISSN 09593780. doi: 10.1016/j.gloenvcha.2012.10.015.

Rachel A. Howell. Investigating the Long-Term Impacts of Climate Change Communications on Individuals' Attitudes and Behavior. *Environment and Behavior*, 46(1):70–101, 1 2014. ISSN 00139165. doi: 10.1177/0013916512452428.

Rachel A Howell and Simon Allen. People and planet: Values, motivations and formative influences of individuals acting to mitigate climate change. *Environmental Values*, 26(2): 131–155, 2017.

Martina Z. Huber and Lorenz M. Hilty. Gamification and sustainable consumption: Overcoming the limitations of persuasive technologies. *Advances in Intelligent Systems and Computing*, pages 367–385, 2015. ISSN 21945357. doi: 10.1007/978-3-319-09228-7{_}22.

Johan Huizinga. *Homo Ludens: A study of the play-element in culture*. Routledge, London, UK, 1949.

Mike Hulme. *Why We Disagree about Climate Change*. Cambridge University Press, 2009. ISBN 9781107268890, 1107268893.

Robin Hunicke, Marc Leblanc, and Robert Zubek. MDA: A Formal Approach to Game Design and Game Research. In *The AAAI Workshop on Challenges in Game AI*, page 1722, 2004.

Leila Hurmerinta-Peltomäki and Niina Nummela. Mixed methods in international business research: A value-added perspective. *Management International Review*, 46(4):439–459, 2006. ISSN 09388249. doi: 10.1007/S11575-006-0100-Z/METRICS. URL https://link.springer.com/article/10.1007/s11575-006-0100-z.

G. Tanner Jackson and Danielle S. McNamara. Motivation and performance in a game-based intelligent tutoring system. *Journal of Educational Psychology*, 105(4):1036–1049, 11 2013. ISSN 00220663. doi: 10.1037/a0032580.

Rudd Jacobs and Jeroen Jansz. The Present of Persuasion: Escalating Research into Persuasive Game Effects. In Teresa De La Hera, Jeroen Jansz, Jeroen Jansz, and Ben Schouten, editors, *Persuasive Gaming in Context*, pages 185–200. Amsterdam University Press, 2021.

Ruud Jacobs. Play to Win Over: Effects of Persuasive Games. *Psychology of Popular Media Culture*, 7(3), 2018.

Ruud S Jacobs, Julia Kneer, and Jeroen Jansz. Playing against abuse: Effects of procedural and narrative persuasive games. *Journal of Games, Self, and Society*, 1(1):97–120, 2019.

Jenna R. Jambeck, Roland Geyer, Chris Wilcox, Theodore R. Siegler, Miriam Perryman, Anthony Andrady, Ramani Narayan, and Kara Lavender Law. Plastic waste inputs from land into the ocean. *Science*, 347(6223):768–771, 2015.

Shamila Janakiraman, Sunnie Lee Watson, and William R. Watson. Using Game-based Learning to Facilitate Attitude Change for Environmental Sustainability. *Journal of Education for Sustainable Development*, 12(2):176–185, 9 2018. ISSN 0973-4082. doi: 10.1177/0973408218783286.

Paige Brown Jarreau, Zeynep Altinay, and Amy Reynolds. Best Practices in Environmental Communication: A Case Study of Louisiana's Coastal Crisis. *Environmental Communication*, 11(2):143–165, 3 2017. ISSN 17524040. doi: 10.1080/17524032.2015.1094103. URL `https://www.tandfonline.com/doi/abs/10.1080/17524032.2015.1094103`.

Jonathan Jenkins Ichikawa. *Contextualising Knowledge: Epistemology and Semantics*. Oxford University Press, New York, NY, first edition edition, 2017.

Jennifer Ann's Group. Power and Control, 2011. URL `https://jenniferann.org/`.

Stephanie Jennings. A Meta-Synthesis of Agency in Game Studies. Trends, Troubles, Trajectories. *Jennings, Stephanie C. G/ A/ M/ E Games as Art, Media, Entertainment*, 1(8), 2019. URL `https://www.gamejournal.it/?p=3912`.

Jamie Jirout and David Klahr. Children's scientific curiosity: In search of an operational definition of an elusive concept. *Developmental Review*, 32(2):125–160, 6 2012. ISSN 02732297. doi: 10.1016/j.dr.2012.04.002.

Daniel Johnson, Sebastian Deterding, Kerri Ann Kuhn, Aleksandra Staneva, Stoyan Stoyanov, and Leanne Hides. Gamification for health and wellbeing: A systematic review of the literature. *Internet Interventions*, 6:89–106, 2016. ISSN 22147829. doi: 10.1016/j.invent.2016.10.002. URL `http://dx.doi.org/10.1016/j.invent.2016.10.002`.

Daniel Kahneman. *Thinking, fast and slow*. Penguin Books, London, 2012. ISBN 9780141033570.

Daniel Kahneman and Amos Tversky. Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2):263–292, 1979. doi: 10.2307/j.ctv1kr4n03.21. URL http://links.jstor.org/sici?sici=0012-9682%28197903%2947%3A2%3C263%3APTAAOD%3E2.0.CO%3B2-3.

Ronit Kampf. Computerized simulations of the Israeli-Palestinian conflict, knowledge acquisition and attitude change. *Proceedings of the European Conference on Games-based Learning*, 2015-Janua:269–275, 2015. ISSN 20490992.

Ronit Kampf. Long-term effects of computerized simulations in protracted conflicts: The case of global conflicts. In *International Conference on Persuasive Technology*, pages 242–247. Springer International Publishing, 2016a.

Ronit Kampf. The Context is the Message?! Learning about the Israeli-Palestinian Conflict through Computerized Simulations in Different National Contexts. *Universal Journal of Educational Research*, 4(8):1787–1796, 2016b. ISSN 2332-3205. doi: 10.13189/ujer.2016.040807.

Ronit Kampf and Esra Cuhadar. Do computer games enhance learning about conflicts? A cross-national inquiry into proximate and distant scenarios in Global Conflicts. *Computers in Human Behavior*, 52:541–549, 2015. ISSN 07475632. doi: 10.1016/j.chb.2014.08.008. URL http://dx.doi.org/10.1016/j.chb.2014.08.008.

Bandana Kar. Citizen science in risk communication in the era of ICT. *Concurrency and Computation: Practice and Experience*, 28(7):2005–2013, 5 2016. ISSN 15320634. doi: 10.1002/cpe.3705.

George Kelly. *A theory of personality: The psychology of personal constructs*, volume 152. WW Norton & Company, 1963.

Shawna Kelly and Bonnie Nardi. Playing with sustainability: Using video games to simulate futures of scarcity. *First Monday*, 2014.

Elin Kelsey. Propagating Collective Hope in the Midst of Environmental Doom and Gloom. *Canadian Journal of Environmental Education*, 21:23–40, 2016.

Theodore D. Kemper and Richard S. Lazarus. Emotion and Adaptation. *Contemporary Sociology*, 21(4):522, 1992. ISSN 00943061. doi: 10.2307/2075902.

Steve L. Kent. *The ultimate history of video games : from Pong to Pokemon and beyond : the story behind the craze that touched our lives and changed the world.* Crown, 2001. ISBN 9780307560872.

Shabana Khan, Jyoti L. Mishra, Kuna hui Elaine Lin, and Emma E.H. Doyle. Rethinking communication in risk interpretation and action. *Natural Hazards*, 88(3):1709–1726, 9 2017. ISSN 15730840. doi: 10.1007/s11069-017-2942-z.

Jihyun Kim, Hayeon Song, Kelly Merrill, Younbo Jung, and Remi Junghuem Kwon. If You

Quit Smoking, This Could Happen to You: Investigating Framing and Modeling Effects in an Anti-Smoking Serious Game. *International Journal of Human-Computer Interaction*, 38(8):730–741, 2022. ISSN 15327590. doi: 10.1080/10447318.2021.1970429. URL `https://doi.org/10.1080/10447318.2021.1970429`.

Myung Ja Kim, Namho Chung, Choong Ki Lee, and Michael W. Preis. Dual-route of persuasive communications in mobile tourism shopping. *Telematics and Informatics*, 33(2):293–308, 2016. ISSN 07365853. doi: 10.1016/j.tele.2015.08.009.

Nigel King. Using templates in the thematic analysis of text. In Catherine Cassell and Gillian Symon, editors, *Essential guide to qualitative methods in organizational research*, pages 257–270. Sage, London, UK, 2004.

James L. Kinneavy and Catherine R. Eskin. Kairos in Aristotle's rhetoric. *Written communication*, 17(3):432–444, 2000.

Jens E. Kjeldsen. Pictorial Argumentation in Advertising: Visual Tropes and Figures as a Way of Creating Visual Argumentation. In *Argumentation Library*, volume 22, pages 239–255. Springer Nature, 2012.

Jan H.G. Klabbers. On the Architecture of Game Science. *Simulation and Gaming*, 49(3): 207–245, 6 2018. ISSN 1552826X. doi: 10.1177/1046878118762534.

Christoph Klimmt. *Serious Games and Social Change: Why They (Should) Work*. Routledge; 1 edition, London, 2009. ISBN 9780203891650.

Avraham N Kluger and Angelo Denisi. The Effects of Feedback Interventions on Performance: A Historical Review, a Meta-Analysis, and a Preliminary Feedback Intervention Theory. *Psychological Bulletin*, 9(2):254–284, 1996.

Erik Knol and Peter W. De Vries. In-depth EnerCities, a Serious Game to Stimulate Sustainability and Energy Conservation: Preliminary Results. *eLearning Papers*, 25(July):1–10, 2011.

Jason Koebler. The Radical Environmentalism of the Sega Genesis, 2017. URL `https://www.vice.com/en/article/wnzdk9/the-radical-environmentalism-of-the-sega-genesis`.

Lukáš Kolek, Vít Šisler, and Cyril Brom. Video games and attitude change – can we reliably measure this? The challenges of empirical study design. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 11385 LNCS:445–448, 2019. ISSN 16113349. doi: 10.1007/978-3-030-11548-7{_}46.

Lukáš Kolek, Vít Šisler, Patrícia Martinková, and Cyril Brom. Can video games change attitudes towards history? Results from a laboratory experiment measuring short- and long-term effects. *Journal of Computer Assisted Learning*, 37(5):1348–1369, 2021. ISSN 13652729. doi: 10.1111/jcal.12575.

Miloslav Kolenatý, Roman Kroufek, and Jan Činčera. What Triggers Climate Action: The

Impact of a Climate Change Education Program on Students' Climate Literacy and Their Willingness to Act. *Sustainability (Switzerland)*, 14(16), 8 2022. ISSN 20711050. doi: 10.3390/su141610365.

Hannu Korhonen. *Evaluating Playability of Mobile Games with the Expert Review Method*. PhD thesis, University of Tampere, 2016. URL `http://tampub.uta.fi`.

Martijn J.L. Kors, Gabriele Ferri, Erik D. Van Der Spek, Cas Ketel, and Ben A.M. Schouten. A breathtaking journey. On the design of an empathy-arousing mixed-reality game. In *CHI PLAY 2016 - Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, number October 2017, pages 91–104, 2016. ISBN 9781450344562. doi: 10.1145/2967934.2968110.

Martijn J.L. Kors, Erik D. van der Spek, Gabriele Ferri, and Ben A.M. Schouten. You; the observer, partaker or victim. Delineating Three Perspectives to Empathic Engagement in Persuasive Games using Immersive Technologies. In *CHI PLAY 2018 - Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*, number November, pages 493–501, 2018. ISBN 9781450359689. doi: 10.1145/3270316.3271547.

Chelsea L. Kracht, Elizabeth D. Joseph, and Amanda E. Staiano. Video Games, Obesity, and Children. *Current obesity reports*, 9(1):1–14, 2020.

Marina Krcmar, Kirstie Farrar, and Rory McGloin. The effects of video game realism on attention, retention and aggressive outcomes. *Computers in Human Behavior*, 27(1):432–439, 1 2011. ISSN 07475632. doi: 10.1016/j.chb.2010.09.005.

Petr Květon and Martin Jelínek. Frustration and Violence in Mobile Video Games: An Experimental Evaluation of Their Effect on Implicit Aggression. *Swiss Journal of Psychology*, 79(2), 11 2019. ISSN 14210185. doi: 10.1024/1421-0185/A000236. URL `https://econtent.hogrefe.com/doi/10.1024/1421-0185/a000236`.

Roberta Kwok. Can climate change games boost public understanding? *Proceedings of the National Academy of Sciences of the United States of America*, 116(16):7602–7604, 2019. ISSN 10916490. doi: 10.1073/pnas.1903508116.

Petros Lameras, Sylvester Arnab, Ian Dunwell, Craig Stewart, Samantha Clarke, and Panagiotis Petridis. Essential features of serious games design in higher education: Linking learning attributes to game mechanics. *British journal of educational technology*, 48(4):972–994, 2017.

Kristin A. Lane, Mahzarin R Banaji, Brian A Nosek, and Anthony G Greenwald. Understanding and using the implicit association test: IV. In y Bernd Wittenbrink and Norbert Schwarz, editors, *Implicit measures of . . .*, pages 59–102. The Guilford Press, 2007.

Benjamin P. Lange, Johannes Breuer, Benny Liebold, and Daniel Pietschmann. Why an Evolutionary Psychological Approach to Digital Games? In *Evolutionary Psychology and Digital Games*, pages 1–13. Routledge, 2018. doi: 10.4324/9781315160825-1.

Matthew A. Lapierre, Frances Fleming-Milici, Esther Rozendaal, Anna R. McAlister, and Jessica Castonguay. The effect of advertising on children and adolescents. *Pediatrics*, 140: S152–S156, 2017. ISSN 10984275. doi: 10.1542/peds.2016-1758V.

Terry Lavender. Games Just Wanna Have Fun... Or Do They? Measuring The Effectiveness of Persuasive Games. *Loading...*, 1(1), 2007. URL `www.goarmy.com?`

Nathalie Lazaric. The role of routines, rules and habits in collective learning: Some epistemological and ontological considerations. *European Journal of Economic and Social Systems*, 14 (2), 2000.

Nicole Lazzaro. Why we play: affect and the fun of games. In Andrew Sears and Julie A. Jacko, editors, *Human-computer interaction: Designing for diverse users and domains*, pages 679–700. CRC Press, 2009.

Hervé Le Treut, Richard Somerville, Ulrich Cubasch, Yihui Ding, Cecilie Mauritzen, Abdalah Mokssit, Thomas Peterson, and Michael Prather. Historical Overview of Climate Change Science. In *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pages 95–127. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007.

Hoesung Lee, José Romero, and IPCC The Core Writing Team Synthesis Report. IPCC: the Intergovernmental Panel on Climate Change. Technical report, Intergovernmental Panel on Climate Change, Geneva, Switzerland, 2023. URL `https://www.ipcc.ch/report/ar6/syr/`.

Joey J. Lee, Pinar Ceyhan, William Jordan-Cooley, and Woonhee Sung. GREENIFY: A Real-World Action Game for Climate Change Education. *Simulation and Gaming*, 44(2-3):349–365, 2013. ISSN 10468781. doi: 10.1177/1046878112470539.

Taejun (David) Lee, Hyojung Park, and Junesoo Lee. Collaborative accountability for sustainable public health: A Korean perspective on the effective use of ICT-based health risk communication. *Government Information Quarterly*, 36(2):226–236, 4 2019. ISSN 0740624X. doi: 10.1016/j.giq.2018.12.008.

Anthony Leiserowitz, Connie Roser-Renouf, Jennifer Marlon, and Edward Maibach. Global Warming's Six Americas: a review and recommendations for climate change communication, 12 2021. ISSN 23521546.

Jennifer S. Lerner, Ye Li, Piercarlo Valdesolo, and Karim S. Kassam. Emotion and decision making. *Annual Review of Psychology*, 66:799–823, 1 2015. ISSN 15452085. doi: 10.1146/annurev-psych-010213-115043.

Zoe Leviston, Murni Greenhill, and Iain Walker. Australian attitudes to climate change and adaptation: 2010-2014. *CSIRO: Land and Water*, pages 1–81, 2015. URL `https://publications.csiro.au/rpr/pub?list=SEA&pid=csiro:EP158008`.

Benjamin J. Li, Rabindra Ratan, and May O. Lwin. Virtual game Changers: how avatars and virtual coaches influence exergame outcomes through enactive and vicarious learning. *Behaviour and Information Technology*, 41(7):1529–1543, 2022. ISSN 13623001. doi: 10.1080/0144929X.2021.1884290.

Jih Hsuan Tammy Lin and Dai Yun Wu. Newsgames for the Greater Good: The Effects of Graphic Realism and Geographic Proximity on Knowledge Acquisition and Willingness to Help. *Journalism and Mass Communication Quarterly*, 97(1):30–51, 3 2020. ISSN 2161430X. doi: 10.1177/1077699018820315.

Hoi Shing Lo, Yan Kin Lee, Beverly Hoi Ki Po, Leung Chun Wong, Xiaoyu Xu, Cheuk Fung Wong, Chun Yuen Wong, Nora Fung Yee Tam, and Siu Gin Cheung. Impacts of Typhoon Mangkhut in 2018 on the deposition of marine debris and microplastics on beaches in Hong Kong. *Science of the Total Environment*, 716, 5 2020. ISSN 18791026. doi: 10.1016/j.scitotenv.2020.137172.

Michael Loadenthal. "Eco-terrorism": An incident-driven history of attack (1973-2010). *Journal of the Study of Radicalism*, 11(2):1–33, 9 2017. ISSN 19301197. doi: 10.14321/JSTUDRADI.11.2.0001.

Edwin A Locke and Gary P Latham. New Directions in Goal-Setting Theory. *Current directions in psychological science*, 15(5):265–268, 2006.

Alejandro Lozano. Creative possibilities of repetition in videogame aesthetics. *Studi di estetica*, (12), 2018. ISSN 0585-4733. doi: 10.7413/18258646061. URL `https://journals.mimesisedizioni.it/index.php/studi-di-estetica/article/view/627`.

Adrian Lubowiecki-Vikuk, Anna Dąbrowska, and Aleksandra Machnik. Responsible consumer and lifestyle: Sustainability insights, 1 2021. ISSN 23525509.

Zihan Ma. *Exploring the Relationship Between Game Mechanics and Ethical Play: A Study of Pandemic and Papers, Please.* PhD thesis, Worcester Polytechnic Institute, 2023.

Joan K Magilvy and Eileen Thomas. A first qualitative project: Qualitative descriptive design for novice researchers. *Journal for Specialists in Pediatric nursing*, 14(4):298–300, 2009. doi: 10.1111/j.1744-6155.2009.00212.x. URL `http://www.nova.edu/ssss/QR11-2/Thomas.pdf`.

Jeana L. Magyar-Moe. Positive Psychological Tests and Measures. In Jeana L. Magyar-Moe, editor, *Therapist's Guide to Positive Psychological Interventions- Practical Resources for the Mental Health Professional*, chapter 3, pages 43–72. Academic Press, 2009. URL `https://doi.org/10.1016/B978-0-12-374517-0.00003-6`.

Cian Maher. A new wave of indies are using games to explore climate change - The Verge, 2020. URL `https://www.theverge.com/2020/2/13/21135321/video-games-climate-change-beyond-blue-bee-simulator-temtem-endling`.

Durairaj Maheswaran and Joan Meyers-Levy. The influence of message framing and issue

involvement. *Journal of Marketing research*, 27(3):361–367, 1990. URL https://doi.org/10.1177/002224379002700310.

Edward W Maibach, Matthew Nisbet, Paula Baldwin, Karen Akerlof, and Guoqing Diao. Reframing climate change as a public health issue: an exploratory study of public reactions. *BMC Public Health 2010,*, 10(299), 2010.

Péter Kristóf Makai. Simulated Climate in Ecological Games: Mediating Climate Change to Endow Players with Transformative Agency. In *The Palgrave Handbook of Intermediality*, pages 1061–1088. Palgrave Macmillan, Cham, 2023. ISBN 978-3-031-28322-2. doi: 10.1007/978-3-031-28322-2{_}51. URL https://link.springer.com/referenceworkentry/10.1007/978-3-031-28322-2_51.

David M. Markowitz, Rob Laha, Brian P. Perone, Roy D. Pea, and Jeremy N. Bailenson. Immersive Virtual Reality field trips facilitate learning about climate change. *Frontiers in Psychology*, 9(NOV), 2018. ISSN 16641078. doi: 10.3389/fpsyg.2018.02364.

Ezra Markowitz, Caroline Hodge, and Gabriel Harp. Connecting on Climate: A Guide to Effective Climate Change Communication. Technical report, Center for Research on Environmental Decisions, Earth Institute, Columbia University, 2014.

Jennifer R. Marlon, Brittany Bloodhart, Matthew T. Ballew, Justin Rolfe-Redding, Connie Roser-Renouf, Anthony Leiserowitz, and Edward Maibach. How Hope and Doubt Affect Climate Change Mobilization. *Frontiers in Communication*, 4, 2019. ISSN 2297900X. doi: 10.3389/fcomm.2019.00020.

Tim Marsh. Designing for positive and serious experience: devices for creativity, engagement, reflection and learning. In *Lecture Notes in Computer Science*, volume 9090, pages 3–10. Springer Verlag, 2015. ISBN 9783319191256. doi: 10.1007/978-3-319-19126-3{_}1.

Tim Marsh. Slow serious games, interactions and play: Designing for positive and serious experience and reflection. *Entertainment Computing*, 14:45–53, 5 2016. ISSN 18759521. doi: 10.1016/j.entcom.2015.10.001.

Rustono Farady Marta, Joshua Fernando, Angelia Sampurna, Jesus Rafael Boado Jarata, and Kenn Lazuardhi Syarnubi. Interactivity in E-Sport Future Learning from the Choices and Attributes Perspectives of Online News. *Review of International Geographical Education Online*, 11(4):1192–1202, 2021. ISSN 21460353. doi: 10.33403/rigeo.8006835.

Marjolaine Martel-Morin and Erick Lachapelle. The Five Canadas of Climate Change: Using audience segmentation to inform communication on climate policy. *PLoS ONE*, 17(11 November), 11 2022. ISSN 19326203. doi: 10.1371/journal.pone.0273977.

José Martí-Parreño, Jesús Bermejo-Berros, and Joaquín Aldás-Manzano. Product Placement in Video Games: The Effect of Brand Familiarity and Repetition on Consumers' Memory. *Journal of Interactive Marketing*, 38:55–63, 2017. ISSN 15206653. doi: 10.1016/j.intmar.2016.12.001.

Jeff Vance Martin and Gretchen Sneegas. Critical Worldbuilding: Toward a Geographical Engagement with Imagined Worlds. *Literary Geographies*, 6(1):15–23, 2020.

John Matthews, Khin Than Win, Harri Oinas-Kukkonen, and Mark Freeman. Persuasive Technology in Mobile Applications Promoting Physical Activity: a Systematic Review. *Journal of Medical Systems*, 40(3):1–13, 3 2016. ISSN 1573689X. doi: 10.1007/s10916-015-0425-x.

Lindsey C. Maxwell and Alec C. Tefertiller. Watching is the new reading: Comparing the outcomes of popular books, TV shows, and video games. *First Monday*, 24, 2019. doi: http://dx.doi.org/10.5210/fm.v24i8.9157.

Aaron M. McCright, Riley E. Dunlap, and Chenyang Xiao. The impacts of temperature anomalies and political orientation on perceived winter warming. *Nature Climate Change*, 4(12): 1077–1081, 2014. ISSN 17586798. doi: 10.1038/nclimate2443.

Paul McDivitt. *The Information Deficit Model is Dead. Now What?Evaluating New Strategies for Communicating Anthropogenic Climate Change in the Context of Contemporary American Politics, Economy, and Culture*. PhD thesis, University of Colorado, 2016.

Patrick McGuire. What's the Trouble with 'Pipe Trouble,' the Satirical Game That's Inflamed Canada's Energy Battle?, 2013. URL `https://www.vice.com/en/article/53385b/the-trouble-with-pipe-trouble`.

Charlotte M Mckernan. *Worldbuilding: a survey of games and architecture at play*. PhD thesis, The University of New Mexico, 2017. URL `https://digitalrepository.unm.edu/arch_etdsWorldbuilding:asurveyofgamesandarchitectureatplay.`".

Alison Mcmahan. Immersion, engagement, and presence: A method for analyzing 3-D video games. In *The video game theory reader*, pages 67–86. Routledge, New York, NY, USA, 2003. URL `https://www.researchgate.net/publication/284055280`.

Erin L. Merz, Vanessa L. Malcarne, Scott C. Roesch, Celine M. Ko, Marc Emerson, Vincenzo G. Roma, and Georgia Robins Sadler. Psychometric properties of Positive and Negative Affect Schedule (PANAS) original and short forms in an African American community sample. *Journal of affective disorders*, 151(3):942–949, 2013.

Malcolm Miles. Representing nature: Art and climate change. *Cultural Geographies*, 17(1): 19–35, 2010. ISSN 14744740. doi: 10.1177/1474474009349997.

Matthew Miles, A. Michael Huberman, and Johnny Saldana. *Qualitative Data Analysis: A Methods Sourcebook*. SAGE Publications, fourth edition edition, 2019. ISBN 9781506353081. URL `https://us.sagepub.com/en-us/nam/qualitative-data-analysis/book246128`.

Taciano L. Milfont. Global warming, climate change and human psychology. In V. Corral-Verdugo, C.H. García-Cadena, and M. Frías-Arment, editors, *Psychological approaches to sustainability: Current trends in theory, research and practice*. Nova Science Publishers, New York, 2010. URL `www.milfont.com`.

Taciano L. Milfont. The Interplay Between Knowledge, Perceived Efficacy, and Concern About Global Warming and Climate Change: A One-Year Longitudinal Study. *Risk Analysis*, 32 (6):1003–1020, 6 2012. ISSN 02724332. doi: 10.1111/j.1539-6924.2012.01800.x.

Taciano L. Milfont, Danny Osborne, Kumar Yogeeswaran, and Chris G. Sibley. The role of national identity in collective pro-environmental action. *Journal of Environmental Psychology*, 72, 12 2020. ISSN 15229610. doi: 10.1016/j.jenvp.2020.101522.

Clark A. Miller, Jason O'Leary, Elisabeth Graffy, Ellen B. Stechel, and Gary Dirks. Narrative futures and the governance of energy transitions. *Futures*, 70:65–74, 6 2015. ISSN 00163287. doi: 10.1016/j.futures.2014.12.001.

Konstantin Mitgutsch and Narda Alvarado. Purposeful by design?: A serious game design assessment framework. In *Proceedings of the International Conference on the Foundations of Digital Games (FDG '12)*, pages 121–128, 2012. ISBN 9781450313339. doi: 10.1145/2282338.2282364.

Mithra Moezzi, Kathryn B. Janda, and Sea Rotmann. Using stories, narratives, and storytelling in energy and climate change research. *Energy Research and Social Science*, 31:1–10, 9 2017. ISSN 22146296. doi: 10.1016/j.erss.2017.06.034.

Nabilah Mokhtar, Lim Zhi Xuan, Hairul Faiezi Lokman, and Noor Hayati Che Mat. Theory, Literature Review, and Fun Learning Method Effectiveness in Teaching and Learning. *International Journal of Social Science and Education Research Studies*, 03(08), 8 2023. ISSN 27702782. doi: 10.55677/ijssers/V03I8Y2023-30. URL `https://ijssers.org/single-view/?id=8823&pid=8674`.

Janice M. Morse and Seung Eun Chung. Toward Holism: The Significance of Methodological Pluralism. *International Journal of Qualitative Methods*, 2(3):13–20, 2003. ISSN 1609-4069. doi: 10.1177/160940690300200302. URL `https://journals.sagepub.com/doi/full/10.1177/160940690300200302`.

Susanne Moser. Communicating climate change: history, challenges, process and future directions. *Wiley Interdisciplinary Reviews: Climate Change*, 1(1):31–53, 2010. doi: 10.1002/wcc.011.

Vicki Moulder, Lorna R. Boschman, Ron Wakkary, Carman Neustaedter, and Hiroki Hill Kobayashi. HCI interventions for science communication. In *Conference on Human Factors in Computing Systems - Proceedings*, volume 2018-April. Association for Computing Machinery, 4 2018. ISBN 9781450356206. doi: 10.1145/3170427.3174357.

Emily Moyer-Gusé and Katherine Dale. Narrative Persuasion Theories. *The International Encyclopedia of Media Effects*, pages 1–11, 2017. doi: 10.1002/9781118783764.wbieme0082.

Sheila T. Murphy, Lauren B. Frank, Joyee S. Chatterjee, and Lourdes Baezconde-Garbanati. Narrative versus Nonnarrative: The Role of Identification, Transportation, and Emotion

in Reducing Health Disparities. *Journal of Communication*, 63(1):116–137, 2013. ISSN 00219916. doi: 10.1111/jcom.12007.

Soraya Murray. Postcoloniality, Ecocriticism and Lessons from the Playable Landscape. In *Ecogames: Playful Perspectives on the Climate Crisis*, pages 145–162. Amsterdam University Press, 2024.

Museum of the Game. Growl - Videogame by Taito International Arcade Museum. *https://www.arcade-museum.com/Videogame/growl*, 1991. URL `https://www.arcade-museum.com/Videogame/growl`.

Robin L. Nabi. Exploring the framing effects of emotion: Do discrete emotions differentially influence information accessibility, information seeking, and policy preference? *Communication Research*, 30(2):224–247, 2003. ISSN 00936502. doi: 10.1177/0093650202250881.

Robin L. Nabi and Melanie C. Green. The Role of a Narrative's Emotional Flow in Promoting Persuasive Outcomes. *Media Psychology*, 18(2):137–162, 4 2015. ISSN 15213269. doi: 10.1080/15213269.2014.912585. URL `https://www.tandfonline.com/doi/abs/10.1080/15213269.2014.912585`.

Robin L. Nabi, Abel Gustafson, and Risa Jensen. Framing Climate Change: Exploring the Role of Emotion in Generating Advocacy Behavior. *Science Communication*, 40(4):442–468, 2018. ISSN 15528545. doi: 10.1177/1075547018776019.

Lennart E. Nacke, Sophie Stellmach, and Craig A. Lindley. Electroencephalographic assessment of player experience: A pilot study in affective ludology. *Simulation and Gaming*, 42(5):632–655, 10 2011. ISSN 10468781. doi: 10.1177/1046878110378140.

Imogen Ellen Napper and Richard C. Thompson. Plastic Debris in the Marine Environment: History and Future Challenges. *Global Challenges*, 4(6):1900081, 6 2020. ISSN 2056-6646. doi: 10.1002/gch2.201900081.

National Research Council (U.S.). Committee on Risk Perception and Communication. *Improving risk communication*. National Academy Press, 1989. ISBN 0309039460.

Isabel Newsome. An educational game bringing awareness to declining insect populations. In *CHI PLAY 2020 - Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play*, pages 326–329. Association for Computing Machinery, Inc, 11 2020. ISBN 9781450375870. doi: 10.1145/3383668.3419912.

Robert J Nicholls, Sally Brown, Mark Tebboth, William Neil, Bashir Ahmad, Hester Biemans, Florence Crick, Arthur F Lutz, Safra De Campos, Mohammed Said, Chandni Singh, Modathir Abdalla Hassan Zaroug, Eva Ludi, Mark New, and Philippus Wester. The need for bottom-up assessments of climate risks and adaptation in climate-sensitive regions. *Nature Climate Change*, 9(7):503–511, 2019.

Makuochi Nkwo and Rita Orji. Persuasive technology in African context deconstructing persua-

sive techniques in an African online marketplace. In *ACM International Conference Proceeding Series*, pages 89–98. Association for Computing Machinery, 12 2018. ISBN 9781450365581. doi: 10.1145/3283458.3283479.

Megan A Norcia. *Gaming Empire in Children's British Board Games, 1836-1860*. Routledge, 2019.

Alicia O'Cathain, Elizabeth Murphy, and Jon Nicholl. Three techniques for integrating data in mixed methods studies. *British Medical Journal*, 341:1147–1150, 9 2010. ISSN 0959-8138. doi: 10.1136/BMJ.C4587. URL `https://www.bmj.com/content/341/bmj.c4587https://www.bmj.com/content/341/bmj.c4587.abstract`.

Robert Ighodaro Ogie, Juan Castilla Rho, and Rodney J. Clarke. Artificial intelligence in disaster risk communication: A systematic literature review. In *5th International Conference on Information and Communication Technologies for Disaster Management (ICT-DM)*, page 1. IEEE, 2018. ISBN 9781538666388.

Harri Oinas-Kukkonen and Marja Harjumaa. Persuasive Systems Design: Key Issues, Process Model, and System Features. *Communications of the Association for Information Systems*, 24 (1):28, 3 2009. ISSN 1529-3181. doi: 10.17705/1CAIS.02428. URL `https://aisel.aisnet.org/cais/vol24/iss1/28`.

Maria Ojala. Hope and climate change: The importance of hope for environmental engagement among young people. *Environmental Education Research*, 18(5):625–642, 2012. ISSN 14695871. doi: 10.1080/13504622.2011.637157.

Maria Ojala. Hope and climate-change engagement from a psychological perspective. *Current Opinion in Psychology*, 49, 2 2023. ISSN 2352250X. doi: 10.1016/j.copsyc.2022.101514.

Daniel J. O'Keefe and Jakob D. Jensen. Do loss-framed persuasive messages engender greater message processing than do gain-framed messages? A meta-analytic review. *Communication Studies*, 59(1):51–67, 2008. ISSN 17451035. doi: 10.1080/10510970701849388.

Saffron O'Neill and Sophie Nicholson-Cole. "fear won't do it": Promoting positive engagement with climate change through visual and iconic representations. *Science Communication*, 30 (3):355–379, 2009. ISSN 10755470. doi: 10.1177/1075547008329201.

Laura Op De Beke, Joost Raessens, and Stefan Werning. Ecogames: An Introduction. In *Ecogames: Playful Perspectives on the Climate Crisis*, pages 9–70. Amsterdam University Press, Amsterdam, 2024a. doi: 10.1515/9789048557219-001/HTML.

Laura Op De Beke, Joost Raessens, Stefan Werning, and Gerald Farca. *Ecogames: Playful Perspectives on the Climate Crisis*. Amsterdam University Press, Amsterdam, 2024b.

Fidelia A. Orji, Kiemute Oyibo, Rita Orji, Jim Greer, and Julita Vassileva. Personalization of Persuasive Technology in Higher Education. In *the 27th ACM Conference on User Model-*

*ing, Adaptation and Personalization*, pages 336–340. Association for Computing Machinery (ACM), 6 2019a. doi: 10.1145/3320435.3320478.

Rita Orji and Karyn Moffatt. Persuasive technology for health and wellness: State-of-the-art and emerging trends. *Health Informatics Journal*, 24(1):66–91, 3 2018. ISSN 17412811. doi: 10.1177/1460458216650979.

Rita Orji, Regan L. Mandryk, and Julita Vassileva. Improving the efficacy of games for change using personalization models. *ACM Transactions on Computer-Human Interaction*, 24(5), 2017. ISSN 15577325. doi: 10.1145/3119929.

Rita Orji, Gustavo F. Tondello, and Lennart E. Nacke. Personalizing persuasive strategies in gameful systems to gamification user types. In *Conference on Human Factors in Computing Systems - Proceedings*, volume 2018-April. Association for Computing Machinery, 4 2018. ISBN 9781450356206. doi: 10.1145/3173574.3174009.

Rita Orji, Derek Reilly, Kiemute Oyibo, and Fidelia A. Orji. Deconstructing persuasiveness of strategies in behaviour change systems using the ARCS model of motivation. *Behaviour and Information Technology*, 38(4):319–335, 2019b. ISSN 13623001. doi: 10.1080/0144929X.2018.1520302.

Ben Orlove, Rachael Shwom, Ezra Markowitz, and So-Min Cheong. Climate Decision-Making. *Annual Review of Environment and Resources*, 45, 2020. doi: 10.1146/annurev-environ-012320. URL `https://doi.org/10.1146/annurev-environ-012320-`.

Tania Ouariachi, María Dolores Olvera-Lobo, and José Gutiérrez-Pérez. Analyzing Climate Change Communication Through Online Games: Development and Application of Validated Criteria. *Science Communication*, 39(1):10–44, 2017. ISSN 15528545. doi: 10.1177/1075547016687998.

Tania Ouariachi, José Gutiérrez-Pérez, and María Dolores Olvera-Lobo. Can serious games help to mitigate climate change? Exploring their influence on Spanish and American teenagers' attitudes. *Psyecology*, 9(3):365–395, 2018a. ISSN 19899386. doi: 10.1080/21711976.2018.1493774. URL `https://doi.org/10.1080/21711976.2018.1493774`.

Tania Ouariachi, María Dolores Olvera-Lobo, José Gutiérrez-Pérez, and Edward Maibach. A framework for climate change engagement through video games. *Environmental Education Research*, 25(5):701–716, 2018b. ISSN 14695871. doi: 10.1080/13504622.2018.1545156. URL `https://doi.org/10.1080/13504622.2018.1545156`.

Tania Ouariachi, Chih Yen Li, and Wim J.L. Elving. Gamification approaches for education and engagement on pro-environmental behaviors: Searching for best practices. *Sustainability (Switzerland)*, 12(11), 2020. ISSN 20711050. doi: 10.3390/su12114565.

Tania Ouariachi, María D. Olvera-Lobo, and José Gutiérrez-Pérez. Gaming Education: Learning about Climate Change through Digital Game-Based Teaching. In *Education for Democ-*

*racy 2.0: Changing Frames of Media Literacy*, volume 6. Brill, 2021. ISBN 978-90-04-44849-0. doi: 10.1163/9789004448490. URL https://brill.com/display/title/59612.

Brian C. O'Neill, James M. Done, Andrew Gettelman, Peter Lawrence, Flavio Lehner, Jean Francois Lamarque, Lei Lin, Andrew J. Monaghan, Keith Oleson, Xiaolin Ren, Benjamin M. Sanderson, Claudia Tebaldi, Matthias Weitzel, Yangyang Xu, Brooke Anderson, Miranda J. Fix, and Samuel Levis. The Benefits of Reduced Anthropogenic Climate changE (BRACE): a synthesis. *Climatic Change*, 146(3-4):287–301, 2 2018. ISSN 15731480. doi: 10.1007/s10584-017-2009-x.

Janne Paavilainen. Defining playability of games: Functionality, usability, and gameplay. In *ACM International Conference Proceeding Series*, pages 55–64. Association for Computing Machinery, 2020. ISBN 9781450377744. doi: 10.1145/3377290.3377309.

James Painter and Teresa Ashe. Cross-national comparison of the presence of climate scepticism in the print media in six countries, 2007-10. *Environmental Research Letters*, 7(4), 2012. ISSN 17489326. doi: 10.1088/1748-9326/7/4/044005.

Felan Parker. Boutique indie : Annapurna interactive and contemporary independent game development. *Independent Videogames*, pages 129–147, 10 2020. doi: 10.4324/9780367336219-11. URL https://www.taylorfrancis.com/chapters/edit/10.4324/9780367336219-11/boutique-indie-felan-parker.

Joe Parlock. How independent video game developers are exploring the world's environmental issues, 2017. URL https://www.telegraph.co.uk/gaming/what-to-play/independent-video-game-developers-exploring-worlds-environmental/.

Sarah R. Partan and Peter Marler. Issues in the classification of multimodal communication signals. . *The American Naturalist*, 166(2):231–245, 2005.

Trista Patterson, Sam Barratt, Spartaco Albertarelli, Piero Fraternali, Jasminko Novak, Andrea Emilio Rizzoli, and Cristina Rottondi. Playing for the Planet – How video games can deliver for people and the environment. *Proceedings of the 11th European Conference on Games Based Learning, ECGBL 2017*, pages 935–938, 2017.

Warren Pearce, Brian Brown, Brigitte Nerlich, and Nelya Koteyko. Communicating climate change: Conduits, content, and consensus, 11 2015. ISSN 17577799.

Reinhard Pekrun, Thomas Goetz, Lia M. Daniels, Robert H. Stupnisky, and Raymond P. Perry. Boredom in Achievement Settings: Exploring Control-Value Antecedents and Performance Outcomes of a Neglected Emotion. *Journal of Educational Psychology*, 102(3):531–549, 8 2010. ISSN 00220663. doi: 10.1037/a0019243.

Jorge Peña and Juan Francisco Hernández Pérez. Game perspective-taking effects on willingness to help immigrants: A replication study with a Spanish sample. *New Media & Society*, 22 (6):–958, 2019. ISSN 14617315. doi: 10.1177/1461444819874472. URL https://journals.sagepub.com/doi/abs/10.1177/1461444819874472.

Jorge Pena, Juan Francisco Hernandez Perez, Subuhi Khan, and Angel Pablo Cano Gomez. Game Perspective-Taking Effects on Players' Behavioral Intention, Attitudes, Subjective Norms, and Self-Efficacy to Help Immigrants: The Case of "Papers, Please". *Cyberpsychology, Behavior, and Social Networking*, 21(11):687–693, 2018. ISSN 21522723. doi: 10.1089/cyber.2018.0030.

Wei Peng, Mira Lee, and Carrie Heeter. The Effects of a Serious Game on Role-Taking and Willingness to Help. *Journal of Communication*, 60(4):723–742, 2010. ISSN 00219916. doi: 10.1111/j.1460-2466.2010.01511.x.

Richard E. Petty and John T Cacioppo. Source Factors and the Elaboration Likelihood Model of Persuasion. In Thomas C. Kinnear, editor, *Advances in Consumer Research*, volume 11, pages 668–672. Association for Consumer Research, 1984.

Richard E. Petty, Zakary L. Tormala, and Derek D. Rucker. Resisting persuasion by counterarguing: An attitude strength perspective. *Perspectivism in social psychology: The yin and yang of scientific progress.*, pages 37–51, 2005. doi: 10.1037/10750-004.

Aleksandra Pilarska. Sense of identity and self-control: The mediating role of goal characteristics. *Psihologijske Teme*, 29(2):291–310, 2020. ISSN 13320742. doi: 10.31820/pt.29.2.5.

Alonzo Plough and Sheldon Krimsky. The Emergence of Risk Communication Studies: Social and Political Context. In *Readings in Risk*, number 3, pages 223–231. RFF Press, 2013. URL `https://www.jstor.org/stable/689375?seq=1&cid=pdf-`.

Wouter Poortinga, Alexa Spence, Lorraine Whitmarsh, Stuart Capstick, and Nick F. Pidgeon. Uncertain climate: An investigation into public scepticism about anthropogenic climate change. *Global Environmental Change*, 21(3):1015–1024, 8 2011. ISSN 09593780. doi: 10.1016/j.gloenvcha.2011.03.001.

Sharyn J. Potter, Mary Flanagan, Max Seidman, Hannah Hodges, and Jane G. Stapleton. Developing and Piloting Videogames to Increase College and University Students' Awareness and Efficacy of the Bystander Role in Incidents of Sexual Violence. *Games for Health Journal*, 8(1):24–34, 2 2019. ISSN 21617856. doi: 10.1089/G4H.2017.0172. URL `https://www.liebertpub.com/doi/10.1089/g4h.2017.0172`.

Sharyn J. Potter, Jennifer M. Demers, Mary Flanagan, Max Seidman, and Elizabeth A. Moschella. Can video games help prevent violence? An evaluation of games promoting bystander intervention to combat sexual violence on college campuses. *Psychology of Violence*, 11(2), 2021. ISSN 2152081X. doi: 10.1037/VIO0000365.

Marc Poumadère, Raquel Bertoldo, and Jaleh Samadi. Public perceptions and governance of controversial technologies to tackle climate change: Nuclear power, carbon capture and storage, wind, and geoengineering, 2011. ISSN 17577799.

C. Aaron Price, Katherine Gean, Claire G. Christensen, Elham Beheshti, Bryn Pernot, Gloria Segovia, Halcyon Person, Steven Beasley, and Patricia Ward. Casual Games and Casual

Learning About Human Biological Systems. *Journal of Science Education and Technology*, 25(1):111–126, 2 2016. ISSN 15731839. doi: 10.1007/s10956-015-9580-6.

Jennifer C. Price, Iain A. Walker, and Fabio Boschetti. Measuring cultural values and beliefs about environment to identify their role in climate change responses. *Journal of Environmental Psychology*, 37:8–20, 3 2014. ISSN 02724944. doi: 10.1016/j.jenvp.2013.10.001.

André Queirós, Daniel Faria, and Fernando Almeida. Strengths and limitations of qualitative and quantitative research methods. *European Journal of Education Studies*, 3(9):369–387, 9 2017. ISSN 25011111. doi: 10.46827/EJES.V0I0.1017. URL `https://oapub.org/edu/index.php/ejes/article/view/1017/2935https://oapub.org/edu/index.php/ejes/article/view/1017/2936https://oapub.org/edu/index.php/ejes/article/view/1017`.

Francis Rasamoelina, Carole Bouchard, and Améziane Aoussat. EcoKansei : An Emotional Investigation For Environmental Behaviors. Technical report, Product design and innovation laboratoty report, 2013.

Werner Siegfried Ravyse, A. Seugnet Blignaut, Verona Leendertz, and Alex Woolner. Success factors for serious games to enhance learning: a systematic review. *Virtual Reality*, 21(1): 31–58, 2017. ISSN 14349957. doi: 10.1007/s10055-016-0298-4.

Diana Reckien and Klaus Eisenack. Climate Change Gaming on Board and Screen: A Review. *Simulation and Gaming*, 44(2-3):253–271, 2013. ISSN 10468781. doi: 10.1177/1046878113480867.

Amber Marie Reinhart, Heather M. Marshall, Thomas Hugh Feeley, and Frank Tutzauer. The Persuasive Effects of Message Framing in Organ Donation: The Mediating Role of Psychological Reactance. *Communication Monographs*, 74(2):229–255, 2007. doi: 10.1080/03637750701397098.

Ortwin Renn. Risk Communication: Insights and Requirements for Designing Successful Communication Programs on Health and Environmental Hazards. In *Handbook of risk and crisis communication*, pages 80–98. Routledge, 2020.

Minjin M.J. Rheu, Youjin Jang, and Wei Peng. Enhancing Healthy Behaviors Through Virtual Self: A Systematic Review of Health Interventions Using Avatars. *Games for Health Journal*, 9(2):85–94, 2020. ISSN 21617856. doi: 10.1089/g4h.2018.0134.

Sofia Ribeiro and Viriato Soromenho-Marques. The Techno-Optimists of Climate Change: Science Communication or Technowashing? *Societies*, 12(2), 4 2022. ISSN 20754698. doi: 10.3390/soc12020064.

Linda Riebel. Creativity and the long emergency. *Ecopsychology*, 7(4):238–244, 12 2015. ISSN 19429347. doi: 10.1089/eco.2015.0015.

Danielle Riendeau. Old Sega Games Were Really Environmentalist, 2017. URL `https://www.vice.com/en/article/z4yna9/old-sega-games-were-really-environmentalist`.

Sco Rigby and Richard Ryan. The Player Experience of Need Satisfaction (PENS): An applied model and methodology for understanding key components of the player experience. *Immersyve Inc*, 2007.

Ute Ritterfeld, Michael Cody, and Peter Vorderer. *Serious games: Mechanisms and effects*. Routledge Taylor & Francis Group, 8 2009. ISBN 0203891651. doi: 10.4324/9780203891650.

Colin Robson. *Real world research: A resource for users of social research methods in applied settings*. Wiley, Chichester, West Sussex, 3rd edition edition, 2011.

Caspar T.J. Roebroek, Shaun Harrigan, Tim H.M. Van Emmerik, Calum Baugh, Dirk Eilander, Christel Prudhomme, and Florian Pappenberger. Plastic in global rivers: Are floods making it worse? *Environmental Research Letters*, 16(2), 2 2021. ISSN 17489326. doi: 10.1088/1748-9326/abd5df.

Ryan Rogers. The motivational pull of video game feedback, rules, and social interaction: Another self-determination theory approach. *Computers in Human Behavior*, 73:446–450, 2017.

Carla Roncoli. Ethnographic and participatory approaches to research on farmers' responses to climate predictions. *Climate Research*, 33(1):81–99, 2006. URL `www.int-res.com`.

J. N. Rooney-Varga, J. D. Sterman, E. Fracassi, T. Franck, F. Kapmeier, V. Kurker, E. Johnston, A. P. Jones, and K. Rath. Combining role-play with interactive simulation to motivate informed climate action: Evidence from the World Climate simulation. *PLoS ONE*, 13(8): 1–28, 2018. ISSN 19326203. doi: 10.1371/journal.pone.0202877.

Juliette N. Rooney-Varga, Florian Kapmeier, John D. Sterman, Andrew P. Jones, Michele Putko, and Kenneth Rath. The Climate Action Simulation. *Simulation and Gaming*, 51(2): 114–140, 4 2020. ISSN 1552826X. doi: 10.1177/1046878119890643.

Lynn D. Rosentrater, Ingrid Sælensminde, Frida Ekström, Gisela Böhm, Ann Bostrom, Daniel Hanss, and Robert E. O'Connor. Efficacy Trade-Offs in Individuals' Support for Climate Change Policies. *Environment and Behavior*, 45(8):935–970, 11 2013. ISSN 00139165. doi: 10.1177/0013916512450510.

Alexander J. Rothman, Peter Salovey, Carol Antone, Kelli Keough, and Chloé Drake Martin. The influence of message framing on intentions to perform health behaviors. *Journal of Experimental Social Psychology*, 29(5):408–433, 1993. ISSN 10960465. doi: 10.1006/jesp.1993.1019.

Paul Rozin and Edward B. Royzman. Negativity bias, negativity dominance, and contagion. *Personality and Social Psychology Review*, 5(4):296–320, 2001. ISSN 10888683. doi: 10.1207/S15327957PSPR0504{_}2.

Dana Ruggiero. The effect of playing a persuasive game on attitude and affective learning. *Computers in Human Behavior*, 45:213–221, 2014. ISSN 0747-5632. doi: 10.1016/j.chb.2014.11.062. URL http://docs.lib.purdue.edu/dissertations/AAI3592098/.

Dana Ruggiero. The effect of a persuasive social impact game on affective learning and attitude. *Computers in Human Behavior*, 45:213–221, 2015. ISSN 07475632. doi: 10.1016/j.chb.2014.11.062. URL http://dx.doi.org/10.1016/j.chb.2014.11.062.

Robert A.C. Ruiter, Loes T.E. Kessels, Gjalt Jorn Y. Peters, and Gerjo Kok. Sixty years of fear appeal research: Current state of the evidence. *International Journal of Psychology*, 49(2):63–70, 4 2014. ISSN 1464-066X. doi: 10.1002/IJOP.12042. URL https://onlinelibrary.wiley.com/doi/full/10.1002/ijop.12042https://onlinelibrary.wiley.com/doi/abs/10.1002/ijop.12042https://onlinelibrary.wiley.com/doi/10.1002/ijop.12042.

Danya Rumore, Todd Schenk, and Lawrence Susskind. Role-play simulations for climate change adaptation education and engagement. *Nature Climate Change*, 6(8):745–750, 8 2016. ISSN 17586798. doi: 10.1038/nclimate3084.

Marie-Laure Ryan. *Narrative as Virtual Reality Immersion and Interactivity in Literature and Electronic Media*. The Johns Hopkins University Press, Baltimore, MD, USA, 2003. ISBN isbn0801864879. URL www.press.jhu.edu.

Richard M. Ryan, C. Scott Rigby, and Andrew Przybylski. The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, 30(4):347–363, 2006. ISSN 01467239. doi: 10.1007/s11031-006-9051-8.

Sefat Salama and Khalil Aboukoura. Role of emotions in climate change communication. *Climate Change Management*, pages 137–150, 2018. ISSN 16102010. doi: 10.1007/978-3-319-69838-0{_}9/COVER. URL https://link.springer.com/chapter/10.1007/978-3-319-69838-0_9.

Muniba Saleem and Craig A. Anderson. Arabs as terrorists: Effects of stereotypes within violent contexts on attitudes, perceptions, and affect. *Psychology of Violence*, 3(1):84–99, 2013. ISSN 21520828. doi: 10.1037/a0030038.

Katie Salen and E Zimmerman. Game design and meaningful play. In *Handbook of Computer Game Studies*, pages 59–79. The MIT Press, 2005. ISBN 0262182408. URL http://www.waffler.org/wp-content/uploads/2009/05/Game-Design-and-Meaningful-Play.pdf.

Rainier Sales, Esteban Clua, Daniel de Oliveira, and Aline Paes. An Artificial Emotional Agent-Based Architecture for Games Simulation. In Junia C. Anacleto, Esteban W. G. Clua, Flavio S. Correa da Silva, Sidney Fels, and Hyun S. Yang, editors, *Entertainment Computing*, Lecture Notes in Computer Science. Springer Berlin Heidelberg, Berlin, Heidelberg, 2013. ISBN 978-3-642-41105-2. doi: 10.1007/978-3-642-41106-9. URL http://link.springer.com/10.1007/978-3-642-41106-9.

Samar Sallam, Yumiko Sakamoto, Jason Leboe-Mcgowan, Celine Latulipe, and Pourang Irani. Towards Design Guidelines for Effective Health-Related Data Videos: An Empirical Investigation of Affect, Personality, and Video Content. In *the 2022 CHI Conference on Human Factors in Computing Systems*, number 1, pages 1–22. Association for Computing Machinery, 2022. ISBN 9781450391573. doi: 10.1145/3491102.3517727.

David M. Sanbonmatsu and Russell H. Fazio. The Role of Attitudes in Memory-Based Decision Making. *Journal of Personality and Social Psychology*, 59(4):614–622, 1990. ISSN 00223514. doi: 10.1037/0022-3514.59.4.614.

José Luis González Sánchez, Francisco Luis Gutiérrez Vela, Francisco Montero Simarro, and Natalia Padilla-Zea. Playability: analysing user experience in video games. *Behaviour & Information Technology*, 31(10):1033–1054, 2012. ISSN 0144929X. doi: 10.1080/0144929X.2012.710648. URL `https://www.tandfonline.com/doi/abs/10.1080/0144929X.2012.710648`.

Candice Satchwell. "Carbon literacy practices": textual footprints between school and home in children's construction of knowledge about climate change. *Local Environment*, 18(3): 289–304, 3 2013. ISSN 13549839. doi: 10.1080/13549839.2012.688735.

Leila Scannell and Robert Gifford. Personally Relevant Climate Change: The Role of Place Attachment and Local Versus Global Message Framing in Engagement. *Environment and Behavior*, 45(1):60–85, 1 2013. ISSN 1552390X. doi: 10.1177/0013916511421196.

Renata Schiavo, Gil Eyal, Rafael Obregon, Sandra C. Quinn, Helen Riess, and Nikita Boston-Fisher. The science of trust: future directions, research gaps, and implications for health and risk communication. *Journal of Communication in Healthcare*, 15(4):245–259, 2022. ISSN 17538076. doi: 10.1080/17538068.2022.2121199.

Florian Schimanke, Robert Mertens, and Oliver Vornberger. Spaced repetition learning games on mobile devices: Foundations and perspectives. *Interactive Technology and Smart Education*, 11(3):201–222, 1 2014. ISSN 17588510. doi: 10.1108/ITSE-07-2014-0017.

Florian Schimanke, Florian Schimanke, Robert Mertens, and Oliver Vornberger. Designing for motivation: Design-considerations for spaced-repetition-based learning games on mobile devices. *International Journal on E-Learning*, 16(3):287–311, 2017. ISSN 1537-2456.

Michael T. Schmitt, Caroline M.L. Mackay, Lisa M. Droogendyk, and Daphne Payne. What predicts environmental activism? The roles of identification with nature and politicized environmental identity. *Journal of Environmental Psychology*, 61:20–29, 2 2019. ISSN 15229610. doi: 10.1016/j.jenvp.2018.11.003.

Josje D. Schoufour, Michael Tieland, Rocco Barazzoni, Somaya Ben Allouch, Joey van der Bie, Yves Boirie, Alfonso J. Cruz-Jentoft, Doris Eglseer, Eva Topinková, Bart Visser, Trudy Voortman, Amalia Tsagari, and Peter J.M. Weijs. The Relevance of Diet, Physical Activity, Exercise, and Persuasive Technology in the Prevention and Treatment of Sarcopenic Obesity

in Older Adults. *Frontiers in Nutrition*, 8, 5 2021. ISSN 2296861X. doi: 10.3389/fnut.2021.661449.

Paul Schrodt, Paul L. Witt, Paul D. Turman, Scott A. Myers, Matthew H. Barton, and Kodiane A. Jernberg. Instructor Credibility as a Mediator of Instructors' Prosocial Communication Behaviors and Students' Learning Outcomes. *Communication Education*, 58 (3):350–371, 7 2009. ISSN 03634523. doi: 10.1080/03634520902926851. URL `https://www.tandfonline.com/doi/abs/10.1080/03634520902926851`.

Olaf Schroth, Jeannette Angel, Stephen Sheppard, and Aleksandra Dulic. Visual climate change communication: From iconography to locally framed 3D visualization. *Environmental Communication*, 8(4):413–432, 10 2014. ISSN 17524040. doi: 10.1080/17524032.2014.906478.

Norbert Schwarz. Attitude construction: Evaluation in context. *Social Cognition*, 25(5):638–656, 2007. doi: https://doi.org/10.1521/soco.2007.25.5.638.

Norbert Schwarz and Gerald L. Clore. Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology*, 45(3):513–523, 1983. ISSN 00223514. doi: 10.1037/0022-3514.45.3.513.

Anna Scolobig, Tim Prior, Dagmar Schröter, Jonas Jörin, and Anthony Patt. Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality, 6 2015. ISSN 22124209.

Tim Sellnow and Deanna Sellnow. The instructional dynamic of risk and crisis communication: Distinguishing instructional messages from dialogue, 4 2010. ISSN 15358593.

Deborah Sellnow-Richmond, Amiso George, and Deanna Sellnow. An IDEA Model Analysis of Instructional Risk Communication in the Time of Ebola. *Journal of International Crisis and Risk Communication Research*, 1(1):135–166, 2018. ISSN 25760017. doi: 10.30658/jicrcr.1.1.7.

Maged Senbel, Victor Douglas Ngo, and Erik Blair. Social mobilization of climate change: University students conserving energy through multiple pathways for peer engagement. *Journal of Environmental Psychology*, 38:84–93, 2014. ISSN 02724944. doi: 10.1016/j.jenvp.2014.01.001. URL `http://dx.doi.org/10.1016/j.jenvp.2014.01.001`.

Michael A. Shapiro, Jorge Peña-Herborn, and Jeffrey T. Hancock. Realism, imagination, and narrative video games, 2006.

Shreela V. Sharma, Ross Shegog, Joanne Chow, Carrie Finley, Mike Pomeroy, Carolyn Smith, and Deanna M. Hoelscher. Effects of the Quest to Lava Mountain Computer Game on Dietary and Physical Activity Behaviors of Elementary School Children: A Pilot Group-Randomized Controlled Trial. *Journal of the Academy of Nutrition and Dietetics*, 115(8):1260–1271, 8 2015. ISSN 2212-2672. doi: 10.1016/J.JAND.2015.02.022.

Stephen R.J. Sheppard. Visualizing Climate Change : A Guide to Visual Communica-

tion of Climate Change and Developing Local Solutions. *Visualizing Climate Change*, 3 2012. doi: 10.4324/9781849776882. URL https://www.taylorfrancis.com/books/mono/10.4324/9781849776882/visualizing-climate-change-stephen-sheppard.

Brett Sherrick. The Role of Engagement in Facilitating Games-Based Persuasion. In Nicholas David Bowman, editor, *Video games: a medium that demands our attention*. Routledge; 1 edition, New York, NY, 2018. ISBN 9781351235266.

E Shinkle. Of Particle Systems and Picturesque Ontologies: Landscape, Nature and Realism in Video Games. *Art Journal*, 79(2):59–67, 2020. doi: 10.1080/00043249.2020.1765556. URL http://www.westminster.ac.uk/westminsterresearch.

Elena Shliakhovchuk. Video Games as Awareness Raisers, Attitude Changers, and Agents of Social Change. *International Journal of Computer Games Technology*, 2024, 2024. ISSN 16877055. doi: 10.1155/2024/3274715.

Miguel Sicart. Against Procedurality. *the international journal of computer game research*, 11 (3), 2011.

Guillaume Simonet and Sandra Fatorić. Does "adaptation to climate change" mean resignation or opportunity? *Regional Environmental Change*, 16(3):789–799, 3 2016. ISSN 1436378X. doi: 10.1007/s10113-015-0792-3.

Gale M. Sinatra, Carol Anne M. Kardash, Gita Taasoobshirazi, and Doug Lombardi. Promoting attitude change and expressed willingness to take action toward climate change in college students. *Instructional Science*, 40(1):1–17, 1 2012. ISSN 00204277. doi: 10.1007/s11251-011-9166-5.

Neera M. Singh. The affective labor of growing forests and the becoming of environmental subjects: Rethinking environmentality in Odisha, India. *Geoforum*, 47:189–198, 6 2013. ISSN 00167185. doi: 10.1016/j.geoforum.2013.01.010.

Michael Slater, David Karan, Donna Rouner, and Denise Walters. Effects of threatening visuals and announcer differences on responses to televised alcohol warnings. *Journal of Applied Communication Research*, 30(1):27–49, 2002. doi: 10.1080/00909880216575.

Michael D. Slater. Integrating application of media effects, persuasion, and behavior change theories to communication campaigns: A stages-of-change framework. *Health Communication*, 11(4):335–354, 1999. ISSN 10410236. doi: 10.1207/S15327027HC1104{_}2.

Erica L Snow, asuedu G Tanner Jackson, Danielle S McNamara, and Laura K Varner. Investigating the Effects of Off-Task Personalization on In-System Performance and Attitudes within a Game-Based Environment. In *Proceedings of the 6th International Conference on Educational Data Mining*, pages 272–275, Heidelberg, Berlin, Germany, 2013. Springer.

Erica L. Snow, Laura K. Allen, Matthew E. Jacovina, and Danielle S. McNamara. Does agency matter?: Exploring the impact of controlled behaviors within a game-based environment.

*Computers and Education*, 82:378–392, 2015. ISSN 03601315. doi: 10.1016/j.compedu.2014.12.011.

Mara Soekarjo and Herre van Oostendorp. Measuring Effectiveness of Persuasive Games Using an Informative Control Condition. *International Journal of Serious Games*, 2(2), 2015. ISSN 2384-8766. doi: 10.17083/ijsg.v2i2.74.

Aleksandra Solinska-Nowak, Piotr Magnuszewski, Margot Curl, Adam French, Adriana Keating, Junko Mochizuki, Wei Liu, Reinhard Mechler, Michalina Kulakowska, and Lukasz Jarzabek. An overview of serious games for disaster risk management – Prospects and limitations for informing actions to arrest increasing risk. *International Journal of Disaster Risk Reduction*, 31:1013–1029, 10 2018. ISSN 22124209. doi: 10.1016/j.ijdrr.2018.09.001.

Hayeon Song, Jihyun Kim, Remi J. Kwon, and Younbo Jung. Anti-smoking educational game using avatars as visualized possible selves. *Computers in Human Behavior*, 29(5):2029–2036, 2013. ISSN 07475632. doi: 10.1016/j.chb.2013.04.008. URL `http://dx.doi.org/10.1016/j.chb.2013.04.008`.

Paola Andrea Spadaro. Climate Change, Environmental Terrorism, Eco-Terrorism and Emerging
} Threats. *Source: Journal of Strategic Security*, 13(4):58–80, 2020. doi: 10.2307/26965518.

Laura Specker Sullivan and Peter Reiner. Digital Wellness and Persuasive Technologies. *Philosophy and Technology*, 34(3):413–424, 9 2021. ISSN 22105441. doi: 10.1007/s13347-019-00376-5.

Alexa Spence, Wouter Poortinga, Nick Pidgeon, and Irene Lorenzoni. Public perceptions of energy choices: The influence of beliefs about climate change and the environment. *Energy and Environment*, 21(5):385–407, 2010. ISSN 0958305X. doi: 10.1260/0958-305X.21.5.385.

Alexa Spence, Wouter Poortinga, and Nick Pidgeon. The Psychological Distance of Climate Change. *Risk Analysis*, 32(6):957–972, 2012. ISSN 02724332. doi: 10.1111/j.1539-6924.2011.01695.x.

Marion Speth, Jens Müller, Thomas Rist, Julia Seidl, and Markus Faschina. ECO CHAMPION: A Transcultural Educational eco Game for Children. In *European Conference on e-Learning*, 2018.

Matthew John Sprengeler. *Playing by new rules: board games and America's cold war culture, 1945-1965*. PhD thesis, University of Northern Iowa, 2013. URL `https://scholarworks.uni.edu/etd/67`.

Marios Stanitsas, Konstantinos Kirytopoulos, Élise Vareilles, Elise Vareilles, and ( K Kirytopoulos. Facilitating sustainability transition through serious games: A systematic literature review. *Journal of Cleaner Production*, page 208, 2019. doi: 10.1016/j.jclepro.2018.10.157{\"{i}}. URL `https://imt-mines-albi.hal.science/hal-01918890`.

Peter. N Stearns. *The Industrial Revolution in World History*. Routledge, fourth edition edition, 2012.

Nico Stehr, Hans Von Storch, and Moritz Flügel. The 19th century discussion of climate variability and climate change: Analogies for the present debate? *World Resource Review*, 7:589–604, 1995.

Sharon T. Steinemann, Elisa D. Mekler, and Klaus Opwis. Increasing donating behavior through a game for change: The role of interactivity and appreciation. In *CHI PLAY 2015 - Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, pages 319–330. Association for Computing Machinery, Inc, 10 2015. ISBN 9781450334662. doi: 10.1145/2793107.2793125.

Gerald Steiner, Bernhard Geissler, Günther Schreder, and Lukas Zenk. Living sustainability, or merely pretending? From explicit self-report measures to implicit cognition. *Sustainability Science*, 13(4):1001–1015, 2018. ISSN 18624057. doi: 10.1007/s11625-018-0561-6.

Bailey Jo Stephens. *The Righteous Path of the Virtual Colonizer: Postcolonialism and Morality in Sid Meier's Civilization and Humankind*. PhD thesis, Texas State University, 5 2023.

Benjamin Stokes. Restructuring Civic Engagement: Meaningful Choice and Game Design Thinking. In *The Participatory Cultures Handbook*. Routledge, New York, NY, 2012.

Keith Stuart. Climate Hope City: how Minecraft can tell the story of climate change | Minecraft | The Guardian, 2015. URL `https://www.theguardian.com/environment/keep-it-in-the-ground-blog/2015/jun/12/climate-hope-city-how-minecraft-can-tell-the-story-of-climate-change`.

Michael Svoboda. Cli-fi on the screen(s): Patterns in the representations of climate change in fictional films. *Wiley Interdisciplinary Reviews: Climate Change*, 7(1):43–64, 1 2016. ISSN 17577799. doi: 10.1002/wcc.381.

Penelope Sweetser and Peta Wyeth. GameFlow: A Model for Evaluating Player Enjoyment in Games. *Computers in Entertainment (CIE)*, 3(3):3, 2005. URL `https://dl.acm.org/doi/abs/10.1145/1077246.1077253`.

Melanie B. Tannenbaum, Justin Hepler, Rick S. Zimmerman, Lindsey Saul, Samantha Jacobs, Kristina Wilson, and Dolores Albarracín. Appealing to Fear: A Meta-Analysis of Fear Appeal Effectiveness and Theories. *Psychological Bulletin*, 141(6):1178–1204, 11 2015. ISSN 00332909. doi: 10.1037/A0039729.

James T. Tedeschi. *Impression Management Theory and Social Psychological Research*. Academic Press, 2013. ISBN 0126851808. doi: 10.2307/2068842.

David W.J. Thompson, Susan Solomon, Paul J. Kushner, Matthew H. England, Kevin M. Grise, and David J. Karoly. Signatures of the Antarctic ozone hole in Southern Hemisphere surface climate change, 11 2011. ISSN 17520894.

Khushbu Tilvawala, David Sundaram, and Michael Myers. Serious Games for Sustainable Development Serious Games for Sustainable Development: A Decision-driven Transformative Approach. In *Twenty-fifth Americas Conference on Information Systems*, 2019.

TimeWizardStudios. Another Chance. *itch.io*, 2017. URL https://timewizardstudios.itch.io/.

Alexandra To, Safinah Ali, Geoff Kaufman, and Jessica Hammer. Integrating Curiosity and Uncertainty in Game Design. In *International Joint Conference of DiGRA and FDG*, 2016.

Hilde Tobi and Jarl K. Kampen. Research design: the methodology for interdisciplinary research framework. *Quality and Quantity*, 52(3):1209–1225, 5 2018. ISSN 15737845. doi: 10.1007/S11135-017-0513-8/FIGURES/1. URL https://link.springer.com/article/10.1007/s11135-017-0513-8.

Jason Tocci. "You Are Dead. Continue?": Conflicts and Complements in Game Rules and Fiction. *Eludamos. Journal for Computer Game Culture*, 2(2):187–201, 2008. URL http://www.eludamos.org.

Weimin Toh and David Kirschner. Self-directed learning in video games, affordances and pedagogical implications for teaching and learning. *Computers and Education*, 154(April):103912, 2020. ISSN 03601315. doi: 10.1016/j.compedu.2020.103912. URL https://doi.org/10.1016/j.compedu.2020.103912.

Diego Fellipe Tondorf and Marcelo da Silva Hounsell. The Pursuit of Fun in Digital Games: From the Sandpit to the Console and Beyond. In *Communications in Computer and Information Science*, volume 1702, pages 25–46. Springer Science and Business Media Deutschland GmbH, 2023. ISBN 9783031276385. doi: 10.1007/978-3-031-27639-2{_}2/FIGURES/3. URL https://link.springer.com/chapter/10.1007/978-3-031-27639-2_2.

Kieren Topp, Michael Thai, and Deanne H. Hryciw. The role of entertainment in engagement with climate change. *Environmental Education Research*, 25(5):691–700, 2019. ISSN 14695871. doi: 10.1080/13504622.2019.1572072.

Zakary L. Tormala. The role of certainty (and uncertainty) in attitudes and persuasion. *Current Opinion in Psychology*, 10:6–11, 2016. ISSN 2352-250X. doi: 10.1016/J.COPSYC.2015.10.017.

Panagiotis Tragazikis and Michael Meimaris. Engaging Kids with the Concept of Sustainability Using a Commercial Video Game – A Case Study. In Z. Pan, A.D. Cheok, W. Müller, and M. Chang, editors, *Transactions on Edutainment III Lecture Notes in Computer Science*, pages 1–12. Springer, Berlin, Heidelberg, 2009. URL https://doi.org/10.1007/978-3-642-11245-4_1.

Giovanni Maria Troiano, Dylan Schouten, Michael Cassidy, Eli Tucker-Raymond, Gillian Puttick, and Casper Harteveld. Ice Paddles, CO2 Invaders, and Exploding Planets: How Young Students Transform Climate Science into Serious Games. In *CHI PLAY 2020 - Pro-*

*ceedings of the Annual Symposium on Computer-Human Interaction in Play*, pages 534–548. Association for Computing Machinery, Inc, 11 2020. ISBN 9781450380744. doi: 10.1145/3410404.3414256.

Rebecca Tuhus-Dubrow. Cli-fi: Birth of a genre. *Dissent*, 60(3):58–61, 2013. ISSN 00123846. doi: 10.1353/dss.2013.0069.

Selen Turkay and Charles K. Kinzer. The relationship between avatar-based customization, player identification, and motivation. In *Transforming Gaming and Computer Simulation Technologies across Industries*, pages 48–79. Information Science Reference, 1st edition edition, 2016. ISBN 9781522518181. doi: 10.4018/978-1-5225-1817-4.ch003.

Iis P. Tussyadiah, Dan Wang, Timothy H. Jung, and M. Claudia tom Dieck. Virtual reality, presence, and attitude change: Empirical evidence from tourism. *Tourism Management*, 66: 140–154, 2018. ISSN 02615177. doi: 10.1016/j.tourman.2017.12.003. URL `https://doi.org/10.1016/j.tourman.2017.12.003`.

Amos Tversky and Daniel Kahneman. The Framing of Decisions and the Psychology of Choice The. *SCIENCE*, 211(4481):453–458, 1981. doi: 10.1126/science.7455683.

Amos Tversky and Daniel Kahneman. Rational choice and the framing of decisions. *The Journal of Business*, 59(4):251–278, 1986. doi: 10.1017/CBO9780511803475.013. URL `http://www.jstor.org/stable/2352759`.

Markus Ulrich. Gaming/Simulation for Policy Development and Organizational Change Games/Simulations About Environmental Issues Existing Tools and Underlying Concepts. In *the International Simulationand Gaming Association (ISAGA)*, pages 301–311, 1997. URL `www.ucs.ch`.

Jukka Vahlo and Veli Matti Karhulahti. Challenge types in gaming validation of video game challenge inventory (CHA). *International Journal of Human Computer Studies*, 143, 11 2020. ISSN 10959300. doi: 10.1016/j.ijhcs.2020.102473.

Lisette van Beek, Manjana Milkoreit, Linda Prokopy, Jason B. Reed, Joost Vervoort, Arjan Wardekker, and Roberta Weiner. The effects of serious gaming on risk perceptions of climate tipping points. *Climatic Change*, 170(3-4), 2 2022. ISSN 15731480. doi: 10.1007/s10584-022-03318-x.

Sander van der Linden, Edward Maibach, and Anthony Leiserowitz. Improving Public Engagement With Climate Change: Five "Best Practice" Insights From Psychological Science. *Perspectives on Psychological Science*, 10(6):758–763, 11 2015. ISSN 17456924. doi: 10.1177/1745691615598516.

Ellen Van der Werff, Linda Steg, and Kees Keizer. It is a moral issue: The relationship between environmental self-identity, obligation-based intrinsic motivation and pro-environmental behaviour. *Global Environmental Change*, 23(5):1258–1265, 2013. ISSN 09593780. doi: 10.1016/j.gloenvcha.2013.07.018.

Femke van Horen, Michaela Wänke, and Thomas Mussweiler. When it pays to be clear: the appeal of concrete communication under uncertainty. *International Journal of Advertising*, 43(3):533–553, 2023. ISSN 02650487. doi: 10.1080/02650487.2023.2206689.

Tom Van Laer, Ko de Ruyter, Luca M. Visconti, and Martin Wetzels. The extended transportation-imagery model: A meta-analysis of the antecedents and consequences of consumers' narrative transportation. *Journal of Consumer research*, 40(5):797–817, 2014. doi: 10.1086/673383.

Paul A.M. Van Lange, Jeff Joireman, Craig D. Parks, and Eric Van Dijk. The psychology of social dilemmas: A review. *Organizational Behavior and Human Decision Processes*, 120(2): 125–141, 3 2013. ISSN 07495978. doi: 10.1016/j.obhdp.2012.11.003.

Paul A.M. Van Lange, Jeff Joireman, and Manfred Milinski. Climate Change: What Psychology Can Offer in Terms of Insights and Solutions. *Current Directions in Psychological Science*, 27(4):269–274, 8 2018. ISSN 14678721. doi: 10.1177/0963721417753945.

Jan Van Looy, Cédric Courtois, Melanie De Vocht, and Lieven De Marez. Player Identification in Online Games: Validation of a Scale for Measuring Identification in MMOGs. *Media Psychology*, 15(2):197–221, 2012. ISSN 15213269. doi: 10.1080/15213269.2012.674917.

Erik Van Sebille, Stefano Aliani, Kara Lavender Law, Nikolai Maximenko, José M. Alsina, Andrei Bagaev, Melanie Bergmann, Bertrand Chapron, Irina Chubarenko, Andrés Cózar, Philippe Delandmeter, Matthias Egger, Baylor Fox-Kemper, Shungudzemwoyo P. Garaba, Lonneke Goddijn-Murphy, Britta Denise Hardesty, Matthew J. Hoffman, Atsuhiko Isobe, Cleo E. Jongedijk, Mikael L.A. Kaandorp, Liliya Khatmullina, Albert A. Koelmans, Tobias Kukulka, Charlotte Laufkötter, Laurent Lebreton, Delphine Lobelle, Christophe Maes, Victor Martinez-Vicente, Miguel Angel Morales Maqueda, Marie Poulain-Zarcos, Ernesto Rodríguez, Peter G. Ryan, Alan L. Shanks, Won Joon Shim, Giuseppe Suaria, Martin Thiel, Ton S. Van Den Bremer, and David Wichmann. The physical oceanography of the transport of floating marine debris, 2 2020. ISSN 17489326.

Johan L.H. Van Strien, Yvonne Kammerer, Saskia Brand-Gruwel, and Henny P.A. Boshuizen. How attitude strength biases information processing and evaluation on the web. *Computers in Human Behavior*, 60:245–252, 2016.

Martijn van Zomeren, Inga L. Pauls, and Smadar Cohen-Chen. Is hope good for motivating collective action in the context of climate change? Differentiating hope's emotion- and problem-focused coping functions. *Global Environmental Change*, 58, 9 2019. ISSN 09593780. doi: 10.1016/j.gloenvcha.2019.04.003.

Jonathan Van 't Riet, Annika C. Meeuwes, Laura Van der Voorden, and Jeroen Jansz. Investigating the Effects of a Persuasive Digital Game on Immersion, Identification, and Willingness to Help. *Basic and Applied Social Psychology*, 40(4):180–194, 2018. ISSN 01973533. doi: 10.1080/01973533.2018.1459301. URL `https://doi.org/10.1080/01973533.2018.1459301`.

S. Veland, M. Scoville-Simonds, I. Gram-Hanssen, A. K. Schorre, A. El Khoury, M. J. Nordbø, A. H. Lynch, G. Hochachka, and M. Bjørkan. Narrative matters for sustainability: the transformative role of storytelling in realizing 1.5°C futures, 4 2018. ISSN 18773435.

Joost M. Vervoort, Manjana Milkoreit, Lisette van Beek, Astrid C. Mangnus, David Farrell, Steven R. McGreevy, Kazuhiko Ota, Christoph D.D. Rupprecht, Jason B. Reed, and Matthew Huber. Not just playing: The politics of designing games for impact on anticipatory climate governance. *Geoforum*, 137:213–221, 12 2022. ISSN 00167185. doi: 10.1016/j.geoforum.2022.03.009.

Jernej Vičič and Tine Šukljan. Motivating Cultural Heritage Artifacts Presentation Using Persuasive Technology. *Informatica*, 40(4):457–461, 2016. URL `https://www.project-as.eu/api/path/get_paths`.

Patricia Villarrubia-Gómez, Sarah E. Cornell, and Joan Fabres. Marine plastic pollution as a planetary boundary threat – The drifting piece in the sustainability puzzle. *Marine Policy*, 96:213–220, 10 2018. ISSN 0308597X. doi: 10.1016/j.marpol.2017.11.035.

Tobias Vogel and Michaela Wanke. *Attitudes and Attitude Change*. Routledge, London, 2nd edition edition, 2016. doi: https://doi.org/10.4324/9781315754185.

Sophia von Salm-Hoogstraeten and Jochen Müsseler. Perspective taking while interacting with a self-controlled or independently-acting avatar. *Computers in Human Behavior*, 118(May 1), 2021. ISSN 07475632. doi: 10.1016/j.chb.2021.106698.

N. Voulvoulis, T. Giakoumis, C. Hunt, V. Kioupi, N. Petrou, I. Souliotis, C. Vaghela, and WIH I.H. binti Wan Rosely. Systems thinking as a paradigm shift for sustainability transformation. *Global Environmental Change*, 75, 2022. ISSN 0959-3780. doi: 10.1016/J.GLOENVCHA.2022.102544.

David I. Waddington and Thomas Fennewald. Grim FATE: Learning About Systems Thinking in an In-Depth Climate Change Simulation. *Simulation and Gaming*, 49(2):168–194, 4 2018. ISSN 1552826X. doi: 10.1177/1046878117753498.

Lynda Walsh. The visual rhetoric of climate change. *Wiley Interdisciplinary Reviews: Climate Change*, 6(4):361–368, 7 2015. ISSN 17577799. doi: 10.1002/wcc.342.

Steffen Walz. Delightful identification & persuasion: towards an analytical and applied rhetoric of digital games. In *DiGRA Conference*, 2003.

Jun Wang, Lin Lu, Mingxiao Wang, Tao Jiang, Xiaoshou Liu, and Shaoguo Ru. Typhoons increase the abundance of microplastics in the marine environment and cultured organisms: A case study in Sanggou Bay, China. *Science of the Total Environment*, 667:1–8, 6 2019. ISSN 18791026. doi: 10.1016/j.scitotenv.2019.02.367.

Ruijie Wang, Reece Bush-Evans, Emily Arden-Close, Elvira Bolat, John McAlaney, Sarah Hodge, Sarah Thomas, and Keith Phalp. Transparency in persuasive technology, immersive

technology, and online marketing: Facilitating users' informed decision making and practical implications, 2 2023. ISSN 07475632.

Brian J. Wardyga. *The Video Games Textbook: History • Business • Technology: Second Edition*. CRC Press, 1 2023. ISBN 9781000868180. doi: 10.1201/9781003315759/VIDEO-GAMES-TEXTBOOK-BRIAN-WARDYGA. URL https://www.taylorfrancis.com/books/mono/10.1201/9781003315759/video-games-textbook-brian-wardyga.

David Watson, Lee Anna Clark, and Auke Tellegen. Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology*, 54(6):1063–1070, 1988. ISSN 00223514. doi: 10.1037/0022-3514.54.6.1063.

Elke U. Weber. What shapes perceptions of climate change?, 2010. ISSN 17577799.

T Duane Wegener, E Richard Petty, and J David Klein. Effects of mood on high elaboration attitude change: The mediating role of likelihood judgments. *European journal of social psychology*, 24(1):25–43, 1994.

Paul Weiser, Dominik Bucher, Francesca Cellina, and Vanessa De Luca. A Taxonomy of Motivational Affordances for Meaningful Gamified and Persuasive Technologies. In *Proceedings of EnviroInfo and ICT for Sustainability*, 2015. URL http://www.researchgate.net.

Natalie A.C. Welden and Amy L. Lusher. Impacts of changing ocean circulation on the distribution of marine microplastic litter, 5 2017. ISSN 15513793.

Thomas Wernbacher, Alexander Pfeiffer, Michael Wagner, and Jörg Hofstätter. Learning by Playing: Can Serious Games be fun? In *European Conference on Games Based Learning*, 2012.

Roger M. Whitaker, Gualtiero B. Colombo, Liam Turner, Yarrow Dunham, Darren K. Doyle, Eilish M. Roy, and Cheryl A. Giammanco. The Coevolution of Social Networks and Cognitive Dissonance. *IEEE Transactions on Computational Social Systems*, 9(2):376–393, 2022. ISSN 2329924X. doi: 10.1109/TCSS.2021.3090833.

Matthew Alexander Whitby, Sebastian Deterding, and Ioanna Iacovides. "One of the baddies all along": Moments that challenge a player's perspective. In *CHI PLAY 2019 - Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, pages 339–350. Association for Computing Machinery, Inc, 10 2019. ISBN 9781450366885. doi: 10.1145/3311350.3347192.

Bruce Whitehill. Games of America in the Nineteenth Century. *Board Games Studies Journal*, 9:65–87, 2015. ISSN 2183-3311. URL http://bgsj.ludus-opuscula.orgbgsj@ludus-opuscula.orgEditorialBoard.

L Whitmarsh and S Capstick. Perceptions of climate change. In S Clayton and C. Manning, editors, *Psychology and Climate Change*, pages 13–33. Academic Press, an imprint of Elsevier, 2018.

Lorraine Whitmarsh, SAffron O'Neill, and Irene Lorenzoni. Public engagement with climate

change: what do we know, and where do we go from here? *Media and Cultural Politics*, 9 (1):1–23, 2013.

Victoria Wibeck, Tina Simone Neset, and Björn Ola Linnér. Communicating climate change through ICT-based visualization: Towards an analytical framework. *Sustainability*, 5(11): 4760–4777, 2013. ISSN 20711050. doi: 10.3390/su5114760.

Yohana Dewi Lulu Widyasari, Lukito Edi Nugroho, and Adhistya Erna Permanasari. Persuasive technology for enhanced learning behavior in higher education. *International Journal of Educational Technology in Higher Education*, 16(1), 2019.

Daniel Wilcox-Netepczuk. Immersion and Realism in Video Games - The Confused Moniker of Video Game Engrossment. In *International Conference on Computer Games*, pages 92–95, 2013. ISBN 9781479908202.

Timothy D Wilson, Samuel Lindsey, and Tonya T Schooler. A model of Dual Attitudes. *Psychological Review*, 107(1):101–126, 2000. URL `http://www2.psych.ubc.ca/~schaller/Psyc590Readings/Wilson2000.pdf`.

Kim Witte. Fear control and danger control: A test of the extended parallel process model (EPPM). *Communication Monographs*, 61(2):113–134, 1994. doi: 10.1080/03637759409376328.

Mark J. P. Wolf. The video game explosion; a history from Pong to Playstation and beyond. *Reference and Research Book News*, 23(2), 2008.

Mark J.P Wolf. *Building Imaginary Worlds: The Theory and History of Subcreation*. Routledge, New York and London, 2012.

Kelli Wood. A History of Play in Print Board Games from the Renaissance to Milton Bradley. Technical report, Center for Gaming Research Occasional Paper Series, Las Vegas, Nevada, 2018.

Lauren Woolbright. Environmental game design as activism. *Ecozon: European Journal of Literature, Culture and Environment*, 8(2):88–102, 2017. ISSN 2171-9594.

Lauren Woolbright. There Is No Planet B: A Milieu-Specific Analysis of Outer Wilds' Unstable Spaces. In Laura Op De Beke, Joost Raessens, Stefan Werning, and Gerald Farca, editors, *Ecogames: Playful Perspectives on the Climate Crisis*. Amsterdam University Press, 2024.

Pieter Wouters, Herre Van Oostendorp, Rudy Boonekamp, and Erik Van Der Spek. The role of Game Discourse Analysis and curiosity in creating engaging and effective serious games by implementing a back story and foreshadowing. *Interacting with Computers*, 23(4):329–336, 7 2011. ISSN 0953-5438. doi: 10.1016/J.INTCOM.2011.05.001. URL `https://dx.doi.org/10.1016/j.intcom.2011.05.001`.

Sophie Wright and Alena Denisova. "It's a terrible choice to make but also a necessary one": Exploring player experiences with moral decision making mechanics in video games. *Com-*

*puters in Human Behavior*, 161, 2024. ISSN 07475632. doi: 10.1016/j.chb.2024.108424. URL https://linkinghub.elsevier.com/retrieve/pii/S0747563224002929.

Jason S. Wu and Joey J. Lee. Climate change games as tools for education and engagement. *Nature Climate Change*, 5(5):413–418, 2015. ISSN 17586798. doi: 10.1038/nclimate2566.

Seth Wynes and Kimberly A. Nicholas. The climate mitigation gap Education and government recommendations miss the most effective individual actions. *Environmental Research Letters*, 12(7), 2017. doi: 10.1088/1748-9326/aa7541.

Ningning Xu, Jiachen Liang, Kexiang Shuai, Yuwen Li, and Jiaqi Yan. HeritageSite AR: An Exploration Game for Quality Education and Sustainable Cultural Heritage. In *Conference on Human Factors in Computing Systems - Proceedings*. Association for Computing Machinery, 4 2023. ISBN 9781450394222. doi: 10.1145/3544549.3583837.

Rohit Yadav, Mohit Yadav, and Amit Mittal. Effects of gain-loss-framed messages on virtual reality intervened fitness exercise. *Information Discovery and Delivery*, 2021. URL https://doi.org/10.1108/IDD-04-2021-0051.

Katsuya Yamori. The Roles and Tasks of Implementation Science on Disaster Prevention and Reduction Knowledge and Technology: From Efficient Application to Collaborative Generation. *Journal of Integrated Disaster Risk Management*, 1(1):48–58, 2011.

Javier Yanes. Video Games Against Climate Change | OpenMind, 2019. URL https://www.bbvaopenmind.com/en/science/environment/video-games-against-climate-change/.

Grace S. Yang, Bryan Gibson, Adam K. Lueke, L. Rowell Huesmann, and Brad J. Bushman. Effects of Avatar Race in Violent Video Games on Racial Attitudes and Aggression. *Social Psychological and Personality Science*, 5(6):698–704, 2014. ISSN 19485514. doi: 10.1177/1948550614528008.

David S. Yeager and Carol S. Dweck. What can be learned from growth mindset controversies? *American Psychologist*, 75(9):1269–1284, 12 2020. ISSN 1935990X. doi: 10.1037/amp0000794.

Sunghwan Yi and Hans Baumgartner. Regulatory focus and message framing: A test of three accounts. In *The Proceedings of the Society for Consumer Psychology*, pages 28–30, 2008.

David Zendle, Daniel Kudenko, and Paul Cairns. Behavioural realism and the activation of aggressive concepts in violent video games. *Entertainment Computing*, 24:21–29, 2018. ISSN 18759521. doi: 10.1016/j.entcom.2017.10.003.

Zeping Zhan, Batu Aytemiz, and Adam M. Smith. Taking the Scenic Route: Automatic Exploration for Videogames. *arXiv preprint arXiv:1812.03125.*, 12 2018. URL http://arxiv.org/abs/1812.03125.

John W Zillman. A history of climate activities. *World Meteorological Organization (WMO) Bulletin*, 58(3):141, 2009.