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Kristoffer Skomsøy Fjællingsdal

The Green Gaming Project

The Role of Games in Promoting Environmental Literacy

Doctoral thesis

NTNU
Norwegian University of Science and Technology
Thesis for the Degree of
Philosophiae Doctor
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Department of Psychology

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Acknowledgements

On his list of the "Top 10 Videogame Emotions", game designer Chris Bateman found that people who play games experience a rollercoaster of emotions while they are immersed in their own little virtual worlds – ranging from positive emotions such as *bliss* and *amusement* to the more obscure *fiero* (an intense feeling of achievement when overcoming adversity) and *naches* (the feeling of pride related to the accomplishments of others). As I am sitting here at my desk, towering stacks of research papers and expensive books balancing precariously on either side of me alongside a variety of highlighters, writing tools, Post-It notes and a dirty coffee mug, I realize that writing my PhD thesis has a – as academics might say – *significant degree of overlap* with the emotions that Bateman has jotted down on his list. Behind me are more than 4 turbulent years that have seen some of the most significant life changes I have yet to experience. I have met a lot of intriguing characters through various conferences and virtual meetings, argued with reviewers, slipped into extended periods of self-doubt regarding my writing only to moments later feel a boost of confidence when receiving an email from someone who found my work interesting. I have felt the weight of solitude that writing a PhD entails, and performed intensive project-related work in interdisciplinary groups. I have been submitted, rejected, praised, heavily criticized, and ultimately it has all been a very, very wild ride. And at the end of it, despite all the ups and downs, I feel I have somehow emerged on the other side as a somewhat more informed (if not misinformed) person. Flowery words aside, this section of my thesis is dedicated to the people who have helped me along the way.

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"The game is fun. The game is a battle. If it's not fun; why bother?"
- Reggie Fils-Aimé, former president of Nintendo America

"Reality is broken. Game designers can fix it."
- Jane McGonigal, "Reality is Broken"

"Making a delicious pastry is difficult. Making a delicious pastry that can cure cancer is even harder."
- Jesse Schell, on the difference between making good games and making good transformative games

List of papers

This thesis is based on three published research papers.

Paper 1:

Fjællingsdal, K.S., & Klöckner, C.A. (2017). ENED-GEM: A Conceptual Framework Model for Psychological Enjoyment Factors and Learning Mechanisms in Educational Games about the Environment. *Frontiers in Psychology, 8,* 1-17. doi: 10.3389/fpsyg.2017.01085

Paper 2:

Fjællingsdal, K.S., & Klöckner, C.A. (2019). Gaming Green: The Educational Potential of Eco – A Digital Simulated Ecosystem. *Frontiers in Psychology, 10,* 1-13. doi: 10.3389/fpsyg.2019.02846

Paper 3:

Fjællingsdal, K.S., & Klöckner, C.A. (2020). Green Across the Board: Board Games as Tools for Dialogue and Simplified Environmental Communication. *Simulation & Gaming, 51*(5), 632-652. doi: 10.1177/1046878120925133

Abstract

The scientific evidence for how human activity negatively impacts the natural environment is now nearly unequivocal, but the public understanding of man-made climate change and its underlying issues still suffers from the prevalence of old-fashioned and often ineffective forms of communication strategies and -interventions. Recently, innovative and disruptive forms of communication and learning about the multifaceted nature of anthropogenic climate change are rapidly establishing themselves as promising new arenas for research and sustainable development. One of the new approaches to scientific communication about environmental issues comes in the form of games, both digital and board-based, which have captivated, engaged, and entertained mankind for millennia. Using games for learning purposes has been a viable pedagogical strategy since the early 1970s, and scientific interest in using games for sustainability education is seeing rapid growth across a variety of fields and academic disciplines. This thesis serves as a contribution towards the general understanding of how, when, and why environmental and sustainability-oriented games affect their players, and how they can be utilized as tools for increasing environmental literacy. It consists of three qualitative empirical research papers, where the overarching purpose has been to gain an understanding of how games can be used in strengthening the environmental literacy of their players. The results overall show that games can be effective tools for environmental education, especially regarding their innate ability to simplify and visualize complex systems and environmental issues that otherwise appear distant or invisible. More specifically, **article 1** contains a thorough review of the research literature on the use of serious games within the fields of climate, environment and sustainability, and utilizes 249 reviews of Fate of the World, a sophisticated environmental game, to develop a game enjoyment model (the Environmental Educational Game Enjoyment Model, or ENED-GEM) for future environmental game design. Articles 2 and 3, using a qualitative approach, attempt to establish a more concrete understanding of how contemporary and commercially available environmental games affect their players. For **article 2**, 7 respondents were individually interviewed regarding their experiences with a digital simulated ecosystem game called Eco. The data from this study, analyzed and categorized using thematic analysis, resulted in two main themes that highlighted both game-based learning outcomes as well as barriers against learning. The findings of article 2 generally indicate that Eco is a viable tool for promoting some aspects of environmental consciousness about ecosystems, and suggestions for future implementation of Eco are provided. Lastly, **article 3** contains the results from 5 focus group interviews of 17 respondents who participated in environmental board game nights arranged

by the lead researcher. A thematic analysis of the datasets revealed 2 main themes: the first revolving around board games as simplified environmental simulations and the second revolving around the players' perceptions of their own impact on the game board. Overall, the results from article 3 suggest that board games can be highly effective tools in some aspects of environmental communication. Simultaneously, the research also shows that there are significant barriers and hurdles towards the use of games for environmental education and provides preliminary future research guidelines to circumvent these barriers.

Sammendrag

Det vitenskapelige grunnlaget for hvordan menneskelig aktivitet negativt påvirker det naturlige miljøet er nå nesten utvetydig, men offentlighetens generelle forståelse av menneskeskapte klimaendringer og dens underliggende problematikk er fortsatt skadelidende av gammeldagse og ofte ineffektive former for kommunikasjonsstrategier og -intervensjoner. I nyere tid har innovative og inngripende kommunikasjons- og læringsformer om den mangesidige strukturen i menneskeskapt klimaforandring raskt etablert seg som lovende arenaer for forskning og bærekraftig utvikling. En av de nye tilnærmingene til vitenskapelig kommunikasjon om miljøproblematikk kommer i form av spill i både video- og brettformat, som har oppslukt, engasjert, og underholdt menneskeheten i flere tusen år. Bruken av spill i læringssammenheng har vært en gunstig pedagogisk strategi siden tidlig 1970-tall, og den vitenskapelige interessen rundt det å bruke spill i bærekraftutdanning ser en rask økning i en rekke felter og akademiske disipliner. Denne tesen er et bidrag til den generelle forståelsen av hvordan, når, og hvorfor miljø- og bærekraftrelaterte spill påvirker spillerne sine, og hvordan de kan benyttes som verktøy for å øke miljøkompetanse. Den består av tre kvalitative, empiriske forskningsartikler, hvor det overhengende målet har vært å danne en forståelse av hvordan spill kan brukes for å styrke miljøkompetansen til spillerne. Resultatene viser generelt at spill kan være effektive verktøy i læring om miljøet, særlig på grunnlag av at de er i stand til å forenkle og visualisere komplekse systemer og miljøproblematikk som ellers virker fjern og usynlig. På et mer spesifikt nivå inneholder **artikkel 1** en nøye gjennomgang av litteraturen rundt bruken av læringsspill innen tematikk som klima, miljø og bærekraft, og benytter 249 anmeldelser av Fate of the World, et sofistikert miljøspill, i konstruksjonen av en modell for spillglede (ENED-GEM) for framtidig design av miljøspill. Artikkel 2 og 3 forsøker, ved bruk av en kvalitativ tilnærming, å etablere en mer konkret forståelse av hvordan kontemporære og kommersielt tilgjengelige miljøspill påvirker spillerne sine. I **artikkel 2** ble 7 respondenter intervjuet individuelt angående deres opplevelser med et digitalt simulert økosystem kalt Eco. Data fra denne studien ble analysert og kategorisert ved bruk av tematisk analyse, og resulterte i to hovedtema som påviste både spillbasert læring og barrierer mot denne læringsformen. Funnene fra artikkel 2 indikerer generelt at Eco er et nyttig verktøy når det gjelder promotering av enkeltaspekter rundt økosystemisk miljøbevissthet, og forslag til framtidig implementering av Eco fremlegges i tillegg. Sistnevnte artikkel, **artikkel 3**, inneholder resultatene fra 5 fokusgruppeintervjuer av 17 respondenter som deltok på brettspillkvelder med miljøspilltema arrangert av forskeren. En tematisk analyse av datasettene avdekket to hovedtema: det første omhandlet brettspillenes rolle som forenklede

simuleringer av virkeligheten og det andre dreide seg rundt spillernes oppfatninger av egen påvirkning på spillbrettet. Overordnet sett tilsier resultatene fra artikkel 3 at brettspill kan være svært effektive verktøy innen enkelte aspekter av miljøkommunikasjon. Samtidig viser forskningsresultatene at det foreligger signifikante barrierer og hindre mot bruken av spill i læring om miljøet, og bidrar med preliminære framtidige retningslinjer for forskning som kan imøtekomme og håndtere disse barrierene.

Chapter 1 – Introduction

The scientific consensus surrounding the evidence on anthropogenic climate change is often cited as being unequivocal (Carlton, Perry-Hill, Huber & Prokopy, 2015; Cook et al., 2013; Cook et al., 2016; Eisenack & Reckien, 2013; IPCC, 2013; Powell, 2016), with very few scientific papers actively rejecting it (Benestad et al., 2016). The full picture of how this affects biological life is hugely complex (den Haan & van der Voort, 2018), and often far beyond comprehension even when seasoned climate psychologists attempt to explain it (Stoknes, 2017, p.89). Across decades, science has revealed some of the more detrimental effects that climate change has already caused as well as generated predictive theoretical models that showcase or suggest what might happen in the future if the global temperature continues to increase. Human activity and industry have clear and measurable impacts on oceans, ecosystems and biodiversity (Klaniecki, Wuropulos & Hager, 2019), and this impact is extremely negative in nature – leading to abnormal alterations in oceanic life and acidity (IPCC, 2019; Lejeusne, Chevaldonné, Pergent-Martini, Boudouresque & Pérez, 2009; Pörtner & Peck, 2010; Wrona et al., 2006), a decline in or extinction of important keystone species in a variety of ecosystems and biomes (Maxwell, Fuller, Brooks & Watson, 2016; Redpath et al., 2018; Salafsky, Margoluis, Redford & Robinson, 2002), glacial melting (IPCC, 2013) and increased rates of extreme nature events such as forest fires (Lenihan, Drapek, Bachelet & Neilson, 2003) and flooding (Christensen & Christensen, 2002; Ely, Enzel, Baker & Cayan, 1993; Milly, Wetherald, Dunne & Delworth, 2002).

Climate change also severely impacts human living conditions on a global scale, causing unstable or severely damaged crop yields (Parry, Rosenzweig, Iglesias, Livermore & Fischer, 2004; Patz, Campbell-Lendrum, Holloway & Foley, 2005; Schlenker & Roberts, 2009), increasing the spread of infectious diseases due to warmer climates (Haines, Kovats, Campbell-Lendrum & Corvalan, 2006; Patz, Epstein, Burke & Balbus, 1996) and causing large-scale climate migration due to reduced living conditions (Raleigh & Jordan, 2010) – factors that in turn are likely to cause a dramatic increase in violent conflicts and human death rates (Barnett & Adger, 2007). These are only a few contemporary examples of the measurable consequences of climate change, and there are numerous instances in environmental communication history where the threat of climate change has been framed as an outright war (Flusberg, Matlock & Thibodeau, 2017) against an invisible enemy that is gradually "sneaking up on us". The invisibility of these developing environmental issues has posed an enormous challenge for scientists and depicting and illustrating them might be

among the biggest challenges that environmental communicators are faced with today (Hansen & Machin, 2013; Moser, 2010).

1.1 Innovative environmental communication and -psychology

Traditionally, scientific communication about climate change has followed an *information deficit model* (Schultz, 2002; Sturgis & Allum, 2004), where a group of 'experts' (scientists) provide education, facts, and knowledge to a 'non-expert' audience (the general public) about how to counteract environmental issues (Illingworth et al., 2018; Miller, 2001). The core idea behind such a model is that the general public lacks the required knowledge to act in a pro-environmental manner, and that increasing the prevalence of pro-environmental actions is a simple matter of providing so-called 'non-experts' with sufficient information. The utilization of such a model of communication, however, fails to both acknowledge 1) the way in which people have different ways of reacting to specific forms of information (Swim et al., 2011), and 2) that a lack of trust in experts impacts to what degree the message is received (van der Linden, 2015). Additionally, the understanding of climate change remains plagued by limited knowledge of environmental issues, a lack of concrete action, politization of the environment with little to no scientific foundation, as well as a growing sense of overwhelming hopelessness in the public sphere (Moser, 2016). Recent trends in environmental communication, however, are seeing a divergence towards a more dialogue-based model of two-way communication (van der Sanden & Meijman, 2008), where the conventional 'non-expert' audience is actively involved in the development and conduct of research (Illingworth et al., 2018). This is important not only due to the local and personal experience and knowledge that laypeople possess (Loroño-Leturiondo, O'Hare, Cook, Hoon & Illingworth, 2019), but also because active involvement and experimentation with climate-related topics is pertinent in order to raise awareness and to increase the understanding of environmental issues as man-made (Hassol, 2008). Additionally, actively participating in environmental interventions is shown to be effective at generating environmental behavior (Zelezny, 1999), contrary to the more traditional classroom practices of passively absorbing information from a knowledgeable source (Bineham, 1988). Arguments have also been presented that environmental communication research should focus more on the visualization of climate change, the use of new media for engagement, as well as generating arenas for dialogue and inter-stakeholder discussions (Moser, 2010). Although such forms of communication interventions can be difficult and resource-intensive to implement, the field of environmental

psychology could hold some answers as to how such interventions can and should be conducted.

Environmental psychology is a discipline which focuses mainly on the role of individuals in regard to topics of sustainability, conservation, and nature – its main focus being the interaction between humans and their physical environments (Holahan, 1986; Klöckner, 2015, p.11; Russell & Ward, 1982; Steg, van den Berg & de Groot, 2012, p.2; Stokols, 1978) and how to bring about positive changes in this relationship (Saegert & Winkel, 1990). It is a branch of psychology that has seen (and is seeing) tremendous growth (Gifford, 2014; Stokols, 1978), in part due to its extensive focus on a wide variety of psychological variables that influence the degree of performed pro-environmental behavior – ranging from knowledge and education to values, attitudes, worldviews, norms, and habits (Gifford, 2014). Implicit in the field of environmental psychology is the notion that individuals are acting, thinking, critical, and influential stakeholders who exert considerable influence on their surrounding layers of society and politics (e.g.,, O'Brien & Sygna, 2013), meaning that at least some of the solutions to anthropogenic climate change, logically, rely on the environmental literacy factors of the public sphere. Primarily, environmental psychology is concerned with increasing the understanding of how these factors influence pro-environmental behavior as well as generating models and frameworks to predict alternative future environments (Sörqvist, 2016). The ways in which it attempts to reach these goals, however, are highly varied. In addition to drawing on interdisciplinary or cross-paradigm research rather than exclusively focusing on psychological variables (Stokols, 1995), environmental psychology also gains insight from both positivist and phenomenological researchers (Seamon, 1982) and involves innovative communication-based interventions with which to engage various stakeholders in various ways (e.g.,, Klöckner, 2015). Environmental psychology, while adhering to the basic principles of good communication practices, also frequently attempts to discover and conduct research on more innovative and creative ways of interacting about the environment, and a core contemporary example of such communication strategies can be found in environmental games – the subject of this thesis.

1.2 Environmental games – playing with environmental issues

In April 2007 there was a massive oil shortage in the United States, heavily affecting both the access to gas as well as bringing major companies to the brink of bankruptcy due to severely heightened fuel costs and diminished operating capacity. A committee was soon established to find creative solutions to the shortage, consisting of approximately two thousand individuals

from all 50 U.S. states and diverse walks of life – ranging from hobby farmers and soldiers to art students and employees at General Motors. In addition to the major societal issues arising with a shortage of oil, this committee also had to consider how everyday behaviors such as getting to work, preparing dinner, or even socializing with friends and family would work. For each day of the six week-long crisis, new issues arose – airlines would cancel their flights, food shortages arose due to delivery vans not being able to restock produce, and public transportation broke down under the new pressure from people who could no longer afford using their own cars. The committee would eventually release an online document containing their proposed solutions to some of the problems the oil shortage had brought along, and included such examples as how the architectural industry, neighborhoods, parenting, and motorsports could make the transition into a shift towards a more sustainable future. The 'kicker' here is that none of this actually happened in real life – it was a massive online alternate reality game (or ARG) called World Without Oil (or WWO), invented and conducted by writers, game designers, and laypeople with funding from the Corporation for Public Broadcasting (McGonigal, 2012, p.303).

Since its inception the WWO project has received a disappointingly low degree of media interest, and the main website for the project is now defunct and solely accessible through Internet archiving utilities (WWO, 2006). Today, looking back at the WWO project and the way in which it was conducted, it is difficult to reject the notion that it was ahead of its time. The publications focusing on environmental games as a communication tool have increased exponentially (Reckien & Eisenack, 2013), and more sophisticated games by both academics, professional game designers, and interdisciplinary teams are now becoming more common (e.g., Assadorian & Hansen, 2011; Roberts, 2011; Strange Loop Games, 2020). Even when such games are becoming more commercially available, however, the majority (55%) of academic publications about them for the past two decades has largely revolved around descriptive commentaries on how environmental games *can* be used in certain settings rather than actual empirical work (33%) where the games *are* used and tested for their educational properties (Hallinger, Wang, Chatpinyakoop, Nguyen & Nguyen, 2020). Otherwise, the remaining research on environmental games is limited to research reviews (6%) and conceptual suggestions for future research on them (6%). The headline from an article by Christine Boomsma and colleagues from 2018, titled "Should We Play Games Where Energy Is Concerned?", succinctly summarizes the academic view on environmental games in general, and while the article does not outright reject the notion of using environmental games, it does highlight some pertinent issues for other game scholars to consider (Boomsma,

Hafner, Pahl, Jones & Fuertes, 2018). The problematic side of using games for educational purposes is one that is often highlighted in contemporary research, and the reason for this is manifold. First of all, games are most often (and perhaps stereotypically) thought of as difficult to implement (Skaug, Husøy, Staaby & Nøsen, 2020, p.145), lacking a serious pedagogical foundation (Madani, Pierce & Mirchi, 2017), or simply being too removed from reality to teach usable real-life problem-solving skills (Bogost, 2010, p.43). Additionally, in academia games are almost synonymous with the ongoing debates surrounding to what degree they instigate violent or aggressive behavior (e.g., Anderson & Bushman, 2001) or are simply addictive (e.g., van Rooij, Schoenmakers, Vermulst, van der Eijnden & van de Mheen, 2010). Although there is no denying that parts of the criticism directed towards games is genuine and in need of further research, it also stigmatizes and narrows the view of games as inherently violent, escapist timewasters. It is therefore just as important to consider that games also have positive effects such as increasing positive affect and social functioning (Jones, Scholes, Johnson, Katsikitis & Carras, 2014) as well as a host of perceptual, visual-attentional, empathic, cognitive, and creative skills (Cochrane, Prot, Blanco, Green & Gentile, 2020). Additionally, educating about the challenges of sustainability and environmental issues requires the adoption of a systemic perspective (Wals, 2011), where complex systems (e.g., ecosystems, the relationship between meat consumption and carbon emissions, the life cycle of marine plastic in circular economy) are simplified and presented in an innovative, comprehensible manner. Games appear to be an effective and holistic approach to understanding the complexities of such systems (Kriz, 2003). Conducting more empirical research on how games can be utilized in a positive way, such as by investigating if they can be used to teach about contemporary social issues such as the multifaceted nature of climate change, is therefore warranted. This thesis, the Green Gaming Project, is specifically tailored towards this goal.

1.3 The Green Gaming Project – a brief introduction

The project that this thesis is based on, hereafter referred to as the Green Gaming Project, was initialized in the autumn of 2015 and formally concluded in September 2019. Over the course of these four years, three research projects were conducted. The first study is tailored towards the design and evaluation of a psychological framework for enjoyable environmental games, as up to the timeframe of the study, no such framework existed (Fjællingsdal & Klöckner, 2017). The intention behind this was to understand which psychological factors were involved in the motivation to play environmental games, the gameplay stage itself, and the learning

outcomes that might result from playing. Ultimately, this framework will serve a supportive function to any interdisciplinary teams that might wish to design environmental games in the future, and ease the process behind creating engaging, enjoyable, and educational gaming experiences.

The second study is a pilot trial of the digital simulated ecosystem game called Eco, where the players need to actively collaborate in order to maintain balance in the ecosystem as well as develop advanced technology to shoot down an incoming meteor that will obliterate the virtual world after 30 real-life days have passed (Fjællingsdal & Klöckner, 2019). Eco is a so-called 'infinity game', meaning that it is a subject of continuous co-development between its designers and fan feedback. At the time of the study, however, Eco was still in the early stages of its design phase, and as a result had not been subjected to any rigorous fan feedback outside of general quality testing. The study therefore serves as the very first evaluation of the game as a learning tool and revealed that playing Eco was capable of both providing new information as well as reinforcing pre-existing environmental knowledge in the players.

The third and final study of the Green Gaming Project left the digital sphere in favor of an analog, board-based approach to using games in environmental literacy learning (Fjællingsdal & Klöckner, 2020). After surveying the field for games with suitable thematic content, meaning games that have some form of environmental component which might feasibly lead to some form of learning outcome from playing it, a total of seven environmental board games were obtained – CO_2 (Lacerda, 2012), Keep Cool (Eisenack & Petschel-Held, 2004), Catan: Oil Springs Scenario (Assadourian & Hansen, 2011), Evolution: Climate (Crapuchettes, 2016), Green Deal (Al-JouJou, 2014), Global Warming (Bucak, 2011), and Baumland (Bouslama, 2016). The games were briefly introduced and played by 17 respondents across four board game nights in two Norwegian municipalities. The results suggest that board games can be highly effective as tools in environmental communication, although only four of the provided games ended up being evaluated.

1.4 Thesis structure

This thesis is structured into six separate chapters, one reference list and one section reserved for supplementary materials (appendices). The first and current chapter, the introduction, is intended to clarify the overall purpose of the three empirical research papers that constitute the basis of the thesis itself. The second chapter, a list of aims, serves as a summary of the project's core goals and subgoals for referential purposes to the reader. The third chapter, innovative environmental communication and environmental psychology, introduces core

concepts and psychological models from the fields of environmental psychology and communication, and composes half of the thesis' theoretical foundation. The remaining half can be found in the fourth chapter, game psychology, which revolves around core concepts surrounding how, when, and why games affect and change us in various ways during and after gameplay. The fifth chapter, methods, details and explains the methodical choices that were made throughout the project, as well as containing more detailed information about the demographics, datasets, rigor and validity concepts in qualitative research, ethical guidelines, and detailed reflections on the research processes themselves. This chapter is primarily aimed towards increasing the transparency of the conducted research to give the reader in-depth knowledge and insight into the methods used and the choices behind them. Lastly, the thesis concludes with a sixth chapter, results and discussion, which summarizes the findings of the three empirical studies. These results are then subjected to a thorough reflective discussion, drawing on insight both from previously established theoretical foundations as well as personal thoughts and comments by the thesis author. Lastly, the thesis finishes with a list of cited publications as well as a section with supplementary materials and addendums.

Chapter 2 – Aims

The overarching goal of this thesis is to investigate *how games can be utilized as communicational tools about a variety of environmental topics*. The reason for this is twofold. Firstly, the research into environmental games is very scarce (Klöckner, 2015), even though the environmental games scene has grown drastically over the last 30 years (Reckien & Eisenack, 2013). Secondly, games have been shown, through decades of research, to be highly motivating forms of learning (e.g., Abt, 1970; Dickey, 2007; Garris, Ahlers & Driskell, 2002; Klein & Freitag, 1991; Yang, 2012), situating the learner in an interactive space unlike what most other forms of communication-based media can achieve. To reach the overarching aim, several sub-goals had to be reached:

1. First, establish a clear insight into the contemporary use and implementation of environmental games to understand the extent of their use in research. This preliminary work provided the theoretical backbone for the papers of this thesis.
2. Once this insight has been gained, construct an evidence-based tool that future environmental game designers and -scholars can utilize during the construction of sophisticated environmentally themed games. This became the framework for the first paper – the ENED-GEM (Fjællingsdal & Klöckner, 2017).
3. Conduct empirical studies on the use of environmental games – both digital and board-based – with special emphasis on the personal experience of the respondents after gameplay. This became the framework for two empirical research papers (Fjællingsdal & Klöckner, 2019, 2020).
4. Provide personal reflections surrounding the finished research process, highlighting strengths and weaknesses of environmental game-based learning as well as providing suggested guidelines for future research.

Chapter 3 – Innovative Environmental Communication and Environmental Psychology

The key to proper environmental management lies in the combined efforts of both the natural and social sciences (Ashley & Boyd, 2006). The purpose of this chapter is therefore to introduce the concept of contemporary environmental issues from the angle of the natural sciences, as well as innovative communication strategies centered on combating them from the social sciences. The chapter furthermore seeks to address and illustrate the role of psychology in environmental science communication, and to demonstrate the crucial inclusion of psychology in the interdisciplinary effort to combat environmental issues. The chapter begins with a broad introduction to environmental communication and -psychology as a field before it delves deeper into contemporary findings on how and why insight from environmental psychology can contribute to communication-based environmental interventions.

3.1 The fundamentals of environmental communication

The term *communication* can fundamentally be defined as "*information transfer between different points in space or time, where the term information is loosely employed to cover standard formats that we are all familiar with, such as voice, audio, video, data files, web pages, etc*." (Madhow, 2008, p.1). Communication constitutes how we, as humans, make sense of the world around us through the sharing of knowledge and meaning, as well as being our main tool for persuasion (Morreale, Spitzberg & Barge, 2007, p.5). Due to how all-encompassing and far-reaching communication is, it is possible to conclude that communication is always happening in one form or another, everywhere, and that *not communicating in any way* is an impossibility (Watzlawick, Beavin & Jackson, 1967, p.51). As humans, we have various ways and strategies for communicating (see Littlejohn & Foss, 2011), both linearly from one recipient to another and through exchanging dialogues. For the purpose of this thesis, and in particular due to the qualitative nature of the research it is built on, this chapter will focus particularly on the *phenomenological approach to communication* – a set of communication theories where the importance of personal experience and direct exposure to a subject matter is key (Klöckner, 2015, p.48; Littlejohn & Foss, 2011). This phenomenological approach will be backed by core findings from the field of environmental (or conservational) psychology, a branch of the social sciences that revolves around how individuals think and act regarding the natural environment (Klöckner, 2015, p.11).

A fundamental problem for environmental psychology and the phenomenological communication tradition in general is how to communicate effectively about issues

surrounding climate change and all its underlying facets of interconnected environmental issues. Such forms of *environmental communication* - processes where the meaning of the environment and its core issues are exchanged between various individuals through symbols, signs and behavior (Canter & Craik, 1981; Pearson, Nelson, Titsworth & Harter, 2011) – are entirely necessary both in order to 1) develop cleaner and more efficient technology as well as 2) changing peoples' behavior in a more pro-environmental direction (Klöckner, 2015, p.4). Through these transactions of knowledge, meaning and behavior, individuals change (and are, in turn, changed by) their environment in various ways (Gifford, Steg & Reser, 2011). "Environment" is defined very broadly, and includes such aspects as social settings, architecture, learning spaces and informational locations (De Young, 1999). The importance of effective and impactful environmental communication is difficult to overstate, and the reasons for this will be explored in the next section of this thesis.

3.2 Climate change and its underlying environmental issues

The scientific consensus surrounding the evidence on anthropogenic (man-made) climate change is often cited as being unequivocal (Carlton, Perry-Hill, Huber & Prokopy, 2015; Cook et al., 2013; Cook et al., 2016; Eisenack & Reckien, 2013; IPCC, 2013; Powell, 2016), with very few scientific papers actively rejecting it (Benestad et al., 2016). The full picture of how climate change and its related environmental issues affects biological life is hugely complex (den Haan & van der Voort, 2018), and often far beyond comprehension even when climate psychologists attempt to explain it (Stoknes, 2017, p.89). Across decades, science has revealed some of the more detrimental effects that climate change has already caused as well as generated predictive theoretical models that showcase or suggest what might happen in the future if the global temperature continues to increase. Human activity and industry have clear and measurable impacts on oceans, ecosystems and biodiversity (Klaniecki, Wuropulos & Hager, 2019), and this impact is extremely negative in nature – leading to alterations in oceanic life and acidity (IPCC, 2019; Lejeusne, Chevaldonné, Pergent-Martini, Boudouresque & Pérez, 2009; Pörtner & Peck, 2010; Wrona et al., 2006), a decline in or extinction of important keystone species in a variety of ecosystems and biomes (Maxwell, Fuller, Brooks & Watson, 2016; Redpath et al., 2018; Salafsky, Margoluis, Redford & Robinson, 2002), glacial melting (IPCC, 2013) and increased rates of extreme nature events such as forest fires (Lenihan, Drapek, Bachelet & Neilson, 2003) and flooding (Christensen & Christensen, 2002; Ely, Enzel, Baker & Cayan, 1993; Milly, Wetherald, Dunne & Delworth, 2002).

Climate change also severely impacts human living conditions on a global scale, causing unstable or severely damaged crop yields (Parry, Rosenzweig, Iglesias, Livermore & Fischer, 2004; Patz, Campbell-Lendrum, Holloway & Foley, 2005; Schlenker & Roberts, 2009), increasing the spread of infectious diseases due to warmer climates (Haines, Kovats, Campbell-Lendrum & Corvalan, 2006; Patz, Epstein, Burke & Balbus, 1996) and causing large-scale climate migration due to impaired living conditions (Raleigh & Jordan, 2010) – factors that in turn are likely to cause a dramatic increase in violent conflicts and human death rates (Barnett & Adger, 2007). These are only a few contemporary examples of the measurable consequences of climate change, and there are instances in environmental communication history where the threat of climate change has been framed as an outright war (Flusberg, Matlock & Thibodeau, 2017) against an "invisible" enemy that is gradually "sneaking up on us".

3.3 "Invisible" environmental issues

The "invisibility" of some environmental issues has posed an enormous challenge for scientists, and depicting and illustrating them might be among the biggest challenges that environmental communicators are faced with today (Hansen & Machin, 2013; Moser, 2010). In addition to the literal invisibility of carbon dioxide (CO_2) (Sheppard, 2012, p.3), the driving force behind climate change, other environmental issues are often perceived as "invisible" because the majority have little to no direct experience with them and their direct effects (Myers, Maibach, Roser-Renouf, Akerlof & Leiserowitz, 2013), instead learning about them through non-interactive media such as documentaries and films (e.g., Greitemeyer, 2013), newspapers (Reis, 1999), religious or politically affiliated outlets (e.g., Greeley, 1993; Jones & Dunlap, 1992; McCright, Xiao & Dunlap, 2014), or miniscule portions of selected school curriculums (Huckle, 1993). While scientists generally use media to combat misinformation (Dudo & Besley, 2016), other outlets may have different priorities (Foltz et al., 2019). As a result, much of the informational material on the environment that most people consume is politically or religiously skewed, or biased. Scientific findings are also occasionally wrongfully interpreted and presented by journalists due to miscommunications with the field of science (e.g., Dunwoody & Peters, 1992). On the other hand, scientific climate change models are frequently met with public skepticism, scrutiny, and uncertainty due to their vagueness and lack of explanatory rigidity (Vatne, 2013, p.43). This vagueness stems from imperfect knowledge about the science of climate change as well as the overall uncertainty

about how it will affect us in the future (Houghton, 2015, p.14), and is known to direct peoples' selective use of scientific findings (Opotow & Weiss, 2000).

As the invisibility of environmental issues has become so pervasive, visualization of the environment and resource use (also known as *eco-visualization* (Löfström & Svanæs, 2017)) has become a popular field in the environmental sciences (Böttinger & Röber, 2019) and the (visual) arts (Holmes, 2007; Roosen, Klöckner & Swim, 2018), and there is dawning scientific evidence that suggests its educational impact. Several studies have shown the positive influence of simulated or otherwise artificial environments, such as a deeper understanding of the greenhouse effect (Thacker & Sinatra, 2019), the ecological impact of personal computer usage (Kim, Hong & Magerko, 2010) and increased rates of pro-environmental behavior in a nature simulation (Klein & Hilbig, 2018). However, although simulated environments might be effective on a certain level, more interactive elements should be introduced and researched in order to understand their impacts on the meaning-making processes involved in being "present" in an artificial environment (Ballantyne, Wibeck & Neset, 2016). Despite the promising findings from eco-visualization strategies, however, they are still in their infancy. Much of the literature on eco-visualization exists in the form of sporadic conference papers (e.g., Morreale, McAllister, Mishra & Dowluri, 2015; Truong, Francisco, Khosrowpour, Taylor & Mohammadi, 2017), and peer-reviewed papers on eco-visualization are currently relatively scarce.

Further complicating the invisibility and complexity of environmental issues and anthropogenic climate change is the fact that humans operate behind an array of psychological barriers that prevent and circumvent behavior that could demonstrably lead to noticeable environmental improvement. Some of these barriers, as well as the central and overarching topic of environmental knowledge, will be discussed in the next sections of this thesis.

3.4 Knowing vs. acting: environmental knowledge and pro-environmental behavior

One of the biggest scholarly debates in the social sciences revolves around the attitude-behavior correspondence, or which underlying factors are demonstrably connected to human behavioral change (Petty & Cacioppo, 1986). This debate also extends into the environmental sciences, where the central issues revolve around informing laypeople that climate change is real as well as motivating them to act more pro-environmentally (Abrahamse & Matthies, 2013, p.225; Bain et al., 2016). In some fields of environmental communication, the general belief up until recently has been that simply informing people about the benefits of pro-environmental behavior is enough to initiate behavioral change – the so-called *knowledge-*

deficit model (Schultz, 2002; Sturgis & Allum, 2004). *Knowledge* is an important, yet often insufficient precursor to behavioral change (Abrahamse, Steg, Vlek & Rothengatter, 2007; Deci & Flaste, 1995, p.36; Finger, 1994; Frick, Kaiser & Wilson, 2004; Geller, 1981; Hines, Hungerford & Tomera, 1987; Jensen, 2002; Johnson & Johnson, 2009, p.50; Keeble, 1988; Kollmuss & Agyeman, 2002; Moser, 2010; Roth, 1992; Staats, Wit & Midden, 1996), loosely defined as the overall educational outcome of an abstract or concrete learning process (Kolb, 1984). While there are numerous models describing the multifaceted nature of knowledge, it can roughly be divided into four categorical dimensions: *situational* (knowledge about domain-based situational scenarios), *conceptual* (simple and declarative factual knowledge), *procedural* (knowledge about what actions and manipulations to perform) and *strategic* (knowledge about how to organize and utilize information in a concrete process) (de Jong & Ferguson-Hessler, 1996). This categorization of knowledge is found across the literature on the field (e.g., Alexander & Judy, 1988), although situational knowledge is occasionally omitted. The concept of knowledge also has some overlap and linkage with the similar concepts of *opinion* and *belief* (Broudy, 1977; Prestin & Pearce, 2010), which are more subjective and often more resistant to attempted corrections (Schacter & Scarry, 2000, p.177).

Within the environmental sciences, the complexity of knowledge is compounded by the continuous spread of deliberately planned environmental disinformation, which has caused considerable polarization even in Western societies where the consensus among scientists regarding anthropogenic climate change is nearly unequivocal (van der Linden, Leiserowitz, Rosenthal & Maibach, 2017). There are also several other interconnected barriers between gaining knowledge about a subject and changing behavior. First and foremost, knowledge gain is impacted by both the context in which it is supposed to take place, through the medium in which it is imparted upon the recipient and even by the recipient's pre-existing knowledge structures (Friestad & Wright, 1994). Some individuals are highly knowledgeable about environmental topics and issues, while others are not – suggesting that there are, in fact, a variety of misunderstandings and confusion surrounding climate change and other environmental issues (e.g., Chang, Pascua & Ess, 2018; Plutzer et al., 2016) also in our contemporary information society. Different people also require different types and qualities of information to bolster their knowledge adequately. For most environmental awareness campaigns, however, the information provided often tends to be either too non-specific or vague for certain individuals to act upon (Klöckner, 2015, p.165). Added to the fact that behavior is influenced by a variety of other individual factors such as personal values, attitudes and norms (Ajzen, 1991), perceived knowledge about

environmental problems and decline alone is rarely enough to initiate pro-environmental behavior. Perhaps due to these arguably disappointing findings, contemporary research has shifted its focus away from environmental knowledge as a behavioral determinant in favor of more "promising" factors such as values or motivation (Jensen, 2002).

3.4 Beyond knowledge: psychological components of behavioral change

While existing literature implies that knowledge and information provision alone are insufficient in causing behavioral change, there is also significant agreement that they are important *components* in the psychological framework that drives and moderates pro-environmental behavior (Bamberg, 2013; Klöckner & Blöbaum, 2010; Kozar & Connell, 2013; Meinhold & Malkus, 2005; Stern, 1999; Thøgersen, 2009; Zsóka, Szerényi, Széchy & Kocsis, 2013). The combination of cognition, affect and behavioral intent, for example, constitutes a core component of an individual's set of attitudes towards performing a specific behavior (Secord & Backman, 1964; Stoknes, 2017, p.90). Some authors have also concluded that environmental cognitions, an umbrella term for the overall degree of knowledge and information an individual has acquired about the environment as well as the mental process of obtaining said knowledge and information, forms the basic foundation for pro-environmental behavior (Dunlap & Scarce, 1991). The complexity of the framework behind alterations in human environmental attitudes and behavior, however, requires far more consideration for effective change interventions to be properly designed and implemented. This section of the thesis will therefore describe some of the core elements involved in the process surrounding pro-environmental behavioral change to illustrate at least a basic picture of the psychological factors involved in it.

3.4.1 Attitudes

Attitudes have long been known to exert influence over individual responses to various objects and situations (Allport, 1935), defined as favorable or unfavorable feelings towards specific objects, individuals, situations, behaviors or principles (Klöckner, 2015, p.71; Skaalvik & Skaalvik, 2005, p.63) and considered to be such a crucial factor in environmental psychology that more than half of all scientific publications in the field reference them in some way (Milfont & Duckitt, 2010). Attitudes can be either explicit or implicit and are subject to change when exposed to different types of information (Rydell & McConnell, 2006). *Implicit attitudes* generally form over a long period of time (Rydell & McConnell, 2006), whereas *explicit attitudes* are more likely to alter rapidly (Fazio, 1995; Petty & Wegener, 1998). Although attitudes do not directly determine behavior, they are theorized to

be strongly related to *behavioral intent* or the intention to act **(**Ajzen, 1991; Hines et al., 1987; Klöckner & Blöbaum, 2010; Kollmuss & Agyeman, 2002), which in turn accounts for an approximation of 41-51% of our ecological behavior (Kaiser & Gutscher, 2003). Such environmental attitudes, the sum of which might be described as a person's overall *environmental concern* (Fransson & Gärling, 1999), start developing during childhood and are derived from influential factors such as family, media, and education (Eagles & Demare, 1999). It is also theorized that individuals with strong environmental attitudes are more likely to participate in pro-environmental behaviors that require more investment and effort (Kaiser, Byrka & Hartig, 2010). Despite this, a considerable gap exists between our pro-environmental attitudes and our pro-environmental behavior, thus suggesting that pro-environmental attitudes alone are seldom enough to explain why we act the way we do (Kollmuss & Agyeman, 2002). While some of this discrepancy can be explained by factors such as the lack of a unified concept of environmental attitudes (Kaiser, Wölfing & Fuhrer, 1999; Mainieri, Barnett, Valdero, Unipan & Oskamp, 1997) and a similar lack of direct experience with environmental issues (Rajecki, 1982), it is also important to consider the prevalence of other psychological factors in the process of change towards pro-environmental behavior.

3.4.2 Norms

Another important psychological factor involved in behavioral change is norms. A *norm* is essentially a rule, implicit or explicit, that is constructed by a group to regulate in-group behavior (Johnson & Johnson, 2009, p.17). Norms are commonly divided into two main categories: personal norms and social norms. *Personal norms* are individual feelings of moral obligation to perform a specific behavior (Klöckner, 2015, p.76; Schwartz, 1977), whereas *social norms* are moral standards that belong in a collective and guide acceptable or desirable ways of living (Hynes & Wilson, 2016). Prosocial personal norms are derived from exposure to social norms during formative childhood years and are commonly activated when something or someone require help (Schwartz, 1977; Schwartz & Howard, 1981). In the context of environment and sustainability, this normally occurs when awareness-raising interventions centered on a specific issue, such as environmental decline, are conducted (Klöckner, 2015, p.76). Social norms can be either injunctive or descriptive, and the distinction between these two is paramount to ensure the development of normative appeals during persuasion attempts (Cialdini, 2003). *Injunctive social norms* refer to how we perceive what others approve or disapprove of (otherwise known as the *valued social* behavior) and motivate us to act by having us consider the potential rewards and punishments of following

these norms. *Descriptive social norms,* on the other hand, revolve around whether other people engage in this normative behavior, and the consideration of what is appropriate behavior in a given context (Cialdini, Reno & Kallgren, 1991; Smith et al., 2012). As with attitudes and knowledge, norms are considered to be one of the core motivational factors towards pro-environmental behavior such as the purchase of organic or otherwise environmentally friendly foods (Thøgersen & Ölander, 2006; Widegren, 1998), sustainable consumption (Demarque, Charalambides, Hilton & Waroquier, 2015), eco-friendly travelling (Doran & Larsen, 2016) and recycling (Czajkowski, Hanley & Nyborg, 2017).

3.4.3 Values and beliefs

In addition to attitudes and norms, humans also operate based on a set of personal and shared values. *Values* constitute a person's guiding principles in life (Schwartz, 1992) and exist in a system of priorities, meaning that human choice is based on the value that is considered most important (de Groot & Thøgersen, 2013). They are normally shaped during childhood and have proven to be extremely resistant to change later in life (Jacobs, Vaske, Teel & Manfredo, 2013, p.80), although some research suggests that both context and value strength are important components in generating value-driven behavior (Verplanken & Holland, 2002). Three specific value orientations (egoistic, altruistic and biospheric) are of particular interest to the environmental sciences (de Groot & Steg, 2008). A person who acts in accordance with an *egoistic* value orientation will largely consider the personal costs involved with engaging in pro-environmental behavior, a person with an *altruistic* or social value orientation would consider the costs and benefits for other people before engaging in pro-environmental behavior, whereas a person with a *biospheric* value orientation would act pro-environmentally based on the perceived costs and benefits to entire ecosystems and the planet as a whole (de Groot & Steg, 2008).

Values are also significant to the field of environmental psychology and communication in that they are shown to be guiding principles for environmental beliefs, which in turn regulate behavior (Johnson, Bowker & Cordell, 2004; Martin & Czellar, 2017; Nguyen, Lobo & Greenland, 2016; Ojea & Loureiro, 2007; Pooley & O'Connor, 2000; Stern, 2000; Stern & Dietz, 1994; van der Werff, Steg & Keizer, 2013). An environmental *belief* is a set of underlying assumptions that are used as a referential framework for interaction with the environment (Gray & Weigel, 1985), and are shown to directly influence pro-environmental behavior and attitudes such as water conservation practices (Corral-Verdugo, Bechtel & Fraijo-Sing, 2003), general environmental concern (Kilbourne & Pickett, 2008), pro-

environmental purchases (Mainieri et al., 1997; Pickett-Baker & Ozaki, 2008), and energy saving behaviors (Gadenne, Sharma, Kerr & Smith, 2011). Environmental beliefs furthermore appear to vary with gender, with women being more willing to take voluntary pro-environmental action and men being more apt to support invasive pro-environmental governmental policies (O'Connor, Bord & Fisher, 1999).

3.4.4 Habits

Another psychological factor that is known to steer our daily routine is that of *habits* - behaviors that are formed under repeat exposure to situational cues (Aarts & Dijksterhuis, 2000; Lally & Gardner, 2011; Verplanken, 2006), and become particularly strong when the outcome of the repeat behavior is rewarding (Ouellette & Wood, 1998). One study suggests that anywhere between 35 and 53 percent of human behavior is habitual (Wood, Quinn & Kashy, 2002). When a certain action or behavior is conducted, a mental link between said behavior and the context in which it took place is formed. Repeating similar actions in similar environments further strengthens this mental link, and eventually a new habit is formed (Wood & Neal, 2009). The function of habits is essentially to regulate and enable various forms of behavior. They are largely subconscious and automatic, thus alleviating the strain on activities that require deeper cognitive processing (Aarts & Dijksterhuis, 2000; Jager, 2003). In the context of sustainability, habits partially account for several of our environmentally damaging behaviors, such as car use (Bamberg, Ajzen & Schmidt, 2003; Gärling, Fujii & Boe, 2001) and electricity consumption (Klöckner & Verplanken, 2013, p.198). Such forms of environmentally damaging habits are often carried out with little to no regard for their effects (Dahlstrand & Biel, 1997), both because they allow for daily functioning but also because they are largely subconscious and therefore subjected to less scrutiny when compared to more cognitively demanding activities and tasks.

Due to their subconscious nature, habits are often very difficult to break. One of the more common strategies has been to conduct interventions designed to establish implementation intentions, or simple action plans on when, where and how the more desired behavior (i.e., not the habitual behavior) will be conducted (Gollwitzer, 1999). While intentions to change habits are known to be effective in changing weaker habits, the same does not apply for habits that are stronger and more enduring (Webb, Sheeran & Luszczynska, 2009). In fact, if a habit is sufficiently strong it is unlikely that behavioral alternatives to the habit will even be perceived or processed (Klöckner, 2015, p.91). Additionally, habits are tied to common, everyday contexts and situations that actively trigger

the habit in question (Wood, Tam & Witt, 2005), and changing these circumstances in order to allow for old habits to be broken could be challenging. Deliberately changing or removing the context in which the habitual cues are normally triggered is considered to be one of the prime strategies for changing habits (Jager, 2003; Verplanken & Wood, 2006), and there is empirical research that supports this notion. In two separate studies, a free one-month bus ticket was given to a selection of drivers that mostly travelled by car (Fujii & Kitamura, 2003; Thøgersen & Møller, 2008). In the first study, the free ticket ensured that attitudes towards- and habitual use of public transport remained positive over an extended period (Fujii & Kitamura, 2003). In the later study, the drivers would eventually resort to their old habits of personal car use the moment the free ticket was used up, possibly suggesting that a positive evaluation of the alternative to the habitual behavior is necessary to instigate more permanent behavioral change (Thøgersen & Møller, 2008).

3.5 Major theories of behavioral change

In the fields of environmental communication and -psychology, the relationship between factors such as knowledge, attitudes, norms, values, beliefs, habits, and behavioral change is a central and complex issue. Several explanatory models exist that seek to explain this relationship. Currently dominating our understanding of pro-environmental attitudes, intentions and behavior are the *theory of planned behavior* or *TPB* (Ajzen, 1985), the *norm-activation model* or *NAM* (Schwartz, 1977), the *value-belief-norm theory* or *VBN* (Stern, Dietz, Abel, Guagnano & Kalof, 1999), *goal-framing theory* or *GFT* (Lindenberg & Steg, 2013), and the *motivation-opportunity-ability model* or *MOA* (Ölander & Thøgersen, 1995). Together, these theoretical frameworks constitute large parts of the understanding of which psychological factors ultimately affect environmentally responsible behavior. Due to their overall importance to the field, each of these frameworks will be discussed in more detail in this section of the thesis. In Chapter 6, core factors from these models will be related to the field of environmental gaming to highlight which of the factors can be said to also be, to some extent, present in a gaming context.

3.5.1 The theory of planned behavior (TPB)

Within the field of environmental psychology, the most cited explanatory theoretical framework for pro-environmental behavior is known as the theory of planned behavior, or TPB for short (Klöckner, 2015, p.70). The TPB is an extension of the earlier *theory of reasoned action* (Fishbein & Ajzen, 1975), which held that behavior is a direct result of *behavioral intentions* to act. These intentions to act, which account for approximately 50% of

peoples' ecological behavior alone (Kaiser & Gutscher, 2003) are, in turn, shaped by a person's pre-existing attitudes and subjective norms, which are discussed in sections 3.4.1 and 3.4.2 of this thesis, respectively. Ajzen (1985) later extended this theoretical framework by including *perceived behavioral control*, or PBC, which revolves around a person's beliefs, resources, opportunities, and abilities to perform the behavior in question (Klöckner, 2015, p.70). This new framework, the TPB, has become a staple in environmental psychology research and has been shown to account for as much as 95% of peoples' conservation behavior (Kaiser, Hübner & Bogner, 2005), including the purchase of green products (Maichum, Parichatnon & Peng, 2016), environmental activism (Fielding, McDonald & Louis, 2008) and recycling (Kaiser & Gutscher, 2003).

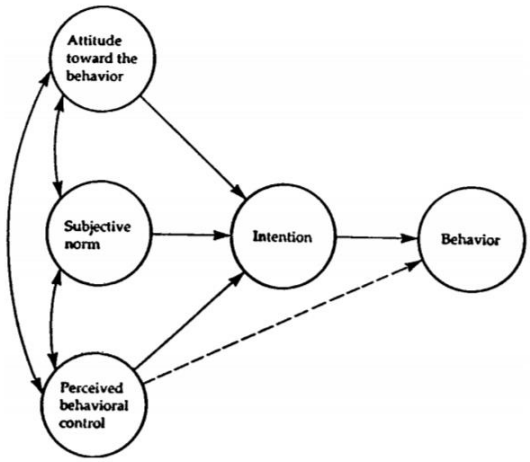

Figure 1: The theory of planned behavior (Ajzen, 1991, p.182). Used with permission from Elsevier.

Due to its explanatory power, the TPB is still widely utilized in contemporary environmental communication research. However, the model has also received criticism due to its simplicity. While the original model revolves around pro-environmental behavior as a generalized category (Klöckner, 2015, p.74), suggestions have been made to extend this framework to account for more situational variables. This is especially pertinent due to how the TPB framework implicitly assumes that factors such as sociodemographic variables, beliefs and values are all subcomponents of the more explicit categories of attitudes, subjective norms and PBC (Steg & Nordlund, 2013, p.187). Such suggestions for extensions include habit strength (Conner & Armitage, 1998), environmental ethics and beliefs (Chen &

Hung, 2016), subjective norms (Yadav & Pathak, 2016) and personal characteristics or demographic variables (Qi & Ploeger, 2019).

3.5.2 The norm-activation model (NAM)

A more specific theoretical framework for behavioral change can be found in the norm-activation model, or NAM (Schwartz & Howard, 1981). Unlike the previously mentioned TPB, which has a very general approach to the underlying mechanics of behavioral change, the NAM was originally designed to explain what causes *altruistic behavior* (Klöckner, 2015, p.76), actions that are conducted out of interest for the welfare of others rather than the self (Trivers, 1971). It is based on the notion that there exists a causal relationship between a person's feelings of personal obligation to act and their personal norms (Schwartz, 1977), which are activated in situations where the person is made aware that someone or something is in need of help (Klöckner, 2015, p.76). Although the NAM is commonly depicted as a singular framework, two separate interpretations of it exist: the NAM as a moderator model, and the NAM as a mediator model (de Groot & Steg, 2009). Proponents of a *moderator model* approach claim that the relative strength of two core psychological variables – awareness of consequences and ascription of responsibility – moderate the effect that personal norms have on prosocial intentions and behavior (see Figure 2). *Awareness of consequences* (AC) refers to the perceived detrimental effects of not acting pro-environmentally, whereas *ascription of responsibility* (AR) refers to feeling personally responsible for these detrimental effects (de Groot & Steg, 2009). On the contrary, proponents of a *mediator model* state that an individual's personal norms is the product of AC and AR, and that the NAM is a relatively linear psychological framework (de Groot & Steg, 2009).

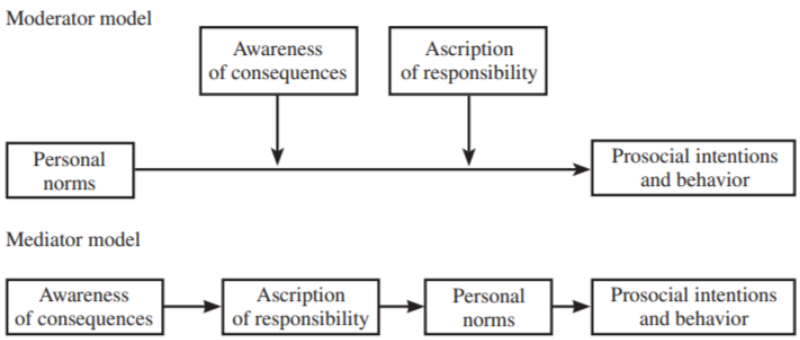

Figure 2: The two main conceptualizations (moderator and mediator model) of the norm-activation model (de Groot & Steg, 2009, p.427). Used with permission from Taylor & Francis.

As in the TPB, the psychological variables of the NAM have also been widely used to explain pro-environmental behaviors such as recycling practices (Hopper & Nielsen, 1991), alternate modes of transportation (Harland, Staats & Wilke, 2007) and saving electricity in the workplace (Zhang, Wang & Zhou, 2013). Despite these promising findings, the use of the NAM as an interpretative framework suffers from the model's lack of formalization and the different interpretations of its underlying, driving mechanisms (Klöckner, 2015, p.78). Therefore, using the NAM as an interpretative framework for environmental behavior alone is seldom enough. As a result, the NAM is integrated with the TPB in some contemporary psychological studies to boost their collective explanatory power (e.g., Liu, Sheng, Mundorf, Redding & Ye, 2017; Park & Ha, 2014; Rezaei, Safa, Damalas & Ganjkhanloo, 2019; Setiawan, Santosa & Sjafruddin, 2014; Shi, Fan & Zhao, 2017; Shin, Im, Jung & Severt, 2018; Zhang, Geng & Sun, 2017).

3.5.3 The value-belief-norm theory (VBN)

Norms are also important components of more contemporary theoretical frameworks of pro-environmental change. One of these is the value-belief-norm theory, or VBN, proposed by Stern (2000). As with the previously mentioned NAM, the VBN also holds that pro-environmental behavior is driven by a normative, moral obligation to act (Klöckner, 2015, p.80). However, the VBN contends that norms are the result of underlying values (egoistic, altruistic and biospheric) that, in turn, reflect on a person's ecological worldview and beliefs. This ecological worldview, sometimes described as the *new ecological paradigm* or *NEP*, reflects the growing tendency that humans are gradually realizing the effects of their actions on the environment (Dunlap, Van Liere, Mertig & Jones, 2000; Stern et al., 1999) and, consequentially, that pro-environmental action is required. The model furthermore states that a person needs to be aware that environmental issues pose a threat to something valuable and important, such as clean air and water, and that they are somehow capable of counteracting these detrimental effects through their actions (Klöckner, 2015, p.81).

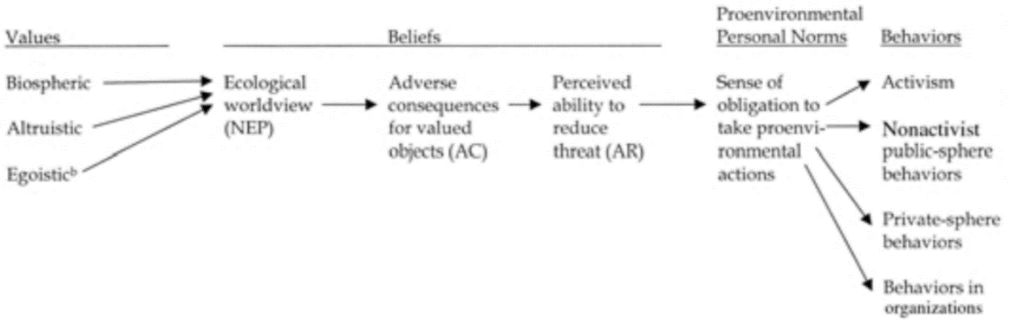

Figure 3: The value-belief-norm theory (Stern, 2000, p.412). Used with permission from John Wiley & Sons.

Much like the formerly mentioned mediator model of the NAM, the VBN is a very linear framework that suggests a direct relationship from one psychological factor to the other (Steg & Nordlund, 2013, p.191). Although there is some empirical support for this causal hierarchy (e.g., Steg, Dreijerink & Abrahamse, 2005), the relationships between the variables of the framework are occasionally found to be less stringent than the model claims. Citing numerous studies, Klöckner (2015, p.81) states that several of the proposed variables in the framework often have direct effects on other variables further down in the causal chain, thus suggesting that the model is not as linear as earlier publications claim. This is similar to the case of the TPB, where PBC was found to affect the *intention* to act, as well as behavioral change directly (see Figure 1). In addition to this, the VBN has also been shown to be less accurate at describing the relationships between its included psychological variables than the previously mentioned TPB (Kaiser et al., 2005). Regardless of its weaknesses, the VBN, like its predecessors, has been shown to predict a wide range of pro-environmental behaviors – ranging from the adoption of alternative fuel vehicles (Jansson, Marell & Nordlund, 2011) and renewable energy devices (Fornara, Pattitoni, Mura & Strazzera, 2016) to marine conservation (Wynveen, Wynveen & Sutton, 2015) and household energy conservation (Abrahamse & Steg, 2011).

3.5.4 Goal-framing theory (GFT)

Attitudes, norms, values, and beliefs are indisputably important factors in psychological research on pro-environmental behavioral change. One factor that is commonly overlooked, however, is that of *context* – and with it, the fact that people regard different things as

important at different times and in different situations (Klöckner, 2015, p.83). When something is of particular importance or interest to an individual, they are likely to try and achieve it in some way – i.e., to reach some form of goal. Goal-framing theory, or GFT, states that humans generally follow three overarching goal frames: hedonic goals, gain goals, and normative goals (Lindenberg & Steg, 2013). *Hedonic goals* involve anything that makes the individual feel short-term relief or comfort, whereas *gain goals* revolve around guarding and improving one's resources. By some contrast, *normative goals* refer to acting appropriately in a given situation (Steg & Nordlund, 2013, p.193). The goals are ordered in a hierarchy of importance and, due to their sharp contrasts, are not always compatible (Klöckner, 2015, p.83). A person could, for instance, have normative ambitions to travel by train, only to find that they strongly prefer going by car instead. In such situations, the notion of acting appropriately (i.e., taking the train and thus activating the normative goal of travelling in an eco-friendly manner) is easily overridden by the desire to maximize personal comfort (i.e., by taking the far less eco-friendly car and thus activating the hedonistic goal). Furthermore, individuals who act pro-environmentally only because it is somehow profitable and comfortable to them (i.e., individuals with strong hedonistic and gain goals rather than normative goals) will likely discover that this is not always feasible (de Groot & Steg, 2009).

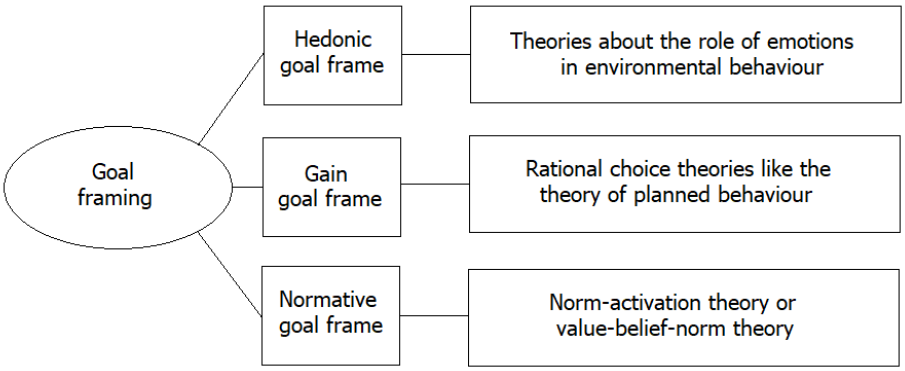

Figure 4: The goal-framing theory (Klöckner, 2015, p.84). Used with permission from Springer Nature.

The core idea behind GFT is that the three overarching goal frames factor into what people pay attention to, which attitudes and knowledge factors are the most accessible, and what behavioral alternatives or actions are considered in a given situation or context (Lindenberg & Steg, 2007). As different people operate in accordance with different goal frames, their decisions and behavior often stand in stark contrast depending on what each

actor considers to be the best course of action (Foss & Lindenberg, 2013). Several goal frames may be active simultaneously (Lindenberg & Steg, 2007), and the relative strength of each goal frame will either strengthen or weaken the degree to which the target behavior occurs (Tang, Chen & Yuan, 2019). In contemporary research, the GFT has also been used to showcase how differently framed environmental messages can have different effects on the perceived acceptability of sustainability policies (Westin, Nordlund, Jansson & Nilsson, 2020), and that tailored, innovative forms of information should be used to appeal to people that exhibit particularly strong goal frames (Yang, Chen & Zhang, 2020).

3.5.5 Motivation-opportunity-ability model (MOA)

Another example of a psychological model that considers the influence of contextual cues on behavior is the motivation-opportunity-ability model, or MOA, which contends that behavior is a result of an interaction between intrinsic qualities of the individual as well as the situation they are currently in (Ölander & Thøgersen, 1995; Thøgersen, 2010). As the model's name suggests, it consists of three main components: *motivation* (a motive or inspiration to act or not act in a pro-environmental way, consisting of subcomponents such as environmental attitudes, norms, concern, and self-efficacy), *opportunity* (external and contextual factors that either enable or prohibit pro-environmental behavior) and *ability* (the personal resources, cognitive and financial, an individual has to conduct the behavior in question) (Thøgersen, 2010). Essentially, the model illustrates that an individual needs to be in a situation where acting pro-environmentally is a realistic option to less environmentally friendly behaviors (Klöckner, 2015, p.22). The model also claims that motivation alone is not enough to initiate behavioral change (Pieters, 1991), and that both the ability to perform as well as the contextual opportunities to do so also need to be present.

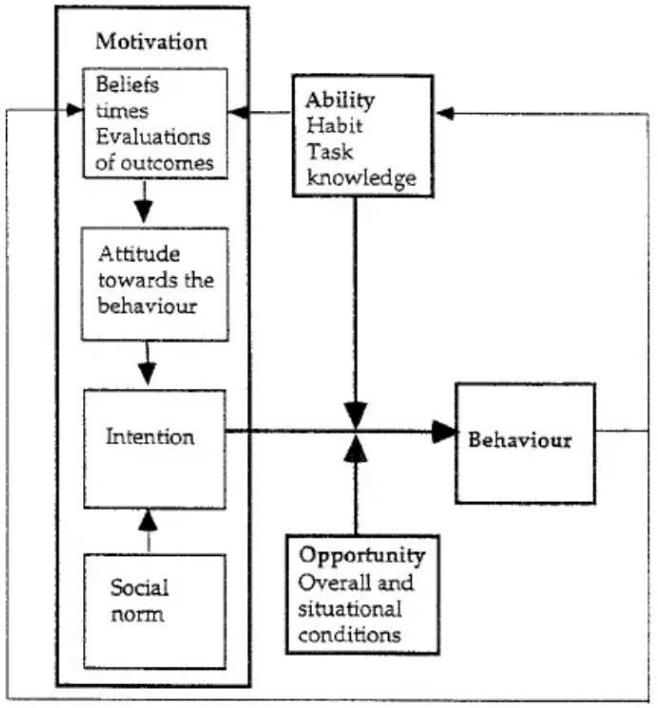

Figure 5: The MOA model (Ölander & Thøgersen, 1995). Used with permission from Springer Nature.

Although the MOA model has not received as much attention as some of the other psychological frameworks in this chapter, like the TPB and the NAM, it heavily features the same categorical variables (attitudes, norms, beliefs) that the other frameworks are built upon. It further expands upon these factors by also considering the underlying effects of the context an individual is in, which could also explain (at least partially) the missing connection between a person's pro-environmental attitudes and subsequent behavior (e.g., Boulstridge & Carrigan, 2000; Kollmuss & Agyeman, 2002; Thøgersen, 2010). Despite the fact that it is not as commonly utilized as an explanatory psychological framework, the components of the MOA have been validated through studies within the environmental sciences such as the acceptability rate of eco-fashion use (Zhang & Lang, 2018), green fertilization practices (Li, Zeng, Mei, Li & Li, 2019) and sustainable public procurement (Grandia & Voncken, 2019). Approaching the components of the MOA model from a slightly different angle, one study also focused on how *competing* motivations combined with *insufficient* opportunities and abilities to act are *detrimental* to limiting food waste (van Geffen, van Herpen, Sijtsema & van Trijp, 2020), thus adding to the model's validity.

3.6 Barriers against pro-environmental behavior

In addition to the psychological factors that *facilitate* pro-environmental behavior mentioned in the previous section, there is also a multitude of psychological factors that *prevent* it. For many, environmental issues are difficult to understand (Stoknes, 2017), highly complex and interconnected (den Haan & van der Voort, 2018; Fennewald & Kievit-Kylar, 2012), often barely noticeable (Hansen & Machin, 2013) and frequently presented in an overwhelming or doomsday-oriented manner where the actions of the individual are framed to ultimately be futile (Stoknes, 2017). In other cases, even the basic mechanisms underlying climate change are not fully understood by laypeople (Ranney & Clark, 2016), meaning that any attempts to understand the more complex and interconnected web of environmental issues becomes impossible. When faced with such abstract issues caused by human activity, humans have a series of psychological defense mechanisms that often result in a lack of behavioral change. In addition to cognitive deficiencies related to lack of knowledge and even ignorance of environmental issues, we are also apt to discredit and deny scientific evidence that anthropogenic climate change is occurring, due to factors such as political ideology, scientific exaggerations of regional climate change effects, and an inability to understand the co-benefits of climate change mitigation for society as a whole (Bain, Hornsey, Bongiorno & Jeffries, 2012; Farmer & Cook, 2012; Jacques, 2012; Gifford, 2011). Furthermore, we tend to be overly optimistic about the future without conducting any specific pro-environmental actions (Costa-Font, Mossialos & Rudisill, 2009), or we might just put our faith entirely in the hands of talented engineers wishing to develop some kind of end-all technological solution to the problem of environmental decline as a whole (Clark, Robert & Hampton, 2016; Gardezi & Arbuckle, 2018; Hickman & Banister, 2009).

Several attempts to categorize psychological barriers that prevent behavioral change have been made, such as the list of the most commonly used arguments from climate change skeptics and -deniers that climate change is either not occurring or natural (Skepticalscience.com, 2020) as well as more domain-specific attempts to identify barriers to environmental practices in organizations or the built environment (e.g., Hoffman & Bazerman, 2007; Hoffmann & Henn, 2008). One study roughly divides these barriers into the three categories of *individuality* (involves conflicting or confounding attitudes), *responsibility* (the degree to which an individual feels personally responsible for environmental decline) and *practicality* (contextual and external factors such as a lack of time and money to act) (Blake, 1999), whereas another study identifies these barriers both on an individual and a societal level (Lorenzoni, Nicholson-Cole & Whitmarsh, 2007). The most comprehensive taxonomy

of psychological barriers against pro-environmental behavior, however, is known as the *Dragons of Inaction* and consists of 7 main categories (Gifford, 2011). These categories (described by Gifford as dragons) will be briefly described here to illustrate the most central psychological barriers towards pro-environmental behavior.

3.6.1 Dragon 1 – Limited cognition

The first dragon described by Gifford (2011) revolves around the limitations in human memory, rationality, and cognitive resources. When put in situations involving pressure, such as time constraints, humans often tend to make decisions and perform actions that are irrational and self-centered (Gifford & Chen, 2017). Although humans are capable of thinking about long-term future scenarios, it is far easier to focus on short-term present gains and situations (Gifford, 2013), meaning that the distant and possibly catastrophic scenarios caused by environmental issues are often neglected as a result (Hendrickx & Nicolaij, 2004). Environmental issues are also frequently presented in repetitive and droll ways that cause people to grow tired of the message (Burke & Edell, 1986; Gifford, 2011; Stoknes, 2017), there is a great deal of scientific uncertainty surrounding their impact (Houghton, 2015, p.14; Vatne, 2013, p.43), and people tend to be more optimistic rather than realistic about the current state of their surrounding environment (Gifford et al., 2009). These issues tend to combine to form a perceived lack of control, where any pro-environmental actions are discounted as useless or ineffective (Gifford, 2013).

3.6.2 Dragon 2 – Ideologies

The second dragon revolves around ingrained ideologies and worldviews steering human behavior. As previously mentioned, human environmental knowledge often comes from religious or politically charged media outlets (Greeley, 1993; Jones & Dunlap, 1992; McCright et al., 2014). Religion and political affiliation also constitute core components of a person's ideology or worldview, which is shown to have a clear impact on how certain individuals treat their surrounding environment (Gifford, 2011). An adherence to a capitalist political system, for example, clearly has personal benefits in terms of increased affluence, but is also shown to reduce the availability of shared resources (Heath & Gifford, 2006). Some religious worldviews are also connected to a lack of pro-environmental behavior, in particular due to how a perceived higher power or deity will eventually intervene on the behalf of humans to save them (Gifford & Chen, 2017). Lastly, while it is not a religion in and by itself, people also tend to have an inflated belief that technology will provide the solutions to any and all environmental issues that humans might cause (Clark et al., 2016; Gardezi &

Arbuckle, 2018; Gifford, 2008; Hickman & Banister, 2009; Houghton, 2015, p.221; Lacroix & Gifford, 2018), a term that is commonly known as *technosalvation* (Gifford, 2008, 2011).

3.6.3 Dragon 3 – Comparisons with other people

The third dragon revolves around how we, as humans, compare ourselves and our behavior to others. Much of human behavior is steered by what is normatively considered to be socially acceptable or proper (Cialdini, Reno & Kallgren, 1991; Heath & Gifford, 2002; Hynes & Wilson, 2016; Smith et al., 2012). Norms and comparisons with others might therefore also result in behavioral barriers towards pro-environmental action, such as in situations where one might observe others perform environmentally damaging behavior without any personal consequences (Gifford, 2011). These social comparisons extend far beyond the sphere of individuals. It is common to hear comparisons between different nations, celebrities and corporations in terms of their carbon emissions (Gifford, 2011), and humans have a tendency to dislike what they perceive as an inequity or inequality between themselves and others (Kerr, 1983). Seeing others perform environmentally damaging behaviors might therefore create justifications for one's own environmentally damaging behavior (i.e., "why should I make an effort when nobody else does?").

3.6.4 Dragon 4 – Sunk costs

The fourth dragon revolves around investments or routines that are difficult to abandon. Humans are famously loss-averse (Cialdini, 2007, p.238), meaning that we tend to have difficulties dispensing of something that we have invested considerable resources into (Arkes & Hutzel, 2000; Knox & Inkster, 1968). By extension it would also be difficult to give up environmentally damaging behaviors, such as driving a car, as the high cost of the initial purchase makes future car driving feel more justifiable to the driver (Gifford, 2011). Continued performance of environmentally harmful behaviors such as these could furthermore become habitual, and as I explored in the previous sections of this thesis, habits can be difficult to break (Aarts & Dijksterhuis, 2000; Klöckner, 2015, p.91). Bad habits and loss aversion combined could subsequently cause a barrier, even to individuals who have developed personal goals to act more sustainably (Gifford & Chen, 2017; Lindenberg & Steg, 2013).

3.6.5 Dragon 5 – Discredence

The fifth dragon revolves around discrediting or belittling scientific understanding of the climate and the effects of human activity on it. In contemporary society, it is shown that the

prevalence of so-called *alternative facts* – the perseverance in a belief that is either ignorant, disconnected from reality, or both (Strong, 2017) – are on the rise, leading some scientists to suggest that we are moving into a *post-truth society* (e.g., Iyengar & Massey, 2019) where scientific evidence is frowned upon in favor of material produced by thinktanks, lobbyist groups, or misinformation campaigns (Demeritt, 2006). Even minor exposure to certain material attempting to debunk anthropogenic climate change can be sufficient in sowing distrust in climate scientists (van der Linden, 2015), and combined with poorly implemented environmental campaigns as well as the aforementioned vague explanatory models about climate change (Houghton, 2015, p.14; Vatne, 2013, p.43) can lead to active denial of anthropogenic climate change in general (Gifford, 2011).

3.6.6 Dragon 6 – Perceived risks

The sixth dragon revolves around the risks that are associated with changing one's behavior in a more pro-environmental direction. Citing Schiffman and colleagues, Gifford (2011) notes that there are at least 6 potential sources of risk to any pro-environmental behavior: functional, physical, financial, social, psychological, and temporal. *Functional risk* revolves around whether a certain pro-environmental action works at all. A person might purchase an electric car, for instance, only to find out that the battery is of poor quality and that the car is overall not in line with their initial expectations for it. There is also a *physical risk* associated with a variety of pro-environmental behaviors, such as the increased vulnerability to bodily injury when deciding to ride a bicycle rather than a car to and from the workplace. *Financial risks* are also a factor when deciding to purchase green products and technologies, such as how the implementation of solar panels might not generate enough revenue to justify the initial cost of installing them. *Social* and *psychological risks* are heavily interconnected and are primarily normative in nature due to how they arise from a perception of what others might think or feel about one's actions and behavior (Cialdini et al., 1991; Hynes & Wilson, 2016; Smith et al., 2012). Purchasing or utilizing green products might leave a person open for critique from their social peers, and this critique might be understood by the recipient as unpleasant or out of line with what is normatively considered acceptable. Lastly, the process of deciding to act more pro-environmentally might take up a significant amount of time and resources yet fail to produce the desired outcome. This is known as *temporal risk* and, although it technically applies to most forms of behavioral decision-making, might require a bit more sacrifice when acting for the environment rather than for the self.

3.6.7 Dragon 7 – Limited behavior

The seventh and final dragon identified by Gifford (2011) is that of *limited behavior*, or the tendency for people to adopt pro-environmental behavior that has little impact yet is easy to conduct. This form of low-impact and low-cost behavior is also known as the *low-cost hypothesis* (Diekmann & Preisendörfer, 2003), and involves the performance of symbolic and comparatively inconsequential behaviors (i.e., lowering the thermostat or switching off lights in rooms that are not in use) rather than actions that have a more noticeable, longitudinal effect (i.e., using a bicycle or public transportation rather than a personal car when going to and from work) (Gifford & Chen, 2017). Additionally, human behavior is shown to be the subject of *rebound effects* – both economic and psychological. The *economic rebound effect*, otherwise known as the Khazzoom-Brookes postulate (Brookes, 1990; Khazzoom, 1980), refers to the tendency where any gains and positive impact of energy-efficient technology is cancelled out by overusing it. Additionally, psychological rebound effects might also occur in cases where pro-environmental behavior is concerned. Also known as mental accounting or moral licensing, psychological rebound occurs when a feeling of "having done one's bit" in a certain domain, such as the purchase of an electrical car, results in the tendency to feel "permitted" to consume more in other domains (Seebauer, 2018). A person who has invested in a more environmentally friendly car, for example, might end up taking said car for longer and more frequent journeys, ultimately *increasing* rather than decreasing their carbon emissions and negative environmental impact (Gifford, 2011).

3.7 Environmental communication in the media

While it is important to consider the psychological facilitators and -barriers to pro-environmental behavior, it is just as important to consider the media landscapes which help form them. The media, in its many forms, is a highly pervasive component of human society and communication, and is shown to influence our consumerist values (Paek & Pan, 2004), social norms (Ho, Poorisat, Neo & Detenber, 2014), emotions (Bartsch & Viehoff, 2010), and the level of public support for certain political topics (Azrout, van Spanje & de Vreese, 2012; de Vreese & Boomgarden, 2006) just to name a few examples. Even though media are shown to affect us in a variety of ways, it is also important to understand that the opposite is also true. Media users will critically interpret and evaluate the media they consume rather than passively absorb it, or being directly "injected" with immediate and measurable effects (the so-called *hypodermic model* or *magic bullet theory* of media effects (Bineham, 1988)). Although it is a common notion in media research that keeping a certain psychological and

critical distance to the media we consume is normal (Lull, 2000, p.171), there is little doubt that we also experience a wide range of media-based emotions and communicative behaviors as if they were "real" (Reeves & Nass, 1996). However, the "direct" effects of media exposure, mediated by a person's pre-existing attitudes, values and norms, appear to be stronger when a person has little to no previous exposure to the topic that is being presented (Ball-Rokeach & DeFleur, 1976). This poses a challenge for the field of environmental communication, as people generally choose media that either cover their innate psychological needs (Katz, 1959), or reinforce existing beliefs or behavioral norms (Ball-Rokeach & Fleur, 1976). As a result, media-based interventions designed to promote pro-environmental attitudes, values, norms, and behavior are likely to attract individuals who are environmentally literate and active from before, simply due to revolving around a topic that the consumers are interested in already. Furthermore, any kind of pro-environmental media campaign, regardless of its platform and target audience, can be classified as a persuasion attempt. When people are subjected to such persuasion attempts, they will both 1) understand that they are in the process of being persuaded about something, 2) have certain opinions surrounding the traits, competencies and agendas of who- or whatever is persuading them, and 3) have a certain level of knowledge about the topic of persuasion from before (Friestad & Wright, 1994). As a result, the reactions to a persuasive environmental media campaign will more than likely be met with very individualized responses. In order to understand to what degree pro-environmental media is effective in convincing their audiences, this section of the thesis seeks to explore some of the most commonly utilized forms of media-based environmental communication (according to Klöckner, 2015).

3.7.1 Environmental adverts and information campaigns

Despite the contemporary findings that information provision is seldomly sufficient in causing behavioral change (Bamberg, 2013; Klöckner & Blöbaum, 2010; Kozar & Connell, 2013; Meinhold & Malkus, 2005; Stern, 1999; Thøgersen, 2009; Zsóka et al., 2013), a common strategy to educate the public about environmental issues can be found in adverts and information campaigns. Over the course of the past 30 years, environmental campaigns have covered anything from species preservation to energy efficiency and are framed in a way that assigns responsibility to various parties for environmental decline (VanDyke & Tedesco, 2016). The rationale for creating such adverts and information campaigns is very clear. First, the addition of images to text, as exemplified in some of WWF and Greenpeace's information campaigns (see Appendix 9), is known to deepen the impact of the intended message (Harper,

2002). They are also normally exhibited in locations where they are easily visible and can be mass-produced and tailored to most topics of interest. However, although such campaigns are often targeted towards changing attitudes, motivation, norms or values (Steg & Vlek, 2009), components that have been shown to be important predictors of pro-environmental behavior (see Sections 3.4.1 – 3.4.3), they are rarely effective at increasing the prevalence of pro-environmental behavior alone (Klöckner, 2015, p.24). In most cases, seeing the same message repeatedly and in large quantities is likely to lead to environmental numbness (Burke & Edell, 1986; Gifford, 2011; Stoknes, 2017), where the message gradually loses its initial appeal or shock value. Furthermore, science-based adverts and information campaigns can be characterized as a form of *one-way communication*, in which a message is transferred from one instance to another without the possibility of providing feedback on the given message (Moser, 2010). This form of communication often tends to be ineffective and unsatisfactory, especially when contrasted with *two-way communication* where feedback from the respondents can be provided to the original sender of the message (Johnson & Johnson, 2009, p.157; Moser, 2010).

3.7.2 Traditional environmental news media

In addition to adverts, sustainability topics and environmental issues are frequently portrayed in a variety of traditional media such as newspapers, books, radio, and television. *Newspapers*, for instance, are a natural source of information related to a wide variety of contemporary topics and societal issues (Dimopoulos & Koulaidis, 2003), and are shown to be a very common tool for teachers in promoting environmental literacy in the classroom (Klosterman, Sadler & Brown, 2012). This is hardly surprising, as newspapers are easily available and their coverage of sustainability-related topics has seen an incremental increase since the early 90s (Barkemeyer, Figge, Holt & Hahn, 2009). Despite their accessibility, however, newspapers are also vulnerable to portraying sustainability-related articles in accordance with the political affiliations and worldviews of the chief editor (Klöckner, 2015, p.121) rather than opinions from scientists and NGOs, who comparatively tend to be rarely quoted (Wei, Wei, Western, Skinner & Lyle, 2015). On the other hand, the similar printed media of environmental *books* are often written by proficient environmental scientists who can present promising arguments to the reader as to why they should care about current environmental issues. Some environment-oriented books, especially those made for children, also contain images which are shown to further enhance the impact of the media upon the consumer (Harper, 2002; Muthukrishnan & Kelley, 2017). However, the reader must be

willing to invest both time and money into the purchase and use of such books (Klöckner, 2015, p.126), which might alienate a significant part of their potential audience.

Other forms of traditional news media include radio and television. The *radio* has been instrumental in highly contextual situations, such as warning Nigerian villagers about bushfires during dry season and flooding during rainy season (Boulahya, Cerda, Pratt & Sponberg, 2005), but largely appears to be an effective mode of communication when an environmental disaster has already struck or is set to occur in the very near future. Furthermore, the use of radio generally involves very mixed forms of content, ranging from pure news to entertainment media such as music or interviews (Klöckner, 2015, p.121), and therefore remains rather lacking in terms of its focus on actual sustainability issues. The *television* is also facing its own set of issues with reaching media audiences. While it is capable of portraying environmental issues both from a journalistic and entertainment media angle (Klöckner, 2015, p.122), existing literature suggests that television viewing makes people less likely to make personal sacrifices for the environment (Shanahan, Morgan & Stenbjerre, 1997) as well as reporting less pro-environmental activism in general (Jiménez-Castillo & Ortega-Egea, 2015), and that both print media and the Internet are considered more credible sources of environmental information (Ostman & Parker, 1987; Postmes & Brunsting, 2002). Television broadcasters are also skeptical of including environmental change-related programming, believing that their production will both be too costly and poorly received by their audience (Smith, 2017). Perhaps as a result, there are few regular shows and broadcasts that revolve exclusively around the environment, and they often tend to trivialize the environmental issues they deal with (Spellerberg, Buchan & Early, 2006). Despite these findings, television does provide a platform for environmental documentaries, which will be discussed in the next section.

3.7.3 Environmental documentaries

While television broadcasts of environmental topics are rather limited in their scope, environmental documentaries such as *An Inconvenient Truth* (Guggenheim, 2006), *Cowspiracy* (Andersen & Kuhn, 2014) and *Blue Planet II* (Honeyborne & Brownlow, 2017) appear to garner more public attention. In terms of their ability to motivate and inspire pro-environmental action, documentaries have been shown to provide motivation to recycle and conserve energy (Holbert, Kwak & Shah, 2003), a general pro-environmental disposition (Liu, 2017), and entertaining approaches to topics that are otherwise difficult to approach and engage with (Deogracias & Mateos-Pérez, 2013). Documentaries also frequently have an

emotional component, such as showcasing a variety of marine animals swimming in polluted oceans or depicting rainforests before and after deforestation, which could generate further involvement with the depicted issues (Lorenzoni et al., 2007). They are also, like games (see Chapter 4), capable of generating immersive narratives that allow the viewer to experience environmental issues up-close and thus further increase the aforementioned involvement into the topic that the documentary portrays (Cooper, 2018, p.16-23).

While environmental documentaries certainly have some degree of persuasive power, they are not entirely without flaws. Firstly, documentaries tend to be made on a biased or warped scientific foundation (Hooper, Lilienfeld & Arrigo, 2011). As an example, the animal agriculture documentary Cowspiracy (Andersen & Kuhn, 2014) received considerable criticism from scientists when it inaccurately stated that livestock are responsible for 51% of greenhouse gases (Boucher, 2016). In reality, the scientific consensus is that 8-18% of global greenhouse gases are emitted from livestock systems (Herrero et al., 2015), a number that, while high, is still quite low compared to the way the documentary frames it. Secondly, the way a documentary frames a topic can also influence how its viewers perceive it. For instance, in some documentaries on the oil industry, oil corporations tend to be depicted as inhuman entities that poison drinking water sources and so on (Szeman, 2012). Although there is significant scientific consensus that oil is an environmental hazard (e.g., Beyer, Trannum, Bakke, Hodson & Collier, 2016; Boesch et al., 1987), such documentaries hardly present a balanced view of what the oil industry actually does on a societal level. Finally, documentaries are also shown to draw in and appeal to individuals who are already interested in and motivated to act within the sphere of environment and sustainability. One such documentary, for instance, only managed to inspire pro-environmental monetary donations from individuals who already scored high on their level of connectedness to nature *before* they viewed the documentary (Arendt & Matthes, 2016).

3.7.4 The environment and social media

An unprecedented arena and database for environmental knowledge can be found online, and distributing environmental information through Internet spaces is theorized to have great potential (Hamid, Ijab, Sulaiman, Anwar & Norman, 2017). Going from a crowd of about 37 million users in 1996 (Bradshaw, 2001) to being utilized by approximately 4.7 billion people in 2020 (Internet World Stats, 2020), the Internet is, by far, the biggest and most easily accessible arena for publishing and sharing information about the environment and sustainability practices. The core information sharing channels that exist online usually come

in the form of *social media*, a conglomeration of networking channels and platforms where individuals and groups can socialize, collaborate, play, share content and gain exposure (Kaplan & Haenlein, 2010). The popularity of social media platforms has exploded, with nearly 75% of all Internet users in 2008 using them actively (Kaplan & Haenlein, 2010) and nearly two-thirds of corporations using them to communicate with their customers and clients (Reilly & Hynan, 2014). Examples of social media are numerous, but the most used ones include clients such as Facebook, YouTube, Instagram, Pinterest, LinkedIn, Snapchat, Twitter, WhatsApp and Reddit, just to name a few (Perrin & Anderson, 2019). In addition to these named brands, social media can also be categorized according to their functionality or design. Such categories include anything from blogs, forum comments and homepages to emails, instant messengers, wikis and virtual worlds (Williams, Page & Petrosky, 2014).

Today, social media such as these are highly pervasive and influence environmentally friendly living on a variety of levels (Haider, 2016), and are capable of simplifying complex environmental topics in order to ease their transition into everyday sustainable practice (e.g., Joosse & Brydges, 2018). However, the use of social media to get informed about environmental topics does have its pitfalls. Firstly, organizations who use social media to communicate about environmentally friendly practices tend to not utilize the full potential of their platforms to create effective dialogues with their followers (e.g., Lee, VanDyke & Cummins, 2017). Secondly, as they are seldom peer-reviewed, social media also tend to be ripe with misinformation and fake facts (Wallace, 2019) that could potentially guide wrongful behavior, despite whatever well-meaning intentions might be behind it. The recent influx of conspiracy theorists such as *flat earthers* (individuals who believe the Earth is flat) (Mohammed, 2019) and *anti-vaxxers* (individuals who refuse to take vaccines out of fear of catching vaccine-induced diseases) (Smith & Graham, 2019) are contemporary examples of how communication with and through uncritical social media could lead to attitudes, beliefs and behaviors of malign nature, even in today's information society. Thirdly, even in cases where social media are initially effective at instigating pro-environmental action, their effects tend to come and go in "spikes" – bursts of intense activity that very suddenly declines and remains low thereafter (Thorson & Wang, 2020) - meaning that their longitudinal efficiency is questionable. Lastly, some literature suggests that certain social media platforms such as Facebook and Twitter are not frequented by a representative sample of the population (e.g., Mellon & Prosser, 2017), by extension meaning that pro-environmental communication interventions here stand the risk of targeting the wrong audience or demographic.

3.7.5 Innovative environmental communication

Reviewing the literature on environmental communication through the years, it is clear that previous attempts to promote pro-environmental action have been affected in various degrees by political and religious influence (Gifford & Chen, 2017; Greeley, 1993; Jones & Dunlap, 1992; Klöckner, 2015, p.121; McCright et al., 2014), the spread of environmental misinformation and conspiracy theories (Boucher, 2016; Hooper et al., 2011; Mohammed, 2019; Smith & Graham, 2019), psychological barriers (Gifford, 2011; Gifford & Chen, 2017; Kollmuss & Agyeman, 2002), contextual and physical limitations (Cialdini et al., 1991; Friestad & Wright, 1994; Jager, 2003; Klöckner, 2015, p.83; Kollmuss & Agyeman, 2002; Ölander & Thøgersen, 1995; Smith et al., 2012; Thøgersen, 2010; Verplanken & Wood, 2006), one-way communication interventions (Johnson & Johnson, 2009, p.157), a lack of direct exposure to environmental issues (e.g., Klöckner, 2015, p.48; Littlejohn & Foss, 2011), repetitive and often vague scientific statistics and data (Houghton, 2015, p.14; Stoknes, 2017; Vatne, 2013, p.43) as well as a feeling of psychological distance from what can only be described as an "invisible" entity that slowly sneaks up on us (Hansen & Machin, 2013; Myers et al., 2013; Sheppard, 2012, p.3). It is very difficult or perhaps even impossible to design and implement a singular communications-based intervention capable of circumventing all these barriers against pro-environmental behavior at once. Although pro-environmental information campaigns have been the standard for the past 30 years (VanDyke & Tedesco, 2016), it is likely that more innovative, interactive and immersive communication strategies need to be prioritized in the way going forward in order for pro-environmental behavior to become the norm.

Examples of such innovative communication practices can increasingly be found in a variety of sectors and professions. Despite being seldomly used in environmental communication (Curtis, 2011), the visual arts, aided by the principles behind eco-visualization (Löfström & Svanæs, 2017), can frame environmental issues in a concrete way that motivates widespread pro-environmental engagement (Roosen et al., 2018). Such sensory-based interventions, like the *Pollution Pods* installation (climart.info, 2020) and the *World of Wild Waters* (woww.no, 2020), represent intriguing steps towards bringing climate change "closer" to individuals who experience psychological distance to environmental issues. Other art forms, such as rock festivals, sporting events and theatre, are also showing a stronger environmental profile, although their impact is not fully understood (Klöckner, 2015, p.213; Sharpe, 2008). One form of environmental communication that has received far too little attention, however, despite their growing audience, is the main subject of this thesis – games.

In the next chapter, games (both digital and board-based) as an innovative form of environmental communication will be explored in-depth.

Chapter 4 – Game Psychology

One of the most important contributors to the development of human social, emotional, and cognitive skills can be found in childhood play (Barnett, 1990; Vygotsky, 1967). By enabling children to explore objects using their senses, they will first be able to utilize these objects in basic, unimaginative make-believe situations, and later in complex social situations bound by sets of rules where they can interact, compete and collaborate with their peers (Scharer, 2017). While there is much research dedicated to the importance of play in children and youth, little work has been done that explores the value and function of playfulness in other age groups. What is known, however, is that playful adults generally exhibit more life satisfaction (Proyer, 2013), curiosity and creativity in their everyday lives (Guitard, Ferland & Dutil, 2005; Proyer & Ruch, 2011), and that playfulness is found to be a very important component in effective teaching and learning (Youell, 2008). Because playfulness appears to be a relatively stable construct in terms of its importance to cognitive development throughout the human life cycle, it should come as no surprise that it also becomes important to implement play and playfulness in emerging arenas for learning – such as through the use of games, the main subjects of this thesis.

Playing games is a staple of human culture, and games have existed for a long time. The Lydians, the originators of the ancient Etruscan culture, allegedly utilized dice games to pass the time in order to get through an 18-year famine (McGonigal, 2012, p.351). In a variety of other ancient cultures, ample evidence exists to conclusively demonstrate that board games were used as leisure (Bell, 1979; Decker, 1992; Wilkins, 2002). Even today, games remain a popular pastime, although both game types and gaming motivations are varied. In the U.S., 75% of all Americans had at least 1 gamer in every household, 65% of the population played video games and nearly 80% felt that playing provided them with mental stimulation, relaxation, and stress relief (ESA, 2020). In Norway, where the research for this thesis was conducted, the majority of gaming demographical statistics are centered around children and youth and it is generally agreed that approximately 46% of girls and 92% of boys in the age range of 9-10 years are active gamers (Medietilsynet, 2020). Citing numerous statistical reports, McGonigal (2012, p.3) notes that the online gaming community alone numbers more than 4 million in the Middle East, 10 million in Russia, 105 million in India, 10 million in Vietnam, 10 million in Mexico, 13 million in Central and South America, 15 million in Australia, 17 million in South Korea, 100 million in Europe and 200 million in China. Whereas more localized Norwegian statistics commonly revolve around the prevalence of game addiction, a popular debate in contemporary gaming research (e.g., Adachi &

Willoughby, 2011; Bushman & Anderson, 2001; Greitemeyer, 2014), the trend in the U.S. appears to lean more towards the potential positive side of gameplay. In addition to the previously mentioned stress relief, mental stimulation and relaxation factors, a total of 62% of gamers in the age range of 35-54 think that games can be educational (ESA, 2020) – a finding that in many ways is interesting for the growing field of environmental psychology and communication.

This section of the thesis is roughly divided into three separate parts – 1) an introduction to (serious) games, 2) an exploration of how the gameplay experience is perceived and how it affects us, and 3) an overview of how games are used as experiential learning tools. The first section contains theoretical insight into what serious games are. It goes on to explain how they can engage and motivate us in various ways, as well as how and why they can change us. The first section then ends with a brief discussion of factors that can be detrimental to the perceived quality of serious games. The second section of this chapter revolves around the overall gameplay experience. Here, core concepts such as immersion, flow and narrative transportation are explored in order to illustrate how a serious gaming session occurs in practice. Lastly, the third part of the chapter delves into the concept of experiential learning and explains how games can and should be used as experiential learning tools. The chapter then ends with an overview of previously conducted research on serious games in environmental communication.

4.1 What is a game?

Games have rapidly evolved into a popular leisure-time activity for people of all ages and social backgrounds (Yee, 2014, p. 24), and are cited as having surpassed other forms of media, such as recorded music, in terms of popularity (Egenfeldt-Nielsen, Smith & Tosca, 2013, p.16). They can be found in any society (Laamarti, Eid & El Saddik, 2014), in various forms, and the experience of playing a game will always hold a certain sense of familiarity to it – because nearly everyone *plays something* at *some point in their lives* (Upton, 2015, p.9). Defining exactly what constitutes a game, however, is a bit of a challenge. McGonigal (2012, p.21) argues that all games share four primary traits; 1) a *goal* that the players wish to achieve, 2) a set of *rules* dictating how the players can reach the goal, 3) a *feedback* system which lets the players know how close they are to achieving the goal and 4) the notion of *voluntary participation* – a shared understanding that the goal, rules and feedback system are all willingly and knowingly accepted by the players themselves. Some scholars state that a *game* "is a system in which players engage in an artificial conflict, defined by rules, that

results in a quantifiable outcome" (Salen & Zimmerman, 2004, p.81). This definition contains a great degree of overlap with the previously mentioned concept of *play*; a voluntary time-based activity conducted within the constraints of a set of publicly accepted rules, where the "meaning" is entirely intrinsic to the people conducting the activity (Huizinga, 1950, p.13). An amplification of Huizinga's original definition can be found in Upton (2015, p.15), who describes play as "free movement within a system of constraints". In addition to these various definitions, games and simulations are commonly spoken of as a singular entity, although this does not appear to be the case. Games are "fictitious, whimsical or artificial situations in which players are put in a position of conflict", whereas simulations are "simplified, dynamic and precise representations of reality defined as realistic systems" (Sauvé, Renaud, Kaufman & Marquis, 2007). It is also possible to say that all games simulate aspects of reality, regardless of how unrealistic these representations might be, and that simulations are direct rather than fantastical representations of reality (Prensky, 2001). As it stands, the proposed definitions for terms such as *games*, *simulations* and *play* are now so numerous that assembling a complete, all-encompassing terminology for them is nearly impossible. What we can glean from the definitions above, however, is that a game is something voluntary and pleasurable – a self-imposed obstacle that humans willingly engage with and derive pleasure from. Games can be used for more than just entertainment and leisure, however, which is the subject of the next section of this thesis.

4.2 Serious games – conceptual definitions

While the historical lineage of games can be traced back several millennia (Sebbane, 2001), the more recent label of *serious games* has emerged as an object of interest for a variety of researchers in different fields – more recent, despite the fact that even the earliest known games were designed with explicit educational purposes (see Laamarti et al., 2014 for a review). The term itself traces its roots back to the 1970s, however, when it was introduced as "games with an explicit and carefully thought-out educational purpose not intended to be played primarily for amusement" (Abt, 1970, p.9). Since their conception, serious games have gradually evolved through the decades and generated a wide variety of subgenres – so wide, in fact, that some researchers have argued for a single, comprehensive terminology for educational games (Schmidt, Emmerich & Schmidt, 2015) or removing the label entirely in favor of focusing more on *what* the game teaches and in *which ways* it does so (Bogost, 2010, p.233; Crookall, 2010). Several of the alternative terminologies for serious games, such as *games-for-change, games with a purpose* or *transformative games* (Egenfeldt-Nielsen et al.,

2013, p.230), contain significant overlaps in their definitions yet exist as separate entities in research and game design (Schmidt et al., 2015) – no doubt complicating scientific literature searching and academic debates. To further exacerbate an already complex field, serious games, like all other games, are often categorized by genre (see Arsenault, 2009). This means that a serious game is not *only* a serious game; it can be a *serious role-playing game*, a *serious puzzle game* or even a *serious simulation game* – experimental and rule-based interactive virtual environments where the players learn by taking actions and experiencing their consequences through in-game feedback mechanisms (Mayer, 2009). Further complicating matters, games also exist in both digital and analog, physical formats. While digital games (i.e., any game that can be played on a digital surface) have become the standard in the field of game studies (Stenros & Waern, 2011), board games are seeing a resurgence in popularity among various researchers (e.g., Nakao, 2019; Nasir, 2008; Zagal, Rick & Hsi, 2006). In order to provide a general framework for this thesis, encompassing all kinds of games, Abt's (1970) original definition of serious games is used. Despite its age, Abt's definition of serious games - games with an explicit and carefully thought-out educational purpose not intended to be played primarily for amusement (Abt, 1970, p.9) - has remained relatively consistent even in contemporary research literature (e.g., Hamari et al, 2016). It also encompasses a wide variety of genres and game types due to its holistic view of games, implying that both digital and board-based games (and also simulations) can be of an educational nature.

4.3 The effectiveness of serious games as learning tools

It is theorized that as serious games continue to immerse, evolve, engage, and capture the interest of their players, their position in learning will become more commonplace (Crisp, 2014). They are highly adaptable to teaching about any given subject (Annetta, Minogue, Holmes & Cheng, 2009), engaging a multitude of audiences (Hamari et al., 2016; Pourabdollahian, Taisch & Kerga, 2012; Rumore, Schenk & Susskind, 2016) and providing safe and simplified representations of reality, *psychosocial moratoriums* or *microworlds* (Egenfeldt-Nielsen et al., 2013, p.237; Gee, 2007, p.59), for exploration of otherwise inaccessible or dangerous subjects and topics (García-Barros, García-Barros, Cruz-Morales & Smith, 2015; McGonigal, 2012, p.303). There is a wealth of evidence suggesting mixed to positive findings in regard to the use of games as tools for learning, although any firm conclusions as to their practical use and correct implementation have yet to be made (e.g., DeSmet et al., 2014; Girard, Ecalle & Magnan, 2012; Lamb, Annetta, Firestone & Etopio,

2018; Lau, Smit, Fleming & Riper, 2017; Wouters, van Nimwegen, van Oostendorp & van der Spek, 2013; Zhonggen, 2019).

Part of the explanation of these mixed findings is the fact that many serious games rarely reveal their pedagogical foundations (Madani et al., 2017). Additionally, measuring the effectiveness of serious games involves a thorough consideration of a sizeable number of psychological variables, ranging from the overall attractiveness and motivational aspects of the game and the subject it wishes to teach, to the levels of immersion and attention-grabbing qualities it might have. It is also important to consider the target group that the game is designed to appeal to (Schell, 2008, p.98), as both gender, age and even sociocultural background are shown to influence how and why people choose to play (e.g., Egenfeldt-Nielsen et al., 2013, p.172; Riemer & Schrader, 2015; Schell, 2008, p.100; Yee, 2014, p.28). For classroom settings, where educational games are normally deemed as highly suitable (Crisp, 2014), it also becomes important to consider the existing skills with-, attitudes towards-, user friendliness of-, and acceptance for game-based learning among both teachers (Becker, 2007; Bourgonjon et al., 2013; Ketelhut & Schifter, 2011; Wang & Goh, 2017), pupils, and students (Afari, Aldridge, Fraser & Khine, 2012; Hao et al., 2010). A multitude of existing game enjoyment models can provide some of the answers as to what could make a serious game attractive and educational to certain target audiences (see section 4.4 for an overview) and, with the introduction of this thesis, a model for enjoying serious games about the environment (Fjællingsdal & Klöckner, 2017) is also added to this growing library.

4.4 Enjoying serious games

One of the more common reasons for consuming entertainment media, such as games, is to fulfil psychological wants and needs (Lull, 2000, p.101). The desire to feel *pleasure*, *enjoyment* and psychological *arousal* constitutes the most prominent reason as to why people choose to play games (Gee, 2005; Hamari et al., 2016; Poels, van den Hoogen, Ijsselsteijn & de Kort, 2012; Ryan, Rigby & Przybylski, 2006; Sweetser & Wyeth, 2005). Some people also play for *escapist* reasons (Warmelink, Harteveld & Mayer, 2009), to momentarily escape from or avoid problems that exist in their everyday lives or the real world. While the exact definition of what game enjoyment entails is far beyond the scope of this thesis, a basic understanding of game enjoyment mechanisms is central in order to comprehend how educational games captivate and immerse their players by contrast to more traditional forms of learning. This section seeks to highlight and delve into some of the most central existing game enjoyment models in order to provide a detailed insight into this topic.

4.4.1 Malone and Lepper's taxonomy of intrinsic motivations for learning

While it is not directly aimed towards game design in principle, the early taxonomy of intrinsic motivations for learning (Malone & Lepper, 1987) consists of 4 elements that are directly applicable to modern-day educational game design. These are 1) *Challenge*, 2) *Curiosity*, 3) *Control* and 4) *Fantasy*. Malone and Lepper claim that all learning activities should be challenging and provide the learners with clear goals and various forms of feedback for them to overcome this challenge. The learning environment should furthermore intrigue and immerse the learner and empower them in various ways to reach desirable learning outcomes. They also theorize that the learning activity should occur in a fantasy setting, where the educational material should be seamlessly integrated with the fantasy setting itself (i.e., it should be possible to be immersed in an artificial fantasy world while simultaneously learning skills that can be applied in a real-world setting).

4.4.2 Bartle's Taxonomy of Player Types

Another early attempt to investigate player enjoyment comes from Richard Bartle, who wished to examine player enjoyment in so-called MUDs (Multi-User Dungeons). His resulting taxonomy roughly divides players into four categories – Killers, Achievers, Socializers and Explorers – and suggests that people play games to fulfill desires and needs depending on which player types they exhibit the most (Bartle, 1996). *Killers*, for example, play to sabotage the game for other players, whereas *Socializers* desire more in-game interaction than actual gameplay. *Achievers* play to overcome obstacles and challenges, and *Explorers* play to interact with and become immersed in the game world. Bartle's taxonomy is still widely discussed in contemporary research literature (Ryan et al., 2006), and is still commonly cited even in contemporary game design principles (e.g., Schell, 2008).

4.4.3 Sweetser and Wyeth's GameFlow Model

A more contemporary example of a game enjoyment taxonomy comes in the form of the GameFlow model (Sweetser & Wyeth, 2005). Building on the principles of flow theory (Csikszentmihalyi, 1990) as well as a variety of existing game design principles, the GameFlow framework adds the elements of *concentration, player skills* and *immersion* to the previously established taxonomies of learning and game enjoyment (Bartle, 1996; Malone & Lepper, 1987). As we have already explored in section 3.5.4 on goal-framing theory in Chapter 3, the GameFlow model advices the inclusion of elements that are also central to environmental communication practices, such as goal setting and feedback (e.g., Abrahamse et al., 2007) and interventions that boost self-efficacy or PBC (Tabernero & Hernández,

2011). As the GameFlow model is rather intricate by comparison to the earlier taxonomies, each of its individual elements is described in detail below:

1) *Concentration*: The model states that a game needs to capture the player's attention over an extended time period, and that the game's attention-grabbing qualities should stem from a variety of sensory stimuli such as intriguing graphics and immersive audio. Furthermore, the game should not overload the player's ability to perform too many tasks at once, and the tasks that the player is instructed to perform should not feel unimportant or otherwise undesirable to complete.
2) *Challenge*: Building on central concepts in flow theory (Csikszentmihalyi, 1990), the GameFlow model states that games should have a difficulty level that matches the players' abilities. This means that an adjustable difficulty level should be implemented so that the player can regulate the game in accordance with their own skill level. The model also states that the level of challenge should consistently grow higher as the game progresses, although the level of challenge should not be insurmountable.
3) *Player skills*: Playing the game should follow *Bushnell's Law* of being "easy to learn, hard to master", and the player should be able to play the game without the need for much instruction – excepting tutorials that ease the players into the gameplay. The player's skills should furthermore increase as the difficulty increases, and any interfaces, menus or instructional material should be easy to learn and utilize.
4) *Control*: The player should feel a certain sense of freedom, control and impact on the game world, which includes their ability to move around, when they can stop playing, when they can save their progress and to what extent their actions have any effect on the game's environment.
5) *Clear goals*: Any goals and demands for success in the game should be clearly stated and easily understood by the player. They should be clarified early in the game process and should also be accessible at opportune times during the gameplay sessions.
6) *Feedback*: Appropriate levels of feedback should be provided as the player progresses towards their in-game goal, and the actions that the player takes should be met with immediate feedback in order to guide their way towards said goal. If the game operates with a scoring system, the player should also receive feedback on this.
7) *Immersion*: The player should experience a deep level of involvement with the game, and simultaneously experience less awareness of their physical surroundings and the

flow of time. Everyday real-life worries should be suppressed in favor of emotional involvement with the game's progression.

8) *Social interaction*: The game should allow the player to interact, cooperate and / or compete with other players, as well as supporting communities both in the game world and outside of the game itself (such as in the shape of forums).

The GameFlow model focuses more on commercial game design rather than educational game design, although the principles described above can and should be applied to serious games as well. However, an extension of the GameFlow model, EGameFlow (Fu, Su & Yu, 2009), introduced the additional factor of *knowledge improvement*. This factor captures whether the game increases the player's knowledge on a given topic, if and how they utilize this knowledge in a real-life setting, if the game motivates the player to apply their new knowledge, and to what degree the player wants to learn more about the topic that the game teaches.

4.4.4 LeBlanc's Eight Kinds of Fun

The final typology for game enjoyment that is considered in this section of the thesis is proposed by game designer Marc LeBlanc. LeBlanc hypothesizes that the word "fun" is merely a stand-in term for a much more complex phenomenon, and thus created his own conceptual framework of what makes a game intriguing to play. He (as cited in Salen & Zimmerman, 2004, p.334) lists the following eight pleasurable elements that make games enjoyable; 1) the game as *sense-pleasure*, 2) the game as *make-believe*, 3) the game as a *drama* or a *narrative*, 4) the game as a *challenging obstacle course*, 5) the game as a *social framework*, 6) the game as an *uncharted territory for exploration*, 7) the game as *self-discovery* and 8) the game as some form of *masochism*. While several of these game enjoyment elements, such as the ability to explore, socialize or experience challenges in a make-believe fantasy world are recurring elements in the previously discussed game- and learning enjoyment taxonomies (Bartle, 1996; Malone & Lepper, 1987; Sweetser & Wyeth, 2005), LeBlanc also makes the claim that games can be "masochistic" – i.e., an obstacle or hassle that the players place upon themselves voluntarily. LeBlanc claims that, in so doing, they will experience the hypnotic pleasure of submitting to the system and rules of the game (Salen & Zimmerman, 2004, p.334). It is also true that voluntarily playing certain types of games is known to elicit outwardly negative emotions and responses such as frustration, anxiety, anger and sadness (Granic, Lobel & Engels, 2014; Vorderer, Klimmt & Ritterfeld, 2004), but this also factors into what LeBlanc's taxonomy describes as an attractive,

masochistic gameplay element. While it may seem paradoxical to voluntarily engage in an activity that is designed to result in such negative affect, humans are inherently sensation-seeking (Zaleski, 1984) and desire emotional gratification for a variety of reasons (see Bartsch & Viehoff, 2010, for a review). Due to how entertainment media such as movies and games provide safe spaces where humans can have their media needs gratified, the masochistic tendencies of voluntarily submitting to negative emotions during gameplay could, again perhaps paradoxically, be considered a core enjoyment factor.

4.5 The quality of educational games

"I don't want to be educated! I want to rot my brain!" (Cinemassacre, 2011).

The quote above is from James Rolfe, otherwise known as the *Angry Video Game Nerd*, or *AVGN* for short – an online game reviewer famous for the skits featuring his character, the aptly named AVGN, harshly critiquing games that he considers to be of low quality. He is seated in front of his television, playing the educational video game *Mario Is Missing!* (The Software Toolworks, 1993) for an online crowd of over 3 million YouTube subscribers. "This is Luigi's first game, and this is what he gets?!" the AVGN continues, before turning his attention back to his television screen.

The notion of *wanting* to "rot his brain" while playing games might be hyperbole from the AVGN's side, but he does have a point in that educational games tend to be less enjoyable than games without an emphasis on educational content. In the case of educational board games, for example, they are often geared towards younger audiences and take a short amount of time to complete (Koehler, Greenhalgh & Boltz, 2016), possibly suggesting a lack of strategic or immersive depth that older audiences seem to enjoy (Woods, 2012, p.151). Other researchers found that reviews of educational games rarely emphasize the educational properties of the games (Willet, Moudgalya, Boltz, Greenhalgh & Koehler, 2018), and that the significant amount of time dedicated to learning how to play them often alienates certain players (McNamara, Jackson & Graesser, 2009). Educational games are also, perhaps paradoxically, frowned upon in classroom settings – both due to the negative opinions on them held by educators, but also due to their commonly low levels of graphical quality (Rice, 2006), lower production values and less well-developed gameplay (Illingworth & Wake, 2019). Additionally, educational games exist in a variety of formats and are perceived very differently from one person to another (Roscoe, Snow, Brandon & McNamara, 2013), meaning that one player might enjoy a game that a different player does not, and vice versa. Compounding this, good serious games need to be developed and designed in close

cooperation between professional game designers and educators, as it has been shown that being an expert in the pedagogical sciences does not imply similar expertise in good game design (Theodosiou & Karasavvidis, 2015). Conversely, academics have a tendency to treat educational games as convenient smokescreens for traditional didactic methods (Galarneau, 2005), meaning that many games from the edutainment era can be perceived as relatively poor when compared to more successful games on the market. In other cases, serious games are simply criticized for being overall poorly designed or for artificially trying to make a boring activity into something that is fun and enjoyable (game designer Jesse Schell, as quoted in Sinclair, 2013). These findings suggest an unfortunate disconnect between the original intent behind serious games – that is, providing an entertaining, educational and possibly behavior-altering activity (Connolly et al., 2012) for a very wide audience – and the reality that they might not even be played at all due to being perceived as uninteresting or otherwise lacking in quality (Sweetser & Wyeth, 2005).

Recent years have seen the advent of serious environmental games that are co-developed by environmental scientists and professional game designers, such as Keep Cool (Eisenack & Petschel-Held, 2004), Fate of the World (Roberts, 2011) and Eco (Strange Loop Games, 2020), and some of these games have seen preliminary evaluations already (e.g., Eisenack, 2013; Waddington & Fennewald, 2018). Interestingly, these games also appear to receive overall positive reviews on major gaming websites and platforms (see Appendix 8), suggesting that interdisciplinary collaboration is effective at generating serious games that are both enjoyable and educational. While these results show some clear promise and ample evidence for the value of interdisciplinary collaboration in game design, it still leaves the question of exactly what game enjoyment entails. For the next section of this thesis, core components of an enjoyable gameplay experience will be described in order to provide at least a basic understanding of how games can captivate, engage, motivate and (ultimately) change us in different ways.

4.6 Immersion and presence in serious games

As mentioned previously, immersion is a vaguely defined yet crucial element of the gameplay experience. Immersion is a core motivational factor as to why people choose to play games (Brockmyer et al., 2009; Christou, 2014; Jennett et al., 2008; Sweetser & Wyeth, 2005; Yee, 2007) and a recurring yet implicit element in all of the formerly mentioned game enjoyment models. Despite this, the term is often vague and unspecific due to being used differently by researchers, players and game designers (Brown & Cairns, 2004; Ermi & Mäyrä, 2005). Due

to this conceptual vagueness as well as their centrality to the gameplay experience (Qin, Rau & Salvendy, 2009; Sweetser & Wyeth, 2005; Weibel & Wissmath, 2011), the next section of this thesis seeks to illustrate the immersion and flow phenomena respectively, with the aim of deducing their roles in educational or serious gaming.

One of the earliest known attempts at explaining immersion comes from the Dutch historian Johan Huizinga. Through his studies of play he became the originator of the term "*magic circle*", which he defined as "temporary worlds within the ordinary world, dedicated to the performance of an act apart" (Huizinga, 1950, p.10). Although Huizinga did not explicitly state that the magic circle theory applied to games, contemporary definitions of the immersion phenomenon strengthen the notion that the phenomena are not separate entities. In modern-day ludology, immersion into *virtual worlds* – defined here as any simulated (although not necessarily digital) spaces shaped by inhabitants through the use of some kind of avatars (Girvan, 2018) - is thought to make players less aware of several aspects of "real life", such as physical surroundings, flow of time and awareness of the physical self (Brown & Cairns, 2004; Sweetser & Wyeth, 2005). Also, while commonly discussed as a singular phenomenon, immersion is arguably a multi-faceted psychological construct consisting of at least three primary forms: sensory, challenge-based and imaginative immersion (Ermi & Mäyrä, 2005). *Sensory immersion* refers to the game's audiovisual elements that engross the player and enable their journey into the game world, *challenge-based immersion* occurs as a result of the game's puzzles and obstacles that the player must overcome, and *imaginative immersion* happens when a player can use their imagination, empathize and gain emotional involvement in the characters and story, or plainly enjoy the fantasy aspects of the game world. Immersion is furthermore theorized to be stage-based, leading the player from basic engagement (learning the game's controls and gaining appreciation of the game's theme) through engrossment (emotional involvement in the game) and eventually total immersion or presence (psychological detachment from physical reality and attentional shift to the game world) (Brown & Cairns, 2004).

Immersion and presence are often used interchangeably but are in fact separate (yet connected) entities. *Presence* is a term used for the feeling that one is inside a virtual environment (Christou, 2014; Ryan et al., 2006; Weibel & Wissmath, 2011; Wirth et al., 2007), or "the subjective experience of being in one place or environment, even when one is physically situated in another" (Steuer, 1992; Witmer & Singer, 1998). Presence has also been cited as requiring *focus* (Fontaine, 1992) and an attentional shift towards the medium in question (Witmer & Singer, 1998). Presence is therefore a product of the interaction between

two separate entities: characteristics of the media being consumed, as well as characteristics of the media user (Baños et al., 2004). Although presence, like immersion, is also a complex entity in and by itself, a general agreement exists that it creates an *illusion of nonmediation* – a failure to acknowledge the existence of a medium in a communication arena and responding as if the medium is not there (Lombard & Ditton, 1997). Despite some definitional disagreements, immersion is the phenomenon of media absorption itself, whereas presence is the subjective experience and sensation of being immersed.

4.7 Flow in serious games

While immersion and presence are generally indicative of high game enjoyment, it is also important to consider the role of flow during gameplay. *Flow* was first described as the psychological phenomenon of complete immersion into an activity or action, and the subsequent enjoyment one gets from this experience – the so-called "optimal experience" (Csikszentmihalyi, 1990, p. 4). While the concept of flow is highly similar to the previously mentioned concept of immersion, resulting in a considerable degree of conceptual overlap in the research literature (Takatalo, Häkkinen, Kaistinen & Nyman, 2010, p.27), some researchers argue that there are clear differences between the two. Immersion could be described a *precursor* to flow, for example, in the sense that immersion simply involves a loss of context whereas flow constitutes complete involvement into an action (Nacke & Lindley, 2008). Other researchers have described flow as a *form* of immersion (Weibel & Wissmath, 2011), although it is worth nothing that despite this conceptual overlap, separate questionnaires and scales for immersion (Jennett et al., 2008), presence (Witmer & Singer, 1998) and flow respectively (Jackson, Martin & Eklund, 2008) do exist, suggesting that they are indeed separate entities despite their similarities.

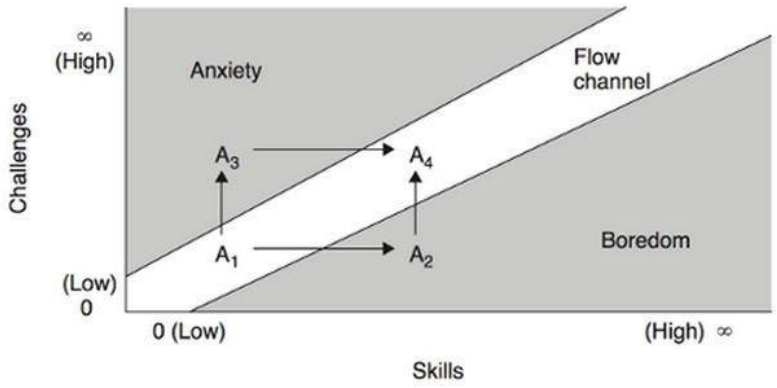

Figure 6: A typical flow chart, as described by Csikszentmihalyi. The flow channel (or flow state) is considered to illustrate the level of optimal experience where an activity's level of challenge and the performer's skills are ideally matched. Source: Schell, 2008, p.119. Used with permission from Taylor & Francis.

Flow has been used to describe the absorption into gaming activities for decades (e.g., Bowman, 1982), and continues to be a staple in contemporary research literature on game-based learning. Achieving a *flow state* (see Figure 6), the perfect balance of challenge and skill (Johnson & Wiles, 2003), is frequently shown to be one of the main motivators for consuming various forms of media (Sherry, 2004), including video games (Voiskounsky, Mitina & Avetisova, 2004), and is also shown to create positive affect during certain game-like simulation tasks (Lackey, Salcedo, Szalma & Hancock, 2016). Experiencing the flow state is also paramount in serious games, as there is a clear connection between flow and game-based learning (Kiili, 2005; Perttula, Kiili, Lindstedt & Tuomi, 2017) as well as the attention-grabbing qualities of the game (Schell, 2008, p.118). When individuals experience flow during a learning experience, they appear to integrate it better than if they are not in a flow state. This is likely due to how flow is essentially the "level of optimal experience", where individuals function perfectly in the divide between their personal skills and the difficulty of the task being performed. In serious games specifically, however, a flow state can be difficult to achieve if the game's topic is perceived as too complex, unenjoyable, or tedious. In fact, players who experience flow in serious games generally do so because the activity of playing itself is engaging, and not because they expect some extrinsic benefit (such as learning outcomes) from playing (Kiili, de Freitas, Arnab & Lainema, 2012). Also, as with any flow activity, it is important that the game has a gradually rising difficulty curve that matches the skill growth of individual players (Hamari et al., 2016).

4.8 Narrative transportation in serious games

Games are commonly considered to be highly *multimodal* – meaning that they contain a very wide variety of sensory information (e.g., animation, music, and design) for the player to perceive and make sense of (Burn, 2008). If asked to consider the sensory components of games, many would likely state that a game consists of a visual and possibly auditory layout, perhaps with some tactile pieces in the case of board games. However, a central aspect of games that is commonly overlooked is the narrative - the "fictional 'reality' in which the characters of the story are supposed to be living and in which its events are supposed to take place" (Rimmon-Kennan, 2002, p.6). As a rule, a narrative consists of a beginning, middle, and end that provide information about the characters and plot (Lu, 2015). Although a narrative is often considered a literary device that appears largely in books and magazines, they appear in any number of media and are known to create highly immersive experiences (Murray, 1997, p.21). In games, for instance, there will always be a narrative that guides the player through the events of the game. Even in games where the narrative appears to not exist or is overly abstract, such as in the game of Chess, there will always be opportunities for the player to create an imaginary narrative (Schell, 2008, p.263). Media-based narratives are often used as tools for persuasion, such as in the case of communicating science to a lay audience. One such study explains that immersive narratives increase comprehension, interest in- and engagement with scientific topics (Dahlstrom, 2014), while another suggests that immersion into a good narrative can foster attitude and behavior change by generating an emotional bond between the "reader" (i.e., the consumer of the media text) and the characters of the narrative (Green & Clark, 2012). High levels of personal identification with characters in immersive narratives are shown to, at least temporarily, be a moderator of behavior (Sestir & Green, 2010; Yee, Bailenson & Ducheneaut, 2009). The immersion into a deep narrative, otherwise known as *narrative transportation* (Green & Brock, 2004), postulates three processes for how narratives and stories can be instrumental in persuasion:

1) If the narrative in question is perceived as realistic enough, this is shown to reduce the number of counterarguments towards the persuasion attempt. This is likely due to a *willing suspension of disbelief*, where irrationalities or inaccuracies in a media experience are ignored in favor of enjoying the experience for its own sake (Holland, 2003; Suspend (one's) disbelief, 2020).

2) The perception that the narrative is personally relevant, mirroring the environmental communication intervention policies of tailored information (e.g., Abrahamse et al., 2007), yields stronger effects on the resulting attitude change.
3) Deep and emotional connections and identifications with the characters and the world presented in the narrative also enhance the narrative's degree of persuasiveness.

While narrative transportation is experienced to varying degrees from person to person (Wang & Calder, 2006), its inclusion in serious games design serves several purposes. First and foremost, interesting narratives are core contributors to the "fun" aspect of games (Baranowski, Thompson, Buday, Lu & Baranowski, 2010) and normally revolve around the development of the game's characters and the player's relationships with them (Schumann, Bowman & Schultheiss, 2016). Due to their interactive nature by contrast to most traditional and didactic storytelling (Skaug et al., 2020, p.15), they also enable the player to make choices and gain agency in their impact on how the plot evolves (Costikyan, 2002; Elson, Breuer, Ivory & Quandt, 2014; Green & Jenkins, 2014). Research has also shown that narrative-driven serious games are more likely to change attitudes, engagement, skill acquisition and motivation than more traditional forms of instruction (Jackson, O'Mara, Moss & Jackson, 2018), and that narrative immersion appears to be a core component in this positive outcome on learning effects (Hafner & Jansz, 2018; Lu, 2015).

4.9 Serious games as experiences

All the previous sections of this thesis chapter have one thing in common; they each represent part of what constitutes the *experience* of playing a game. Measuring gaming experiences holistically and attempting to generalize research findings from them is very difficult, as no gaming experience is ever the same (Schell, 2008, p.10). In addition to the fact that everyone perceives a game differently at least to some degree, games are not just singular experiences but rather several types of experiences packed into a single package (Ijsselstein, de Kort, Poels, Jurgelionis & Bellotti, 2007). The experience of playing the meditative puzzle game Tetris (AcademySoft, 1984) for example, provides a completely different atmosphere than psychological horror games such as Silent Hill (Konami Computer Entertainment Tokyo, 1999) or immersive role-playing games like Baldur's Gate (BioWare, 1998) and Divinity: Original Sin (Larian Studios, 2014). Research has also concluded that the experience of playing a game tends to linger long after the game is finished, and that this experience can be both positive and negative, and short- or long-term (Poels, IJsselstein, de Kort & Van Iersel, 2010, p.161). As a result, an exact definition of what constitutes the core gameplay experience

is not likely to be agreed upon anytime soon (Phillips, 2006). However, some experiential aspects of games are largely universal. These are:

- *Immersive experiences:* As described previously, well-designed games are inherently immersive experiences – meaning that they are capable of deeply absorbing their players (Brown & Cairns, 2004; Sweetser & Wyeth, 2005) and maintaining their attention towards the game world.
- *Entertaining experiences:* Well-designed games provide fun and engagement in various ways (Sweetser & Wyeth, 2005), and serve to cover the human needs and wants of entertainment (Lull, 2000). Entertainment experiences gained from playing games can be positive or negative, but they can also be thought-provoking, profound, and deeply serious (Bopp, Mekler & Opwis, 2016; Marsh & Costello, 2012; Odenweller, Hsu & DiCarlo, 1998).
- *Emotional experiences:* Games can provide meaningful insight into a variety of both relatable and otherwise inaccessible emotional domains (Oliver et al., 2016). They can be used to vent frustration safely through catharsis, and they can provide emotional relief during bouts of sadness and depression (Schell, 2008, p.442). They can also serve to illustrate experiences that are otherwise difficult to imagine, such as how *That Dragon, Cancer* (Numinous Games, 2016) attempted to illuminate the parental experience of handling the death of a terminally ill child, or how *My Child Lebensborn* (Sarepta Studio, 2018) tasks the player with taking care of a bullied child from the Lebensborn initiative during the post-WWII era in Norway.

The experiential and interactive aspects of serious games is arguably what sets them apart from other, more static forms of media designed for the provision of information, such as newspapers, documentaries, or books. In many ways, a serious game can be considered an educational *microworld*, or a small domain of interest where the level of immersion into the material is particularly high (Rieber, 1996). Playing in such microworlds gives players a sense of agency and autonomy where they can learn and gather information on their own volition – a form of *self-regulated* (Zimmermann, 1990) or experiential learning (Kolb, 1984; Kolb & Kolb, 2005). As the experiential aspect of serious games is central to the topic of game psychology and game-based learning, it will be explored further in the next section of this thesis.

4.10 Serious games and experiential learning

One of the main subjects of debate in environmental communication is the exact role of environmental knowledge in generating pro-environmental behavior. While there is a significant library of literature stating that knowledge is an important yet insufficient predictor of behavioral change (Abrahamse et al., 2007; Deci & Flaste, 1995, p.36; Finger, 1994; Frick et al., 2004; Geller, 1981; Hines et al., 1987; Jensen, 2002; Johnson & Johnson, 2009, p.50; Keeble, 1988; Kollmuss & Agyeman, 2002; Moser, 2010; Roth, 1992; Staats et al., 1996), surprisingly little research has been done on how environmental knowledge is ideally obtained. Even contemporary research literature appears to assume that environmental knowledge is communicated and perceived on a very general level, without necessarily specifying how, why, or when this environmental knowledge is obtained and/or applied. Understanding the ideal conditions for knowledge growth is therefore central in order to further emphasize and highlight the overall importance of environmental knowledge as a predictor for later pro-environmental behavior. One way of doing this is by considering optimal learning environments where knowledge is both taught, reflected upon and applied in practical settings – so-called experiential learning.

Experiential learning, perhaps better known as *learning by doing* (Dieleman & Huisingh, 2006), is a model of learning that traces its roots back to the writings of Aristotle and Socrates (Ruben, 1999), although it only much later saw practical application through the works of more contemporary educational theorists such as Dewey (1966), Bruner (1961) and Kolb (1984). Today, it remains one of the most pervasive theoretical underpinnings steering the design, implementation, and evaluation of serious games, and is frequently mentioned as a framework upon which entire gaming research agendas are built (e.g., Bochennek, Wittekindt, Zimmermann & Klingebiel, 2007; Dieleman & Huisingh, 2006; Herz & Merz, 1998; Kiili, 2005; Saenz & Cano, 2009; Sato & de Haan, 2016). By definition, experiential learning emphasizes how knowledge is created through direct experience as well as how this knowledge is transformed and applied to a given situation (Kolb, 1984). It furthermore explains that gaining knowledge about something, or "grasping experience", is done either by *concrete experience* with something or through *abstract conceptualization*, and that this new knowledge can be transformed and applied through *reflective observation* or *active experimentation* (Kolb, Boyatzis & Mainemelis, 2000). Concrete experience essentially refers to sensing and perceiving the tangible qualities of the world, while abstract conceptualization revolves around our cognitions, thoughts, and abilities to discern information from less tangible or sensory material. As an illustrative example, playing a game could be considered

concrete experience, whereas reading the game's manual constitutes an abstract conceptualization of how it is supposed to play (adapted from Kolb et al., 2000). Furthermore, some individuals prefer to observe others performing an activity (such as gameplay) in order to gain an understanding of it (reflective observation) whereas others are more hands-on and eager to "jump right in" and experiment for themselves (active experimentation) (Kolb et al., 2000). In essence, Kolb's Experiential Learning Model (see Figure 7) explains that we all learn in different ways, and that we all have ideal learning environments through which we obtain our knowledge (Dieleman & Huisingh, 2006). Direct experience has, however, been shown to both effectively contextualize knowledge about the physical environment where little prior experience with the subject is present (Winn et al., 2006), as well as generating stronger pro-environmental attitudes when compared with indirect experience (Fazio & Zanna, 1978).

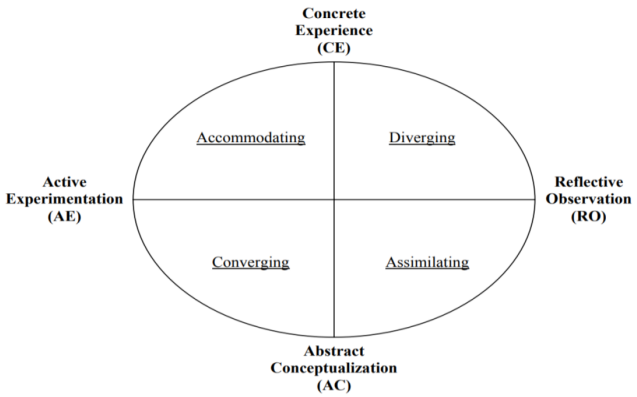

Figure 7: Kolb's Experiential Learning Model. Source: Kolb, Boyatzis & Mainemelis, 2000. Used with permission from Informa UK Limited.

As mentioned previously, serious games can be considered microworlds in which the players can freely and actively experiment to gain knowledge (Rieber, 1996; Zimmermann, 1990). Players can also observe other players performing their activities, or they can get more intimately acquainted with the game's materials by reading in-game menus, manuals, forum posts or Wiki entries. As classrooms become increasingly more digital under the so-called *Net Generation* of learners, experiential learning processes gradually become more desirable (Oblinger & Oblinger, 2005). In that regard, games can cover all bases of Kolb's experiential learning theory. Being exposed to immersive virtual reality, for example, is shown to have clear impacts on engagement and learning (Chung, 2012; Huang, Rauch & Liaw, 2010), also in the case of environmental topics such as climate change (Markowitz, Laha, Perone, Pea &

Bailenson, 2018). Experiencing something in virtual reality is also shown to be internalized as though it was a real event, leading to emotional arousal (Pertaub, Slater & Barker, 2001). While the digital game arena shows clear promise in regards to applying such experiential learning practices, analog games such as card- and board games (Bochennek et al., 2007) and real-life social interaction games (Dieleman & Huisingh, 2006) are also capable of generating learning arenas that appeal to a wide audience, possibly due to their accessibility (Wonica, 2015). Additionally, there is evidence to suggest that experiential learning outcomes from playing simulation games about international climate politics can occur (Meya & Eisenack, 2018).

4.11 Playing beyond knowledge

Most educational games, including environmental ones, are aimed primarily towards increasing knowledge and providing topical information (den Haan & Van der Voort, 2018; Klöckner, 2015, p.203; Reckien & Eisenack, 2013; Turnin et al., 2001), relying much on the traditional drill-and-practice model of simply memorizing facts without necessarily knowing how to apply them (Bruckman, 1999). Information provision in the context of environmental games is likely to primarily increase the occurrence of easier behaviors with few psychological and structural barriers (Steg & Vlek, 2009), whereas in other educational (and commercial) games it has been shown to be effective in changing peoples' health-related attitudes and behaviors (Baranowski, Buday, Thompson & Baranowski, 2008) or increasing their overall level of interest or awareness in a subject (e.g., Aoki et al., 2004; Gerling, Mandryk, Birk, Miller & Orji, 2014; Williams & Williams, 1987; Yee et al., 2009). Occasionally, conventional games also inadvertently lead to intriguing scientific studies by chance. As an example, a glitch in the popular role-playing game *World of Warcraft* (Blizzard Entertainment, 2004) one year after its release caused a weeklong digital epidemic that wiped out entire servers of players' in-game avatars. This incident spurred scientific interest and would provide valuable insight into how real-world humans react to an outbreak of disease through a computer model (Lofgren & Fefferman, 2007). Augmented reality games also have the potential to change the way we think of educational games as merely increasing knowledge, such as how *Pokémon Go* (Niantic, 2016) is theorized to increase worldwide physical activity (Althoff, White & Horvitz, 2016; LeBlanc & Chaput, 2017) and reduce the increasing frequency of social withdrawal in youth (Tateno, Skokauskas, Kato, Teo & Guerrero, 2016). Innovative game-based interventions are also starting to gain traction in the environmental sciences, with games such as the *Finde Vielfalt Simulation* being used to teach

about biodiversity through real-life experiences (Schaal, Otto, Schaal & Lude, 2018) and a variety of games being used to promote energy conservation in locations such as households (e.g., Gamberini et al., 2012; Geelen, Keyson, Boess & Brezet, 2012) and the workplace (e.g., Kalz, Börner, Ternier & Specht, 2014; Orland et al., 2014).

In regard to serious gameplay that seeks to go beyond just increasing knowledge, a basic assumption of serious games and simulations is that the players should be able to transfer the knowledge, skills and behavior from one system (i.e., the serious game) into another (i.e., the real world) (Peters, Vissers & Heijne, 1998). Although games show clear promise in changing us beyond just increasing our knowledge about certain topics, there are still significant ongoing debates about the applicability of what is learned in the game to a real-world setting. As an example, a player might enact and even enjoy the role of a virtual avatar recycling various objects in a fantasy landscape, but might not choose to exhibit a similar behavior in real life at all – a notion that has been described as the *simulation gap* (Bogost, 2010, p.43). For decades, one of the core issues in the use of serious games to promote learning beyond knowledge gain is the degree of realism in the game itself (Harviainen, 2020) – that is, the "level of realism that the game requires in order to have an accurate match of what the user can expect in the real world with what they perceive in the virtual one" (Chalmers & Debattista, 2009). While several older media studies have found that unrealistic media experiences have smaller psychological impacts than realistic ones (e.g., Atkin & Wood, 1976; Gunter & Furnham, 1984; Huesmann, Eron, Klein, Brice & Fischer, 1983; Huston, Wright, Fitch, Wroblewski & Piemyat, 1997), findings on perceived realism in serious games reveal a different picture. Some researchers have found that there is no positive correlation between knowledge gain and realism in simulated experiences (Feinstein & Cannon, 2002), while others have shown that there is little difference in learning outcomes between highly realistic and less realistic simulations (Norman, Dore & Grierson, 2012), meaning that the learning outcomes were the same regardless of whether the participants played a high-realism simulation or a low-realism one.. Others also argue that whereas certain landscapes and representations in games could be perceived as more authentic when they have connections to real-life counterparts (such as urban areas), more fantastical and unrealistic landscapes can still be perceived as relatable to the real world despite the fact that they do not accurately mimic it (Schwartz, 2006). Others again state that the level of ideal realism for games and simulations remains a contextual mystery, and that there does not yet exist a clear answer as to what degree of game-based realism is needed (Ravyse, Blignaut, Leendertz & Woolner, 2017).

4.12 Environmental communication in serious games

Although serious environmental games have existed in the public sphere for a long time (Froehlich, 2014, p.563; Reckien & Eisenack, 2013; Schulze et al., 2015), only recently have they begun to be developed in collaboration between professional game designers and environmental scientists from various fields of study. Also, despite the overarching notion that serious games and simulations can be highly effective learning tools (Clark, Tanner-Smith & Killingsworth, 2016; Connolly, Boyle, MacArthur, Hainey & Boyle, 2012; de Freitas, 2018; Gentile et al., 2009; Hamari et al., 2016; Vogel et al., 2006), they are only sporadically subjected to rigorous research in the environmental sciences (e.g., Cheng, Lou, Kuo & Shih, 2013; Foltz et al., 2019; Hallinger et al., 2020; Hewitt, 1997; Katsaliaki & Mustafee, 2015; Rooney-Varga et al., 2020; Sandbrook, Adams & Monteferri, 2015; Stave, Beck & Galvan, 2014; Wu & Lee, 2015). One of the potential reasons for this is that entertainment game developers seldomly concern themselves with how game-based learning transfers into a real-world setting (Hamari et al., 2016) which, in turn, reduces the usability of the game in educational interventions. For any game developer, creating a game that is fun and engaging is paramount, so this lacking emphasis on the learning content is hardly surprising. However, it might become problematic due to how the educational aspect – such as learning about the environment – becomes secondary to the gameplay experience itself (Klöckner, 2015, p.198). This is an issue that, at least until recently, has been compounded by the gradual decline in game developmental interest among academics (Reckien & Eisenack, 2013). Suggestions have been made to improve upon these discrepancies in the future, ranging from improving communication channels between academics and game designers to arranging joint conferences and developing research-production partnerships (Passarelli et al., 2020).

As serious environmental game research is a limited field that is only occasionally shown some sporadic interest, the findings from the field are largely positive, yet often very limited. Playing a game about waste disposal, for instance, was shown to increase both prosocial thoughts as well as the level of helping behavior, which both transferred beyond the gaming environment and remained sustained, although the playtesting session was described as too short to reach firm conclusions in regard to the game's lasting impact (Bardhan, Bahuman, Pathan & Ramamritham, 2015). Likewise, preliminary research results suggest that playing *Vindby* – a serious simulation game about offshore wind farms – is shown to increase the players' knowledge about the subject, although the authors make few specific suggestions as to how this knowledge can be applied in a practical setting (Dornhelm, Seyr & Muskulus,

2019). In a similar vein, playing the environmental management game *SimGreen* is shown to promote the players' environmental systems knowledge (Zhang & Zwolinski, 2015). Online and mobile environmental games are also seeing some promise in research, enabling their players to reduce energy consumption from appliances in the home (Gustafsson, Bång & Svahn, 2009) or raising awareness of energy efficiency and sustainable purchases (Wood et al., 2014). Additionally, real-life games that move the gameplay session into nature are also becoming gradually more common, such as in the form of a card-based approach to locating invasive seaweed species (Skukan, Borrell, Ordás & Miralles, 2020) or gaining points for performing pro-environmental activities in the home (Ro, Brauer, Kuntz, Shukla & Bensch, 2017). Aside from preliminary pilot tests of basic game prototypes, many of the available research papers on serious environmental games either contain research *proposals* rather than results (e.g., Chen, Bodicherla, Scott & Whittinghill, 2014; Despeisse, 2018; Ghilardi-Lopes et al., 2013; Uribe & Cobos, 2014) or lists of available environmental games on the market for future researchers to utilize (e.g., Ouariachi, Olvera-Lobo & Gutiérrez-Pérez, 2018; Ulrich, 1997). Many of the games on the market have also, until recently, had a very superficial approach to teaching about environmental issues, or implicitly assume that the players already possess a certain amount of knowledge on the topic from before (Reckien & Eisenack, 2013). It is therefore clear that the field of serious environmental gaming needs more research input, which this thesis seeks to ameliorate.

Chapter 5 – Methods

In this chapter, the chosen methods for the Green Gaming Project are discussed in detail. First, the overarching as well as the specific research questions forming the backbone of the thesis are presented. Then, a general introduction to central aspects of qualitative psychological research is provided as a contextual framework for the research that has been conducted during the Green Gaming Project. Lastly, a section for the processes behind each of the three studies conducted within the framework of the Green Gaming Project are described in detail – including important aspects such as recruitment strategies, demographic characteristics of the sample, interviews and focus groups, coding and construction of thematic categories. Excepting article 1, a content analysis with no grounds in interview-based information, the report contained within this chapter adheres to the proposed guidelines for reporting qualitative research for interviews and focus groups (COREQ; Consolidated Criteria for Reporting Qualitative Studies) by Tong, Sainsbury and Craig (2007). These guidelines will be briefly described later in this chapter.

5.1 Research Questions

This thesis was conducted within a qualitative constructionist / interpretivist perspective, which seeks to illuminate an overarching research topic from a multitude of differing, individual angles. In the qualitative research tradition, a good research question is multi-directional and nuanced (Agee, 2009), often offering a broad description of individual perceptions of specific phenomena. It also needs to be clearly stated as well as suitable for qualitative inquiry (Dixon-Woods, Shaw, Agarwal & Smith, 2004), meaning that it should be shaped in a way that lets the respondents reply in accordance with their own experiences, values and worldviews – the "why" and "how" of human interaction (Agee, 2009). Constructing a good qualitative research question contributes significantly to the researcher's credibility (Geertz, 1973, p.16) and, thusly, also to their likelihood of approval for publication among scientific peers (Agee, 2009). This section seeks to illustrate the procedure behind each of the research questions in the Green Gaming Project, starting with the overarching general research question before moving on to the specific ones for each of the articles forming the basis of this thesis.

5.1.1 The overarching research question

The focus of this thesis is to investigate *how games can be utilized as communicational tools about a variety of environmental subjects*. Due to the growing amount of different game types and genres, as well as the various ways in which a game can be defined (see Salen &

Zimmerman, 2004, p.70-92), the thesis assumes a very broad definition of exactly what a game is. This perspective allows the study of both digital games (e.g., video games) and analog games (e.g., board games) on equal grounds rather than as separate, isolated entities – thus contributing towards decreasing the lack of empirical research on environmental game-based learning in general (Hallinger et al., 2020; Klöckner, 2015, p.200/205). As the research on - and access to - commercially available environmental games is rather scarce (Hallinger et al., 2020; Klöckner, 2015, p. 200/205), a decision was made that the project would also have a broad acceptance for a variety of environmental topics and subjects as objects of study. Doing this meant that the rejection rate for environmental games would be very small, while simultaneously allowing for a multitude of different ways of studying them.

The thesis also assumes a broad approach to the concept of 'change' in human cognition and behavior. Although behavioral change is ultimately the goal of environmental communication interventions (Gifford, 2014), it is dependent on a variety of psychological factors that affect to what degree the intervention is effective (see sections 3.4.1 to 3.4.4 for a general overview of such factors). As studies have shown, changes in human behavior do not happen automatically after being subjected to singular communication interventions administered through the media (Bineham, 1988); rather, it is a possible outcome from being subjected to a variety of interventions targeting any or all of the psychological factors introduced in chapter 3 of this thesis. Therefore, when this thesis discusses the occurrence of changes in the respondents from the research studies, these changes are prevalent largely in the psychological factors that are *connected to* or otherwise *involved in* behavioral intent or behavioral change – such as the factors of knowledge (Abrahamse et al., 2007) and social value orientations (Messick & McClintock, 1968).

5.1.2 Specific research questions

Each of the three articles composing the Green Gaming Project have specific research questions relating back to the abovementioned overarching research topic. This section highlights the scientific reasoning behind them and provides the basic theoretical groundwork surrounding their composition.

5.1.2.1 Paper 1 - ENED-GEM

For the first study of the project, it was important to gain an understanding of what had previously been done within the field of environmental gaming research. Before the ENED-GEM study was initialized, an in-depth literature search was therefore conducted to investigate previous attempts at utilizing games in the environmental sciences. This revealed

that while environmental games exist in several different formats (Reckien & Eisenack, 2013), the research on them was highly sporadic and appeared to lack data-driven direction – most of the games were instead developed rather haphazardly by a variety of different institutions (Klöckner, 2015, p.198; Reckien & Eisenack, 2013). Also, while several of these games had become commercially available, very few of them – aside from games such as Keep Cool (Eisenack & Petschel-Held, 2004), Fate of the World (Roberts, 2011) and LandYOUs (Schulze et al., 2015) – had been subjected to rigorous research to determine their potential educational effects. Additionally, while psychological models of game enjoyment did exist (e.g., Fu, Su & Yu, 2009; Sweetser & Wyeth, 2005), it appeared that professional game designers and science educators were not aligned in terms of their views on what a good *educational* game should be – with game designers emphasizing the fun and playful elements of the game and educators focusing largely on the potential learning outcomes (Gunter, Kenny & Vick, 2008). As a result, there was no trace of a dedicated game enjoyment model for environmental games. Lastly, this, combined with a general call for more research into different types of educational games (Riemer & Schrader, 2015) formed the foundation for the development of the ENED-GEM (ENvironmental EDucational Game Enjoyment Model). The research question for this study, guiding the development of the ENED-GEM, therefore revolved around how to "*generate an understanding of the psychological factors that facilitate learning, enjoyment and their interaction in environmental educational games, and present these in a conceptual framework for future studies*" (Fjællingsdal & Klöckner, 2017).

5.1.2.2 Paper 2 - Gaming Green: The Educational Potential of Eco

As previously mentioned, the research on environmental games up until the Green Gaming Project was very scarce and sporadic. Additionally, the few digital games on the market were either overly complex and difficult, such as Fate of the World (Roberts, 2011), or very simplistic, short and meant for very young players – such as the Energy Saving Game (Klöckner, 2015, p.199). It was therefore necessary to find and obtain a digital game with the potential for a wider appeal, while at the same time retaining some of the complexity that environmental issues inherently involve. One such game, Eco (Strange Loop Games, 2020), was currently in development at the time of the study, and after some consideration of the game's beta status – meaning that it was in a state of being unfinished, yet playable (Beta, 2020) – it was decided that it was the most suitable game for the project. As Eco deals with a variety of ecosystem-specific environmental issues, ranging from pollution (Eco Wiki, 2020a) to the extinction of species (Eco Wiki, 2020b), the research question was also designed to

encompass as many of these topics as possible. The second study therefore wished to examine which learning outcomes that would result from playing Eco, and the resulting research question therefore revolved around "*how playing Eco might promote environmental consciousness surrounding ecosystems*" (Fjællingsdal & Klöckner, 2019).

5.1.2.3 Paper 3 - Green Across the Board

For the third and final paper of the Green Gaming Project, the focus was shifted from digital games to board games. Scientific evaluations of board games are even more rare than those of digital games (Klöckner, 2015, p.205), and although environmental board games do exist (e.g., Chappin et al., 2017; Eisenack, 2013; Games4Sustainability.com, 2020) the lead researchers decided that this thesis would further investigate how they can be utilized for communication purposes in the environmental sciences. Also, as board games are generally played together with others in physical groups using physical play pieces whereas digital games are more commonly either played alone or with others through online technology, the learning outcomes of playing physical games were believed to be different from games on the screen to some extent. The third and final research question therefore investigates "*how environmentally themed board games can be used as tools in generating environmental awareness*", with special emphasis on which learning outcomes can be identified from post-gameplay focus groups (Fjællingsdal & Klöckner, 2020).

5.2 The qualitative research paradigm

As previously mentioned, this thesis aims to examine the use of games in the environmental sciences from a qualitative angle. At its core, working within a qualitative paradigm means that the researcher is generally concerned with data rich in descriptive attributes (Elder & Miller, 1995), or any kind of information source that in some way captures the perspective of individual respondents or informants (Howitt, 2010, p.7) or generates knowledge based on human experience (Sandelowski, 2004). Despite its nearly all-encompassing approach to potential data sources – including case studies, personal experiences, life stories and cultural texts – the qualitative tradition generally rejects the use of statistics as a tools of study (Roudgarmi, 2011). Instead of using numbers, questionnaires and statistics, qualitative research data is commonly gathered using in-depth interviews and respondent observations in natural settings, or through accessible documents of interest to the research question (Hammarberg, Kirkman & de Lacey, 2016; Patton, 2002a). The data, once collected, is then subjected to descriptive and/or interpretative attempts to develop a detailed and coherent

narrative or view of the research material through the eyes of the respondents involved in the project (Fellows & Liu, 2008; Hammarberg et al., 2016).

5.2.1 Choosing appropriate qualitative research methods

Qualitative methodology is divided into a series of methods that revolve around various fields of interest, ranging from thematic analysis (e.g., Braun & Clarke, 2006) and grounded theory (e.g., Charmaz, 2006) to narrative analysis (e.g., Riessman, 1993), interpretative phenomenological analysis (e.g., Giorgi, 2009), content analysis (e.g., Mayring, 2000) and ethnography (e.g., Hammersley, 2015), just to name a few. Each of these separate methods come with their own set of advantages and disadvantages as well as proposed guidelines for how to conduct them, often leading novice researchers astray in what has been described as a "baffling number of choices of approaches" (Creswell & Poth, 2018, p.8). While the selection of qualitative methods is overwhelming, there are recommendations in the literature regarding which method is appropriate for any given research subject. As a relevant example, thematic analysis features a myriad of methodical strengths, ranging from its wide rate of acceptance as to what constitutes a good dataset to its equally wide range of epistemological angles for selection (see section 5.2.4.1). Additionally, as mentioned in the previous section on research questions, a thematic content analysis had to be conducted in order to form a basic tool and framework for the design and implementation of environmental games as there was little research done on the field before (Fjællingsdal & Klöckner, 2017). In order to illustrate the usefulness of these methods for this research project, the following sections will detail their advantages and weaknesses as well as their linkage to and justification for inclusion into the Green Gaming Project.

5.2.2 Thematic content analysis

The first paper of the Green Gaming Project (Fjællingsdal & Klöckner, 2017) utilized a qualitative mixed methods design, inspired by thematic analysis (Braun & Clarke, 2006; see section 5.2.3) and featuring elements of content analysis. Datasets were gathered from literature- and game reviews. Although mixed methods are commonly understood and described as a tradition where "*the researcher gathers both quantitative (closed-ended) and qualitative (open-ended) data, integrates the two and then draws interpretations based on the combined strengths of both sets of data to understand research problems*" (Creswell, 2014, p. 2), arguments have been made that singular methods within the qualitative paradigm can be mixed as well (Morse, 2010). Even though thematic analysis and content analysis are methodically similar and sometimes even used interchangeably, a content analysis approach is

generally more suited for situations in which quantification of data is also important (Vaismoradi, Turunen & Bondas, 2013), such as identifying if a game has received mostly positive or negative feedback.

5.2.3 Game reviews

While conducting a mixed method thematic content analysis on game reviews is certainly possible (e.g., Balakrishnan & Griffiths, 2019; Suominen, 2011), they are seldomly utilized for research purposes. Despite this, they are instrumental in guiding future game design and customer opinion (Bond & Beale, 2009), offering theories and insight into how the game designers worked on the game or how to play it (Zagal, Ladd & Johnson, 2009) or even identifying cultural differences in game appreciation (Zagal & Tomuro, 2013). Additionally, no game is ever experienced the same way by two unique players (Egenfeldt-Nielsen et al., 2013, p.269), and game reviews help game researchers by sorting these individual opinions into easily accessible categorical information for further analysis. Despite this, player-generated reviews of video games are seldomly explored in research (Koehler, Arnold, Greenhalgh, Boltz & Burdell, 2017). Therefore, for the first paper of the thesis, tapping into this source seemed to be an ideal focal point. As online reviews of environmental games were scarce at the time of the research, the popular Steam platform for game purchases and public reviews was considered to be one of the few available libraries with sufficient data material for analysis. Being one of the most popular digital game distribution platforms (Lin, Bezemer, Zou & Hassan, 2018), it had an approximation of 95 million active users in 2019 (Strickland, 2020), although the exact number of users playing environmental games is unknown. It also provides information pertaining to how long a reviewer has played a game at the time of the review being published, as well as for other users to provide labels where they express whether the review was helpful to them or not (Eberhard, Kasper, Koncar & Gütl, 2018).

5.2.4 Thematic analysis

The second (Fjællingsdal & Klöckner, 2019) and third paper (Fjællingsdal & Klöckner, 2020) of the Green Gaming Project utilized thematic analysis (Braun & Clarke, 2006) as a research method, and featured the use of both in-depth interviews and focus groups. Thematic analysis was conceived as a term more than 40 years ago (Holton, 1973; Howitt, 2010, p.168) and initially rose to popularity within the field of nursing research (Benner, 1985; Leininger, 1985), but has since seen a wide range of application across a variety of fields and professions (e.g., Braun, Clarke & Weate, 2016; Gupta & Levenburg, 2010; Patel, Tarrant, Bonas, Yates & Sandars, 2015). It is described as a poorly branded yet widely used form of qualitative

research method with the goal of identifying and analyzing recurring patterns in a dataset (Aronson, 1995; Braun & Clarke, 2006; Howitt, 2010, p.164), and the result of conducting a thematic analysis should "highlight the most salient constellations of meanings present in the dataset" (Joffe, 2012) - thereby providing a detailed, coherent narrative across a series of respondents. Despite its increasing popularity, thematic analysis is occasionally considered to merely be an assisting process or tool in research rather than its own, separate method (Holloway & Todres, 2003). Although this view is pervasive in certain academic circles, other authors have argued that thematic analysis is sophisticated enough to be considered its own, separate form of research method (e.g., Braun & Clarke, 2006; King, 2004), leading to the generation of a proposed 6-item set of guidelines for conduct (Braun & Clarke, 2006). In order to illustrate how the research for two of the studies in the Green Gaming Project was conducted, these 6 steps (as informed by Braun & Clarke, 2006; Howitt, 2010, p.173-180) will be outlined here:

- *Step 1: Data familiarization.* In this stage of the process, the researcher reads and re-reads the material from the data gathering procedure, such as interview transcriptions, journal entries, personal notes or any other document of interest. The purpose of this preliminary stage is for the researcher to get intimately acquainted with their datasets, and to begin seeing patterns in these datasets for further analysis.
- *Step 2: Initial coding generation.* For the second stage of a thematic analysis, the researcher needs to conduct line-by-line coding of the data. *Coding* indicates something that is intriguing to the researcher and is usually represented by a small text extract that somehow carries importance for the later construction of thematic categories – i.e., a dawning representation of the contents that the final analysis will revolve around.
- *Step 3: Searching for preliminary themes.* Once the coding stage has been conducted, the resulting codes are divided into clusters of coherent data. These clusters are called *themes* and are the main subjects of a thematic analysis. Each theme represents a unit of interest that has emerged from the datasets through the analytical efforts of the researcher, although on this stage they tend to be small, uncategorized and in need of merging to make the amount of information more compact and easily readable.
- *Step 4: Reviewing themes.* Once the preliminary themes have been found, it is important to systematize them and collect them into bigger thematic categories. Failure to do this might result in the analysis appearing bloated and unsystematic, and

there might be several themes that are irrelevant to the researcher's initial focus of interest. It is furthermore common to discover that there is little data to support a theme, or that a theme should be merged or divided to reveal new patterns of information. In this stage it is common that certain themes are exempt from the final analysis, or a cluster of preliminary themes are connected to such a degree that they could rather be listed as one coherent main theme.

- *Step 5: Defining themes.* In the final stage of the thematic categorization process, the researcher will decide upon a set of themes to include in the final analysis. The themes are named and labelled, listed in a thematic map alongside their subthemes, and then finally illustrated with colorful and detailed extracts from the datasets in the research report. It is also important to note that the thematic categories and their subthemes should adhere to the principles of *internal homogeneity* and *external heterogeneity*. This means that all the data contained within a main theme (i.e., subthemes) should cohere in a meaningful way (internal homogeneity), whereas the main themes themselves should be different and clearly separate entities (Patton, 2002b).
- *Step 6: Report writing.* Writing a thematic analysis involves following the general guidelines for quality and rigor in qualitative research (see section 5.3). In addition, a good thematic analysis report should be able to illustrate the researcher's work in light of the 6 proposed guidelines described here, as well as highlight any difficulties that occurred during the research process. It will also provide a discussion of relevant research literature in relation to the findings that the researcher has made.

5.2.4.1 Advantages of thematic analysis

Aside from its poorly demarcated position in qualitative research (Braun & Clarke, 2006), thematic analysis has several strong points that should be considered. As thematic analysis is exempt from the strict focus on theoretical generation that the similar method of grounded theory has (Charmaz, 2006), it can yield a rich and detailed account of data for a very wide variety of studies (Braun & Clarke, 2006; King, 2004; Nowell, Norris, White & Moules, 2017). It also does not carry any stringent demands or recommendations for a specific sample size of respondents, instead focusing on the density and detail of the respondents' statements (Braun & Clarke, 2006). This view is supported by sociologist David Wainwright (1997), who notes: "*it is the quality of the insight that is important, rather than the number of respondents that share it*". Crouch and McKenzie (2006) also note that interview studies with

a small number of respondents are becoming increasingly more common in the social sciences, and that they should be highly welcomed as long as they are embedded in fields of relevance. Fugard and Potts (2015) agree, stating that "for small projects, 6–10 participants are recommended for interviews". As this PhD project consists of a set of smaller studies, thematic analysis proved to be a suitable method for gaining and analyzing larger datasets while operating under significant time constraints. While the view on recommended sample sizes is controversial in qualitative research (see section 5.2.3.2), the studies in this thesis often resulted in highly detailed narratives from smaller samples of respondents (e.g., Fjællingsdal & Klöckner, 2019) and managed to construct a coherent, experience-based set of results.

Thematic analysis can also be utilized to understand reality from various epistemological angles (Joffe, 2012). For instance, a *realist* approach to thematic analysis carries the assumption that an objective reality 'exists somewhere' and is discoverable through research, whereas a *relativist* or *constructionist* thematic analysis assumes the position that reality is somehow constructed in and through research (Clarke, Braun & Hayfield, 2015). As such, a thematic analysis can both be *semantic* – descriptive and focusing on what is explicitly stated by the respondents – and *latent* – focusing on hidden and subliminal meaning in the dataset (Clarke et al., 2015; Braun et al., 2016). This thesis, for instance, utilizes a relativist, semantic approach to thematic analysis – focusing explicitly on the "how" and "why" regarding the respondents' descriptions of their experiences while playing environmental games.

5.2.4.2 Disadvantages of thematic analysis

Although thematic analysis has a variety of uses, it also comes with a set of weaknesses that should be considered. Firstly, as it is a poorly acknowledged method in research literature with few stringent guidelines and explicit goals (Braun & Clarke, 2006), there has – until recently – been considerable debate about its status as an actual research method rather than a part of a qualitative research process in general (Holloway & Todres, 2003). This is hardly surprising, as both thematic analysis and other qualitative methods aim to generate thematic categories for in-depth studies. To add to this, the literature contains examples of researchers explicitly utilizing thematic analysis without mentioning the method by its proper name (e.g., Gee, Ward & Eccelston, 2003), leading to a rather poor marketing of the method as a whole (Howitt, 2010, p.168). Therefore, thematic analysis often goes unacknowledged as its own research method, or it is considered identical to similar research methods such as grounded

theory (Charmaz, 2006). Additionally, it is worth considering that the flexibility offered by thematic analysis can effectively paralyze the researcher due to offering a very wide variety of data to focus on (Braun & Clarke, 2006), meaning that a poorly conducted analysis could appear "bloated" due to a lack of focus on very specific areas of interest.

5.3 Quality, rigor and validity in qualitative research

Following a positivist, quantitative research paradigm by and large means a researcher must adhere to the principles of reliability and validity in order to ensure rigor in their work (Charmaz, 2006, p.5; Nowell et al., 2017). To some contrast, qualitative research is more concerned with describing and ensuring the overall credibility, transferability, dependability and confirmability of the study in order to ensure that the research results are trustworthy (Lincoln & Guba, 1985; Noble & Smith, 2015; Nowell et al., 2017) and useful (Charmaz, 2006, p.182). This deviation from the positivist tradition does not, however, imply that qualitative research is inherently invalid. Johnson (1997) argues that qualitative research can be both *descriptively valid* (the factual accuracy of the respondents' accounts as interpreted by the researcher), *interpretatively valid* (the degree that the participants' personal traits, viewpoints and experiences are accurately understood and described by the researcher), and *theoretically valid* (the degree that a theoretical explanation from the research fits the actual data) and that adhering to these principles leads to qualitative research being plausible, credible, trustworthy, and defensible. In order to further strengthen the credibility and trustworthiness of their findings, qualitative researchers must also adhere to a set of core principles in addition to more method-specific proposed guidelines. These are:

- *Reflexivity and personal biases.* In qualitative studies, the researcher has a clear impact on the conduct of the research, mainly through interpreting the respondents' statements in accordance with their own identity and perspective (Maxwell, 2002) as well as personal biases and assumptions (Greenbank, 2003). As the qualitative researcher represents a voice for the respondents and the data they provide (Morse, 1998, 2003) while simultaneously presenting their collective narrative (Slembrouck, 2015), it is important that the researcher acknowledges and remains transparent about whatever biases and preconceptions they might have towards the phenomenon being studied. This is a core rule of *reflexivity* (Howitt, 2010, p.330), and is intended to illustrate how the qualitative researcher has assisted the construction of meaning in their project (Nightingale & Cromby, 1999, p.228).

- *Transparency.* In addition to clarifying any preexisting biases and assumptions about their field of study and respondents, qualitative researchers must also remain *transparent* about their research practices. This involves illustrating what has been done in the project, how it was done and why it was done (Tuval-Mashiach, 2017), and should disclose to the reader how the various research processes (methods, sampling, data collection, analysis) have been conducted and justified (Meyrick, 2006). In cases where it is in accordance with ethical guidelines, scholars should also provide access to the data they have used in their analysis (Elman & Kapiszewski, 2014). This makes it possible to conduct replication studies, and serves to possibly eliminate or at least identify any of the hurdles that the initial team of researchers may have encountered.
- *Ethical guidelines*. Ethical concerns are prevalent in any form of research. In the case of studies using human subjects, it is important to ensure that no harm is done to the respondents or their privacy (Orb, Eisenhauer & Wynaden, 2000). Participants in any research project should therefore have the rights to supply informed consent to participate, be assured that their privacy and personal information is confidentially handled, as well as gaining at least a basic understanding of the researcher's agenda (Shaw, 2003). In order to ensure ethical integrity in this thesis, applications for each of the three projects were submitted to the leading ethics facility for the social sciences in Norway (*NSD, Norwegian Centre for Research Data*) for approval.
- *Member checking*. Member checking, also known as participant verification (Rager, 2005) or respondent validation (Morse, Barrett, Mayan, Olson, & Spiers, 2002), involves the respondents of a qualitative study to review and provide feedback on the accuracy of their statements as they were expressed in an inquiry (Harper & Cole, 2012). Member checking allows individual respondents to critically scrutinize the researcher's findings and provide their own comments on potential changes that need to be made to the final product, and ultimately serves as an important component of a qualitative study's credibility (Lincoln & Guba, 1985).

5.3.1 Quality, rigor and validity in this thesis

The principles described above are all important to consider when doing qualitative research and are closely interconnected with the previously mentioned aims of establishing trustworthiness, credibility and usefulness. The following section will therefore try to

illustrate how these principles have formed the foundation for the methods used in this thesis and clarify the thoughts behind the research process in general.

5.3.1.1 Personal biases of the researcher

As thematic analysis – or constructivist research in general – revolves around active meaning-making practices by the researcher (Braun & Clarke, 2006; Clarke, Braun & Hayfield, 2015), it is constantly subjected to the researcher's own views, biases and interpretations. As the prevalence of potential underlying biases is one of the main criticisms directed against qualitative research (e.g., Rolfe, 2006), it is important that the qualitative researcher acknowledges any such biases openly to assure that there is no 'hidden agenda' in their work. In the case of this thesis, the main assumption was that games will have some sort of noticeable impact on the respondents' levels of environmental awareness. The recruitment procedure was accordingly carried out in high schools and game-related Facebook groups, as these groupings were both theorized to contain respondents who would be ideal for the project, as well as being an important target group due to their potential future impact on the environment. Already, two heavily biased elements have become apparent; 1) a research question which implicitly assumes positive results, as well as 2) a recruitment procedure focusing solely on people who (perhaps stereotypically) are believed to have some innate form of interest in games and leisure. To counteract the effects of these underlying biases on the research outcomes, the interview guides for both projects (see Appendix 3) followed a *semi-structured* design. This means that the questions are largely open-ended and value-neutral (Smith & Osborn, 2003, p.61-62), thus allowing the respondents to provide their own accounts of the gaming sessions (Slevin & Sines, 2000) rather than being explicitly tailored to fit any pre-existing biases on the researcher's part. Also, measures were taken to validate the findings with both a separate researcher as well as the respondents themselves, thus ensuring that any personal biases on the lead researcher's part could be pointed out (Lincoln & Guba, 1985; Long & Johnson, 2000; Sandelowski, 1993).

5.3.1.2 Transparency in the research process

In order to ensure an open and transparent research process, each of the thesis papers contains a detailed account of the analysis procedure (informed by Meyrick, 2006; Tuval-Mashiach, 2017). They also contain sections describing their weaknesses and limitations, which is intended to assist future researchers during replication attempts. Regarding the demand for access to the research data (Elman & Kapiszewski, 2014), thematic analysis normally provides this by including detailed excerpts from the respondents' narratives (Braun &

Clarke, 2006), which was done in papers 2 and 3 (Fjællingsdal & Klöckner, 2019, 2020). For paper 1 (Fjællingsdal & Klöckner, 2017), the data material is publicly available on the Steam platform in the form of game reviews (Steam, 2020a).

5.3.1.3 Ethical considerations in the research process

As any study involving human subjects involves a risk of revealing or exposing personal information (Orb, Eisenhauer & Wynaden, 2000), researchers need to take great care to ensure that their respondents are anonymized. NSD, the Norwegian ethical committee for social science research, has strict guidelines pertaining to personally identifying information (NSD, 2020), and these guidelines were first reviewed by the researcher for familiarization purposes. Once the guidelines had been understood, applications for the research projects were submitted for approval. All three projects were accepted (see Appendix 1 for copies of the NSD approvals), and all the respondents in the papers were anonymized, save for some residual information to denote demographic variables such as age and gender. The data was stored safely on password-protected PCs and was not shared outside of the research team.

5.3.1.4 Member checking of the thesis papers

Member checking was impossible for the first thesis paper (Fjællingsdal & Klöckner, 2017), both due to the publicly available nature of the data being collected as well as the privacy settings for the media platform (Steam) from which the data were collected (see Section 6.1). For the remaining two papers (Fjællingsdal & Klöckner, 2019, 2020) member checking was conducted in accordance with the guiding principles delineated above (see Appendix 2 for copies of the member checking texts received by the respondents). Each respondent for the projects surrounding the Eco study (Fjællingsdal & Klöckner, 2019) and the board game study (Fjællingsdal & Klöckner, 2020) received their own complimentary copy of the first draft of the article for proofreading and accuracy checking (as informed by Harper & Cole, 2012; Lincoln & Guba, 1985). No respondents in any of the studies reported any erroneous statements or misquotations in the draft paper.

5.3.2 The COREQ criteria

Until now, general guidelines for conducting qualitative research have been discussed in relation to the contents of this thesis. While these aspects of conduct are useful to consider during a research process there has, until recently, been very few systematic attempts to create actual frameworks for reporting qualitative research (Knafl & Howard, 1984). As a result, the COREQ (Consolidated Criteria for Reporting Qualitative Studies) were developed, and this

thesis has attempted to adhere to these. It is a 32-item checklist for interviews and focus groups intended to provide a comprehensive way of reporting qualitative studies (Tong et al., 2007), and is divided into three domains: *1) Research team and reflexivity*, *2) Study design* and *3) Analysis and findings*. These domains will be discussed briefly, in order to further enhance the transparency of the finished research processes.

5.3.2.1 Research team and reflexivity

The first domain of the COREQ criteria revolves around the personal qualities, credentials, gender, experience and training of the research team as well as their relationship status with their respondents (Tong et al., 2007). This is intended to improve the credibility of the findings by giving other researchers the opportunity to scrutinize how these factors may have influenced the researcher's observations and interpretations of the phenomena under study (Giacomini & Cook, 2000; Malterud, 2001; Mays & Pope, 2000). In accordance with these proposed guidelines - in this thesis - the lead researcher's personal agenda for each study as well as a description of how the respondents' supplied data and personal information would be anonymized was disclosed to all respondents before the research began (see Appendix 4 for information letters given out to the respondents before the research process was initialized). Regarding the relationship status between the researcher and the respondents, there was no preexisting relationship to report outside of the preliminary communications leading into the study itself.

5.3.2.2 Study design

The second domain of the COREQ criteria revolves around the study's theoretical framework, participant selection process, the setting in which the data collection took place as well as central aspects detailing the interview guide, recordings and data saturation (Tong et al., 2007). The three studies in this thesis describe these aspects in detail, except for the subjects of data saturation and participant selection strategy. This is largely a consequence of the analysis strategies that have been utilized. Data saturation in thematic analysis, for example, is seldomly discussed due to its focus on exploring and describing human experience through detailed and descriptive narratives rather than having a focus on generalizing its findings (Braun & Clarke, 2006). It is also arguably difficult (perhaps even impossible) to achieve data saturation when studying something as diverse and individual as the perception of game experiences (Egenfeldt-Nielsen et al., 2013, p.29), especially within the sharp time constraints of a PhD framework. These time constraints also impacted the participant selection process, which eventually lead to the use of *purposive sampling* – the selection of participants with

close connection to central aspects of interest to the research question (Giacomini & Cook, 2000; Guarte & Barrios, 2006). This recruitment procedure was believed to result in a greater number of respondents for each study, although this strategy was ultimately unsuccessful.

5.3.2.3 Analysis and findings

The third domain of the COREQ criteria revolves around the analysis process itself – i.e., how the researcher's considerations and choices affected and formed the analysis through coding practices, construction of themes, presentation of illustrative quotes and member checking (Tong et al., 2007). In this thesis, these aspects have been described in detail in the previous sections as well as the papers themselves (Fjællingsdal & Klöckner, 2017, 2019, 2020).

5.4 Detailed research procedures

For the final section of this Methods chapter, a presentation of each of the research procedures behind the studies in the Green Gaming Project are outlined. While these processes are also described in the papers, some details were omitted due to word constraints. These parts are included here, in order to further enhance the transparency of the finished project.

5.4.1 Paper 1 - ENED-GEM

The first paper of this thesis, published in *Frontiers in Psychology* in 2017, wished to *generate an understanding of the psychological factors that facilitate learning, enjoyment and their interaction in environmental educational games, and present these in a conceptual framework for future studies*" (Fjællingsdal & Klöckner, 2017). To do so, a literature review on environmental games and game enjoyment was conducted alongside a thematic content analysis of game reviews of the environmental video game Fate of the World (Roberts, 2011), which, at the time, was considered to be one of the most scientifically accurate, complex and commercially available games about environmental issues and management (Klöckner, 2015, p.199). In Fate of the World, the player (referred to in-game as GEO, or Global Environmental Organization) is tasked with balancing the protection of Earth's resources and climate while simultaneously tending to the needs of a growing world population with requirements that include food, power and living space (Steam, 2020b). Failure to maintain the balance between the world's nations results in a variety of negative effects, ranging from extreme weather events to the threat of civil war. Balancing the climate and the needs of the people is done by implementing political regulations and restrictions, represented in-game by a set of cards. Once the cards are placed, the player must advance time over a set period of 5 years to see the results of their decisions. The game is won if the player manages to reach

scenario-specific goals, ranging from increasing a nation's GDP (Gross Domestic Product) or HDI (Human Development Index) past a certain threshold, or reaching a certain year without global warming exceeding a certain temperature limit.

The literature review of Fate of the World was intended to both investigate how, when and why environmental games had been utilized in past research, as well as to provide a theoretical foundation for the future empirical studies in the project. Databases such as *Google Scholar, ScienceDirect, PsycNet* and *ERIC* were consulted for literature searches, using combinations of search terms such as "environmental game", "sustainability game", "green games", "educational games" and "educational game enjoyment". Books by game designers and -scholars such as Jesse Schell (2008), Ian Bogost (2010) and James Paul Gee (2003) were also used. Recurring findings and factors from the literature review on environmental and educational game enjoyment would then be compared with the contents of both positive and negative reviews of Fate of the World, in order to gain a dawning understanding of what makes an environmental game attractive to play.

In total, all (at the time of the study) 249 available reviews of the game were investigated for recurring and thematically relevant information. While a few of the reviews were very basic – either describing the game as good or bad, for example – the majority consisted of detailed narratives ranging from how to play it and who it would appeal to, to outright describing it as environmental propaganda. This is fairly in line with previous findings on game reviews as study objects (Bond & Beale, 2009; Zagal & Tomuro, 2013), and certainly confirmed that game reviews are often overlooked as sources of scientifically valuable information (Koehler et al., 2017). Although the reviews did offer valuable insight, however, one central ethical issue was encountered. Due to the Steam platform's privacy settings, it is impossible to directly message individual reviewers unless they have been added to your Friends list. It was therefore not possible for the lead researcher to directly ask each of the individual reviewers if including their review in the analysis was acceptable to them, nor was it possible to reveal any demographical information (such as age or gender) about them. Ultimately, a message was posted on the game's publicly available Steam forums (Steam, 2020c), stating that anyone who wanted their review of the game exempt from the study could message (and therefore also notify) the lead researcher there. This was approved by NSD, Norway's ethical committee for research in the social sciences, who also stated that game reviews fall under the definition of publicly available information.

5.4.2 Paper 2 - Gaming Green: The Educational Potential of Eco

The second paper of this thesis, published in *Frontiers in Psychology* in 2019, wished to examine *how playing Eco, a digital simulated ecosystem, might promote environmental consciousness surrounding ecosystems*. Eco is an online simulated ecosystem game developed by Strange Loop Games, funded by the United States Department of Education (IES, 2015) and an online crowdfunding campaign (Kickstarter, 2015). The game's main objective is to stop a giant meteor from crashing into the surface of the earth, which is set to occur after a default time of 30 real-life days. While developing the requirements for stopping this meteor, players cause pollution which needs to be minimized so that the ecosystem can continue to thrive – a measure of which can be found in an in-game statistical overview available to the players (Fjællingsdal & Klöckner, 2019). At the time the study began in late September of 2017, Eco was in early development – otherwise known as the *beta* stage (Beta, 2020) or *early access* – meaning that it was largely unfinished, yet playable. At this early stage, it also featured the option of purchasing a *Classroom Package*, which provided 100 copies of the game in the form of activation codes that could be sent by e-mail to anyone who wished to play it. While playing and evaluating an unfinished game might be considered less than ideal for a research project, early access to unfinished games is a very common strategy for modern-day game developers as it opens an arena for discussion, feedback and reporting errors (Steam, 2020d). Additionally, aside from the previously mentioned Fate of the World (Roberts, 2011), the selection of commercially available digital games featuring environmental themes was very scarce. Eco was therefore deemed a highly suitable game for the first empirical study of the Green Gaming Project. Once the Classroom Package had been purchased, the lead researchers would then discuss how to conduct recruitment for the project.

5.4.2.1 Notes on the recruitment procedure

Before recruitment was formally initialized, the lead researchers each purchased a separate copy of the game to playtest it. Based on this playtesting session it was decided that the game might be too complex for younger players, and that it would more likely be suited towards players aged 16 and up. High schools and university classes therefore became the main arenas of recruitment, in addition to Facebook groups that mainly revolved around a shared interest in games – one of which was specifically dedicated to Eco in particular. In total, recruitment was carried out in 2 Norwegian high schools across 3 separate classes, 3 university lectures on psychology and media conducted by one of the lead researchers and 4 Facebook groups. Snowball sampling was also carried out once the initial recruitment procedure had been

concluded. 59 individuals in the age range of 18 to 31 years responded that they were interested in trying the game and were given a preliminary 41-item Norwegian questionnaire administered through NTNU's questionnaire tool *SelectSurvey* using the respondents' e-mails. The questions were intended to gather demographic data on the participants (age, gender, previous experience with video games) and also included the lead researcher's translations of game-relevant items from the *Environmental Attitudes Inventory* (EAI) (Milfont & Duckitt, 2010) to ascertain the respondents' pre-existing pro-environmental tendencies (see Appendix 5 for a copy of the Norwegian questionnaire). Lastly, responding to the questionnaire was mandatory for receiving a copy of the game. Once the questionnaire was completed, the lead researcher would be notified by SelectSurvey and could freely administer copies of the game alongside instructions on how to install and play it (see Appendix 6), as well as a document in which they could write down their in-game experiences called the Green Journal (see Appendix 7). This document was intended for the respondents to note down their experiences while they were still fresh in their minds but would eventually not be utilized by more than two respondents.

5.4.2.2 Notes on the gameplay procedure

Once the respondents had finished the preliminary questionnaire and received their copy of Eco, they were scheduled to play the game for a period of approximately 4 weeks (Fjællingsdal & Klöckner, 2019). A single gameplay session of Eco takes 30 real-life days when played using the default game settings (Eco Wiki, 2020c), although some of the respondents experienced significant time constraints at the time of the study and therefore played it for as little as 2 weeks. Before gameplay was formally initialized, the lead researcher received help from the game developers to set up and run two dedicated servers for the high school classes where they could play freely. The respondents from the university classes and Facebook groups were encouraged to play on public servers. This was intentionally done with the hopes of 1) maintaining a closed environment where some of the respondents could be observed regularly – the case of the high school classes, and 2) receive feedback on the experience of entering or operating within pre-existing groups and online societies with previous experience with Eco – the case of the university students and Facebook group members. They also received instructions that the lead researcher could be contacted at any point during the study in case they experienced any technical issues, and that they would be invited to a voluntary post-gameplay interview about their experiences with the game.

Ultimately, very few of the respondents in the high school classes utilized the dedicated servers, and they were therefore closed after 30 days of little activity. This was a major weakness in the study, as playing in a private server would have made it possible for the lead researcher to maintain full control over recent logins, server-based activity such as the construction of buildings or deforestation, public chatlogs and player-specific carbon emissions. Further compounding this weakness, none of the high school respondents agreed to participate in post-gameplay interviews or submitting filled-out copies of the previously mentioned Green Journal document (Appendix 7). This means that no data from the high schools could be obtained outside of the preliminary questionnaire results. Despite this high drop-off rate, 7 respondents (n=7, all male) from the university classes and Facebook groups agreed to participate in post-gameplay interviews. The data they supplied contained rich and descriptive narratives that were highly suitable for a subsequent thematic analysis (Braun & Clarke, 2006), although the response rate should have been considerably higher due to the extensive recruitment procedure. The interview procedures with the final 7 respondents are described in the following section.

5.4.2.3 Notes on the interview procedures

A semi-structured interview guide (Appendix 3) consisting of 10 open-ended questions about the experience of playing Eco was constructed by the lead researchers for use in this study. This design was chosen in order to let the respondents provide their own, free accounts of their personal experiences (Howitt, 2010, p.58; Slevin & Sines, 2000), which would stimulate them to select aspects of their gameplay that they themselves found particularly interesting or educational. Semi-structured interviews are also highly suited for smaller studies (Braun & Clarke, 2006; Crouch & McKenzie, 2006; Wainwright, 1997) where 6-10 respondents are involved (Fugard & Potts, 2015). As the researcher and the respondents were in different locations, the interviews were carried out through the online messaging services *Skype* and *Appear.in* (later renamed into Whereby.com) and recorded with the screen- and audio-capture software *SnagIt*. Each interview lasted between 30 minutes to 1 hour, and frequently deviated from the interview guide as new points of interest were brought up by the respondents themselves. One respondent also experienced difficulty with his Internet connection and was therefore given the opportunity to fill out the interview guide manually using a Microsoft Word document. Despite these deviations, which are normal in qualitative interviewing (Howitt, 2010, p.61), the 7 respondents provided detailed and highly personalized answers to all the 10 questions in the interview guide.

5.4.2.4 Notes on transcription and coding

Once the interviews had been conducted, the lead researcher engaged in the data material by listening to the recordings and transcribing them from speech to text line-by-line. While transcription is often left to research assistants or graduate students (Skukauskaite, 2012), largely due to the time constraints that qualitative researchers often face (Tilley & Powick, 2002), it was decided that the lead researcher would do the transcriptions personally. This was done in order to ensure that the proposed guideline regarding data familiarization in thematic analysis is followed (Braun & Clarke, 2006), as well as to circumvent the potential issue of the lacking connection to the data material that an external transcriber sometimes experiences (Tilley & Powick, 2002). A lack of connection to the data material might lead to inaccuracies in the transcripts, which in turn will negatively affect the dependability of the final analysis (Stuckey, 2014).

Once the transcriptions were completed, the lead researcher initialized the coding stage. Each transcript was subjected to line-by-line coding in Microsoft Word, a coding strategy where smaller units of data are extracted from individual sentences in the data sets and used to generate core categories (or themes) of information (e.g., Braun & Clarke, 2006; Gibson, Drennan, Hanna & Freeman, 2000; Howitt, 2010, p.174; Noble & Smith, 2014; Thomas & Harden, 2008). As this study utilized interview transcripts, each of these were entered in separate Word documents. Each transcript was then read and re-read several times in accordance with data familiarization principles (Braun & Clarke, 2006) before smaller subsets of each sentence were color-coded to denote an object of interest. Codes with similar colors were then eventually clustered together to signify narrative coherence across the respondents' statements, which in the later parts of the analysis would be used to generate preliminary themes.

5.4.3 Paper 3 - Green Across the Board

The third paper of this thesis, published in *Simulation & Gaming* in 2020, wished to examine *how environmentally themed board games can be used as tools in generating environmental awareness*. While the analysis procedure for this paper strongly resembles that of the Eco study, there are some differences that should be addressed – namely the procedure behind obtaining suitable games for the study, the subsequent recruitment strategy, the use of physical focus groups rather than online qualitative interviews as well as the direct observations of the gameplay sessions.

5.4.3.1 Locating and selecting environmental board games

By comparison to digital games about the environment, environmental board games appear to be more common. Despite this, significantly less systematic research exists on them (Klöckner, 2015, p.205). In a similar vein to how the Strange Loop Games website and Steam were chosen as the platforms for obtaining digital games for the first two papers, the leading board game databank *Boardgamegeek.com* was chosen to locate board games featuring environmental elements. The study incorporated a wide approach to what an environmental game entails, and the general criteria for inclusion were that the game had to be 1) connected to environmental topics, 2) in physical or analog format (i.e., board- or card-based) and 3) commercially available for replication purposes (Fjællingsdal & Klöckner, 2020). Much like Steam, Boardgamegeek allows its users to post reviews, discuss their gaming experience with specific games, and even put board games up for sale or trade (Boardgamegeek.com, 2020). It also features a game tagging system, which makes it easier for its users to locate games of a specific genre or theme. Using search terms such as "environmental game", "sustainability game", "educational game", "serious game" and combinations of these, a small library of environmental board games was eventually established. These search terms were also used in scientific databases such as Google Scholar and ScienceDirect in order to do preliminary checks for previous evaluations of these board games. It was also discovered that as board games largely exist in physical format, and that some of the environmental board games in the Boardgamegeek database were quite old, they were either no longer commercially available or went for premium prices on online auctions (this was the case for the first edition of the game CO_2 , for example). In total, 2 environmental board games were obtained online – Keep Cool (Eisenack & Petschel-Held, 2004) and Baumland (Bouslama, 2016). One board game, Environment: Climate (Crapuchettes, 2016), was purchased from a local game store. The remaining games used for the study were already in possession of one of the lead researchers, and consisted of Settlers of Catan: Oil Springs (Assadourian & Hansen, 2011), Global Warming (Bucak, 2011), Green Deal (Al-JouJou, 2014) and CO_2 (Lacerda, 2012).

5.4.3.2 Notes on the recruitment procedure

As traditional board games take place in a physical environment, excepting digital board game simulators, the first step of the recruitment strategy was to find a location where the gameplay sessions could take place. A laboratory in the lead researchers' university was chosen as the venue, as it contained numerous opportunities for both video- and audio recording, as well as observation of the gameplay sessions through a one-way mirror. By

contrast to the previous study, the recruitment for the board game study was conducted exclusively online through various Facebook groups, consisting of local communities such as a popular pub with a strong gaming profile, a casual gaming club and an environmental interest group. Considering that science and researchers can be mistrusted or met with some public skepticism (Braun, 1999; Iyengar & Massey, 2019; Kabat, 2017), the administrators of these groups were contacted for help with recruitment. This was done in order to present the invitation through a credible source to the followers of the Facebook group (i.e., the administrators of the group itself) rather than the lead researcher, who had not yet established any rapport with the potential recruits. It would also ensure that anyone who followed the group without muting notifications from it would be notified that the event was being arranged and could therefore sign up to the board game night by contacting the researcher personally. This recruitment strategy led to the establishment of 2 board game nights and yielded a significantly higher number of respondents than the Eco study.

Later in the recruitment procedure, 2 additional board game nights were set up in a second municipality in connection with a separate environmental research project. Here, the local municipality's official Facebook page was utilized to announce when and where the board game nights would take place. The board game nights here took place in a conference hall supplied by the municipality. By contrast to the previously selected psychology laboratory, this location did not contain suitable recording equipment or opportunities for anonymous observation. Instead, the lead researcher supplied the recording equipment and observed the gameplay sessions from a distance to avoid disturbing the research process.

5.4.3.3 Notes on the focus groups

Once the board game nights had started and the information sheets explaining the purpose of the project as well as the respondents' rights (Appendix 4) had been given out, the respondents were tasked with choosing a game they all wished to play together. The games were prominently displayed on a separate table, and the lead researcher gave a short, descriptive introduction to each of the games as well as their complexity rating. Certain games such as Green Deal (Al-JouJou, 2014) and CO_2 (Lacerda, 2012) were quickly excluded by the respondents due to their perceived complexity. Once a game had been chosen and gameplay had been initialized, each of the board game nights lasted approximately 2 hours before a 1-hour long post-gameplay *focus group interview* was conducted. Focus group interviews emphasize the communication between the participants in the research setting (Kitzinger, 1995; Morgan, 1996), and as board gaming takes place in a physical location involving

groups of (usually) 3-6 people the use of such focus groups seemed ideal – especially considering that the proposed ideal group size for a focus group generally fits in the range of 4-12 (Kitzinger, 1995; Longhurst, 2010, p.105). The lead researcher asked questions from a semi-structured interview guide (Appendix 3), while simultaneously including certain comments about observations that had been made during the gameplay sessions for the respondents to reflect upon. Focus groups are normally based around such questions and comments from the lead researcher surrounding the topic of interest (Powell & Single, 1996; Powell, Single & Lloyd, 1996), and can help people to explore and clarify the respondents' views in ways that would be difficult in a one to one interview (Kitzinger, 1995). As it is natural in focus groups for respondents to influence each other (Krueger & Casey, 2000), it requires a strong set of interpersonal skills on the side of the researcher – ranging from accepting uncomfortable silences to controlling the flow of conversation (Krueger, 1998). In this project, conversational moderation normally involved activating some of the more passive members of the group by probing them with questions surrounding their experiences, and then using their feedback to initialize new directions for exploring the topic at hand. Consequentially, the entire group would be actively participating in the conversation and providing insight into their personal experiences with the gameplay session.

Finished papers

Paper 1:

Fjællingsdal, K.S., & Klöckner, C.A. (2017). ENED-GEM: A Conceptual Framework Model for Psychological Enjoyment Factors and Learning Mechanisms in Educational Games about the Environment. *Frontiers in Psychology, 8,* 1-17. doi: 10.3389/fpsyg.2017.01085

Paper 2:

Fjællingsdal, K.S., & Klöckner, C.A. (2019). Gaming Green: The Educational Potential of Eco – A Digital Simulated Ecosystem. *Frontiers in Psychology, 10,* 1-13. doi: 10.3389/fpsyg.2019.02846

Paper 3:

Fjællingsdal, K.S., & Klöckner, C.A. (2020). Green Across the Board: Board Games as Tools for Dialogue and Simplified Environmental Communication. *Simulation & Gaming, 51*(5), 632-652. doi: 10.1177/1046878120925133

Paper I

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ENED-GEM: A Conceptual Framework Model for Psychological Enjoyment Factors and Learning Mechanisms in Educational Games about the Environment

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Based on a thorough review of psychological literature, this article seeks to develop a model of game enjoyment and environmental learning (ENvironmental EDucational Game Enjoyment Model, ENED-GEM) and delineate psychological processes that might facilitate learning and inspire behavioral change from educational games about the environment. A critically acclaimed digital educational game about environmental issues (Fate of the World by Red Redemption/Soothsayer Games) was used as a case study. Two hundred forty-nine reviews of the game from the popular gaming and reviewing platform known as *Steam* were analyzed by means of a thematic content analysis in order to identify key player enjoyment factors believed to be relevant to the process of learning from games, as well as to gain an understanding of positive and negative impressions about the game's general content. The end results of the thematic analysis were measured up to the suggested ENED-GEM framework. Initial results generally support the main elements of the ENED-GEM, and future research into the importance of these individual core factors is outlined.

Keywords: educational games, environmental games, motivation, immersion, flow, semantic memory, episodic memory, perceived behavioral control

As educational games grow more sophisticated and subject-specific, new models for understanding their influence on human learning are required. In environmental communication, the use of games is considered an innovative and highly specialized method of reaching out to a new and growing media audience about the various global issues we might be facing. In the case of videogames in particular, an estimated 65% of U.S. households alone are home to at least one person who plays regularly for 3 h or more per week (ESA, 2017). Older numbers from a study encompassing eight major European nations suggest that about 25% of adults have played a videogame in the past 6 months, and that approximately 95.2 million adult gamers were divided across the 18 countries covered in the survey (ISFE, 2010). Both of these reports suggest that

there is a relatively even distribution of gamers in regards to age and gender (ISFE, 2010; ESA, 2016). Board games, on the other hand, are commonly played on mobile phones and have thus become considerably more digitized, although individuals who regularly play videogames tend to play board games less often (ESA, 2016). However, websites such as Boardgamegeek.com have been established in order to let people review, trade, discuss, and chat about tabletop gaming.

An educational game is commonly defined as any type of game that wants to do more than just entertain the player, normally by increasing certain fields of knowledge or teaching new skills through gameplay (Griffiths, 2002; Barab et al., 2010). Considering educational games as *microworlds* might help to understand how games might contribute to these forms of learning. A microworld is commonly described as a small domain of interest where the degree of immersion into the subject is particularly high (Rieber, 1996). When subjected to such microworlds, learners are encouraged to obtain information and skills on their own volition, in what is called *self-regulated learning* (Zimmermann, 1990). Educational games fit the definition of microworlds in that they usually portray a small domain in which the learner is immersed and encouraged to achieve some form of learning outcome, normally in the form of increased knowledge about a topic or perhaps even behavioral change.

In research literature, educational games are also known under a wide variety of different names, such as serious games or transformational games. These terminologies are often used interchangeably, even leading some researchers to suggest the development of an all-fitting descriptive category (Schmidt et al., 2015).

Educational games need to be considered as conglomerates of different genres and game types (Riemer and Schrader, 2015). Due to the large variety of educational games available on the market, it is likely that there are several psychological factors in play that vary across game types and facilitate learning in the players. In order to understand the potential impact of these factors, it is important to consider the interaction between the gaming audience as well as the interactive, motivational and entertaining aspects a game usually consists of. This article attempts to generate an understanding of the psychological factors that facilitate learning, enjoyment and their interaction in *environmental* educational games, and present these in a conceptual framework for future studies, which we like to refer to as the *ENED-GEM* (ENvironmental EDucational Game Enjoyment Model).

In this article we will present existing research on how games are utilized in educational contexts. Then we shall attempt to put forth the initial suggestions for how the ENED-GEM framework is structured, as well as to highlight central psychological processes that occur before and during gameplay and facilitate learning. Then, in order to provide preliminary evidence for the suggested ENED-GEM framework, a thematic analysis was conducted on reviews of a modern environmental game to identify some of the proposed elements of the model. Lastly, limitations of the study as well as potential future research guidelines are highlighted.

Game-Based Learning and the Environment

Games and simulations have long been successfully used as educational tools within a wide variety of fields, ranging from geography (Tüzün et al., 2009) to medical education (Gutiérrez et al., 2007) and industrial engineering (Braghirolli et al., 2016). Games such as the ones studied in these papers primarily seek to increase the player's knowledge, or to positively affect the player's level of intrinsic motivation to learn. Meta-analyses on the effects of educational gaming tend to reveal mixed to positive findings (e.g., Vogel et al., 2006; Ke, 2009; DeSmet et al., 2014), suggesting that implementing educational games requires a careful consideration of contextual variables. Additionally, very few game-based learning tools are focused on the environment (Klöckner, 2015, p. 200), although the number of sophisticated environmental games has steadily increased since the earliest known publication on the subject in 1983 (Reckien and Eisenack, 2013).

While games exist in many formats, this paper primarily considers digital games and board games when accounting for educational value. This is due to the large body of scientific literature proving the efficiency of these types of games in other learning contexts, as well as the fact that digital games and board games often share significant similarities in design and layout. Educational videogames tend to be immersive learning experiences that attract wide audiences, and allow players to set goals and interact with the game environment experimentally without having to worry about failure (Griffiths, 2002). Studies focusing on environmentally oriented videogames also suggest that games can be attention-grabbing as well as tools for initiating discussions about complex environmental topics. One example includes *LandYOUs*, a game designed to teach the players about sustainable land management and the utilization of limited resources (Schulze et al., 2015). In regards to board games, where research is slightly more limited than in the case of digital games, positive learning outcomes from playing them have been observed across a wide range of subjects (e.g., Ogershok and Cottrell, 2004; Amaro et al., 2006; Eisenack, 2012). Within environmental research, board games such as CO^2 and the Oil Expansion pack of *Settlers of Catan* are perhaps the most well-known educational games, featuring such topics as pollution, biofuel and the use of oil, just to name a few.

Player Enjoyment, Motivations and Game-Based Learning

Player enjoyment is a highly complex and multifaceted psychological construct known to be significantly related to a pleasurable gameplay experience as well as positive learning outcomes. Examples include increasing personal skills such as visual short-term memory (e.g., Boot et al., 2008), and general knowledge structures (Gee, 2003; Fu et al., 2009) as well as contributing to a higher degree of mental well-being (Schell, 2008; Johnson et al., 2013, p. 442). Player enjoyment generally stems from perceiving a game as 'fun,' which in turn could be defined as the essence of play in general (Huizinga, 1938–2014, p. 3). An environmental game that is considered fun or

enjoyable to play would also likely provide a strong foundation for intrinsic motivation to keep playing and learning from it (Bisson and Luckner, 1996). On the other hand, if a game is not considered fun or enjoyable, nobody wants to play it (Sweetser and Wyeth, 2005). Within the field of learning, perceiving a topic as boring will result in a decline in learning outcomes (De Baker et al., 2010). To conclude, the quality of educational games is directly relatable to the quality of the learning that takes place (McCallum, 2012) as well as the player's voluntary interaction with the game itself. To elaborate, environmental games need to be *perceived* as "good" by the player in order for intrinsically motivated play and subsequent learning outcomes to occur. Such motivational factors to play are well-known in the commercial game industry. Therefore, a good educational game should aim to capture the player's attention while simultaneously applying the same motivational elements that commercially successful games tend to do.

While the list of such elements is extensive, examples according to Sweetser and Wyeth (2005) include a sufficient level of challenge, having players feel a degree of control over the game they play, appropriate feedback on how close the player is to achieving their goal and even the ability to cooperate and interact with other players. Together, these elements should lead to a higher degree of player enjoyment, which becomes paramount when applied to the subgenre of *serious games*. The term "serious games" is generally used synonymously with educational games, and refers to games that seek to increase knowledge and alter behavior (Connolly et al., 2012) where in-game content can transfer to real-world experience through repeated play (Bogost, 2010, p. 236). If a game does not engage the player from the very start, it is likely that such repeated play will not occur (Sweetser and Wyeth, 2005). Due to the interplay between enjoyment, immersion and good learning, it is likely that the game needs to be enjoyable or pleasurable to the person playing it in order for the learning outcomes to be high.

Player enjoyment has been the focus of several psychological frameworks attempting to understand its importance in regards to individuals' motivations to play. Examples include the GameFlow model (Sweetser and Wyeth, 2005) and its derivative EGameFlow scale (Fu et al., 2009). The GameFlow model states that player enjoyment stems from eight primary categories of gameplay, ranging from more visual in-game elements such as attention-grabbing and immersive stimuli, to smooth and operable game mechanics. The EGameFlow tool added knowledge improvement to this model, and is utilized for the evaluation of e-learning games where increasing the player's semantic memory in some way is the intended outcome. This framework is highly comprehensive and serves as a useful tool in game design, and the ENED-GEM is an attempt to further conceptualize the potential path to learning through gameplay, with a special emphasis on how environmental games can provide increased levels of knowledge and perceived behavioral control over environmental topics.

While the body of literature on player enjoyment is growing, there is still a lack of player enjoyment models dedicated to educational games about the environment. Educational games seek to increase the player's knowledge, skills, involvement or interest in a given topic, usually through presenting this topic in an attractive and highly immersive context (Barab et al., 2010). Environmental games almost certainly contain some of the traditionally enjoyable elements found in other types of educational games. However, they should also aim to have a measureable positive effect on the players' motivation to perform some kind of pro-environmental behavior in order to be considered effective. Furthermore, the call for research into different types of educational games, environmental ones included, has been made (Riemer and Schrader, 2015). This article seeks to present the ENED-GEM as an example of such an attempt and clarify its potential role in the design and development of entertaining and educational environmental games, as well as to provide insight into how certain psychological constructs and processes important to behavioral change can be facilitated and strengthened by playing.

Focused Environmental Themes in Games and Ideal Level of Information

According to the Tbilisi Declaration (UNESCO, 1978), responsible environmental behavior needs to be outlined, detailed, and explained in a fashion understandable to the major public. While games can be capable of increasing an individual's level of knowledge about an environmental topic according to these guidelines, one of the biggest challenges for game designers in implementing environmental themes in educational games is the high complexity of environmental issues (Fennewald and Kievit-Kylar, 2012). If a game presents too much information at once, which would likely be the case if several environmental issues are outlined and intended to be overcome simultaneously, the player would likely suffer from cognitive overload due to how complex environmental issues are. This form of information overload is generally considered to be one of the most detrimental factors in computer-based learning (Chen et al., 2011). Furthermore, providing environmental information alone generally does not lead to behavioral change unless the information provided is highly tailored to the recipients (Abrahamse et al., 2005) or is highly specific in nature (Klöckner, 2015, p. 165). However, it should be noted that this is likely just the case of educational games focused toward increasing some aspect of knowledge. Games can also enable learners to acquire new skills, teach complex problem-solving and even experience emotional journeys where they can identify with or even adopt traits from the characters they encounter in the virtual world (Klimmt et al., 2009).

A promising strategy to avoid the issue of information overload in particular is to design games dedicated to singular faceted environmental issues rather than to focus on the full environmental picture, such as focusing on *biodiversity problems* rather than the general moniker of *environmental problems* (e.g., Sandbrook et al., 2015). Designing a thematically focused game would allow the player to allocate cognitive resources toward solving one manageable problem rather than dedicate their attention toward too many variables at once. In gameplay, the tendency for games to demand that the player directs their attention toward a large quantity of in-game

variables at once is called *micromanagement*. A high degree of micromanagement might detract from the player's ability to learn from environmentally oriented games in favor of having to keep up with the game's progression or memorize unnecessary details. A lower degree of micromanagement in educational games allows the player to focus more on the environmental issue being presented.

Understanding the issue as well as the tools required to overcome it could ideally result in a higher degree of *perceived behavioral control* (PBC), or the degree to which a behavior is perceived as easy or difficult to perform (Ajzen, 2002). PBC is commonly considered a central determinant for behavioral change. A game designed in this manner should also provide a higher degree of tailored information and feedback according to the individual's chosen play style, which in other contexts has been shown to have a positive impact on pro-environmental behavior (e.g., Abrahamse et al., 2007). In so doing, it should aim to present the topic in a novel way, ideally by appearing as personally relevant to the player. Novel strategies for communication are known to increase interest in the topic through encouraging the individual to approach the phenomenon in question from a different angle than what is common or familiar. When such novel forms of communication strategies succeed, there is reason to believe that the individual will be motivated to seek out more knowledge about the topic willingly, as well as to expand upon knowledge they already possess (Ainley et al., 2002). Additionally, perceiving topical information as personally relevant is known to have a significant impact upon peoples' attitudes toward specific sustainability issues (Kang et al., 2013).

THE ENED-GEM

As Riemer and Schrader (2015) point out, new models for understanding and designing educational games are required. One way to answer this call is to design more subject-oriented conceptual models for educational games, where variables related to the topic at hand are put into focus. In the case of educational games about environmental issues and subjects, there is currently no such model available in existing research. Also, considering the unique complexity of understanding environmental topics, as explained by Klöckner (2015) as well as Fennewald and Kievit-Kylar (2012), it would make sense to develop a model for this exact purpose. Therefore, we suggest the ENED-GEM as a potential explanatory framework for the design and implementation of environmental games. In order to establish a prototypical framework, existing literature about educational and environmental games were retrieved, and central recurring factors in said literature were implemented in the ENED-GEM. Insight from fields such as media psychology and environmental communication were used to establish the current version of the ENED-GEM (**Figure 1**), drawing inspiration from established frameworks such as the comprehensive GameFlow model (Sweetser and Wyeth, 2005) as well as various articles related to game-based learning. Additionally, central determinants for game-based enjoyment and motivation were identified as potential facilitators of learning through games. These were implemented into the model where applicable.

The ENED-GEM is a three-stage conceptual framework seeking to describe the psychological processes that occur before, during and after playing an educational game, with a special emphasis on factors that might influence pro-environmental behavior. ENED-GEM also takes into account the *external influential factors* that might affect a person's willingness to engage in any of these three stages. The three stages of the ENED-GEM consist of a *motivational stage*, a *gameplay stage* and the subsequent *learning outcomes* from the gameplay stage. As a general rule it can be assumed that the model is largely linear, with the motivational stage coming before the gameplay stage and the subsequent learning outcomes that are gained from playing. However, it is important to note that a game could be played more than once, meaning that any new knowledge gained from playing the game the first time will likely be carried into the second stage of gameplay.

External Influential Factors

Although the pedagogical properties of the game itself can be efficient in teaching on their own, it is important to also consider the interaction effects between the game and any psychological learning factors that exist outside of it. The ENED-GEM assumes that four external factors are influential in regards to motivating and steering gameplay. These factors are *pre-existing environmental tendencies, sociodemographic variables, player type* and *repeated play*.

Pre-existing Environmental Tendencies

Environmental awareness is known to stem from several sources, and subsequent environmental behavior or behavioral intention depends on a highly complicated framework of social, habitual, and personal factors (Kollmuss and Agyeman, 2002). People are motivated by both intrinsic (altruistic or moral) as well as extrinsic factors (rewards or incentives) to act in an environmentally friendly manner (De Young, 2000). Furthermore, to avoid the feeling of being regarded as incompetent or helpless in relation to a given topic, it is expected that individuals are motivated to learn, acquire information and actively participate in situations where they feel they should be involved or express interest, which is also applicable to the environmental domain (Kaplan, 2000). Taken together, the sum of an individual's motivations to engage with environmental issues and topics constitute their *pre-existing environmental tendencies*.

Pre-existing environmental tendencies, such as attitudes toward specific environmental topics, are generally thought to affect a person's behavior in regards to these topics (Fishbein and Ajzen, 1975, p. 335). It is therefore likely that the learning outcomes from playing an educational game about the environment are determined by the player's pre-existing attitudes toward educational games and the environment in general, even before gameplay is initiated. A sufficient understanding of which personal factors are the most influential in determining environmental action does not exist, although factors such as knowledge of environmental issues and individual locus

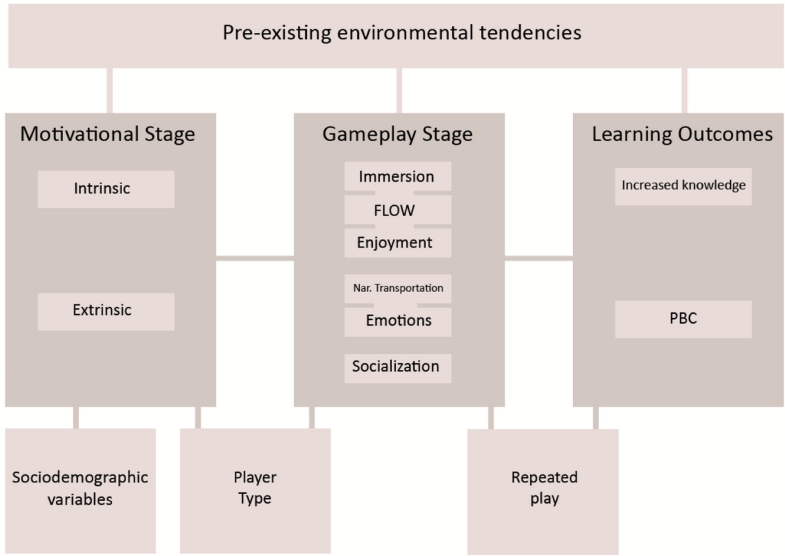

FIGURE 1 | The ENED-GEM framework.

of control have been suggested as significant contributors (Hines et al., 1986/1987). However, based on existing research, the ENED-GEM assumes that an individual's pre-existing environmental tendencies, such as their attitudes, beliefs and level of environmental knowledge, to a certain degree will influence their motivation to interact with an environmental game. They are also likely to play a part in the enjoyment and learning outcomes the players will gain from their gameplay sessions. As an example, it is likely that a person who is otherwise engaged and interested in bio-conservation perhaps would be more apt to play an environmental game with bio-conservation as its major theme than a person who is not involved in bio-conservation.

Sociodemographic Variables

Considering a player's individual, social and cultural background can be important when examining for effects of educational games, regardless of the game's theme or topic. In the case of gender for example, it is widely acknowledged that both men and women spend a great deal of their time playing games, and that certain gender differences tend to affect their motivations for playing. According to recent statistics based on more than 4000 American households, 67% of the households contained some form of gaming device (ESA, 2017). Furthermore, 59% of US gamers are male and 41% are female (ESA, 2016). Males generally tend to be more motivated by competition and achievements in their gameplay sessions (Williams et al., 2009), whereas females are shown to be more motivated to play games when no other leisure activities are available at the time (Chou and Tsai, 2007).

Different variations of game genres are also believed to induce flow states in players of a certain gender more easily than the other, such as in the case of how fighting and shooting games overall tend to appeal more to males than to females (Sherry, 2004). Females, on the other hand, show a tendency to be more attracted to the social interaction aspects of games (Hartmann and Klimmt, 2006), thus suggesting that they are more apt to play games with a multiplayer component rather than games solely meant for single players. The consideration of gender motivations in gameplay during the design phase of an educational game about the environment could positively affect the gameplay experience, and thus facilitate the learning outcomes generated by the gameplay sessions. Furthermore, gender is shown to have a significant role in regards to the level of positive or negative affect a person has toward the use of different types of educational games (Riemer and Schrader, 2015).

Another significant factor in gameplay is the age of the player. Although players are represented by all age groups, there are some differences between these that demand consideration. Firstly, the average player is normally assumed to be approximately 30 years old, and adults often play for longer hauls than younger players (Williams et al., 2008). Elderly players are also shown to enjoy games, especially when the game exists in a format other than digital and offers the possibility to socialize (IJsselsteijn et al., 2007). Intriguingly, elderly players have also been shown to exhibit a higher degree of self-reported well-being after playing digital games (Goldstein et al., 1997).

As for racial background, little consistent research exists to suggest any significant differences in the motivation to engage with games. In fact, designing games that are appealing across highly diverse audiences has been shown to be possible, such as teaching about artificial intelligence through role-playing games

(Sintov et al., 2016). Furthermore, some research suggests that players do not exhibit any tendencies to play significantly more or less depending on what national background they have (Williams et al., 2008).

Player Type

The quality of an individual's playing experience also depends on what type of player they are, and a person's player type often reflects individual motivations for gameplay. One of the most cited taxonomies of player types divides players into four distinct categories: *explorers, achievers, socializers,* and *killers* (Bartle, 1996). *Explorers* enjoy discovering as much as they can about a virtual world, *Achievers* set in-game goals and try to reach them, *Socializers* wish to expand their in-game social networks, and *Killers* seek to disrupt and sabotage the gameplay for others. What is immediately apparent from these descriptions is that people have various motivations and needs for playing games, and that a failure to implement game elements that might satisfy these needs would result in a lower degree of game enjoyment for a wide variety of people. In educational games, the final consequence of low game enjoyment could be lack of attention toward the learning properties of the game as well as the inability for the players to enter a flow state or becoming immersed.

It is very rare that an individual fits exclusively within just one of these player types, and it is generally more common to exhibit traits from several player types at once. However, understanding this taxonomy as an overall categorization of existing player types is important in order to understand the intrinsic motivation an individual has toward playing a specific game, as environmental games designed to appeal to these player types would be perceived as enjoyable by a large part of the known gaming audience.

Repeated Play

Repeated play, or the desire to keep playing despite facing serious adversity or even beating the game in its entirety, also serves as an important component of digital educational games in that it re-initiates gameplay and contributes toward repeated exposure to the game's educational content. The initiation of the repeated play of a game is determined by its *replay value* or *replayability* (Kelle et al., 2011), a measurement for a game's potential for continued use after its initial completion (Wolf, 2012, p. 524). Modern sophisticated games, such as *Dark Souls 3* (From Software, 2016), often have multiple potential endings, achievements and quests that are only obtainable if the player chooses to play through the game at least twice or thrice. The game difficulty is often increased drastically on the second playthrough, and the game design tends to be slightly different from the first playthrough due to subtle or major changes to the game world. These new gameplay elements are intended to motivate the player to initiate repeated play, and to gain more enjoyment from their gameplay experience.

Repetition in educational games also serves a potentially important function in memory retention and ultimately the specific use of this retained knowledge in a practical setting (Ruben, 1999). First and foremost, repeating a set of implemented strategies to overcome in-game challenges could and should eventually lead to some form of reward for the player (Coyne, 2003). The reward can come both in the form of breaking out of the game's repetition loop by finding a strategy that beats the challenge and allows the game to proceed, or it could provide the player with a tool that makes them stronger or more capable of overcoming future challenges. The player eventually learns which strategies and tools to use, and retains these important insights for similar events in later gameplay. In the event that an educational game is meant to simulate or otherwise resemble a real-life setting, it should also be possible for the player to integrate and implement learned in-game strategies to overcome real-life challenges (Bogost, 2010, p. 236).

Motivational Stage

The motivational stage of the ENED-GEM initiates as soon as a potential player becomes aware of an environmental game, and includes the sum of motivations (both intrinsic and extrinsic) he or she has toward playing it. Motivations to play environmental games stem from a variety of sources such as their pre-existing environmental and gaming knowledge, values, attitudes and beliefs about environmental issues, as well as their potential desire to replay a game to complete unfinished quests or unlock new endings (see "Repeated Play"). The externalized factor of *player type* also serves as a central determinant as to whether or not an individual feels motivated to play, in that different player types are motivated to engage in gameplay by widely different in-game elements.

Intrinsic Motivators

Intrinsic motivation refers to any activity that is inherently enjoyable, meaning that the act of performing the activity is a reward in and by itself (Ryan and Deci, 2000). Commercially successful games generally feature a wide variety of known intrinsically oriented player motivators that eventually factor into player enjoyment, and these factors normally account for the game's eventual popularity on the market. McGonigal (2011, p. 49) writes that the four intrinsic rewards we as humans crave the most can be summarized as (1) *satisfying work*, (2) *the experience or hope of being successful*, (3) *social connections,* and (4) *meaningful activities to do*. To a person playing a satisfying and well-designed game, all of these factors can be fulfilled through the act of playing.

Playing games is often a satisfying voluntary activity in and of itself (McGonigal, 2011, p. 21). Social connections can be established through in-game chatrooms and forums dedicated to the game, and the experience of being successful arises from becoming stronger and overcoming increasingly difficult obstacles the game world contains. However, research on game design states that there are several other factors influencing the intrinsic motivation to play. These motivational factors include *player-focused* as well as *in-game* elements, and can be both *intrinsic* as well as *extrinsic*. Intrinsic *player-focused* motivators generally arise from the player's own willingness to engage and interact with a game (McGonigal, 2011, p. 51), and include the ability for players to become immersed into the visual aspects or atmosphere of the game (e.g., Brown and Cairns, 2004; Ermi and Mäyrä, 2005; Jennett et al., 2008). Players also tend to be motivated to experience emotionally charged narrative transportation (e.g., Green et al., 2000) in which the players

are gradually absorbed into the relatable aspects of the game's storyline. Additionally, the ability to socialize through online interaction (e.g., Malone and Lepper, 1987; Yee, 2006) has been proven to be appealing to a great number of individuals and particularly to female players (Hartmann and Klimmt, 2006). Facilitation and enablement for these experiences to occur happens through the presence of a wide variety of intrinsic *in-game* motivators, which include high-quality aesthetics such as graphics and soundtracks (Schell, 2008, p. 42), an optimal level of challenge (e.g., Malone and Lepper, 1987; Garris et al., 2002) and smooth controls (Wang et al., 2009).

Extrinsic Motivators

In contrast to intrinsic motivation, *extrinsic motivation* refers to performing an activity that leads to some form of separable outcome or external reward (Ryan and Deci, 2000), thus meaning that the motivation to perform does not stem from the activity itself. Externally motivated gaming activities focused toward education about a specific topic are commonly centered around some form of externalized reward such as course credit rather than intrinsically motivating in-game factors such as those described above. A large body of literature suggests that extrinsic motivation has a strong negative effect on existing intrinsic motivation to complete interesting tasks (Deci et al., 1999), as well as potentially limiting creativity in individuals who feel they are being controlled by an outside source (Amabile, 1998). For an environmental game that is inherently interesting to the player, offering some form of reward to complete the game (e.g., course credits or monetary compensation) would thus be likely to ruin the player's enjoyment of the game as a whole as well as possibly limiting the amount of autonomous and creative thinking necessary to solve the game's challenges. This would be likely to happen in educational institutions such as schools, where educational games are played to gain external rewards such as extra course credit or as a requirement for passing a class.

In cases where the game-based learning outcomes themselves are considered extrinsic rewards, however, it is clear that both intrinsically and extrinsically motivating elements need to be considered as complementary rather than mutually exclusive (Garris et al., 2002). There is also a possibility that games that are initially introduced solely with a promise of externalized rewards could contain intrinsically motivating elements as well, thus leading to voluntary repeated play and enjoyment of the game.

Gameplay stage

The gameplay stage of the ENED-GEM begins when the player has begun actively engaging with the game, and normally features a certain degree of emotional activation in the person playing. During gameplay, the player is *immersed* in the audiovisual and narrative aspects of the game, and a flow state is achieved in cases where the game is highly immersive. In cases where the game features a deeply intriguing narrative the player might also experience *narrative transportation*, where they are so deeply immersed in the story and the characters of the game that they establish an *emotional connection* with the game world.

Immersion

Immersion, otherwise known as *presence* (e.g., Weibel and Wissmath, 2011), is a commonly cited, yet poorly understood construct in game-based learning. A common description of immersion is the feeling of being so absorbed into an experience or task that the flow of time seems to go by faster than usual, bodily needs such as hunger or thirst are suppressed and physical surroundings seem to matter less than they did before (Brown and Cairns, 2004). Immersion shows a considerable overlap with the flow phenomenon (Section "Flow"), although immersion is more fleeting and less persistent in nature (Brown and Cairns, 2004). It is also common to separate between flow as the pleasurable involvement in an activity, whereas immersion refers more to the feeling of being part of a mediated environment (Weibel and Wissmath, 2011). Immersion can be divided into three distinct categories; *sensory, challenge-based,* and *imaginative*. *Sensory immersion* refers to how audiovisual stimuli directs the players attention to the game, *challenge-based immersion* occurs when there is a fair balance between the game's challenge level and the player's skills, and *imaginative immersion* happens when the player starts to somehow identify with the game characters (Ermi and Mäyrä, 2005). Immersion is furthermore theorized to evolve gradually from a stage where it is easily broken to more robust full immersion (Brown and Cairns, 2004). Immersion is often associated with the degree of knowledge acquisition taking place during gameplay (Garris et al., 2002), with some researchers theorizing that it leads to intense experiences which increase learning, interest and retention of information (e.g., Murphy, 2011). In research, Weibel and Wissmath (2011) concluded that immersion and flow are both positively affected by motivation, and in turn have a concrete effect on the enjoyment and performance of a given task or activity.

Flow

Flow is a concept used to describe the psychological phenomenon of being so immersed in an activity or action that nothing else seems to matter, and the subsequent enjoyment one gets from this experience (Csikszentmihalyi, 1990, p. 4). It is commonly thought to follow the immersive stage of gameplay (Weibel and Wissmath, 2011), as described in the previous section (Immersion) of this article. A person who is experiencing flow is said to be in a flow state, which is generally considered to be highly beneficial to a wide variety of learning outcomes (e.g., Shernoff and Csikszentmihalyi, 2009), as well as to intrinsic motivation (Ryan et al., 2006). The flow state is also well known and sought after in game design, where it is commonly shown to increase player enjoyment as well as steering the player's attention to what is happening in the game (Schell, 2008, p. 118). Being in a flow state during gameplay is significantly linked to learning, such as through increased concentration, interest, and enjoyment of the learning activity taking place (Hamari et al., 2016).

One of the most common precursors to these flow states during gameplay is an even balance between the game's difficulty and the player's own skills (Johnson and Wiles, 2003), where the difficulty should remain slightly higher than the point of frustration to give the player a goal to aim for. On the

contrary, bad usability and slow feedback have been shown to be detrimental to the flow state in gaming (Kiili, 2005). Bad usability could refer to a variety of issues arising during gameplay that would otherwise ruin the immersion of the gaming experience, such as a poor relationship between the game's difficulty level and the player's own skills, or glitchy game mechanics.

Another intriguing finding is that flow states experienced together with others tend to be perceived as more enjoyable than when one is in a solitary flow state (Walker, 2010), thus suggesting that including a multiplayer function in the game is likely to boost the in-game flow state experience in some cases. It has also been shown that allowing the game to feature a structure where the players can enter into teams and compete against one another can increase their learning frequency (Admiraal et al., 2011).

Narrative Transportation

A *narrative* can be described as a cohesive story featuring a beginning, a middle section, and an ending, which provides the reader with some form of information regarding the characters, scene, conflict, and resolution (Hinyard and Kreuter, 2007). When one gets involved in the narrative to the point where an emotional connection is established with the characters and other elements of the story, this is known as *narrative transportation* (Van Laer et al., 2013). Narrative transportation is not limited to written materials such as books or magazines, but may be applicable in other forms of media as well (Green and Brock, 2000). The ultimate goal of narrative transportation is to have a persuasive effect on the reader or listener (Van Laer et al., 2013), thus indicating its potential use in educational games. Narrative transportation is also shown to have a distinguished effect on a person's real-world beliefs regardless of whether it is based on fictitious or scientific material (Green and Brock, 2000).

Emotions

A key motivation to partake in the use of entertainment media, such as games, is the desire to experience strong emotional activation (Bartsch and Viehoff, 2010). During gameplay, players often experience a wide range of powerful emotions ranging from fear and surprise to wonderment and personal triumph (Lazzaro, 2004). Emotional activation is known to play a significant role in learning and memorization. On a purely biological level, an individual's emotional and memory systems, mainly the *amygdala* and the *hippocampus*, respectively, are closely interconnected, and memories formed during certain emotionally aroused states could therefore be more easily recalled from memory (Sylwester, 1994; Brosch et al., 2013). Additionally, our attention tends to prioritize information that could somehow be emotionally relevant to us (Brosch et al., 2013). Experiencing positive emotions is also known to broaden the scope of human attention (Fredrickson and Branigan, 2005), suggesting that the ability to focus on more informational material and possibly also comprehend it more fully is increased. Positive emotions such as amusement and excitement are furthermore cited among the most common emotional occurrences during gameplay (Bateman, 2008), meaning that games could foster learning by broadening attention through emotional activation.

While the role of emotions is important in certain aspects of learning, it is largely neglected in educational game-based research (Wilkinson, 2013). Game-based social and emotional learning has been shown to be highly motivating, especially for younger learners (Hromek, 2009). Additionally, games can create powerful scenes that allow the player to experience emotionally charged events in a simulated virtual environment. This could, potentially, prepare the players for a real-life equivalent of this situation. Some games such as *That Dragon, Cancer* (Numinous Games, 2016) which thematically introduces the player to a child's fight against cancer, are designed especially to provide such emotional journeys for the player to experience and gain insight from.

The Importance of Social Interaction

The ability to initiate some form of social interaction (e.g., cooperation, socialization, and competition) in games has been shown to significantly predict game enjoyment across a wide range of disciplines (e.g., Malone and Lepper, 1987; Bartle, 1996; Jennett et al., 2008; Fu et al., 2009). Games that teach language skills, for example, are shown to be effective when the opportunity to socialize and interact through the game environment is encouraged (Berns et al., 2013, p. 29). Additionally, female players (Hartmann and Klimmt, 2006) and the elderly (IJsselsteijn et al., 2007) are more likely to find gameplay enjoyable if they are given the opportunity for social interaction. Based on these findings, environmentally oriented games would do well to integrate a social arena through which the players can interact with each other.

Learning Outcomes

Once the gameplay stage is finished it is likely that a well-designed educational game, regardless of the subject it is designed to teach, should result in some form of learning outcome for the player. The nature of these learning outcomes will likely depend on what the game is designed to accomplish; some games merely increase a subject's knowledge or awareness of a specific topic, while others provide tools and procedural instructions on how to solve certain problems or change the player's behavior in a desired direction.

Semantic and Episodic Knowledge Gain

Games have been shown to affect an individual's cognitive structure on a wide variety of levels, ranging from spatial cognition (Feng et al., 2007) to certain elements of visual processing (Green and Bavelier, 2007). One of the more intriguing aspects of educational games is their ability to impact the human declarative memory. Tulving (1972, 1985) divided the human declarative memory into two interconnected parts; the *semantic* and the *episodic* memory. Semantic memory revolves around the perception, use and understanding of words in a meaningful and coherent fashion, while episodic memory contains information about episodes or events a person has experienced. Alterations in the human memory happens after repeated exposure to various types of information, and information campaigns are decidedly one of the most common strategies in environmental communication as a consequence (Klöckner, 2015, p. 164). Furthermore, information is one of

the key factors leading to environmental action (Hines et al., 1986/1987). Studies show that playing specific types of games can lead to such alterations in the hippocampal area and thus the episodic memory (Clemenson and Stark, 2015). Similar results are found in more semantically oriented games where the goal is to acquire knowledge about language, especially when central player enjoyment factors are identified by the participants themselves (Butler, 2015).

Increased Perceived Behavioral Control

Perceived behavioral control refers to the perceived ease or difficulty of performing some sort of behavior (Ajzen, 2002), and is shown to significantly predict the intention to engage in pro-environmental actions (Bamberg and Möser, 2007). A closely related psychological phenomenon, locus of control, refers to an individual attributing their ability to bring about change either by themselves (internal) or through factors such as governmental structure or significant others (external) (Hines et al., 1986/1987). Showing how to perform a desired behavior has a tendency to reduce the perceived difficulty of a task, as well as increasing the PBC over it (Klöckner, 2015, p. 165). Games have the distinct advantage over other forms of media in that not only are they capable of displaying the potential effects of behavior change visually, but they also allow the player to be in control of the situation through their in-game characters and personas. Assuming the role of a virtual character while immersed in an environmental game might provide the player with a new arena through which they can gain an understanding of how to overcome environmental barriers. Playing educational games can also, for some individuals with a high level of external locus of control, lead to an increase in internal locus of control and behavioral intention (Yang et al., 2016). In environmental psychology, the effectiveness of behavioral interventions greatly increases when they attempt to remove barriers for behavioral change (e.g., Steg and Vlek, 2009), which educational games are apt to do through visually displaying the tools the player needs in order to overcome such barriers. Providing tools that make pro-environmental behaviors easier is shown to have a lasting effect in other studies (e.g., Thøgersen, 2009).

Additionally, games often contain colorful characters that the player can identify with or digital avatars that the player can assume the role of (Klimmt et al., 2009). While they didn't test for the role of self-efficacy, Fox and Bailenson (2009) found that participants in a virtual environment would work out more in real life if they observed their similarly designed digital avatars doing it first. A different experiment concluded that taking on the role of a superhero in a virtual reality game caused more prosocial behavior in the participants, likely due to how embodying superpowers in the game briefly shifted the participants' self-concept into someone who is likely to exhibit these traits (Rosenberg et al., 2013). Some researchers also suggest that an individual tends to experience an in-game narrative more positively than didactic instructions about how to act in a given context. In health research, for example, a person is more likely to integrate their vivid and direct in-game character's positive experiences toward a healthier lifestyle than when they merely receive basic instructions on how to become healthier (Lu et al., 2012).

ENED-GEM CASE STUDY – FATE OF THE WORLD

In order to provide preliminary validation for the ENED-GEM, a case study of the environmental PC game *Fate of the World* (Roberts, 2011) was conducted. The game was chosen due to being a rather scientifically accurate example in its representation of the climate system, as well as featuring a high level of difficulty and focus on learning about the environment in general (Klöckner, 2015, p. 199). Before initializing the information gathering stage, an application asking for permission to use informant data from the Steam platform was sent to the NSD (Norwegian Center for Research Data) for approval. NSD approved the project, under the terms that the reviewers had to be contacted by the researchers if their reviews were to be cited individually. Steam does not allow communication between members who have not yet added each other to their lists of acquainted players, however, and as a result communication with the reviewers became impossible. The reviews were therefore analyzed collectively, so as to not identify individual reviewers. This form of collective analysis falls under NSD's guidelines for approval.

The reviews from a popular gaming client (Steam, 2016a) were collectively analyzed in order to gain an understanding of which elements in Fate of the World did and did not provide game enjoyment and if the elements included in the ENED-GEM could be identified in how reviewers refer to one example of a complex environmental computer game. Additionally, one of the researchers played through two of the game's scenarios in order to gain an understanding of the game's mechanics and interface. This process took 2.5 h, and was conducted on a brand new stationary gaming computer in order to ensure that the game ran as smoothly as possible. It should also be noted that the version played by the researcher did not include the downloadable expansion known as *Fate of the World: Tipping Point,* which features a scalable difficulty curve in the form of an "Easy Mode" (Steam, 2016b).

Fate of the World

Fate of the World (FotW) is an award-winning digital card-based global strategy game (Steam, 2016a). Released in 2011, it was created as a joint effort between independent game developer Red Redemption and Oxford University as an attempt to educate the public about the effects of global warming on humanity and the planet as a whole (Soothsayer Games, 2017). In the game, the player takes on the role of GEO (Global Environmental Organization) in order to implement worldwide policies and projects that are intended to prevent environmental disasters such as droughts, famines, and epidemics from happening. These policies are presented to the player in the form of cards, where each card has a different effect on the progression of the game. Every time a set of cards (policies) are chosen, the player must proceed to the next round in order for the cards to take effect.

Going from one round to the next makes the game move forward in time (5 years each round), and the player normally wins if they have completed their in-game tasks before a specific deadline. Depending on how the player chooses to use these cards, the 12 nations of the world (China, Europe, India, Japan, Latin America, Middle East, North America, Northern Africa, Oceania, Russia, South Asia, and Southern Africa) will either praise or resent the GEO's decisions. If a nation becomes too resentful of the policies in play, the GEO will lose control over that nation and can no longer interact with it. Losing too much support from the various nations will cause the player to lose the game. In order to win the game, the player has to complete a set of goals that are unique for each scenario or level of the game. In one scenario (The Rise of Africa), increasing the HDI (Human Development Index) of North and South Africa to 0.7 or greater is the only requirement necessary to win. In another scenario (3°) the player needs to reach a specific deadline (the year 2200) with global warming below 3°, while simultaneously keeping a close attention to the world's HDI and avoiding the loss of landmark species. The game features nine scenarios in total, ending with the Dr. Apocalypse scenario where the goal is to *raise* the global temperature without losing control of the 12 nations[1].

In addition to these nine scenarios, the Steam version of FotW features a set of 32 achievements (trophies obtained after completing specific tasks in the game) available to the player, ranging from simply completing each of the scenarios to globally banning coal and even causing global thermonuclear war (Steam, 2016a).

Reviews

Up until June 13th 2016, the full set of available user reviews of FotW on the popular gaming platform Steam ($N = 249$) were analyzed in order to gain a general understanding of the game's perceived pros and cons. The reviews are public, and can be accessed both through the Steam platform itself as well as through any form of Internet browser (Steam, 2016a). Out of the 249 available reviews, approximately 77% ($N = 192$) rated the game as an overall positive experience. Collectively, the 192 reviewers who rated the game positively had spent a total of 4604.7 h ($M = 23{,}98$) playing the game. By contrast, the 57 reviewers who rated the game negatively had spent a total of 577.1 h ($M = 10{,}12$) playing. Eleven reviews were written based on the beta version of the game as it went through development, and as such will be excluded from this analysis due to potential significant differences between the unfinished and finished versions. Other reviews were largely vague or generalized opinions about the game as a whole, featuring only short statements such as "good game" or "not fun," and thusly did not contribute sufficient information to be included in the final analysis. Furthermore, there are no separate review forums for the original FotW and its expansion, Fate of the World: Tipping Point. It is therefore likely that some of the reviews are based on the original game, whereas others are not. Furthermore, any sociodemographic variables about the reviewers are unavailable, thus making it impossible to ascertain any differences in opinion based on these constructs.

Procedure

First, a short text was published on FotW's Steam forums to inform the reviewers about the research taking place, as well as to give them the opportunity to withdraw their review from the collective analysis (Motsaenggin, 2016). To prevent the risk of identifying users, the reviews were analyzed collectively rather than individually. This was done in compliance with guidelines from NSD (Norsk Samfunnsvitenskapelig Datatjeneste) regarding the ethical treatment of informants in social science research. Statements about FotW contained within the reviews were then entered into an Excel spreadsheet, and listed according to how frequently specific aspects of the game were mentioned across the user base.

Thematic Categories

Due to the usage of public reviews in this study, the informants were not tasked with answering questions from the researchers. The platform where the reviews are submitted (Steam) does not allow direct communication between users who are not added to each others' friends-lists. Consequentially, it would be impossible to conduct interviews with the informants in this setting. Statements that coincided frequently were arranged into thematic categories by one of the lead researchers in an Excel spreadsheet by hand, and analyzed in accordance with existing guidelines for thematic analysis provided by Braun and Clarke (2006). Data extracts from these statements were utilized as codes, and subsequently linked together to form themes. The most frequently recurring positive statements about the game were *challenge* (48), *thought-provoking content about the environment* (19), *realism* (10) and that the game appeared to be *generally well-designed* (6). More negatively oriented reviewers were more apt to describe the game as *unintuitive in terms of layout* (12), *too difficult* (11), *in need of a sandbox mode* (9) as well as being *boring to look at* (8). After sorting the individual arguments found in the reviews of FotW into an Excel spreadsheet and counting the number of recurring arguments, a total of three main thematic categories were found to be relevant for the ENED-GEM framework. Other thematic categories, while interesting, did not occur a sufficient number of times to be included in the final analysis. Other arguments were so closely related to the overall theme of other categories, and were therefore fused together with these in order to avoid loss of valid information. The following section is dedicated to highlighting each of the three identified main themes, and to relate these findings back to the theory presented in the first half of the article.

Theme 1: Challenging or Impossible?

Out of the 249 reviews that were analyzed, a total of 59 mentioned the game's difficulty level. Forty-eight users praised the level of difficulty by generally wording it positively (e.g., "fairly challenging" or "difficult"), while 11 users considered

[1]The exact educational properties of the Dr. Apocalypse scenario is unknown to the authors, and is not made explicit on the developing team's website. It is possible that it simply serves as a scenario that is designed to test the player's accumulated skills through several scenarios of gameplay, rather than educate him or her about the environment. Another possibility is that it attempts to educate the player about global warming by having them do the opposite of lowering the global temperature, thus reaching out to other learner- and player types.

the high level of difficulty to be more negative, using terms such as "frustrating" or "impossible to beat." Several reviewers mentioned that their implemented in-game strategies seemed to fail constantly regardless of how they played their cards, and some users eventually felt depressed or bored with the game as a consequence. Some of the positively inclined reviewers were also openly stating that the game's difficulty level might alienate some players who did not feel comfortable facing off against it, and that a large degree of strategic gameplay was required to overcome it.

According to flow theory, the level of optimal difficulty is important both in regards to game-based learning (Hamari et al., 2016) as well as perceiving the game as fun or immersive (Schell, 2008, p. 118). Failure to make the game optimally challenging for a large crowd of players could result in the game being put down and, as a consequence, for any learning outcomes to remain absent. Should the player be given the option of adjusting the level of difficulty according to his or her skill level in the game it is more likely that the player would remain in a flow state, and thus learn more from the gameplay session due to a more even dispersion of cognitive resources between enjoying the game and focusing attention toward the game's educational properties. A high level of difficulty could also result in the player's attention being directed toward other aspects of the game rather than the educational properties, such as implementing strategies to avoid losing the current scenario or the support of 1 of the 12 major nations. The high challenge level could also cause a lower degree of PBC in that the player generates an understanding of the world as "unsalvageable" or "doomed," due to implementing strategies that fail to fulfill the requirements for winning the game's different scenarios.

While the general challenge level of FotW's planned sequel is set to be lower (Soothsayer Games, 2015), a high degree of challenge could also lead to repeated play. Repeated play is generally an indication that while the game is highly challenging, there are elements of immersion and motivation present that generate an interest in reattempting to beat the game rather than to give up. Additionally, repeated play allows for players to establish a complex connection between the game world and the real world (Bogost, 2010, p. 236). It is likely determined by highly subjective reasons, although a flow state has to occur before repeated play is initiated. As explained earlier, flow is the sphere of optimal difficulty where the individual has achieved a good balance between the difficulty of the task being performed and their current task skill level (Johnson and Wiles, 2003). In flow theory, the enjoyment one gets from performing a task is heavily presumed, but the difficulty of the task and the level of skill exhibited by the individual performing the task have received considerably greater attention in the literature.

Regarding the occurrence of voluntary repeated play, one can infer that the player perceives the game as fun in general, a demonstrably important element in commercially successful yet frustrating games such as the *Dark Souls* series. In this adventure game series the player faces punishingly difficult challenges from the very beginning of the game, and the challenge level rises steeply as the player progresses through the game world. Beating the Dark Souls games conventionally requires a deep and complex understanding of the game's mechanics, and it encourages repeated play by letting the player experiment with how to overcome the game's obstacles, such as by equipping different weapons and armor when facing enemies with certain strengths and weaknesses, or even summoning other players to help them out in battle. By introducing these enjoyable and motivating elements into the game, the player will likely be motivated to keep playing and to memorize recurring patterns that are featured within the game's theme. In educational games about the environment it is likely that player enjoyment factors need to be considered as equally important to the game's difficulty level and the player's skills in overcoming these difficulties. To summarize, player enjoyment factors likely facilitate a player's desire to keep playing and increase their skill level, even when facing serious adversity in the game itself.

Theme 2: No Sandbox – No Fun – No Learning!

A recurring complaint among the reviewers is the lack of an in-game *sandbox mode*. The term "sandbox" in gaming commonly refers to an open world where the player experiences a large degree of freedom in terms of exploring the virtual world present within the game (Bellotti et al., 2009). Reviewers who criticize this lack of personal freedom in the gaming landscape state that the existing interface of the game is boring or takes a long time to get used to, which in turn affected their gameplay experience negatively. This complaint was often made by reviewers who were more occupied by traditional game mechanics than those who gravitated more toward the scientific model the game was based on. The lack of a sandbox mode could, ultimately, terminate the entire gameplay stage of the ENED-GEM framework for individuals who feel that this particular gaming aspect is important, which in turn would be detrimental to any learning outcomes that would normally result from an enjoyable gameplay experience.

For an educational game, being appealing to the player is absolutely fundamental in order for the learning to take place, otherwise it risks being put down before any educational content comes into play (Sweetser and Wyeth, 2005). All too often, educational games tend to be perceived as being more dull than commercially successful games (DeNero and Klein, 2010), which could potentially undermine such important factors as flow and immersion during the gameplay stage of the ENED-GEM. A sandbox mode could, therefore, be an important component in creating an immersive game world in which the players can unfold themselves.

When referring to an immersive game world, a sandbox mode can be considered a conglomerate of various player enjoyment factors that are commonly present at the same time in the game setting. It is likely that a desire for a sandbox mode could therefore, by extension, signify a desire for the presence of more traditional gaming elements that positively reinforce game enjoyment. These missing elements constitute a significant part of the gaming experience that facilitates the intrinsic motivation to play, and in FotW's case includes aspects such as narrative transportation due to the lack of relatable characters as well as the inability to interact with other players. Some of the more highly recognized game enjoyment factors in existing research have been mentioned earlier in this article, but several others are

likely to exist. Those factors that are mentioned, however, are often missing in FotW, such as through the lack of interesting characters in the game's narrative (Hinyard and Kreuter, 2007), an optimal level of difficulty (Malone and Lepper, 1987; Garris et al., 2002) and the option to be able to socialize with other players during gameplay (Malone and Lepper, 1987; Yee, 2006). An environmental game dedicating more resources and attention toward these gaming aspects should, according to research, lead to a higher degree of immersion into the game and higher learning outcomes as a direct consequence.

Theme 3: Educational Game or Depressing Propaganda?

A final central theme emerging from the data were the opposing perceptions of FotW as either a thorough and comprehensive educational game about environmental issues in general on one side, and as depressing propaganda on the other. The reviewers who praised the educational value of the game commonly referred directly to the scientific foundation the game was based upon, whereas the reviewers who wrote the game off as a tool for spreading propaganda generally did so without referring to the science behind the game at all.

Positive reviews of FotW generally reflected the reviewers' perception of the game as challenging but fair, complex, sophisticated and well-designed. A selection of four individuals from the more positively inclined reviewers also stated that they found it entertaining how you could be sadistic in your gameplay (such as by starting genocides to reduce the world's carbon emissions), while others described the game as potential fun for "science-obsessed people." Positive reviews were also more likely to mention that the game was thought-provoking and capable of increasing awareness of environmental issues, while simultaneously giving a realistic depiction of the complexity of the subject matter. A large part of the positive reviews did, however, mention that FotW might be more suitable for individuals who are already interested in the subject matter before gameplay is initiated, and that other players might perceive it as a somewhat confusing and overly difficult strategy game. The more negatively oriented reviews generally reflect this statement.

Negative reviews of FotW describe the game as overly challenging, boring, depressing, and suffering from poor game mechanics. Also, from a total of six reviewers who found the game to be outright depressing, a few of them explicitly noted that they felt a sense of unavoidable doom as a consequence of ever-increasing environmental issues, and that no matter the strategy they implemented in the game to prevent said environmental issues from happening they seemed to lose the scenario regardless. It is possible to assume, based on the tone of these reviews, that the depressing reality portrayed in the game has led to some of the players being left with a reduced PBC in regards to certain pro-environmental actions. The players are commonly faced with environmental issues of varying intensity during gameplay, and are left with a sense that "nothing works" or "we are doomed anyway" when their strategies to counteract these issues fail. This is reminiscent of *learned helplessness*, a phenomenon in which individual efforts to circumvent an unpleasant situation decrease when the situation is perceived as uncontrollable (Abramson et al., 1978). To prevent such learned helplessness in educational games about the environment, it is important to avoid introducing too much information to the player at once. Instead, the game should focus on introducing the player gradually to the environmental issues that the world is facing. Failure to do so would likely result in information overload, which is detrimental especially to educational games played on the computer (Chen et al., 2011).

A lower degree of learned helplessness while playing educational games likely suggests a higher degree of PBC. PBC increases when the tools for circumventing a problem are provided (Klöckner, 2015, p. 165), a finding that FotW does not necessarily address. If the players had been given hints about how to counteract the environmental issues as they arise rather than having to read up on one of the game's many menus to find pointers to a solution, it is likely they would have implemented strategic thinking and problem-solving to overcome the challenge directly. Theoretically speaking, this effect could also be reinforced when an environmental game addresses specific environmental issues rather than the full picture of environmental issues in general, as indicated by research (Sandbrook et al., 2015).

IMPLICATIONS FOR THE ENED-GEM

The initial thematic analysis detailed above provides promising dawning evidence for the relevance and applicability of the ENED-GEM model in educational game design and -research. In future environmental games, it could be important to consider the inclusion of more traditional motivational gameplay elements that draws a larger crowd of players into the gameplay stage, such as the inclusion of a sandbox mode with a narrative, quests, and characters. This might give the player a greater sense of autonomy and options to act in the game world, shaping it according to their own gameplay strategies.

Accounting for the individual components of the ENED-GEM, the reviews suggested that a large part of the players benefitted from immersion, flow and emotional activation during the gameplay stage. Positively inclined reviewers stated that they found the game to be an overall pleasant experience, particularly due to it being well-designed, fairly challenging and thought-provoking. It is difficult to say whether narrative transportation played a significant effect on the players, in particular due to FotW's relative lack of focus on a concrete storyline and relatable characters. The game also does not feature any form of multiplayer mode, thus making any measurements on social interaction between players impossible. Additionally, due to the Steam platform's account privacy guidelines, it is difficult to check for gender effects since players are not required to list their gender in their user profiles. Lastly the reviews contain no statements that directly suggest increased PBC, although a total of 19 reviewers state that the game *generally* "made them think" about environmental issues. 10 reviewers also stated that the game made them think explicitly about the *complexity* of environmental topics, thus suggesting on a very basic level that

they benefitted from increased knowledge about the environment through their gameplay.

The game seemed to appeal particularly to the *achiever* and *killer* player types (Bartle, 1996). Achievers played FotW due to their love for the game's high difficulty level, and were more apt to praise rather than criticize the demanding challenges that the game provided them with. They did, however, also place special emphasis on the fact that they understood how the difficulty could alienate other players, and commonly recommended FotW only to other players who were already accustomed to difficult games. In the case of the killer-type players, they generally seemed to recommend the game for purposes other than being environmentally friendly, such as the Dr. Apocalypse scenario. They also rated the game highly due to how certain game mechanics allowed them to be overly sadistic, such as by lowering the game world's carbon emissions by killing off the majority of the population.

The ENED-GEM framework also supports existing research on intrinsic motivational elements in games, and their effect on player enjoyment. Reviewers who found FotW to be a positive gameplay experience tended to describe the game as more enjoyable, and in some cases even more educational than their more negatively minded counterparts. Positively inclined reviewers were also more likely to engage in repeated play than negatively oriented reviewers. One possible explanation for this is that more environmental-minded players are more capable of suspending their disbelief and outright accepting certain lacking game mechanics than less environmental-minded players in favor of a theme or subject matter they are occupied with from before. Less environmental-minded players are likely just looking for a more traditional gameplay experience where they can become immersed, unfold themselves in the game world, solve quests, implement their favored strategies to overcome challenges, interact with intriguing characters and perhaps also form a social network with other players. FotW's general structure likely does not fulfill these needs for some players and, as a consequence, might alienate players who are less interested in environmental issues from before.

While the number of learning outcomes identified in the FotW reviews were limited, it is highly likely that other forms of learning could take place when playing environmental games. Some games, for instance, utilize the concept of roleplay and avatar customization, where the player is free to design and act out the role of a digital self that is separate from his or her real-life equivalent. A player's avatar often has entirely different values, morals, attitudes, and beliefs than the player does, depending on how the avatar is designed and the whims of the player. However, such forms of roleplay have been shown to be effective in changing real-life attitudes in accordance with the role being enacted (Janis and King, 1954; Elms, 1966; Fox and Bailenson, 2009). Based on these findings, a player scoring low on pro-environmentalism might experience a consequential positive change in his or her real-life views about the environment when roleplaying a more environmentally friendly character. For research into environmental games featuring these factors, it is highly likely that such role play effects can be observable.

LIMITATIONS TO THE STUDY

While the initial framework for the ENED-GEM looks promising for use in educational game design and -research, there are limitations in the study that need to be addressed. First, using reviews as informational sources can result in obtaining information only from individuals who felt very strongly, positively, or negatively, about the game. Focusing exclusively on Steam reviews will also result in the lack of knowledge about the sociodemographic variables of the informants due to how the review system is designed, and potential underlying differences in Steam users from other gamers in regards to skill level or personal background could also affect their opinions about the game.

A second limitation of the ENED-GEM framework is the variation in how much support each of the learning aspects get from the statements of the reviewers. While a change toward pro-environmental behavioral intentions is important for eventual behavior change, for example, this factor did not receive much support from the Steam reviews. While some reviewers stated that the game "made them think," it is difficult to explicitly state that this suggests a change in behavioral intentions rather than, for example, an increased knowledge about environmental issues in general.

A third limitation of the ENED-GEM framework is the lack of research on the effects of gameplay on the *procedural memory*, which allows individuals to see the connections between stimuli and responses as well as to act adaptively to their environment (Tulving, 1985). Games that focus not only on the environmental issue itself, but also on the processes by which to solve it or attempt to make a difference, are perhaps more likely to be efficient in pushing individuals toward pro-environmental behavior than their knowledge-increasing counterparts. Failure to show the player the connection between the proposed problem and the tools with which to overcome that problem would likely result in a lower degree of PBC (Klöckner, 2015, p. 165). A future inclusion of procedural memory learning outcomes in the ENED-GEM framework might therefore be feasible.

Lastly, while it is not a direct limitation in and of itself, the version of the game played by one of the researchers might differ from the version of the game played by the reviewers. In addition to the official expansion pack known as *FotW: Tipping Point*, the game also has a series of fan-made *mods* where the game mechanics are customized to provide a better or more satisfying gameplay experience. A future researcher with technological experience might want to examine these modified versions of the game further in order to obtain a comprehension of how fan-made content could facilitate the gaming experience in educational environmental games.

FUTURE RESEARCH

Future research is needed in order to further expand upon the ENED-GEM, and insight from interdisciplinary fields is warranted. A closer examination of the impact of each individual factor in the model on behavioral change intentions is also required. Additionally, applying the ENED-GEM framework to

future case studies of environmental games would provide a solid foundation for further validation of the model. Despite this, the initial thematic analysis and suggested ENED-GEM framework holds promising suggestions for future research. There are, however, examples of environmentally oriented educational factors that the ENED-GEM found little evidence for during the FotW case study, and these require further expanding upon as environmental games grow more sophisticated. Examples include the use of games to change a person's behavioral intentions, the inclusion of crucial *environmental communication strategies* through the gameplay such as *nudging* or *prompting*, and perhaps even more abstract psychological processes such as designing a game that can showcase the effects of the player's actions directly on their environment, and simultaneously make the player draw a connection from the game world to real-world application. *Eco*, a game currently under development by Strange Loop Games, features game mechanics where the player's actions all carry some form of consequence for his or her surrounding nature. One example is water pollution, where leftover waste from the game's mining system seeps into surrounding bodies of water and thus having a large negative impact on the game's plant and animal life (Strangeloopgames.com, 2016).

This article used the award-winning game Fate of the World as a case study, but environmental games are growing more sophisticated by the day. Current projects that hold some promise for future research on the topic of environmental issues and opportunities for change include digital games currently in development such as *Eco* (Strange Loop Games) as well as board games like CO_2 and the *Oil Springs scenario* of *Settlers of Catan* (Klaus Teuber).[2] The ENED-GEM framework might serve as a useful tool for future researchers wanting to investigate such upcoming projects, especially in regards to the psychological processes that remain active during gameplay and facilitate learning.

ETHICS STATEMENT

Ethics committee for approval: NSD (Norsk Samfunnsvitenskapelig Datatjeneste). This study was carried out in accordance with the recommendations of NSD. NSD deemed the project as exempt from written consent from the participants of the research due to how individual informants were anonymized and the information provided (public reviews of a media product) were analyzed collectively. Informants are entirely anonymous in terms of name, gender, social and cultural background, geographical location and other affiliations.

AUTHOR CONTRIBUTIONS

KF: Initial idea behind the research topic, literature search, article writing, establishment of the conceptual model (ENED-GEM). Lead author. CK: Advisory function, initial review of article content, general approval of article topic, other supervisory responsibilities. Co-author.

[2] Giochix.it

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Paper II

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Gaming Green: The Educational Potential of Eco – A Digital Simulated Ecosystem

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Research into the use of videogames in education is on the rise, and they are cementing their position as part of the modernized, digital classroom. Sustainability education has also become a subject of interest among environmentally minded game developers and understanding the educational impact of such games is rapidly becoming an important field. This study examined the educational potential of the digital simulated ecosystem known as Eco, in order to reveal how playing Eco might promote environmental consciousness surrounding ecosystems. Qualitative data from seven respondents were subjected to a thematic analysis, revealing two main themes that highlight both game-based learning outcomes as well as barriers against learning. The findings indicate that Eco is a viable tool for promoting some aspects of environmental consciousness about ecosystems, and suggestions for future implementation of Eco are provided.

Keywords: serious games, sustainability, ecosystems, environmental consciousness, environmental media

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INTRODUCTION

Videogames represent one of the fastest growing media trends, with an estimation of 2.5 billion people playing them globally (WEPC, 2018). Aside from their use in entertainment (Sweetser and Wyeth, 2005), videogames are also used in education as so-called *serious games* (Wouters et al., 2013). For decades, researchers have shown interest in utilizing such games to educate the public about *sustainability issues* (e.g., Sandbrook et al., 2015; Waddington and Fennewald, 2018).

There is a strong scientific consensus that anthropogenic climate change is occurring (Cook et al., 2013), and that it causes a wide array of negative alterations in oceanic life (Lejeusne et al., 2009), plant disease rates (Garrett et al., 2006), and biodiversity conservation issues (Salafsky et al., 2002; Redpath et al., 2018). Environmental education about these issues can steer human behavior toward a more harmonious relationship with nature (Varela-Candamio et al., 2018). In order to educate the public about environmental issues, novel and creative methodologies are required (Klöckner, 2015). One way of communicating environmental issues is through videogames, due to their long history of raising awareness, educating and presenting contemporary research (Eisenack and Reckien, 2013).

A new addition to the library of games focusing on the environment is *Eco*. It is a *simulated ecosystem* where players must collaborate and build technology to destroy a meteor rushing toward the Earth, while simultaneously preventing harmful pollutants from escaping into the surrounding nature (Strange Loop Games, 2018a). Drawing on interdisciplinary theoretical insight from fields such as psychology, game theory and sustainability, this article examines how playing Eco might promote environmental consciousness surrounding ecosystems.

Eco – What Is It, and How Does It Work?

Eco is an online simulated ecosystem game developed by Strange Loop Games, funded by the United States Department of Education (IES, 2015; Strange Loop Games, 2018b) and an online crowdfunding campaign (Kickstarter, 2015). The game's main objective is to stop a giant meteor from crashing into the surface of the earth, which is set to strike after a fixed time period of 30 real-life days (Meteor, 2018). While developing the requirements for stopping the meteor, players also cause pollution which needs to be minimized so that the ecosystem can continue to thrive – a measure of which can be found in an in-game statistical overview available to the players. In other words, the players need to destroy the meteor as well as maintain balance in the virtual ecosystem that the game provides them with.

Example of a player-generated house from Eco, as well as the game's user interface (UI). Note the stacked wooden logs in the left of the picture, used by the players to make a variety of in-game structures. Image used with permission.

The Effectiveness of Game-Based Learning

Virtual environments, such as educational games, constitute promising new research tools in various kinds of environmental behavior research (de Kort et al., 2003), and have demonstrably been shown to alter behavior in real-life settings. Educational games are also receiving increased attention within the field of sustainability education and conservation (Sandbrook et al., 2015). Here, researchers focus on topics ranging from the effects of environmental change on marine ecosystems (Ghilardi-Lopes et al., 2013) to knowledge of energy use (Yang et al., 2016) and sustainable land management (Schulze et al., 2015). Sustainability games are used in order to make intangible environmental issues more salient, although the learning outcomes from playing them vary (Boomsma et al., 2018). On the positive side, one study revealed a significant correlation between experiencing a high degree of *game enjoyment* while playing a game about local biodiversity (*BioDiv2Go*) and a subsequent increase in attitude toward nature (Schaal et al., 2018). Enjoying environmental gameplay is theorized to have a significant effect on the subsequent learning outcomes from playing (Fjællingsdal and Klöckner, 2017), thus lending support to the study's findings. Another study revealed that individuals who played Red Redemption's *Fate of the World*, a simulation revolving around a 200-year period of societal and environmental impacts (Klöckner, 2015, p. 198), showed a higher degree of environmental *systems thinking* than a control group (Waddington and Fennewald, 2018). Systems thinking – the ability to understand the complexity of all the individual parts of an interconnected system (Aronson, 1996) – is crucial in the understanding of ecosystems.

Environmental Consciousness, Personal Responsibility and Environmental Action

Environmental consciousness is the measure of a person's overall environmental concern, the degree to which they believe that threats toward the environment pose an urgent and immediate problem to their everyday lives (Schlegelmilch et al., 1996). It is a multifaceted psychological construct consisting of cognitive aspects such as knowledge, values, concerns and problem awareness on one end, and vicarious and direct experiences with environmental issues on the other (Kollmuss and Agyeman, 2002; Sánchez and Lafuente, 2010; Sarrica et al., 2016). Environmental consciousness also incorporates an individual's overall level of *environmental awareness* – a general state of alert and understanding of one's impact on the environment (Grob, 1995; Sarrica et al., 2016) – as well as *environmental concern* – negative affect and beliefs about environmental problems (Schultz et al., 2004). An individual's degree of environmental consciousness is dependent on the prevalence and interconnectedness of each of these facets. In practice, this means that a high degree of environmental knowledge, for example, is seldom enough to initiate pro-environmental action on its own (Hines et al., 1987; Kollmuss and Agyeman, 2002; Frick et al., 2004; Abrahamse et al., 2007). However, when paired with other environmental consciousness facets such as behavioral intent and affective components, knowledge can be highly efficient as a driver toward pro-environmental behavior (Secord and Backman, 1964; Stoknes, 2017, p. 90). Previous research has demonstrated the effectiveness of a high degree of interconnected environmental consciousness factors. One study, for instance, showed that feelings of personal responsibility, combined with environmental knowledge and environmental values, accounted for 76–94% of ecological behavior (Kaiser et al., 1999).

While the promotion of environmental consciousness is highly important in order to circumvent the growing number of environmental issues threatening the globe, the level of concern is declining in certain countries – despite the scientific consensus that climate change and other sustainability issues are on the rise (Cook et al., 2013). In Norway, the percentage of the population believing climate change to be one of the three biggest contemporary societal issues went down from 34 to 25% between 2015 and 2016 (TNS Gallup, 2016). Some numbers, however, specify that approximately 97% of the Norwegian population is knowledgeable or aware of climate change (Pelham, 2009) and that the country has a high degree of political emphasis on environmental education (NOU, 2006, 2010, 2014). This illustrates that while the degree of knowledge and problem awareness of climate change

might be high, other environmental consciousness factors such as concern or direct experience might be low – thus leading to an overall low level of environmental consciousness (Sarrica et al., 2016). While being aware of an environmental issue is seldom enough to initiate pro-environmental action, understanding the link between one's own actions and subsequent environmental decline could lead to pro-environmental behavior (Hines et al., 1987). According to the *stage model of self-regulated behavioral change*, an important precursor to pro-environmental action is a feeling of *personal responsibility* for the environment – which also entails being conscious of how one's actions negatively impact nature (Bamberg, 2013). Such personal ecological norms are shown to predict pro-environmental behavior such as sustainable travel mode choices (Hunecke et al., 2001) and the preservation of marine environments (Cottrell and Meisel, 2003).

Immersion and Flow – Directed Attention and Intrinsic Motivation

Educational games must be perceived as enjoyable or *immersive* by the player in order to be voluntarily used (Sweetser and Wyeth, 2005; Ferguson and Olson, 2013; Fjællingsdal and Klöckner, 2017; Hamari and Keronen, 2017) or, despite undermining intrinsic motivation to play and learn, offer some form of externalized reward such as money or extra course credit (Deci, 1996, p. 25). Immersion, otherwise known as *presence*, is the feeling of being spatially present in a media experience (Klimmt et al., 2009). When immersed, the player is absorbed and engrossed in the progression of a game, and their attention is often directed entirely toward the game itself (Brown and Cairns, 2004). A high degree of immersion in virtual content can increase scores on connectedness to nature, which is shown to lower the prevalence of self-focused values and value-laden behaviors (Weinstein et al., 2009). It is also an indicator that the game is intrinsically motivating to play (Przybylski et al., 2010).

Immersion is considered a precursor to the *flow* concept, where a task is perceived as an intrinsically motivating experience (Csikszentmihalyi, 1990, p. 1). If a game is not immersive, it likely won't be played voluntarily (Brown and Cairns, 2004; Sweetser and Wyeth, 2005). Immersion and flow are important for an individual's desire to interact with a game, and a high degree of immersion during gameplay has been shown to increase a player's *suspension of disbelief* (Cheng and Cairns, 2005) where a person overlooks realistic flaws in media in favor of an enjoyable experience (Wirth et al., 2007; Böcking, 2008).

In contemporary literature descriptions, immersion builds as the media user forms a mental representation of the space or world that the media experience seeks to provide, whereupon it becomes subjected to a variety of *individual factors* that either strengthen or break it (Brown and Cairns, 2004) – ranging from the user's degree of involvement in the media experience to their perception of how realistic it is (Wirth et al., 2007). Some researchers also suggest that immersion is gender-based, where *males* tend to be more attracted toward fantasy elements as well as the ability to compete with their social peers (Chou and Tsai, 2004). *Female players* on average tend to play less than men (Hartmann and Klimmt, 2006) and generally refrain from playing competitively (Wood et al., 2004). Female players instead prefer games allowing for meaningful social interaction (Hartmann and Klimmt, 2006) and emotional experiences (Schell, 2008). Furthermore, clear progression goals and feedback from the game as well as continuously increasing difficulty are important for the overall gameplay experience (Schell, 2008).

Feedback and Eco-Visualization

In Eco, the consequences of the player's actions become *eco-visualized* (Löfström and Svanæs, 2017) – trees and water supplies get visibly polluted when waste materials are incorrectly stored (Tailings, 2019), and toxic water turns an abnormal color (Strange Loop Games, 2015). This visualization constitutes a core factor in *feedback*, a central element in both *game design* (Schell, 2008) and *environmental communication* (Abrahamse et al., 2007). In game design, feedback provides the players with information on how they are progressing within the game (Sweetser and Wyeth, 2005; Fu et al., 2009), usually by giving them information on where they are going next or what their current goals are (Schell, 2008). In addition to steering the player's actions, in-game feedback is also significantly related to the enjoyment of the game (Sweetser and Wyeth, 2005). In environmental communication, similar feedback interventions tend to provide information about measurable changes in someone's ecological footprint, such as decreases in energy use (Abrahamse et al., 2007).

Example of a player-generated base society in Eco. Note the pinkish water – one of the indications that it is polluted. Image used with permission.

Goal Framing and Tragedy of the Commons in Eco

According to Goal Framing Theory (GFT), maximizing one's pleasure both in the present (*hedonic goals*), securing a comfortable and secure future (*gain goals*) and acting appropriately in a group (*normative goals*) are central motivators for behavior (Lindenberg and Steg, 2013). A player in Eco is free to gather resources for themselves, thus fulfilling their hedonic and gain goal needs, but they

are also required to share resources with others in their group as well as replant and replenish the resources they consume. Should they fail to do this, other players will not gain access to the resources they need and will not be able to progress in the game.

Furthermore, actions in Eco cost *skill points* that are acquired through a varied diet as well as having a fully furnished home (Skill Points, 2019). A server where resource hoarding is occurring will lead to other players being unable to perform important actions. This simulates the *Tragedy of the Commons*, an occurrence in shared-resource systems where several actors seek to maximize their own gains, usually resulting in a lack of resources for the group as a whole (Hardin, 1968). If a large group of people gather as many resources as they can without replanting or renewing them, the environment will inevitably collapse and become barren. An illustrative experiment on a finite resource dilemma using a fishing simulation revealed that players generally exhibited restraint in their consumption when the fish population was perceived as critically low and that individuals with more pro-environmental values fished less than the other players (Sussman et al., 2016).

Ecosystem Complexity and Systems Thinking in Games

As previously described, Eco simulates a digital ecosystem in which the players must cooperate in order to maintain balance. An *ecosystem* is a complex, adaptive and often non-linear or chaotic system (Fiksel, 2006) consisting of components that are vital for life on Earth (Tansley, 1935). Ecosystems and the biota contained within regulate and enable processes necessary for biological life, such as the sequestering of harmful chemicals and mediating climactic and atmospheric processes on a global level (Levin, 1998). A healthy ecosystem has the ability to remain structured, organized and functioning even when subjected to external stress, which involves numerous complex interactions between its individual components (Costanza and Mageau, 1999). Ecosystems can be resilient, but scientific evidence overall suggests that human activity is severely impacting biological systems on a global level (Rosenzweig et al., 2008). Damages to the ecosystem have been shown to lead to a wide variety of *biodiversity loss*, a reduction in the number of species necessary for maintaining the processes enabling biological life (Loreau et al., 2001; Worm et al., 2006). Ecosystem protection is therefore of great importance, but it is also a highly complex topic where each system component is vital to ecosystemic functioning.

While the interconnectivity of the processes in an ecosystem can be difficult to understand, there are some pedagogical approaches to it that have shown promising results. One such approach is known as *systems thinking* – the ability to see a complex entity as a whole (Checkland, 1999, p. 50). Systems thinking might increase knowledge about how ecosystems function (Frick et al., 2004). It has been shown that simulations and games are highly suitable for teaching about the complexity of systems, and that some games have been developed specifically to address environmental topics such as climate change (Waddington and Fennewald, 2018).

Cooperation in Sustainability and Eco's Profession System

One of the central barriers against pro-environmental behavior is the feeling that individual efforts alone do not lead to change (Stoll-Kleemann et al., 2001; Aitken et al., 2011; Axon, 2017). A common reasoning for this is that environmental issues are global, and that there is therefore little point in individual action (Gifford, 2011). Individuals who *do* engage in pro-environmental behavior overall tend to practice values *beyond* the interests of the self (Steg and Vlek, 2009), such as participating in groups to perform civic engagement or joining environmental organizations (Hamilton et al., 2018). Group membership is also important for developing an individual's *values*, which in turn shape much of our intrinsic motivation to perform some sort of pro-environmental behavior (Kollmuss and Agyeman, 2002).

Eco has a strong focus on cooperation (Getting Started, 2019), and players need to form groups in order to maintain balance in their simulated ecosystem. This mechanic sets it apart from more traditional zero-sum games, where competition, sabotage and fighting results in only one clear winner (Fennewald and Kievit-Kylar, 2013). Each player on a server picks a profession and develops it by acquiring role-based skills (Professions, 2019). Each profession is important for the maintenance of the ecosystem the players live in, and cooperation between the professions is required in order for the game to progress. A *hunter*, for example, needs to fetch meat in order for the *chef* to cook food for the group. The chef receives crops from the *farmer*, which improves food quality. Food helps players perform activities, like the *smith* developing metal ingots for the *engineer* to utilize in various constructions.

MATERIALS AND METHODS

Recruitment and Participants

The respondents were recruited from two Norwegian high schools and three Norwegian university classes as well as four Facebook groups affiliated with the subjects of environment and games. Students in the high school- and university classes received information about the project through lectures, while the Facebook groups received a digital document containing the details of the study. In this document, the respondents were introduced to Eco and the purpose of the research project. They were also informed that they would receive an invitation for a voluntary post-gameplay interview about their experiences once the gameplay sessions were concluded. Once the initial recruitment procedure was finished, some respondents recruited others through *snowball sampling* for six additional participants. A total of 59 individuals agreed to receive a copy of the game for testing. 46 of them (77.9%) were male. The age range of the respondents varied from 18 to 31 years, and 36 (60%) of them were between 16 and

20 years old. The majority of our respondents had previous experience with video games, with a large part of the sample noting that they had played video games actively since childhood. 57 (96.6%) of the respondents reported previous experience with videogames, with 24 (40.6%) of them listing themselves as having played videogames for more than 15 years. Only 3 (5%) individuals had never played videogames before they played Eco. The respondents also appeared to be active gamers, with a majority of 42 (71.1%) of them playing videogames for more than three times a week. 37 (62.7%) respondents stated that they played videogames for more than 3 h per day. They also noted that despite being conscious of environmental issues, they did not always adjust their behavior to circumvent them and would rather perform commonly practiced pro-environmental activities (**Table 1**) that require relatively little effort, such as recycling (Hamilton et al., 2018). Of the 59 individuals who received a copy of the game, 7 ($n = 7$) agreed to participate in the qualitative post-gameplay interviews with the lead researcher.

Instruments and Experimental Procedure

Before the study was initialized, all respondents were given access to Eco through a unique 5-digit user-ID and 4-digit password. Eco was in *beta stage* at the time of the study, meaning that the game was nearly complete but not yet ready for an official release (Beta, 2018). 100 unique user accounts were made available to the lead researcher through the purchase of the *Eco Classroom Pack* (Strange Loop Games, 2018c) before recruitment started. These user accounts were distributed among the respondents with instructions about how to play the game. The respondents were encouraged to recruit other players if they wished. The lead researcher's e-mail was also provided, in case the respondents encountered any technological errors while they played.

Once the respondents had finished their gameplay after 2–4 weeks, the lead researcher interviewed them about their in-game experiences. Qualitative interviews were chosen as an information gathering strategy due to the potential quality of the insight they might provide (Wainwright, 1997), even for smaller samples of respondents (Crouch and McKenzie, 2006; Fugard and Potts, 2015). seven respondents agreed to participate for an interview, all of which were male. six respondents were interviewed online through *Skype* or *Appear.in*, whereas one respondent filled out the interview guide manually in a Word document. Each interview lasted between 30 min and 1 h. The interviews were recorded with the *SnagIt* screen capture software, and the respondents all gave their consent to be recorded. The interview guide was made by the lead researcher and consisted of 10 open-ended questions primarily centered on Eco's educational content (**Table 2**). The participants were instructed to answer each question as honestly as possible and were ensured that the information they provided would be of great assistance to the researchers – a type of questioning considered ideal for the *quality testing of games* (Schell, 2008). Due to the population sample's national background, the questions were asked in Norwegian.

Analysis Procedure

Once the recorded interviews had been transcribed, a thematic analysis based on Braun and Clarke's (2006) framework was conducted by the lead researcher. This was done in six steps: (1) data familiarization, (2) coding, (3) initial thematic categorization, (4) thematic review, (5) thematic naming and definition, and (6) article writing. In the *data familiarization stage*, the lead researcher got acquainted with the existing data sets. Answers from the respondents containing vital information to the research project were then extracted and highlighted using appropriate tools in Adobe Reader and listed as *codes* for later thematic categorization. Recurring answers that signified agreement or opposition between the respondents surrounding one of the interview's main topics were then categorized in a document, serving as *initial thematic categories*. These were then subjected to a *review* from the lead researcher, who established a thematic map of the final thematic categories (**Figure 1**). These were then subsequently *named* and illustrated with direct quotes from the respondents.

Ethics Statement

All of the respondents in the study were provided introductory material about the game and the purpose of the research being conducted. The project was reported to NSD – Norwegian Centre for Research Data, and the respondents were provided with a draft of the article for informant validation. Each informant was given 7 days to provide feedback on any misquotations that the lead researcher may have made.

RESULTS

Theme 1 – Learning Outcomes

The core idea behind a serious game is its ability to teach something to its players (Wouters et al., 2013; Fjællingsdal and Klöckner, 2017) through providing the players with new knowledge, raising awareness for something or presenting research findings in a novel way (Eisenack and Reckien, 2013). The main theme detailing our respondents' learning outcomes contains three subthemes: (1) *Contextualizing knowledge*, (2) *Cooperation is key*, and *(3) Actions have consequences*.

Subtheme 1 – Contextualizing Knowledge

> *"I would say that Eco reminded me that my actions have consequences, and that humans need to try fixing pollution together. Technology can help us save the planet, but eventually we need to do something." (Respondent 2, age 21)*

> *"I didn't get far enough to learn anything particularly new, but I quickly noticed that not everyone could build houses as big as they wanted and how dividing resources is challenging when everyone's got their own projects of equal importance going on." (Respondent 4, age 24)*

> *"I have gotten to feel what happens when you overload the environment – you feel it a bit more by testing it out rather than just hearing about it. It's very abstract, but when you get it simulated through Eco then you see it a bit more clearly." (Respondent 5, age 25)*

TABLE 1 | Active pro-environmental actions performed by the respondents.

Respondent ID	Recycling or clearing trash	Reducing food waste	Biking or public transportation use	Using cloth bags instead of plastic bags	Taking shorter showers
R1, age 28	X				
R2, age 21	X				
R3, age 29	X		X		
R4, age 24	X	X		X	
R5, age 25	X		X		
R6, age 18			X		
R7, age 19	X				X

"I was gathering food and thought 'what is easily accessible that doesn't cost me a lot of time so I can work on other stuff? Fish and blue mussels!' So I spent about 2 h gathering those. But then I saw that seaweed in the ocean just dropped down 2-3000 due to how I had continuously been gathering for 2 h. So if you can imagine 100 people doing the same as I did there, there wouldn't be any life left. It'd just go straight down." (Respondent 7, age 19)

Environmental knowledge is a central determinant for pro-environmental behavior (Hines et al., 1987; Kaiser et al., 1999; Abrahamse et al., 2007). Norway has a strong political emphasis on environmental education (NOU, 2006, 2010, 2014), which likely contributes toward the population's high level of environmental awareness (Pelham, 2009). A result of this is that playing Eco did not teach the respondents anything new about ecosystems, but instead served to *reinforce their existing knowledge* or as a reminder about contemporary issues related to bio-conservation. This reinforced knowledge stems from the way the game presents information and makes this information salient by establishing a concrete link between the players' actions and resulting environmental change – which is of great importance in regard to generating a variety of pro-environmental behaviors (Kaiser et al., 1999; Hunecke et al., 2001; Cottrell and Meisel, 2003; Bamberg, 2013). Respondent 2 mentions that Eco has reinforced his belief that technological development, or *technosalvation* (Gifford, 2011), is not enough in order to circumvent climate change and that human action is required. Respondents 4 and 7 discussed their experiences with how Eco presents the *Tragedy of the Commons*, or the notion that everyone in a shared-resource ecosystem will suffer if one or several parties overuse resources (Hardin, 1968). Respondent 4 mentioned how his team had to set aside their individual-centric hoarding behavior in favor of sharing resources equally among the server population, suggesting that their goal framing shifted from self-centered and hedonic to group-friendly and future-oriented, as described by GFT (Lindenberg and Steg, 2013). Respondent 5 states that while he felt he didn't learn anything particularly new from playing Eco, he did refresh his understanding of how ecosystems work – suggesting reinforcement in his systems knowledge (Frick et al., 2004). Another finding of interest was the story told by Respondent 7, who single-handedly managed to overfish his server's population of fish and shellfish, illustrating how Eco is capable of making environmental issues such as *overfishing* (Sussman et al., 2016), *abnormal alterations in oceanic life* (Lejeusne et al., 2009) and *biodiversity loss* (Loreau et al., 2001; Worm et al., 2006) salient. Intriguingly, Respondent 7 is the only individual in our study specifically mentioning the in-game *statistical overview of existing species* that Eco provides, indicating the importance of highlighting and informing the players about this particular tool for future playing sessions. He was also the most prominent in describing how Eco made him think about the interconnectivity of a complex ecosystem (Tansley, 1935; Costanza and Mageau, 1999; Fiksel, 2006; Rosenzweig et al., 2008), thus suggesting an increase in his level of systems thinking (Checkland, 1999; Frick et al., 2004).

Subtheme 2 – Cooperation Is Key

"I started by playing by myself, but it quickly became too large and too complex. I can't remember how exactly it happened, but suddenly we were five! We set up our own server where we are still playing, where we have one carpenter and one blacksmith and a farmer and an engineer and a hunter with some overlap. You notice that it becomes a completely different game. When you cooperate and plan with others and you ask others for help and you get synergy effects between jobs. . . it is really fun and engaging." (Respondent 3, age 29)

"A challenge for the group I played with was progressing in skillpoints and such (. . .). Other than that it was a very fun social activity and it managed to make us quarrel about how much wood we were allowed to use in order to build our houses, since we quickly realized that there wasn't enough materials in our immediate vicinity for us to gather efficiently until we got carts to carry them in." (Respondent 4, age 24)

TABLE 2 | Interview questions.

Do you consider yourself an environmentally conscious person?
What are your thoughts on using games like Eco in an educational setting?
Do you feel that you have learned something about the environment from playing Eco?
Is there anything about Eco you would describe as particularly good?
Is there anything about Eco you would describe as particularly bad?
Could you describe how you felt while playing Eco?
Do you feel that Eco has changed your view of the environment?
Do you feel that Eco has taught you something about how to circumvent environmental issues?
What are your thoughts about the level of difficulty in Eco?
Do you have any other thoughts or comments about the Eco project?

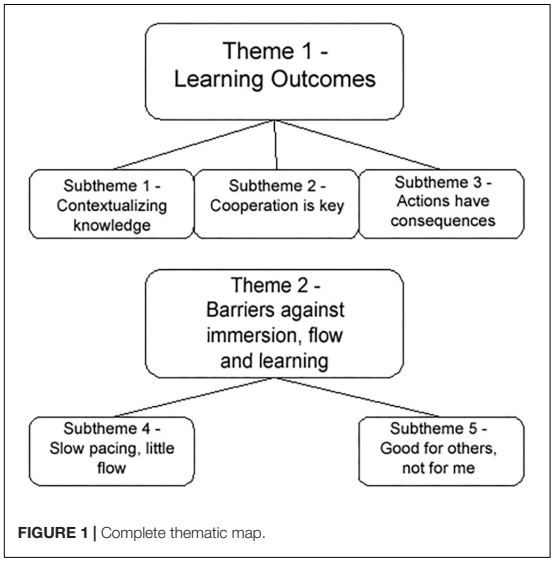

FIGURE 1 | Complete thematic map.

"The game looks like it is intended for other people to become part of your world, especially considering the politics system of the game. But since I played alone, I had no need for politics or cooperation with others. So. . . there wasn't really a happy feeling. Because the game doesn't have one of those 'if you do something good you get something good' – it doesn't have that reward system. (. . .) The game is based on how you can cooperate with others. But it also has a very negative angle on how one person wants everything. So I would say that, yeah, it has changed my view on that a bit." (Respondent 6, age 18)

Ecosystems management requires interdisciplinary insight and collaborative effort in order to be successful (Salafsky et al., 2002). Research also shows that one of the biggest barriers against pro-environmental behavior is the feeling that individual efforts are insufficient to combat climate change (Stoll-Kleemann et al., 2001; Aitken et al., 2011; Gifford, 2011; Axon, 2017). Collaborative action was conducted by the majority of the study sample during gameplay of Eco; 6 out of 7 respondents described Eco as a game that you had to play with others in order for it to be enjoyable. Respondent 3 tried playing Eco alone but got overwhelmed by its complexity, mirroring the notion in scientific literature that ecosystems are highly complex constructs (Tansley, 1935; Costanza and Mageau, 1999) and that interdisciplinary cooperation is required in order to manage them (Salafsky et al., 2002). He notes that once he understood how the professions in Eco are interdependent, he experienced a boost in his gameplay enjoyment. Respondent 4 and his team realized that their server featured limited resources and debated how to share them. It is possible that Respondent 4's group developed a shared value where limited resources were important for the group's survival, showcasing how pro-environmental group-based values [as described by Kollmuss and Agyeman (2002)] can occur in games. It also suggests that that perceived scarcity of resources in games leads to more cooperative behavior among members of a group (Sussman et al., 2016). Respondent 6 played the game alone and described the experience as rather negative, citing what he perceived as a lack of feedback from the game. His actions did not lead to tangible rewards such as becoming stronger or understanding the game's next objective. This type of feedback is almost universally considered to be an important game enjoyment factor (Sweetser and Wyeth, 2005; Schell, 2008; Fu et al., 2009).

Subtheme 3 – Actions Have Consequences

"I started out with a pretty solid understanding (of the environment), but it was interesting to see that when a large group of people arrived, the environment suffered. So it just reinforced what we already have a theory about, if you have ever opened a book on natural sciences. The more people there are, scraping the area for resources, the less careful they are about making them grow again." (Respondent 1, age 28)

"The fact that you have a very limited amount of space for carrying stuff, when you are chopping trees for example, you can't really just bring the entire tree with you back to your base – you have to go back and forth, back and forth and fetch the resources. It makes it feel like you are emptying it more. You really feel how much you are actually collecting, versus Minecraft where you just chop and chop and chop and then suddenly you have thousands of resources. You feel how much you collect, due to the amount of work that takes." (Respondent 5, age 25)

"(. . .) Instead of just gathering resources haphazardly, your actions had a visible effect on the environment. I think that, Minecraft could have a thing where if you cut down a bunch of trees then nature could get worse – I think it makes you become a bit more interested when your environment changes because of something that YOU do." (Respondent 6, age 18)

Eco depicts the consequences of the players' actions on their surrounding environment, a strategy commonly used in eco-visualization (Löfström and Svanæs, 2017). It shows environmental decline through plants turning brown, crops and animals disappearing, the ground becoming barren once a fallen tree lands on it and water turning a pinkish hue (Strange Loop Games, 2015). Pollution in Eco is a sign that the player is doing something wrong and that they need to prevent similar issues in the future, such as by burying mining Tailings (2019). Several of the respondents became aware of these environmental changes while playing, and the visual depiction made them feel as if their pre-existing knowledge of environmental issues had been reinforced. Respondent 1 describes himself as familiar with environmental topics, and that a simulated version of environmental issues and how they develop as a consequence of resource overuse was an interesting experience. Respondents 5 and 6 draw comparisons between Eco and Mojang's *Minecraft* from 2009, a game centered around building and developing structures and items from various materials. In Minecraft, players can carry near-unlimited amounts of materials. In Eco, the amount of resources a player can carry is limited in order to reflect a more realistic resource gathering situation. Respondent 5 mentioned that this made

him aware of how much he was affecting the environment by being given a visual and affective depiction of his own actions. Respondent 6, while feeling restricted by the game's mechanics, also mentions that it was interesting to get these visual depictions.

Theme 2 – Barriers Against Immersion, Flow and Learning

Despite the potential educational benefits of playing Eco, our analysis also revealed that the game contained elements that had an overall negative impact on the players' degree of immersion, flow and learning outcomes – described here as barriers. The construction of this theme revealed two subthemes: (1) Slow pacing, little flow and (2) Good for others, not for me.

Subtheme 4 – Slow Pacing, Little Flow

> *"We always ended up in the situation where one person had to sit and wait for one of the other players for them to get skill points to progress and make something needed to progress. (. . .) . . . you freeze COMPLETELY if you don't cooperate. The issue was that since we were only 5 people, this was difficult to implement. We talked about how we should have been 10 – 20 people, then we would've gotten more out of the game – we were simply too few. (. . .) We tried to tweak the settings a bit in order to adjust how many skills we got, but we never found the sweet spot – it either went too slowly, or too quickly." (Respondent 2, age 21)*

> *"The way the skill system works is that you are supposed to have a big server going and the 30 days before the comet hits are actual real-life days. (. . .) The skill system is what allows you to choose what to learn and do in the game, and it is dependent on time and what food you eat and what house you have. It is interesting, but in practice it works poorly when there are few players. (. . .) 30 real-life days is a long time to experience the comet if you don't have a big server to play on. That said, they do have pretty good systems for adapting these factors – you can control when the meteor is coming, you can turn it on and off, so. . . their server tools are nice like that, like, they make the players do it." (Respondent 5, age 25)*

> *"I think it would get a bit difficult to just sit down and play this, and use a lot of time – because that is what Eco is doing now. With skillpoints, in order to learn stuff, you must be a member of a specific server so and so many days. And the timeframe for starting the server anew is 30 days, so you start from scratch on day 1 and by day 30 you must reach the endgame." (Respondent 7, age 19)*

In educational games, the importance of immersion and flow is frequently highlighted (Brown and Cairns, 2004; Sweetser and Wyeth, 2005; Jennett et al., 2008; Fjællingsdal and Klöckner, 2017), and should the game somehow fail to induce these psychological states in its players it is likely to negatively impact the players' learning outcomes. Immersion and flow are both easily broken, such as through faulty level design or a lack of concentration on the game (Brown and Cairns, 2004; Schell, 2008). A lack of flow leads to frustration and boredom – psychological states that players normally wish to avoid by playing games in the first place (Ferguson and Olson, 2013). As previously mentioned, Eco's gameplay takes place over a period of 30 real-life days (Meteor, 2018). In contemporary research literature, this is known as slow serious games – educational games designed to deliberately allow the player a very limited timeframe to progress. The intention behind this is to provide the player with ample opportunity to reflect, contemplate and learn from their in-game actions (Marsh, 2015). For several of our respondents, this design was perceived as too lengthy for an enjoyable gameplay experience. While there is little consensus in contemporary literature in regard to how long a game should be, our respondents felt "forced" to play it for 30 days consecutively due to how the gameplay session never ceases to progress – even when the players are offline. They also normally composed smaller teams of four to five individuals, whereas established Eco servers can have significantly larger populations. Respondent 2 points to how some of the players on his server had to wait for others to gain skill points in order to make progress, which was not feasible due to how small their group was and how interdependent the individual members were. Respondents 5 and 7 also mirror this notion, with Respondent 5 mentioning that the game can be adjusted and configured to fit the individual player. Respondent 2 made an attempt at this during his gameplay sessions but was unable to properly configure the game to his group's needs. It would appear that the respondents felt an overall lack of control over the game's rules and boundaries, which negatively impacted their sense of flow.

Subtheme 5 – Good for Others, Not for Me

> *"For me it didn't do much – but that likely has to do with how I paid attention to science class. But I won't exclude the possibility that it might do something for very many others, since this tends to be a rather boring topic for many people. Not because they are not interested, but because cause and effect is very abstract for people. If you remove everything the rabbits eat, then the rabbit has nothing to eat and the wild rabbit population in Norway dies out. For them, this seems to be such a distant reality that it appears irrelevant." (Respondent 1, age 28)*

> *"For some it might be effective, but. . . for me, who holds an above average interest in videogames, I can't really avoid "looking under the hood" [of the game] and recognize "oh, this is how that works, that was fun, that was a cool way to implement pollution in the game"." (Respondent 3, age 29)*

> *"I have read a lot about the environment, so I don't feel like I have learned anything new. I think very young people can play this game, but I assume that many adults already know that this is happening in nature." (Respondent 6, age 18)*

Norway has a large focus on environmental literacy education (NOU, 2006, 2010, 2014). Perhaps as a result of this, several of our respondents experienced that playing Eco did not increase their environmental knowledge to any significant degree. They did, however, express that using Eco to teach *new learners* about environmental topics could be a possible future implementation strategy. Respondent 1 states that he has experience with environmental education from before but highlights the importance of fun and playful approaches to learning about unfamiliar or tedious subjects. This mirrors an overall tendency in the use of environmental games to promote learning – they can be fun and engaging despite their

overarching topic (Klöckner, 2015, p. 198). For Respondent 3 it appears that his interest in the game's mechanics and coding was significantly stronger than the emphasis on teaching about the environment, suggesting that a person's mindset and priorities during gameplay will impact the educational benefits of playing Eco. Respondent 6 mentions that despite what he perceives as a narrow target audience, Eco might be capable of teaching younger individuals about the environment.

DISCUSSION AND CONCLUSION

The purpose of this thematic analysis has been to examine how playing Eco might promote environmental consciousness surrounding ecosystems. Our results suggest that Eco has the potential to reinforce and increase some facets of environmental consciousness by visualizing the impact of human activity on ecosystems in a novel way, although the majority of our respondents did not engage with the game. Additionally, a significant amount of respondents declined to participate in post-gameplay interviews. In the first part of this discussion section we will analyze the more promising aspects of Eco's role in sustainability education. In the second part we will consider and analyze the low response rate after the gameplay sessions, as well as the apparent lack of motivation to engage with the game itself.

Overall, our findings add to the growing body of research suggesting that educational games constitute a promising and novel way of learning (Wouters et al., 2013), also mirroring the research done by previous sustainability researchers utilizing games (e.g., Schaal et al., 2018; Waddington and Fennewald, 2018). One of the central findings from our study is that Eco has been shown to reinforce and contextualize our respondents' overall level of environmental literacy and systems thinking. These are highly important skill sets (Fiksel, 2006) that could result in a greater understanding of ecosystem complexity, i.e., how different biomes interrelate and interconnect with one another, or how certain species are interdependent in a cyclic system. Our results show that Eco appears to be capable of visualizing the complexity of an ecosystem in a way that allows its players to comprehend and conceptualize the interconnectivity and balance that exist in nature, as well as the actions that upset or maintain this balance – i.e., that actions have consequences. This level of understanding occurred, at least for some of the study's participants, over a wide range of contemporary ecosystem vulnerabilities – such as *overfishing* (Sussman et al., 2016), *abnormal alterations in oceanic life* (Lejeusne et al., 2009) and *biodiversity loss* (Loreau et al., 2001; Worm et al., 2006).

Perhaps due to the game's ability to visualize otherwise intangible subjects for its players, there is evidence to suggest that playing the game has an impact on environmental consciousness. Going by the definition of environmental consciousness as a multifaceted psychological construct (Sarrica et al., 2016), there is evidence that some of our respondents show a slightly elevated level of environmental awareness. Environmental awareness, a general state of alert and understanding of one's impact on the environment (Grob, 1995; Sarrica et al., 2016), could clearly be identified in some of the vivid experiences illustrated in the subsections of Theme 1 – especially in regard to the game's visualization of personal impact on the game world. Added to the fact that there is a significant degree of political emphasis on environmental education where the study took place (NOU, 2006, 2010, 2014), there is a significant likelihood that other cultures might also benefit from playing Eco.

Eco also showcased the effects of game-based eco-visualization and cooperation. Games are generally voluntary and pleasurable activities (Sweetser and Wyeth, 2005; Ferguson and Olson, 2013; Fjællingsdal and Klöckner, 2017; Hamari and Keronen, 2017) but can also be highly educational. Eco visualizes the effects of anthropogenic climate change in the same vein as past eco-visualization research (Löfström and Svanæs, 2017). Another interesting aspect of Eco is its strong focus on cooperation in counteracting sustainability issues (Getting Started, 2019), which appears to have been fully understood by the majority of our respondents – even those who chose to play alone. Judging from our results, Eco represents an innovative and promising classroom tool for showcasing and contextualizing how group-based activity and behavior can counteract threats to our environment. Added to our findings that Eco is capable of increasing systems thinking and reinforcing existing knowledge about the environment, it is a valuable tool for future environmental education.

The thematic categories in our study did, however, end up being very broad. This is to be expected due to the nature of Eco's mechanics. Eco emulates an entire ecosystem, where each individual theme and facet is interconnected. Focusing only on individual facets would result in the players "missing the bigger picture" as described by Kollmuss and Agyeman (2002). As a result, the players are forced to consider each individual aspect of the ecosystem in order to play the game effectively. The players cannot, for example, go around wiping out various animal species, as this will lead to potential food shortage. They also cannot put mining tailings everywhere, as these will eventually seep into their water supply, poisoning it. They also need to be mindful of their resource use, replanting trees, carbon emissions and the rate of technology development – all on top of considering the different needs in their group. Altogether, this illustrates how much the players need to consider simultaneously. This variety of topics enables the players to engage in *systems thinking*, or the ability to see a complex entity (i.e., an ecosystem) as a whole (Checkland, 1999, p. 50) rather than just the "sum of its parts." A narrow focus on only specific topics in Eco might result in losing the vision that the game wishes to simulate – the complex interconnectivity of an ecosystem. Also, due to the use of a semi-structured interview guide with open-ended questions, the freedom experienced by the respondents left them with a lot of room to answer, and their replies were almost certainly guided by their own unique experiences. As a result, some players will experience the water pollution of

mining tailings, while others will experience the issue of a lack of food to generate skill points. This leads to a variety of different experiences that, consequently, also leads to the generation of wide categories of information.

Despite encountering game mechanics issues common for games in the beta stage, most of our respondents described Eco as an interesting experience. It is worth noting, however, that future researchers wanting to implement Eco into their research need to be aware of these implementation issues. *Firstly*, Eco takes place over a period of 30 days – it therefore needs to be well-planned and well-informed so that the players do not disconnect from the experience during the experiment. *Secondly*, it is crucial to give the players a general introduction to the controls and overall purpose of the game to avoid any confusion and lack of flow during gameplay. *Thirdly*, organizing a debriefing session once the game is over, where the players can clear up any misconceptions they have made during their gameplay as well as to have a scientific discussion about the game's many overarching topics, is warranted. Keeping these considerations in mind could improve the gameplay experience for the respondents, and clear any misconceptions they might have.

While our study demonstrates that Eco does hold some promise in regards to its utilization as an educational tool for environmental consciousness, the recruitment procedure yielded a surprisingly low number of respondents from the high schools. As a result, only respondents from the Facebook groups and university classes participated in the post-gameplay interviews. As a compound issue, none of the interviewed respondents were female. A possible explanation for the lack of respondents from the high schools is that the planned gameplay sessions took place right before the Norwegian high school winter exams. Due to Eco's 30-day forced play cycle (Meteor, 2018) and overall complexity, it is fair to assume that the students simply did not prioritize playing the game over studying for their finals. Curriculum time pressure has been identified as a central barrier in the implementation of educational games in the past as well (e.g., Lim et al., 2006). Added to the fact that playing Eco did not yield any tangible externalized rewards such as extra course credit, likely meant that the students' motivation to play decreased significantly (Deci, 1996, p. 25). It is also possible that the collaborative theme of Eco was less engaging to our sample than a more popularized, competitive and traditional zero-sum game design revolving around sabotaging and beating other players (Fennewald and Kievit-Kylar, 2013) – an aspect of games that is traditionally enjoyed especially by males (Chou and Tsai, 2004). In addition to its lacking integration into the students' planned curriculum, Eco also does not explicitly emphasize gameplay factors that are important to female players such social interaction or tailored emotional experiences (Hartmann and Klimmt, 2006; Schell, 2008). Combined with the fact that females normatively play less than males (Hartmann and Klimmt, 2006), this might at least partially explain the absence of female respondents in the post-gameplay interviews. Despite the small sample size used in our study, however, the amount of information provided by them was rich in detail and featured a sense of coherence in regard to some central gameplay aspects – supporting the notion that even small samples can give interesting results (Wainwright, 1997; Crouch and McKenzie, 2006).

LIMITATIONS

Although the results of our study show some promise, it is also important to acknowledge its limitations. Firstly, all of our respondents were male – it is therefore important that future studies attempt to include more female players so as to avoid skewed research results due to gender differences. Secondly, the version of Eco that was utilized in this study was an unfinished beta version. Future researchers are encouraged to use the finished version of Eco, to avoid some of the issues encountered by our informants (unintuitive game controls, missing in-game textures and items and other related issues). Lastly, if used in a classroom setting, it would appear that integrating Eco as a core element of the curriculum rather than allowing the students to haphazardly play the game on their own leisure would increase the likelihood that the students will interact with the game. This strategy would also allow the teacher and the researcher to form a moderating team where they can engage the students in environment-themed debates and discussions and monitor the students' progress.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/supplementary material.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by NSD – Norsk senter for forskningsdata. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

Both authors participated in generating the initial research idea, conducting the recruitment process, and read and approved the manuscript. KF was responsible for the manuscript writing.

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Conflict of Interest: KF paid for a classroom package of Eco directly from the developer's website.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Paper III

Article

Green Across the Board: Board Games as Tools for Dialogue and Simplified Environmental Communication

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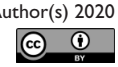

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Abstract

Background. **Board games** are a promising, yet rarely used arena for learning about **environmental issues**. Existing research suggests that they are highly innovative communication tools that make complex sustainability problems more salient and easily understandable. To date, little to no research exists where several environment-themed board games have been compared in a single study.

Method. 17 respondents were invited to board game nights where they were tasked to play an environmental board game of their choosing. The respondents were then invited to participate in subsequent focus group interviews about their gameplay experience and learning outcomes.

Results. 5 focus group interviews were transcribed and subjected to a qualitative thematic analysis, revealing 2 main themes; the first revolving around board games as simplified environmental simulations and the second revolving around the players' perceptions of their own impact on the game board.

Conclusion. Our results suggest that board games can be highly effective tools in some aspects of environmental communication. Limitations of the study and suggestions for future research are discussed.

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board games, educational games, environmental communication, games for change, sustainability

Background

Scientific evidence for the increase in anthropogenic global warming is nearly unequivocal (Cook et al., 2013; Eisenack & Reckien, 2013), and due to the interwoven relationship between the environment and basic human needs such as food, health, energy, and security (Lakoff, 2010), the need for increasing public awareness of environmental issues is at an all-time high. Our ecological impact is increasingly noticeable: higher carbon emissions, deforestation and rapidly rising sea levels are just some of the indications that human life on Earth is threatened (McGonigal, 2011, p. 296). Innovative approaches to communicating about the detrimental effects of climate change are required for increasing public knowledge and consciousness surrounding a variety of environmental topics (Eisenack, 2012; Klöckner, 2015). One such approach comes in the shape of board games, which are shown to be effective learning tools in other fields such as health and medicine (Gauthier et al., 2019; Ogershok & Cottrell, 2004; van der Stege et al., 2010), therapy (Olsen et al., 2013) and a variety of classroom situations (Copeland et al., 2013). Board games such as SETTLERS OF CATAN: OIL SPRINGS (Chappin et al., 2017), KEEP COOL (Eisenack, 2012) and GLOBAL WARMING (Fennewald & Kievit-Kylar, 2013) have become popular in the field of environmental science, where they are primarily used to increase environmental knowledge and encourage debate surrounding environmental topics. To date, however, the empirical foundation surrounding the potential of environmental board games as educational tools is still lacking (Klöckner, 2015, p. 205) – despite the emerging trend of board games being used to clarify and educate about real-life problems (Wonica, 2015). This article therefore seeks to investigate how environmentally themed board games can be used as tools in generating environmental awareness.

Environmental Science Communication and Board Games

Environmental issues are highly complex (Despeisse, 2018; Kollmuss & Agyeman, 2002), distant and often framed as catastrophic or lacking scientific certainty in terms of their future global impact (Weingart et al., 2000). The explanatory climate change models that dominate environmental science are often met with public skepticism due to their perceived vagueness (Vatne, 2013, p. 43), and scientific language about climate change and other environmental issues can be difficult for the general public to comprehend (Fischhoff, 2007; Hassol, 2008). Additionally, environmental decline is often a largely invisible entity (Hansen & Machin, 2013) that, once salient, is no longer preventable. Being able to envision and imagine an environmental issue might

make them appear to be more pressing (Klöckner, 2015, p. 63; Tversky & Kahneman, 1973, 1974), but traditional environmental communication rarely puts emphasis on the visual or tactile aspects of environmental decline. Consequentially, environmental scientists – justifiably criticized for being rather ineffective communicators towards laypeople (Hassol, 2008) – are calling for more approachable, illustrative and participatory forms of scientific communication surrounding the topic of environmental decline (Despeisse, 2018; Stanitsas et al., 2019; Stoknes, 2017).

Board Game Tactility and Simplification of Reality

While board games are incapable of depicting the complexity of environmental issues in scientifically accurate detail, they can simplify them for laypeople (Abt, 1987, p. 21), generate awareness surrounding environmental and social threats (García-Barros et al., 2015), illustrate complex systems (Castronova & Knowles, 2015; Cushman-Roisin et al., 2000) and involve the learners in complex situations where their decisions have a noticeable impact (Despeisse, 2018). They allow their players to interact with physical, tactile elements (Schell, 2008, p. 109; Woodbury et al., 2001; Woods, 2012, p. 161) rather than abstract, text-based representations of what environmental issues involve. The tactile and pleasurable nature of well-made board games is important (Kosa & Spronck, 2018) as it has been shown to encourage repeated play (Costikyan, 2002, p. 26; Xie et al., 2008) and, therefore, repeated exposure to the material the game seeks to teach, as well as making the game feel more 'real' (Rogerson et al., 2016). Tangible pieces on a game board also tend to make the game more engaging and exciting (Price et al., 2003) and more accessible than digital, screen-based interfaces (McNerney, 2004). Additionally, physical components are occasionally shown to be better at making certain players understand the underlying engine of the game when compared to a digital game, where these physical components are removed (Rogerson & Gibbs, 2018). Tactility, therefore, is certainly an important enjoyment component to consider when wanting to apply a board game in an educational setting, as it may have some beneficial impact on learning outcomes as well.

Board Games and Socialization

Game-based simulations also provide a safe, social arena in which people can experience simulated success and failure through their actions, which makes them more capable of applying these experiences in later activities (Cushman-Roisin et al., 2000). More of a necessity rather than a general gameplay element, the social aspect of board games could be considered the primary factor as to why people enjoy playing them (Woods, 2012, p. 167). Social interaction with other players during the gameplay sessions allows for both competition, cooperation and collaboration (Zagal et al., 2006), and in an educational setting it allows the researcher to observe the players as their gameplay session unfolds.

Board Games in Sustainability Education

Board games are often considered a primitive pastime (Woods, 2012, p. 8), which often requires a large investment of both time and energy to conduct (Rogerson & Gibbs, 2018). They are also among the oldest known sources of human cross-culture entertainment, with some board games such as the Egyptian board game *SENET* and the Nordic *HNEFATAFL* games dating back several centuries or even millenia (Sebbane, 2001). While games with an environmental focus date back little more than 30 years (Eisenack & Reckien, 2013) they have recently stirred interest among sustainability researchers and educators – albeit primarily in the form of digital games such as FATE OF THE WORLD (Roberts, 2011) and ECO (Krajewski, 2018). Despite being overshadowed by their digital counterparts in terms of popularity in contemporary research, environmental board games cover a variety of topics. Some, like THE CELSIUS GAME (Carreira et al., 2017) attempt to visualize climate change issues on a holistic level to illustrate their interconnected complexities. Others focus more on specific aspects of climate change, such as the water resource adaptation game WATER ARK (Cheng et al., 2019) and THE FARMERS (Fennewald & Kievit-Kylar, 2013), which revolves around the use of shared resources. Such board games, much like certain forms of art (Ramachandran, 2011, p. 197), have the ability to distort and exaggerate reality and generate meaningful experiences for their audience. They also allow players to experiment with a variety of roles in a coherent narrative (Arnaudo, 2018, p. 27) within the safe confines of the game world (García-Barros et al., 2015). This is found to be a trigger for attitude change in certain settings (Elms, 1966) as well as allowing for exploring opposing perspectives (Klöckner, 2015, p. 206). Furthermore, games can create microworlds (Egenfeldt-Nielsen et al., 2013, p. 237) where the players learn through "doing" and "being" rather than passively absorbing information, as well as allowing for the envisioning and portrayal of alternate futures and realities (Barreteau et al., 2007; Cushman-Roisin et al., 2000; Wu & Lee, 2015). In a more traditional classroom setting, the learner will usually passively absorb information from a knowledgeable source and be expected to remember and understand the instructions they are provided (Dieleman & Huisingh, 2006; Krathwohl, 2002, p. 214). Practical application of the obtained knowledge is often not prioritized (Kolb, 1984). By contrast, as previously mentioned, game-based learning normally situates the learner in a microworld where they can actively participate and interact with their environment (Egenfeldt-Nielsen et al., 2013, p. 237). Games also provide a concrete visualization of the topic at hand, rather than forcing the learner to form a subjective, abstract conceptualization of it – meaning that they "learn through doing and being" (Foltz et al., 2019), an experience-based learning approach (Rusca et al., 2012). Games can also engross and immerse the players by providing rich and immersive narratives, which in turn might affect real-world beliefs by making the gaming experience seem real (Green & Brock, 2000). Research also shows that having someone experience fictional stories about social dilemmas – i.e., a game's narrative – might influence their real-world judgments on them (Strange & Leung, 1999). This illustrates the difference between indirect (classroom) and direct (game or simulation) experience, where direct

experiences are demonstrably more effective in generating pro-environmental action (Fazio & Zanna, 1981; Kollmuss & Agyeman, 2002).

Board Games as Social Dilemma Simulations

Until recently, researchers assumed that people did not possess sufficient knowledge about environmental problems and therefore also lacked the tools to circumvent them – thus making knowledge provision a viable strategy for behavioral change (Schultz, 2002). Although games are effective at increasing knowledge, this alone is seldom enough to initiate pro-environmental behavior (Abrahamse et al., 2007; Frick et al., 2004; Hines et al., 1987; Kollmuss & Agyeman, 2002; Staats et al., 1996). This is compounded by the finding that knowledge gained through traditional forms of learning, especially in situations where the motivation to learn stems from a fear of failure (for example, studying for a test) also tends to be retained very rarely (Grolnick & Ryan, 1987; Lombardi, 2012). While a large quantity of available games are primarily aimed at providing knowledge, some are also designed to situate the players in *social dilemmas* – situations where the interests of the individual are in conflict with the interests of a group or collective (von Borgstede et al., 2013, p. 176). In a game-based social dilemma, players are often forced to consider whether they wish to prioritize their own gain and safety, or if they would rather act in the best interest of the player group as a whole. The use of games to study human behavior in social dilemma situations has been conducted before, the most prominent example being an examination of how WORLD OF WARCRAFT players responded to a virtual plague that would wipe out entire servers (Lofgren & Fefferman, 2007). The extent to which individuals care about their own and others' gains in a dilemma situation is known as their *social value orientation*, or SVO (Messick & McClintock, 1968), and can roughly be divided into an *individualistic* approach where a player tries to act alone with little to no communication with the group, a *cooperative* approach where the player tries to establish active partnerships with other players and a *competitive* approach where the player's emphasis is on defeating the other players (de Groot & Thøgersen, 2013, p. 143). Compared to games focusing on collaboration, games in which the players are encouraged to act according to an individualistic or competitive SVO normally result in *zero-sum victories*, where there is only one clear winner (Fennewald & Kievit-Kylar, 2013).

Methods

As previously stated, the purpose of this study is to examine how four commercially available environment-themed board games can be used to generate environmental awareness. The project follows a qualitative research design following the framework of thematic analysis proposed by Braun and Clarke (2006). Since the overarching idea of using board games in environmental education is relatively new, and due to how the board game nights took place while the respondents were together in a physical location, exploratory focus groups as described by Frey and Montana (1991) were utilized during the information gathering stage.

Recruitment and Sample

Recruitment for the study was conducted through three Facebook groups that were evaluated by the lead researcher as thematically relevant for the research project. Subsequent playtesting was arranged in two Norwegian municipalities in the form of four board game nights where the respondents were given access to four board games with various environmental themes. Recruitment occurred through public Facebook events hosted by the lead researcher, where detailed information about the study procedure as well as ethical guidelines for anonymization and voluntary participation was provided. 18 respondents in the age range of 20 to 39 years joined the gaming sessions, of which 17 (n=17) participated in post-gameplay focus group interviews. 12 (70.6%) of the interviewed respondents were male, 5 (29.4%) were female. 11 (64.7%) respondents were either in the process of obtaining or already had a degree in higher education, defined here as a BA degree or higher, and 2 (11.7%) of the informants additionally listed themselves as members of pro-environmental organizations. Each informant was given a codename, consisting of one letter (M or F) denoting their gender, and a number denoting their age (e.g. M35).

The Games

Although educators and game designers are often worlds apart in terms of their fields of interest (Gunter et al., 2008), making interdisciplinary game development a potentially frustrating and costly affair, a search for environmental board games did yield results. Each of the games that were chosen for the research project were selected due to their innate connection to the topics of environment, climate and sustainability. Another selection criterion was that the games had to be in an analog format, as research into environmentally themed board games is scarce. For replication purposes, the games chosen for the project also needed to be commercially available or otherwise obtainable for researchers wishing to conduct future research into the use of board games in generating environmental awareness. The games chosen for the study were also largely developed as collaborative efforts between environmental educators and game designers, which is a deviation from games that are otherwise normally developed exclusively in academic, governmental or non-governmental institutions (Klöckner, 2015, p. 198). For each of the board game sessions, the participants were asked to choose a game that they all wanted to play together.[1] This section will provide a short description of the games that were used in the study, as it is necessary to understand the basics of a game in order to also conceptualize how the respondents interact with them (Waddington & Fennewald, 2018).

Game 1 – THE SETTLERS OF CATAN: OIL SPRINGS

THE SETTLERS OF CATAN, or simply CATAN (Teuber, 1995) is a hobby board game (Arnaudo, 2018, p. 196) revolving around building civilizations from natural resources produced on the island of Catan. The player who is first to reach 10 points,

achieved by building settlements and cities as well as having the longest road and biggest army, wins the game (Boardgamegeek.com, 2019a). In order to reach this goal, players need to trade resources with each other. However, every trade the players complete will help not only them, but also their opponent, quickly leading to a conflict of interest between diplomacy and self-interest (Salen & Zimmerman, 2004, p. 388). Due to its long-standing popularity, CATAN has become the subject of several fan-made expansions, one of which is the OIL SPRINGS SCENARIO (Assadourian & Hansen, 2011) where oil is introduced as an additional resource and game mechanic. Oil can make the players' settlements grow faster and speed up their path to victory but can also cause environmental damage and climate devastation if abused – resulting in all players losing the game (Boardgamegeek.com, 2019b; Chappin et al., 2017; Lee, 2017). The OIL SPRINGS SCENARIO revolves around a mechanic where the players who choose to utilize oil are more likely to achieve victory than players who refrain from using it (Lee, 2017), simultaneously risking the livelihood of the whole island. As the game revolves around the use of oil as a powerful resource, we feel that it illustrates and simulates a relatively realistic scenario in which the players need to balance their own personal and financial interests versus the interests of the player group as a whole. It is left to the players to decide if they wish to emphasize saving the island of Catan, or if a personal victory is more important (Chappin et al., 2017).

Game 2 – EVOLUTION: CLIMATE

EVOLUTION (Crapuchettes, 2014) is a game where the players are set to adapt and evolve their own species in a changing ecosystem, taking on roles as carnivores and herbivores as well as developing new biological traits such as horns or hard shells to survive (Boardgamegeek.com, 2019c). The expansion pack, EVOLUTION: CLIMATE (Crapuchettes, 2016), introduces a climate component where the temperature in the game world can swing between extreme cold and extreme heat, which results in the deaths of species that are not adapted to survive in the current climate (Boardgamegeek.com, 2019d).

Game 3 – GLOBAL WARMING

GLOBAL WARMING (Bucak, 2011) is an educational card-based strategy game where the players score "happiness points" by providing a variety of goods to the public, which in turn influence the earth's ecology (Boardgamegeek.com, 2019e). In order to provide these goods, oil needs to be gathered and used by placing oil rigs on a map. Eventually, the player who has obtained the highest amount of happiness points wins the game, unless the players have collectively amassed too much pollution. If this is the case, the player who has polluted the least is the winner (Fennewald & Kievit-Kylar, 2013). The overall level of pollution as well as each individual player's level of pollution is shown as separate markers on the game map, and if these markers move past certain points, bad things will happen to the game's ecology as well as the players themselves (Boardgamegeek.com, 2019e).

Game 4 – KEEP COOL

KEEP COOL (Eisenack & Petschel-Held, 2004) is a climate negotiation game where each player takes on the role of a country or nation with a unique set of economic interests, goals and abilities (Boardgamegeek.com, 2019f). The actions required by the players to reach these goals also result in greenhouse gases, and they all lose if the global temperature gets too high (Fennewald & Kievit-Kylar, 2013). The players need to decide each round if they want to implement climate protection measures, which benefit all players, or if they would rather act in their own interest in order to reach their own goal faster. The first player to reach their goal wins, but a complete lack of cooperation with the other players will result in global environmental collapse (Boardgamegeek.com, 2019f).

Research Protocol

To initialize the project, the lead researcher arranged board game nights through public Facebook events. Information about the project was provided in the event description, whereas detailed guidelines regarding ethical concerns and the purpose of the research were given to each respondent as a separate document through Facebook's Messenger client. Four board game nights were arranged across two Norwegian municipalities, where the respondents were observed by the lead researcher during gameplay. Two of the board game nights were filmed; the remaining two were voice recorded. Each board game night was arranged as a tissue testing session, a procedure where the play testers have never interacted with the game before (Schell, 2008, p. 394), and lasted approximately 2 hours. Once the play session was concluded, the respondents were organized into focus groups where the lead researcher asked them a series of open-ended questions (Table 1) about their experience with the game. The questions were primarily asked in Norwegian and repeated in English during sessions where non-native speakers were present. Variations in the line of questioning did occur, depending on their relevance to the game that was being played. Respondents were also encouraged to ask questions in return to the lead researcher in case they needed clarifications. The responses were recorded with voice recording hardware, and then transcribed by the lead researcher. A total of 5 focus group interviews were conducted, and each session lasted between 30 and 60 minutes. One of the games, GLOBAL WARMING (Bucak, 2011), was played twice using the same respondents.

The resulting transcriptions were subjected to a qualitative thematic analysis inspired by the framework provided by Braun and Clarke (2006). The lead researcher repeatedly re-read the transcripts to get acquainted with the datasets, and made custom notes in sections where the informants made statements of interest to the study. These notes formed the basis for qualitative codes, which were clustered in an Excel document and used to form thematic categories. During the subsequent thematic integration procedure, certain subthemes were omitted due to low levels of occurrence in the datasets. Eventually, a total of two main themes with a total of four underlying subthemes were identified and incorporated into the final analysis.

Ethical Guidelines

The project has been registered at the Norwegian Center for Research Data (NSD). Each participant in the project was provided a draft of the article, and a 14-day deadline to provide constructive feedback on its contents to ensure the validity of the findings.

Results

Main Theme 1 - Environmental Board Games as Simplified Environmental Simulations

The first main theme that was uncovered during our analysis revolves around board games as innovative and simplified portrayals of complex environmental issues. Two subthemes emerged from the datasets – 1) Board games as simplified scientific communication about the environment, and 2) Board games as micro-level environmental simulators.

Subtheme 1 - Board games as simplified scientific communication about the environment. Board games are theorized to be capable of simplifying the complexity of environmental issues (Schulze et al., 2015), thus making them more accessible for the general public. During our focus groups, several respondents noted that the games represented an intriguing and simplified alternative to overcomplicated science communication. M35 (SETTLERS OF CATAN: OIL SPRINGS) commented on the miscommunication between scientists and laypeople:

> *"Researchers have been warning us about climate change for several decades but nobody listens to them, which might have something to do with the language they use. (. . .) And they haven't understood that. They present their facts and are stuck in the thought pattern that they are talking to their colleagues."* (M35, SETTLERS OF CATAN: OIL SPRINGS)

F25 (GLOBAL WARMING) would later run a qualitative comparison between her gameplay session and a traditional lecture, also highlighting her perception of scientific language as overly complex:

> *"I'm struggling with ADD and Asperger, so to sit still and listen to a teacher for 45 minutes, I. . . just disconnect after 5 to 10 minutes. (. . .) But something like this. . . you're sitting here, doing things, and you learn so much more at once."* (F25, GLOBAL WARMING)

M25 (GLOBAL WARMING) supports the aforementioned statements by additionally critiquing traditional media for what he perceives as unappealing coverage of climate change issues. He adds:

> *"If you're looking at an online newspaper or something, it says 'watch the climate' or something and you try reading it. . . it doesn't really stick. (. . .) This* [the game] *is simple enough that most people can comprehend it. But at the same time it shows enough for us to be able to understand it."* (M25, GLOBAL WARMING)

These remarks demonstrate that scientific language is difficult for laypeople to understand (Fischhoff, 2007), and that new methods of communicating climate change are required (Despeisse, 2018; Stanitsas et al., 2019; Stoknes, 2017). They also illustrate that board games can be effective at simplifying climate change issues and making them more salient than more conventional communication channels (Schulze et al., 2015).

Subtheme 2 - Board games as micro-level environmental simulators. The full extent of environmental issues is complex (Despeisse, 2018; Kollmuss & Agyeman, 2002), often intangible (Hansen & Machin, 2013; Kollmuss & Agyeman, 2002) and difficult to conceptualize. These perceived complexities and vagueness (Vatne, 2013, p. 43) likely represent significant barriers towards pro-environmental behavior. In order to make environmental issues more salient and understandable, innovative and illustrative approaches are warranted (Stoknes, 2017). It is theorized that educational games might contribute to this issue by portraying reality in a highly concentrated and simplified manner (Abt, 1987, p. 21). Games function as microworlds, little sequences and participatory simulations depicting some aspect of reality, where the player is included as an actor with a clear responsibility and impact (Egenfeldt-Nielsen et al., 2013, p. 237). In our study, the respondents did appear to experience the illustrative power of board game microworlds. M28 (KEEP COOL) notes how effective KEEP COOL is at simulating the complexities of intergovernmental climate debates and decision-making: "*If you were to translate this game into the real world, then this is on a very high level. It's like countries and continents we're talking about.*" In a similar vein, F25 (SETTLERS OF CATAN: OIL SPRINGS) and M25 (GLOBAL WARMING) point to how board games are capable of depicting complex systems in general:

> *"It* [the game] *took a very big subject and gave it a small, concrete picture of it all, like you can explain the entire world with a small game. And then there's a lot of stuff you know from before, except you get it in a more concrete form right in front of you – "oh shit, that's going to affect this and that."* (F25, SETTLERS OF CATAN: OIL SPRINGS)

> *"Here in Norway we try to think about the environment, but there are other countries in the world that are both better and worse than us in terms of environmental consciousness too. So it puts things into perspective when you have it right in front of you, and you can affect it yourself."* (M25, GLOBAL WARMING)

Intriguingly, the respondents are also implying that the board game helped make the connection between their own actions and impacts on the game board more salient – thus suggesting that board games can be a step towards deconstructing climate change

as an invisible entity (Hansen & Machin, 2013) – by showcasing the direct link between one's personal actions and impact within a game-based safety net.

Main Theme 2 – Individual Impact and Resource Distribution

The second main theme that was uncovered during our analysis revolves around how the players perceived the game-based visualization aspect of their own implemented strategies and personal impact on the gameplay sessions. Additionally, the players would also reflect upon their strategies for distributing resources between themselves and the group as a whole. Two subthemes emerged from the datasets – 1) Visualizing individual eco-impacts, and 2) Personal gain vs. the common good.

Subtheme 1 - Visualizing individual eco-impacts. Games center their players in a context where they learn through their own actions and presence in the game world (Foltz et al., 2019) rather than passively absorbing and abstracting information from books and lectures. During our focus group interviews, several of the respondents mentioned either that they had already seen the effects their actions had on the game board, or they expressed a desire to get to a point in the game where they could. When asked about whether playing the game inspires him to counteract environmental issues in any way, M22 (KEEP COOL) notes that "*you think about it more. Because when you're actively doing something in a good session* [of a game], *it* [the game's theme] *goes through your head all the time.*" M35 (SETTLERS OF CATAN: OIL SPRINGS) also became occupied with the game's ability to show direct cause and effect. He states that "*the time* [in the game] *is compacted. I did this fifteen minutes ago, and now I'm screwed up over there*", referring to how his actions on the board led to some clearly visible disastrous changes in his dominance in the game a short while later.

Intriguingly, in some cases it also appeared that the visual elements in the game served to steer the players' in-game behaviors. In the game GLOBAL WARMING (Bucak, 2011) for instance, a set of train miniatures illustrate the carbon emissions of each individual player, while one train is designed to represent the total amount of carbon emission by all players. F25 (GLOBAL WARMING) would comment on the presence of these trains, stating:

> *"For me it was these trains, that show. . . okay, it's fine that you can buy oil and move rigs and stuff, but. . . they were like, okay, if I do this now then the global warming will go way up. So if the trains hadn't been there it'd just be like, eh, I'll do what I want."* (F25, GLOBAL WARMING)

M25 (GLOBAL WARMING) added:

> *"We can't just think about ourselves – we need to think about the fellowship. I have contributed little to pollution, but you need to look at the others too."* (M25, GLOBAL WARMING)

These players had all encountered situations where they had performed an in-game move that later had salient effects. In cases where these occurrences were absent from the gameplay sessions, the respondents expressed frustration and disappointment that they never got to experience them. One likely explanation for this is that games essentially provide a safe arena where failure to achieve a goal or prevent a disaster keeps the game fun (McGonigal, 2011, p. 68). A game where the possibility of failure is at a minimum can quickly become boring. During the session with EVOLUTION: CLIMATE (Crapuchettes, 2016), the interviewer observed that none of the players' in-game actions resulted in any serious climate change-related issues. When confronted with this during the focus group interview, F21 stated that she "*wanted to get there, just to see what happened*" with nods and sounds of agreement from the rest of her 5 fellow players, suggesting an innate curiosity in experiencing an in-game climate change disaster within the safe confines of the game.

Subtheme 2 - Personal gain vs. the common good. A large number of environmental games on the market today revolve around the concept of zero-sum victories, where only one person wins and the others lose (Fennewald & Kievit-Kylar, 2013). These types of games normally feature mechanics that in some way allow the players to attack and weaken one another, such as by damaging other players or otherwise impeding their progress in the game (Boardgamegeek.com, 2019g). By contrast, very few environmental games revolve around cooperation and collaboration in order to achieve a common goal. The games used in our study appear to largely reflect this trend, primarily due to what the respondents identify as a lack of incentives for in-game pro-environmental behavior. This imbalance made it excessively tempting for many of our respondents to exclusively utilize unsustainable resources in order to beat the others, thus falling into the SVO pattern of individualistic or competitive tendencies (de Groot & Thøgersen, 2013, p. 143). F25 (SETTLERS OF CATAN: OIL SPRINGS) attempted to "*not use any oil; just stay on the straight and narrow*", but once she realized that she was in last place she admitted to feeling tempted to follow their example: "*I really wanted to [use oil], because it went so damn slowly! I do have two houses there on the board though. . .*". One of her co-players then noted that the risk of refusing to use oil did not justify the potential rewards:

> *"I don't see any reason not to use the oil here. If the disaster hits all of us with an equal percentage of probability, and you'll only win by using oil, then of course you'll use a lot of oil in the beginning – until there are dangerous levels of pollution, that is. So even if you get a few points for being green, I don't believe you'll win when the oil is so strong. And I guess that's kind of how it is in reality too – that the profits are simply too big in comparison to what you get for being green."* (M22, SETTLERS OF CATAN: OIL SPRINGS)

A similar tendency occurred during the KEEP COOL (Eisenack & Petschel-Held, 2004) play session. Unlike the other games we tested, KEEP COOL explicitly states that the relationship between personal gain and climate protection for everyone is one of the

main topics the game seeks to address (Boardgamegeek.com, 2019f). One of the requirements to win a round of KEEP COOL involves achieving a certain number of factories on the board, and these come in either black or green variants. Black factories represent greenhouse gas-emitting energy production, while green factories represent low-emission technologies. Removing black factories in favor of green ones is a core gameplay mechanic in KEEP COOL (Eisenack, 2012). One of the respondents, M28 (KEEP COOL), signified that the group had understood this: "*The more the climate is stressed, the harder it can hit us. So the game makes you think to build more green factories*". Despite this, the group overall appeared to prioritize building black factories due to their lower cost. M22 (KEEP COOL) comments: "*I went for the black ones! They were cheapest.*" M28 (KEEP COOL) responds that he prioritized green factories, due to how it was one of his explicit requirements to win: "*It was one of my goals, but I also thought that I don't want the carbometer* [an in-game element designed to measure the greenhouse gas emissions caused by the players and natural processes in the game (Eisenack, 2012)] *to go any higher now.*" In a similar vein to the KEEP COOL and the SETTLERS OF CATAN: OIL SPRINGS play sessions, the value of renewable energy appears to be overshadowed by the cheaper and more powerful non-renewable energy sources. Additionally, due to their overall emphasis on zero-sum wins (Fennewald & Kievit-Kylar, 2013), the level of cooperation between the players appears to be rather low.

Discussion

Scientific communication about the complexity of environmental issues has largely been dominated by vague explanatory models (Vatne, 2013, p. 43) and overly advanced scientific language (Fischhoff, 2007; Hassol, 2008). Researchers are calling for more accessible forms of scientific communication about the environment (Klöckner, 2015; Stoknes, 2017), and board games represent an innovative approach to this call. The purpose of our research was to examine how four commercially available environment-themed board games can be instrumental in generating environmental awareness. Our results first and foremost show that board games are capable of simplifying an overly complex system of interconnected environmental issues that is normally presented by scientists in a way that laypeople have great difficulties understanding (e.g Fischhoff, 2007; Hassol, 2008; Stoknes, 2017). They did this by engaging the players in microworlds (Egenfeldt-Nielsen et al., 2013, p. 237) with visual and interactive elements that simulate the real world, allowing players to carry out roles and actions that have a noticeable impact on the in-game environment (as described by Arnaudo, 2018, p. 27). Being able to visualize and experience environmental issues within the safe confines of the game is a unique way to immerse learners into the subject of environmental literacy, and might even represent a possible solution to the problem of environmental issues being perceived as non-salient (Hansen & Machin, 2013; Klöckner, 2015, p. 63; Tversky & Kahneman, 1973, 1974).

The second important finding in our study revolved around how players perceived the visual representation of their personal impact on the game session, as well as their

varying emphasis on resource hoarding versus resource distribution. Firstly, board games were indeed shown to highlight and emphasize the interactions between each individual player and their impact on the flow of the game by situating them in fictional worlds (Foltz et al., 2019). Additionally, the players did occasionally experiment with other roles, personalities and identities than the ones they normally exhibit in a real-life setting (Arnaudo, 2018, p. 27) as long as the game provided an arena for it. From a researcher's perspective, environmental board games can also be utilized to illustrate how players display different SVOs (de Groot & Thøgersen, 2013, p. 143; Messick & McClintock, 1968) in social dilemma situations. Some of the players in this experiment exhibited highly individualistic or competitive SVOs, whereas others tried to collaborate and contribute to the common good. Some of the players even took on an active role where their expressed goal was to experience what would happen if the environment collapsed in the game. This suggests an innate desire to experience what previous research describes as alternate future realities (Barreteau et al., 2007; Wu & Lee, 2015), while simultaneously enjoying the benefits of the relative safety of the real world (García-Barros et al., 2015).

Board games are also interesting in the sense that they both allow and encourage social interaction between the players in a physical, real-life setting. While congregated in such a way, board games can serve as an enabler for discussion, as well as directing the players' attention to what is happening on the game board – thus ensuring a closer relationship between the player and what the game seeks to teach. For the environmental sciences, considering the complexity and interconnectedness of its many underlying facets (Despeisse, 2018; Kollmuss & Agyeman, 2002), the use of a visual representation tool allowing for social dialogue and requiring intensive attention in order to function is likely to encourage learning that can be retained on a higher level than traditional learning methods (Dieleman & Huisingh, 2006; Kolb, 1984; Krathwohl, 2002, p. 214) – especially for learners who might be experiencing problems conceptualizing the abstract contents of a book or a lecture.

It should be noted that there was a degree of variation between the selected games in terms of their ability to produce some form of learning outcome. A likely explanation for this discrepancy can be attributed to the degree of emphasis that the game places on environmental mechanics. KEEP COOL (Eisenack & Petschel-Held, 2004), for instance, integrates them directly into its core design, whereas EVOLUTION: CLIMATE (Crapuchettes, 2016) features the environmental aspect only as an expansion feature to its base game. This is hardly surprising, as the main emphasis when creating most commercial games is that they need to be appealing to interact and play with to ensure sales, meaning that the educational aspect is often underemphasized. Also, due to the different topics brought up by the games, the nature of the learning outcomes also varied considerably. All of the games we tested dealt with climate change and environmental issues on a very holistic and general level and did not explicitly provide advice to the players on how to circumvent similar issues in a real-life setting. However, aside from EVOLUTION: CLIMATE where the environmental aspect turned out to be rather shallow, the games all

functioned as simplified environmental simulations. They were also capable of illuminating the links between the players' actions and their impact on the environment, although the respondents noted that the topic was not new to them.

Conclusion

Out of the four board games tested in this study, three of them appear to hold some promise in the context of generating environmental awareness. The only exception, EVOLUTION: CLIMATE (Crapuchettes, 2016), had a climate component that was too disconnected from the core of the main game, and the players were unable to shift the in-game climate enough to experience any serious consequences of their actions. In sum, however, our main findings suggest that board games can be highly effective in illustrating and visualizing the connections between a player's actions and their impact on the game board. They can also be utilized by researchers to explore how players interact, compete and distribute or hoard resources in a social dilemma situation. They also hold some promise as an answer to the call for more relatable, understandable, concrete and simplified forms of communication about the environment and the social issues that environmental decline might cause.

Limitations and Future Research

While our study reveals some promising dawning indications for the effectiveness of board games in promoting environmental awareness, there are some limitations to the study that need to be addressed. Firstly, due to the qualitative nature of the study, larger-scale triangulated and quantitative studies are required in order to get a more complete picture as to the extent of the effectiveness of environment-themed board game play. Secondly, board games can be very complex and difficult to get into. This means that the players often spend a significant amount of time discussing and explaining the rules, supposing that they are all unfamiliar with the games chosen for the game session. In our study, players using 20-30 minutes of the time schedule to understand the rules was not uncommon, and one group even cancelled their gameplay due to the rules being too complex. A lacking understanding of the rules also caused several of our respondents to call the lead researcher for help during gameplay, which also added to the length of the gameplay session. Future researchers are therefore encouraged to either use a moderator or instructor with previous knowledge of the game to explain the rules before gameplay is initiated, sending the rules out to the players before the gameplay sessions begin, or including a set amount of time in the play session for the players to discuss and explain the rules of the game. Thirdly, our study did not prioritize post-game debriefing sessions due to taking place late in the evening. Debriefing sessions can be useful in clearing up any misconceptions the players might have, providing in-depth knowledge about the game's topic, as well as encouraging reflections and topical debates among the players.

Appendix

Table 1. Interview Guide.

1. What are your thoughts on using games for educational purposes?
2. Why did you choose the game you ended up playing?
3. What, in your opinion, is the main theme or topic of the game?
4. Were the rules easy to understand?
5. Was there anything about the game that you perceived as particularly good?
6. Was there anything about the game that you perceived as particularly bad?
7. What do you think about the relationship between cooperation and competition in the game?
8. Do you feel that the game has taught you anything about our environment?
9. Do you feel that the game gave you a greater degree of insight into how our environment works?
10. Do you feel that the game has inspired you to do something positive for the environment in the near future? In that case; what?
11. How do you feel the game has provided you with insight into how you can circumvent environmental issues?
12. Do you have any other comments about the game session?

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Note

1. The participants were offered a larger selection of environmental board games, but the four games described in the following section were the ones selected by the participants. The complete selection of games offered was SETTLERS OF CATAN – OIL SPRINGS, EVOLUTION CLIMATE, GLOBAL WARMING, KEEP COOL, CO_2 – the board game, BAUM(M)LAND, and GREEN DEAL. Only the games chosen by the players are described in the paper.

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Chapter 6 – Results and Discussion

In the previous sections of this thesis, an introduction to the role of psychology regarding environmental issues as well as the theoretical and methodological foundations for the project have been presented. In this chapter, the theoretical foundation will be connected to the results of the Green Gaming Project to highlight how games can be used as tools for environmental education. The suggestions contained within this chapter will contribute towards future environmental game developmental practices for interdisciplinary game designers, and highlight potential barriers and pitfalls surrounding the use and implementation of environmental games in the public sphere. In the first section of this chapter, the strengths and positive qualities of environmental games identified in the three research papers are summarized and connected to the theoretical foundation presented earlier. In the second part of the chapter, barriers and potential shortcomings of environmental games are outlined based on the observations made during the research processes. Lastly, the results of the Green Gaming Project's three empirical studies are connected to the psychological models presented in chapter 3 of this thesis alongside suggestions for future research guidelines on environmental games.

6.1 The strengths of using games as environmental communication tools

As described in chapter 4, games are an immensely popular cultural phenomenon (ESA, 2020; Medietilsynet, 2020) that has entertained and captivated humanity for several millennia (Bell, 1979; Decker, 1992; McGonigal, 2012, p.351; Wilkins, 2002). With a media audience numbering in the millions (McGonigal, 2012, p.3), it is no surprise that gamers represent a highly intriguing arena to appeal to regarding questions of social change. Media has been used to sway public opinion on a variety of issues in the past, and games are no different. Despite this, games are first and foremost considered to be an activity associated with leisure and entertainment (Sweetser & Wyeth, 2005), which has caused a considerable divide between ambitious game designers (who are, understandably, generally more interested in creating good games that sell) and educational scholars (who, in most cases, want games to be something "more" than "mere entertainment") (Abt, 1970; Gunter et al., 2008). Despite this difference in priorities, a new arena of games developed in collaboration with ambitious and socially aware game designers and innovative scientists is emerging (e.g.,, Eisenack, 2013; Eisenack & Reckien, 2013; Reckien & Eisenack, 2013; Roberts, 2011; Strange Loop Games, 2020). Providing a psychological evaluation of environmental games as communication tools is a valuable contribution to this new arena and, based on the three research papers

constituting the backbone of this thesis, this section is intended to showcase and analyze the ways in which educational games about the environment can be effective.

6.1.1 Games are engaging, immersive, and motivating environmental learning tools

Implicit in most research articles on games is the notion that they are enjoyable, engaging, and voluntary activities (Crisp, 2014; Gee, 2005; Hamari et al., 2016; Jennett et al., 2008; Poels et al., 2012; Pourabdollahian et al., 2012; Rumore et al., 2016; Ryan et al., 2006; Sweetser & Wyeth, 2005). The same applies for serious games (Abt, 1970; Fu et al., 2009), although the exact impact of game enjoyment on game-based learning is not fully known. It is clearly advantageous that the players' attention is steered towards the contents of the game, however, and previous research details how some players became less aware of their physical surroundings and other disturbances while going through particularly immersive gameplay sessions (Brown & Cairns, 2004; Sweetser & Wyeth, 2005). In the 249 game reviews used for the ENED-GEM paper (Fjællingsdal & Klöckner, 2017), game enjoyment (or lack thereof) was a recurring element that largely appeared to determine if a game was favorably or unfavorably received. Reviewers who scored the game negatively also appeared, on average, to play the game significantly less than reviewers who rated it positively. In the case of the two empirical research papers in this thesis (Fjællingsdal & Klöckner, 2019, 2020), the need for an enjoyable and engaging gameplay experience also appeared to be a motivator for participation in the project. Before gameplay was initialized, several respondents in the board game project (Fjællingsdal & Klöckner, 2020) would mention that some games from the provided selection looked or sounded more interesting than others. Evolution: Climate (Crapuchettes, 2016), for example, received praise from the respondents for its creatively designed and colorful creature cards, highly ornate tactile elements, and overarching theme of having to sustain your own species. Several respondents also mentioned that they wanted to play Catan Scenarios: Oil Springs (Assadourian & Hansen, 2011) both because they had heard it was a good game from close associates, as well as the fact that the game was only sold as a limited edition, possibly suggesting a desire for the exclusive access to a game that might otherwise be difficult to obtain and play. In the Eco project (Fjællingsdal & Klöckner, 2019), which was introduced with the use of an early trailer of the game, most respondents noted the visual presentation of the game and its semblance to the highly acclaimed *Minecraft* (Mojang Studios, 2011) as their main motivations to participate. Based on these findings, perceiving a serious environmental game as enjoyable, interesting, familiar, or engaging appears to predict the players' initial willingness to engage with it (Sweetser & Wyeth, 2005)

and, consequentially, their immersion into the game's learning material. Good game design will therefore be more likely to appeal to a wider audience of players and lead to increased engagement with the game. Poor game design, on the other hand, is known to cause frustration and boredom (Ferguson & Olson, 2013; Fjællingsdal & Klöckner, 2019) and acts as a barrier against psychological factors that are known to actively support and facilitate the learning process, such as immersion and flow (Brown & Cairns, 2004; Kiili, 2005; Perttula et al., 2017; Schell, 2008).

6.1.2 Games can generate new environmental knowledge and reinforce existing knowledge

According to Gifford (2011), one of the main barriers against pro-environmental behavior is a general ignorance or lack of real knowledge about environmental issues. As previously explained, serious games are known to be able to improve upon their players' knowledge structures (Klöckner, 2015, p.203; Reckien & Eisenack, 2013; Rieber, 1996; Turnin et al., 2001; Zimmermann, 1990), although many of them tend to rely on very traditional and linear didactic practices such as drill-and-practice learning (Bruckman, 1999), which is often a poor way of depicting complex systems of relationships (Schell, 2008, p.446) such as the environment and climate change. It is therefore obvious that many educational games risk becoming akin to digital textbooks or newspapers rather than the experimental, enjoyable and interactive experiences that quality games can provide (Dieleman & Huisingh, 2006; Gee, 2005; Hamari et al., 2016; Malone & Lepper, 1987; Poels et al., 2012; Ryan et al., 2006; Sweetser & Wyeth, 2005). Also, whereas traditional media are commonly utilized for obtaining information about environment and sustainability (Dimopoulos & Koulaidis, 2003; Klosterman, Sadler & Brown, 2012; Muthukrishnan & Kelley, 2017), games are often overlooked or considered to be less scientific than their more cut-and-dry, traditional media counterparts. One of the reasons for this, until recently, has been that games have often remained rather obscure in the way that they present their pedagogical foundations (Madani et al., 2017). Technically, games can be made by anyone who wishes to do so, but serious environmental games developed in collaboration between professional game developers and environmental scientists have remained rather scarce (Reckien & Eisenack, 2013). However, this trend appears to be changing. Games such as Keep Cool (Eisenack & Petschel-Held, 2004), Eco (Strange Loop Games, 2020), and Fate of the World (Roberts, 2011), for instance, are all joint-developed by professional game designers, environmental scientists and non-governmental organizations. The games specify this on their packaging as well as on dedicated websites and gaming platforms, thus offering a degree of transparency into their

design process and background. The games also represent a deviation from the standard notion that educational games are of lower quality than traditional and commercial games (Koehler et al., 2016; Rice, 2006) in that they are generally well-received among reviewers (see Appendix 8) and respondents alike (Fjællingsdal & Klöckner, 2020).

Although educational games can be perceived as enjoyable, it is just as important that they have some form of educational value (Abt, 1970). While many games rely on the provision of information (Klöckner, 2015, p.203; Reckien & Eisenack, 2013; Turnin et al., 2001), an important yet insufficient predictor of behavioral change (Abrahamse et al., 2007; Deci & Flaste, 1995, p.36; Finger, 1994; Frick et al., 2004; Geller, 1981; Hines et al., 1987; Jensen, 2002; Johnson & Johnson, 2009, p.50; Keeble, 1988; Kollmuss & Agyeman, 2002; Moser, 2010; Roth, 1992; Staats et al., 1996), it is worth considering the possibility that games might provide information in a way that is inherently different from the majority of other environmental communication interventions. Stories told by the respondents in this project signifies that they did obtain new knowledge about the environment by playing, mirroring the findings of other environmental game researchers (Despeisse, 2018; Dornhelm et al., 2019; Katsaliaki & Mustafee, 2015; Madani et al., 2017; Schaal et al., 2018; Waddington & Fennewald, 2018; Zhang & Zwolinski, 2015), but also that they were provided an arena where they could contextualize and experiment with environmental knowledge that they already possessed (Fjællingsdal & Klöckner, 2019, 2020). This is particularly important, as environmental information is often provided through complex, vague, and largely non-interactive one-way communication channels (Johnson & Johnson, 2009, p.157) such as newspapers (Reis, 1999), documentaries (Greitemeyer, 2013), books (Klöckner, 2015, p.126), scientific graphs (Stoknes, 2017; Vatne, 2013, p.43), and information campaigns (VanDyke & Tedesco, 2016). By contrast, using games to bolster environmental literacy allows the player to learn about environmental issues on their own volition and in accordance with their own interests – a form of self-regulated (Zimmermann, 1990) or experiential learning (Kolb, 1984; Kolb & Kolb, 2005). Whereas some players might want to utilize scientific data to sustain, protect, and nurture their in-game environment, others might want to apply strategies with which to damage or break it, "just to see what happens". These two strategies largely dominate amongst the respondents in the two empirical research projects (Fjællingsdal & Klöckner, 2019, 2020), and it is arguable that the learning strategies used by different players vary, possibly depending on their primary motivation from playing the game in the first place (Bartle, 1996; Fjællingsdal & Klöckner, 2017). In other words, some might learn by *protecting* a digital environment, whereas others will learn by *ruining* it.

6.1.3 Games allow for safe experimentation and interaction with the environment

Another core finding of the Green Gaming Project is that games co-developed by professional game designers and environmental scientists are highly experiential and self-regulated forms of learning (Fjællingsdal & Klöckner, 2019, 2020), a contrast to the more traditional drill-and-practice learning approach used by other forms of educational games (Bruckman, 1999). As experiential learning, or learning by doing (Dieleman & Huisingh, 2006), results from concrete experience with something (Kolb, 1984; Kolb, Boyatzis & Mainemelis, 2000), it is difficult to achieve through abstract conceptualizations presented by more static forms of media like books and documentaries. Games are different in that they are interactive and multimodal (Burn, 2008), allowing the player to freely use their senses and problem-solving skills to safely manipulate and experiment with the in-game environment (Egenfeldt-Nielsen et al., 2013, p.237; García-Barros et al., 2015; Gee, 2007, p.59; McGonigal, 2012, p.303). While some serious games are highly didactic, essentially guiding the player through a series of linear and predictable events much in the same framework as the chapters in a textbook or a sequence of digital lectures, the games utilized in this project allow the players to implement their own gaming strategies, establish clear connections of cause and effect between their actions and the subsequent environmental impact, and co-develop social problem solving for environmental maintenance or destruction. In Fate of the World (Roberts, 2011), for instance, the sequence in which the players place the in-game environmental policy cards uniquely determines how their game session will progress (Fjællingsdal & Klöckner, 2017; Waddington & Fennewald, 2018). One player might, for example, choose to play a card that initializes a revolution in dietary habits by switching over to a global vegetarian diet. That player will anger the in-game population that does not support the policies of this card but will also benefit from less water use in the agricultural sector because of the reduced emphasis on meat production. Another player might choose to prioritize climate change adaptation policies, and therefore be more likely to play cards that are designed to circumvent the impact of extreme weather events such as storms and droughts. Here, it is obvious that these two players have very different implementation strategies and, thusly, will also experience the game very differently in terms of how the narrative develops. Other environmental games, such as Eco (Strange Loop Games, 2020) and various thematic board games (e.g., Assadourian & Hansen, 2011; Bucak, 2011; Crapuchettes, 2016; Eisenack & Petschel-Held, 2004), are also shown to allow their players to freely experiment and enact their own unique scenarios. By contrast to Fate of the World, however, which is a single-player game, these games add a social dimension where the players can interact, cooperate, compete, sabotage

and assist one another (Fjællingsdal & Klöckner, 2019, 2020). This arena opens for new learning experiences by allowing the players to interact, converse, share information, debate the game's topic, and so on. These forms of communication are interactive and dynamic rather than static and didactic, and social environmental games are therefore good examples of two-way communication channels (Johnson & Johnson, 2009, p.157; Moser, 2010) or co-construction of knowledge, where information is critically evaluated and discussed rather than passively absorbed (or injected) from a knowledgeable source (Bineham, 1988).

6.1.4 Games can simplify and eco-visualize complex environmental systems

One of the fundamental issues in environmental communication is how to establish a wide-ranging public comprehension of the interconnected parts of environmental systems and to illustrate how they work in tandem with each other (Dieleman & Huisingh, 2006; Moser, 2010), ranging from the interactions between different species in an ecosystem to the environmental impact of the processes involved in meat production and consumption. As these environmental systems are often complex (den Haan & van der Voort, 2018; Stoknes, 2017, p.89), innovative communicative and educational approaches are needed to effectively illustrate their inner workings to the public. The results from this thesis strongly suggest that games are capable of simplifying environmental topics and issues (Fjællingsdal & Klöckner, 2019, 2020), as well as making them more salient for their players by eco-visualizing what has been described as largely invisible or distant global threats (Hansen & Machin, 2013; Hendrickx & Nicolaij, 2004; Löfström & Svanæs, 2017). As games can deeply immerse their players (Brockmyer et al., 2009; Christou, 2014; Jennett et al., 2008; Sweetser & Wyeth, 2005; Yee, 2007), situating them in a multimodal fantasy context as virtual or "other" selves (Burn, 2008; Sestir & Green, 2010; Yee et al., 2009), they are also capable of illustrating and simulating environmental issues on a completely different level than media that merely utilize text, images, or both. In so doing, games can showcase environmental systems "in action" rather than only presenting their individual parts as abstract concepts, and thusly allow their players to experience and see how the different inner workings of the environment affect one another (Dieleman & Huisingh, 2006). This form of systems thinking, the understanding of the interaction and interconnectedness of individual components in an environmental system (Aronson, 1996), such as an ecosystem or a behavioral process, is generally considered to be one of the most important goals of environmental education. However, using traditional methods of learning such as books, magazines, or documentaries, often results in very sparse depictions of exactly how complex these systems are. Overall, older approaches to increasing

environmental literacy appear to focus on singular facets of environmental systems rather than the interactions between them, which leads to an incomplete picture of how environmental systems work (Kollmuss & Agyeman, 2002). It is therefore important to find ways of depicting the complexity of environmental systems to the fullest, such as by using tools that enable and strengthen systems thinking. This was the case for both empirical studies in the Green Gaming Project (Fjællingsdal & Klöckner, 2019, 2020), and the respondents noted that playing games made complex environmental systems appear more manageable and understandable due to the games' simplification of them. In both studies, the respondents became situated in immersive microworlds (Egenfeldt-Nielsen et al., 2013, p. 237; Rieber, 1996) where compressed and simplified depictions of the environment were presented.

During these gaming sessions, the respondents were readily able to understand and visualize the connection between their actions and decisions and the subsequent effects they had on the game world. They were also faced with social dilemma situations where they had to weigh their own needs against those of the rest of the group, and sometimes had to implement strategies that sabotaged other players, such as in the case of the Oil Springs scenario of Catan (Assadourian & Hansen, 2011; Fjællingsdal & Klöckner, 2020). In other cases, such as with Eco (Fjællingsdal & Klöckner, 2019; Strange Loop Games, 2020), the players had to cooperate to reach a shared goal or collaborate to gather and replant resources for their shared world to survive. Also, in the highly condensed simulation of environmental management practices found in Fate of the World (Fjællingsdal & Klöckner, 2017; Roberts, 2011), players are tasked with the almost deity-like responsibility of simultaneously managing every global policy related to sustainability, resource use, military conflicts, economy and health. While these scenarios certainly carry a clear element of fantasy to them, such fantastical elements are shown to be effective at making educational material more fun and engaging (Malone & Lepper, 1987). Although the balance between fantasy elements and scientific data is a difficult chord to strike, especially considering that games exist in a very wide variety of genres and formats (Arsenault, 2009; Egenfeldt-Nielsen et al., 2013, p.230; Reckien & Eisenack, 2013; Schmidt et al., 2015), the Green Gaming Project has demonstrated that interdisciplinary teams of professional game designers and environmental scientists are fully capable of producing environmental games that are both enjoyable, entertaining, and educational (Eisenack, 2013; Fjællingsdal & Klöckner, 2017, 2019, 2020). Taken together, these results overall mirror previous findings that games can be excellent tools for illustrating and teaching about the complexities of climate change (Foltz et al., 2019; Meya & Eisenack, 2018; Waddington & Fennewald, 2018; Wu & Lee, 2015).

6.1.5 Games can help slay (some of) the dragons of inaction

Lastly, it is important to consider the indirect finding that playing environmental games could help in breaking down some of the psychological barriers people face when pro-environmental behavior is concerned. Again due to their inherent multimodality (Burn, 2008) and wide variety of genres (Arsenault, 2009), environmental games have implicitly been shown throughout the Green Gaming Project to have inherent 'dragon slaying' properties in relation to some of Gifford's (2011) Dragons of Inaction. As environmental games focus primarily on increasing their players' environmental knowledge (den Haan & Van der Voort, 2018; Klöckner, 2015, p.203; Reckien & Eisenack, 2013; Turnin et al., 2001), their content and innovative portrayals of nature and sustainability practices can clearly help combat the *dragon of limited cognition.* Being a relatively new tool in education, environmental games can circumvent environmental numbness (Burke & Edell, 1986; Gifford, 2011; Stoknes, 2017) by portraying environmental issues in a new, interactive manner, as well as illustrate environmental issues that seem distant, impersonal, and complex (Hansen & Machin, 2013; Hendrickx & Nicolaij, 2004; Myers et al., 2013; Sheppard, 2012, p.3) by situating the learner in the midst of a virtual environmental crisis. Environmental games can also situate the players in interactive social dilemmas (Fjællingsdal & Klöckner, 2019, 2020) where social consequences of climate change, such as perceived inequity (Gifford, 2011), can be explored further. This intervention strategy can also be used to envision and gain a deeper understanding of the viewpoints, religious and political affiliations of players with varying worldviews, and the ensuing discussion could be an important arena for understanding facets of the *dragon of ideologies* (Eisenack, 2013; Fjællingsdal & Klöckner, 2020). While playing a game is naturally insufficient to change a person's worldview, it does enable the collective envisioning of alternate futures (Wu & Lee, 2015) as well as providing an arena for debate and possibly finding common ground where environmental topics are concerned.

6.2 The barriers to using games as environmental communication tools

There is now little doubt that serious games can be effective and engaging learning tools (Annetta et al., 2009; Hamari et al., 2016; Pourabdollahian et al, 2012; Rumore et al., 2016), also in the fields of environment and sustainability (Fjællingsdal & Klöckner, 2017, 2019, 2020; Foltz et al., 2019; Meya & Eisenack, 2018; Sandbrook et al., 2015; Waddington & Fennewald, 2018). However, it is also important to remember that although research findings on educational games might initially give grounds for an optimistic outlook on their continued use in different settings, there are significant differences in how, when, and what games teach

their players (DeSmet et al., 2014; Girard et al., 2012; Lamb et al., 2018; Lau et al., 2017; Wouters et al., 2013; Zhonggen, 2019). Awareness of potential game design pitfalls is therefore paramount for creating successful serious games, in that they can be identified and avoided during the design process. Although previous publications have already established suggested guidelines for how to avoid game design flaws (e.g., McGonigal, 2012; Schell, 2008; Sweetser & Wyeth, 2005), these guidelines normally tend to pertain to commercial rather than serious games. While most of these guidelines apply to serious games as well, such as the process of making a game enjoyable (Gee, 2005; Hamari et al., 2016; Poels et al., 2012; Ryan et al., 2006; Sweetser & Wyeth, 2005), immersive (Brockmyer et al., 2009; Christou, 2014; Hamari et al., 2016; Jennett et al., 2008; Schell, 2008; Sweetser & Wyeth, 2005; Yee, 2007), challenging (Bartle, 1996; Malone & Lepper, 1987; Schell, 2008; Salen & Zimmerman, 2004, p.334; Sweetser & Wyeth, 2005), goal-based (Malone & Lepper, 1987; McGonigal, 2012, p.21; Schell, 2008; Sweetser & Wyeth, 2005), and fantastical (Bartle, 1996; Malone & Lepper, 1987; Salen & Zimmerman, 2004, p.334), serious environmental games come with their own challenges in design, implementation, and audience effects. This section of the thesis will attempt to explain some of these challenges and connect them to the theoretical underpinnings presented in the previous chapters.

6.2.1 The barrier of game content and presentation

When designing an environmental game, it is important to keep in mind what the game is *intended* to teach. Simultaneously, a consideration of how the game is presented to its players is equally important. Questions such as "is this knowledge useful?", "how does the game educate its players?", or "who am I making this game for?" are therefore pertinent to ask, as failure to understand the game's intended audience is highly detrimental to the gaming experience (Bogost, 2007, p.233; Crookall, 2010; Schell, 2008, p.99) as well as to any learning outcomes one can achieve by playing it. For example, playing a basic game about recycling waste might not be very beneficial if the target audience is a demographic that exhibits a high degree of pro-environmental knowledge from before, although it might – in accordance with the information deficit model of pro-environmental communication (Bickerstaff, 2004; Schultz, 2002; Sturgis & Allum, 2004) – fill in some of the potential gaps that exist in the players' knowledge. Likewise, making a highly advanced game where one is put in charge of an entire virtual world of interconnected environmental systems might be too complex for younger or less environmentally literate players. It is important to consider that people vary in terms of their pre-existing environmental knowledge (Chang et al., 2018;

Plutzer et al., 2016), and that the effects of playing environmental games will be different based on the demographic they are designed to appeal to (Schell, 2008, p.100). A lacking understanding of the game's target demographic will result in the game being perceived as either too simplistic or too complex for the players, which was the case for both Fate of the World (Fjællingsdal & Klöckner, 2017; Waddington & Fennewald, 2018), Eco (Fjællingsdal & Klöckner, 2019) and some of the board games (Fjællingsdal & Klöckner, 2020) utilized in the Green Gaming Project. As the players were often unable to adjust the game's difficulty in accordance with their own skill level, they were also unable to enter a flow state where the balance between skill and challenge would be optimal (Csikszentmihalyi, 1990). It is also clear that the difficulty of the game rules, controls and mechanics in some cases led to a significant amount of time being used to just understand how the game worked rather than what it was designed to teach (Fjællingsdal & Klöckner, 2017, 2019, 2020). Although difficult games are occasionally met with universal acclaim, some of the games used in the Green Gaming Project (such as Fate of the World (Roberts, 2011), CO_2 (Lacerda, 2012) and Eco (Strange Loop Games, 2020)) are almost certainly targeted towards individuals with a high degree of appreciation for strategic rather than casual gameplay, and will therefore not be suitable for a general gaming audience.

Furthermore, game-based learning is often quite different from more conventional forms of learning, such as the drill-and-practice method (Bruckman, 1999) where predetermined course material is often rehearsed, repeated and memorized rather than comprehended. Game-based learning is more interactive, experimental, and unconventional (Costikyan, 2002; Dieleman & Huisingh, 2006; Elson et al., 2014; Green & Jenkins, 2014) and will seldom lead to the same forms of learning outcomes as reading a book or listening to a lecture, leading some game scholars to conclude that games are often written off as "a waste of time" by those who do not condone games in educational contexts (Gee, 2007, p.22). Perhaps as a result, many educational games end up masquerading the same didactic content one might find in a regular textbook, so that it might in some way pass as an innovative or different arena of presentation. Some game designers have described such games as 'chocolate-covered broccoli' (Galarneau, 2005), and while they might have a purpose when applied in specific contexts or for teaching specific subjects, the addition of an immersive fantasy world to the educational aspects of serious games is often beneficial (Malone & Lepper, 1987; Prensky, 2001; Schwartz, 2006). Although the games included in the Green Gaming Project featured fantasy elements, such as making the player into a godlike stakeholder in Fate of the World (Fjællingsdal & Klöckner, 2017), having the players enact a

variety of professions to shoot down an incoming meteor in Eco (Fjællingsdal & Klöckner, 2019), or taking care of a series of fictional species in Evolution: Climate (Fjællingsdal & Klöckner, 2020), most of the games were rooted in reality. Fate of the World (Roberts, 2011), for example, is essentially a greatly exaggerated simulation of environmental policy implementation, although sped up for convenience. Keep Cool (Eisenack & Petschel-Held, 2004) has the player take charge of real-life countries, and Eco (Strange Loop Games, 2020) takes place in a natural environment that is nearly identical (albeit more cartoony and varied) to certain ecosystems and biomes one might find on Earth. Hyperrealistic portrayals might initially seem to be a more logical approach to designing environmental games, as the games are often intended to teach skills that are implementable in real-life settings (which serious games are often meant to mimic), but as I will explore in the next section of this thesis, this expectation does not receive much support from research.

6.2.2 The barrier of realism in environmental games

As explained in chapter 4, games and simulations share similar elements but are not the same entity (Sauvé et al., 2007). While games often imitate or simulate certain aspects of reality (Prensky, 2001), as is the case with the games chosen for the Green Gaming Project, they can hardly be described as scientifically accurate copies of reality – something that is more often the case for simulations. Serious games are simplified, safe, and abstract depictions of reality (Egenfeldt-Nielsen et al., 2013, p.237; García-Barros et al., 2015; Gee, 2007, p.59; Fjællingsdal & Klöckner, 2017, 2019, 2020; McGonigal, 2012, p.303; Sauvé et al., 2007) intended to teach skills that are transferable to a real-life setting (Abt, 1970; Peters et al., 1998), so designing serious games about the environment to be as realistic as possible might seem like a logical strategy, especially when considering early theories about persuasive media effects (e.g., Atkin & Wood, 1976; Gunter & Furnham, 1984; Huesmann et al., 1983; Huston et al., 1997). However, none of the games utilized in the Green Gaming Project were mirror images of reality and were yet shown to be effective educational tools about the real-world environment. It was also shown, as in the case of study of Eco (Strange Loop Games, 2020), that most of the respondents were willing to suspend their disbelief (Holland, 2003) and ignore glitches and bugs that temporarily broke their immersion while playing in favor of enjoying the 'wholeness' rather than mere details of their gameplay experience (Fjællingsdal & Klöckner, 2019). These results mirror that of other researchers who found that the level of realism in simulation-based games is of little relevance to the players' learning outcomes (Feinstein & Cannon, 2002; Norman et al., 2012). Neither does realism appear to be a priority

for environmental game designers (Foltz et al., 2019), who should instead emphasize the creation of enjoyable and fun gaming experiences (Sandbrook et al., 2015). Lack of realistic properties in simulations – so-called *simulation loopholes* – can, in fact, in and by themselves be instructive. They might lead the players to ponder why certain things work in the game but not in the real world and vice versa, and could thereby encourage the players to investigate the topic beyond the game itself (Schell, 2008, p.447).

Although this is an interesting finding, suggesting that environmental games can indeed feature rather heavy fantasy elements without negatively affecting their educational value, there are risks with making an environmental game that is too disconnected from reality as well. Although games have indeed long been used to educate and boost our knowledge (Abt, 1970), it remains unclear to what extent game-based learning outcomes permeate the barrier between the game world and reality. Also, while existing literature does suggest that skills learned through game-based learning can be implemented into a real-life setting (Peters et al., 1998), there is comparatively little empirical evidence (Sestir & Green, 2010; Yee et al., 2009) explicitly describing the inner workings of this transfer process. Despite the fact that the ideal level of realism is a continuous source of debate among serious game scholars (Harviainen, 2020), almost to the point where it might be called one of the 'holy grails' of proper serious game design, there is still no agreement regarding the degree of realism that a game should feature to make it more effective as a teaching tool (Ravyse et al., 2017). To further complicate the issue of realism in serious games, some researchers state that there is a barrier between what goes on in the virtual world versus what goes on in the real world – the so-called *simulation gap* (Bogost, 2010, p.43). While playing an environmental game might put the player into a variety of fantastical and otherwise inaccessible roles and situations (García-Barros et al., 2015; McGonigal, 2012, p.303), which was indeed the case for the Green Gaming Project, the players do not necessarily endorse or act upon the roles they were given while playing (Bogost, 2010, p.238). In many cases, the players simply cannot do so at all due to the constraints they face in real life that do not appear in the virtual world. While games are often aimed towards empowering their players and putting them in positions they could otherwise not achieve (Bogost, 2010, p.238; McGonigal, 2012), reality is far more complex than any game can hope to simulate. Where games are synonymous with free exploration, freedom, sabotage, and socialization (Bartle, 1996; Schell, 2008), real-world pro-environmental behavior is hindered by both psychological (Gifford, 2011; Gifford & Chen, 2017), physical (Ölander & Thøgersen, 1995; Thøgersen, 2010), and contextual

barriers (Jager, 2003; Klöckner, 2015, p.83; Verplanken & Wood, 2006; Wood et al., 2005) that no game alone could hope to accurately illustrate or represent.

It is difficult to make a solid conclusion regarding the ideal level of realism in environmental games, although all of the games used in the Green Gaming Project had ties to the real world in some fashion (Fjællingsdal & Klöckner, 2017, 2019, 2020). While the scenarios and situations that the players were enacting and experiencing were unlikely to be replicated in a real-life setting, all of the games featured recognizable, yet often cartoony and simplified representations of locations, objects and events one might expect to find in the real world – ranging from the real-life countries in Fate of the World (Fjællingsdal & Klöckner, 2017) to the real-life job system available in Eco (Fjællingsdal & Klöckner, 2019). Altogether, our findings suggest that these anchors to reality likely made it easier for the players to see the connection between the game world and their own physical reality – even in the cases where these representations were abstract or fantastical. Future research should consider the question of game-based realism further, as well as the potential consequences (both positive and negative) of increasing the degree of realistic representations of the natural environment.

6.2.3 The barrier of environmental game design costs and usage

While the games utilized in the Green Gaming Project were largely complete and (to a lesser degree) commercially available (aside from Eco, which was in an early access stage at the time of the study (Fjællingsdal & Klöckner, 2019)), a core obstacle surrounding the design and implementation of educational games about the environment is that they can be expensive and time-consuming to produce and implement. Regardless of genre and format, large-scale serious environmental games and virtual worlds require equally large teams with interdisciplinary experience in fields such as 3D graphics, server optimization, game design, storytelling, and community management (Yee, 2014, p.215) in addition to experts within the environmental sciences and communication. They also tend to require much investment from both game designers, teachers, researchers, and students, both in terms of time (Fjællingsdal & Klöckner, 2019) and money (Yee, 2014), and might in some cases not be worth the implementation when cheaper and more accessible alternate interventions are possible. It is important in this regard to consider the learning goal (i.e., what is it that needs to be learned?) in relation to the amount of investment required from the receptors of the intervention. For example, if the object to be taught is merely factual, declarative, or semantic in nature, such as statistical information about increased precipitation due to climate change, it is likely that a

book can be just as effective as a game at communicating surface-level information such as this to its readers.

While environmental games are uniquely suited to illustrate the interconnectedness of individual environmental components – such as by enabling their players to take care of entire virtual worlds (Fjællingsdal & Klöckner, 2017), ecosystems (Fjællingsdal & Klöckner, 2019), and multi-stakeholder climate negotiations (Fjællingsdal & Klöckner, 2020) – they can also be very costly to produce. Eco (Strange Loop Games, 2020), for example, had an initial funding goal of $100 thousand US dollars and ended up receiving more than twice that amount from its fundraiser alone (Kickstarter, 2015). While this sum is already considerable, environmental games also require funding from other sources, ranging from private investors to corporations and non-governmental organizations (Reckien & Eisenack, 2013) – as is the case of so-called *advergames* for instance (Bogost, 2010, p.209). As thematically specific rather than general environmental games are recommended for educational purposes (Sandbrook et al., 2015), and few such commercially available, sophisticated, and scientifically founded games exist (Reckien & Eisenack, 2013), the road to designing and implementing an environmental game can be a costly one – even to the point where only large corporations and game developers have the financial capacity to make them (Yee, 2014, p.214). In addition to the financial cost of production, environmental games can also be resource-intensive in terms of actual use. Even before gameplay is properly initialized, the players need to get accustomed to how the game controls (Brown & Cairns, 2004; Malone & Lepper, 1987; Sweetser & Wyeth, 2005), the set of rules that dictate the speed and progression of the gameplay (Malone & Lepper, 1987; McGonigal, 2012, p.21; Salen & Zimmerman, 2004, p.334), as well as what goals exist in the game and how to reach them (Malone & Lepper, 1987; McGonigal, 2012, p.21; Sweetser & Wyeth, 2005). In the board game study of the Green Gaming Project (Fjællingsdal & Klöckner, 2020), a significant portion of the gameplay sessions was dedicated to learning and discussing the rules rather than the theme, topics, and progression of the game. In a similar vein, the Eco study (Fjællingsdal & Klöckner, 2019) featured a game that also took a significant amount of time and effort to complete. Taking place over a period of 30 real-life days, requiring hours of gameplay every day in order to make proper progress and not being fully integrated with the players' existing curriculums and time schedules, the game was occasionally perceived as being too long and arduous to finish – particularly in cases where the respondent was playing alone rather than in an established group. Eco is therefore a typical example of a highly resource-intensive serious environmental game that requires both a significant amount of

funding – for game design and server costs – as well as a highly dedicated player base. Obtaining sufficient funding for the game design process, establishing a dedicated and professional design team and an advisory environmental expert group, deciding upon and reaching out to an intended audience in a suitable context, and then running a pilot study of a game prototype is a long and very difficult journey. It is therefore safe to say that in many cases, using specifically developed environmental games for transformative purposes – be it in relation to knowledge, attitudes, norms, values, or behavior – can be unfeasible. However, some researchers have argued that modifying existing, commercially available games to include environmental elements appears to be a promising venue (Chappin et al., 2017; Illingworth & Wake, 2019) – as is the case of the Oil Springs scenario of Catan (Assadourian & Hansen, 2011) which was used in the Green Gaming Project. In so doing, and supposing that copyright laws are in order, the cost barrier of producing entirely new games is largely eliminated, while existing familiarity with the base game's rules can ease the players' transition into the gameplay.

6.2.4 The barrier of environmental games as personal experiences

The games used in the Green Gaming Project were played under a variety of individual motivations, which were, in turn, affected by a multitude of personal factors. Pleasure, enjoyment, psychological arousal, and escapism are among the most prominent reasons people have as to why they choose to play (Gee, 2005; Hamari et al., 2016; Poels et al., 2012; Ryan et al., 2006; Sweetser & Wyeth, 2005; Warmelink et al., 2009), but there is a great diversity of psychological and contextual factors that impact how these experiences are generated in and interpreted by the individual player. Demographic factors such as gender, age, and sociocultural background are all shown to influence how and why people choose to play games (Egenfeldt-Nielsen et al., 2013, p.172; Riemer & Schrader, 2015; Schell, 2008, p.100; Yee, 2014, p.28), in addition to the ways in which the game appeals to different player types (Bartle, 1996). The context in which the game is played is also important. In a classroom setting, for instance, serious games are often perceived differently by teachers and pupils (Afari et al., 2012; Becker, 2007; Bourgonjon et al., 2013; Hao et al., 2010; Ketelhut & Schifter, 2011). This was also the case for the Green Gaming Project's Eco study (Fjællingsdal & Klöckner, 2019) where classroom teachers were generally hesitant to get acquainted with the game, instead preferring to let the pupils play on their own leisure or with assistance from the lead researchers. Across all three studies, the perception of the games was generally very varied. Although some respondents did emphasize the educational properties

inherent in the games, they also noted that they were rather limited and superficial, or they would recommend it to target audiences that they claimed had a lower degree of environmental literacy than themselves (Fjællingsdal & Klöckner, 2017, 2019, 2020). Other respondents would largely ignore the educational properties of the games altogether, in favor of focusing more on conventional game enjoyment factors such as difficulty, visual layout, replay value, or narrative. Some would also state that certain games, such as Fate of the World (Roberts, 2011), was merely pro-environmental propaganda rather than a game (Fjællingsdal & Klöckner, 2017). By stating that something is pro-environmental propaganda rather than a game, the reviewers are emphasizing that environmental information is something that they see enough of in their real lives, and that they would rather have fun and disconnect from reality when playing games. Escapism is, by definition, the desire to engage in activities that are disconnected or distant from reality (Warmelink et al., 2009), and some perceive the presence of environmental topics to be a reminder of reality and everyday life, where they keep hearing the same arguments - a form of environmental numbness (Burke & Edell, 1986; Gifford, 2011; Stoknes, 2017) and fatigue. Each description of the gameplay experience, however, both from reviews and direct interviews, confirmed the notion that despite certain similarities, every gameplay experience is uniquely shaped in the individual player's mind (Schell, 2008, p.11).

The barrier of environmental games as personal experiences becomes evident with the realization that a single game can be perceived in a multitude of different ways. Expecting any single game to appeal to every single person in a selection of potential players is illogical, and the same can be said for the game's educational value. Whereas one person plays Catan: Oil Springs (Assadourian & Hansen, 2011) and learns the environmentally damaging effects of oil, another might understand oil as a powerful resource that could be employed to benefit production, business, and economic proliferation. Neither player is fully correct or fully mistaken; they have simply understood the game differently based on their own unique experience with it. In a similar vein, someone who plays Eco (Strange Loop Games, 2020) alone is likely to find it frustratingly difficult, slow-paced, or boring, whereas another who plays with a group of close friends might find it to be relaxing, recreational, and fun (Fjællingsdal & Klöckner, 2019). If an environmental game such as Eco was played in a class of 30 pupils, each learning experience is likely to have unique properties to it – even in cases where there is a large degree of overlap between what each pupil learns, or where there is a controlled, directed debriefing session after the gameplay session has ended. As a result, the learning outcomes of playing environmental games can vary greatly. In some cases, where

there are specific expectations as to what a game is supposed to teach (such as how Eco (Strange Loop Games, 2020) emphasizes the balance between ecosystem management and the evolution of human society), one might find at the end of the gameplay sessions that few, if any, of the players have learned much about either topic. This, however, does not mean that they have learned nothing from playing. Some may have had difficulties with the game controls and would likely need more time to get acquainted with them before they can dedicate more of their cognitive resources to learning the game's material, for instance. Others may have learned about individual components of ecosystem management, such as how felling trees might generate soil erosion but not about ecosystem management in general, which is an interconnected system of such individual components. As previous research on the effectiveness of educational games tend to reveal mixed findings (DeSmet et al., 2014; Girard et al., 2012; Lamb et al., 2018; Lau et al., 2017; Wouters et al., 2013; Zhonggen, 2019) it is pertinent to conduct thorough inquiries as to what each learner has gleaned from their unique gameplay experience, especially considering that much of what is learned from playing games might go unnoticed due to predetermined or overly narrow learning goals – an unfortunate, yet pervasive and largely behaviorist approach to evaluating the effectiveness of serious games (Bogost, 2010, p.237).

6.2.5 The barrier of game-based simplification of the environment

The final core finding of the Green Gaming Project was that games can simplify overly complex environmental topics and issues, making them more accessible and understandable to their players (Fjællingsdal & Klöckner, 2017, 2019, 2020). Although this form of simplification has its clear benefits, such as clarifying the connection between individual components in an environmental system (how increased carbon emissions cause glacial melting, for instance), it also risks providing *misleadingly* simplistic illustrations of sustainability and conservation practices (Sandbrook et al., 2015). By nature, virtual environments presented in games are simplistic and fantastical (Prensky, 2001; Schwartz, 2006) whereas the real-life equivalent is infinitely more complex (den Haan & van der Voort, 2018; Fennewald & Kievit-Kylar, 2012; Stoknes, 2017, p.89). As a result, minor and major inaccuracies surrounding the depiction of the real-life environment will be present in games, and a fully functional, scientifically accurate simulation of it is therefore not feasible. Additionally, playing overly simplistic environmental games might lead to an optimism bias by portraying environmental decline as less serious than it really is, or they might lead to a form of 'slacktivism' by wrongfully making the player think that simply playing the game is a

sufficient environmental conservation strategy rather than getting involved in real-life nature conservation practices (Sandbrook et al., 2015).

It should be noted, however, that this barrier is contingent on the *degree* of how much the game attempts to simplify the real-world environment. If one were to simulate an entire virtual world and the interconnected systems contained within it simultaneously, as is the case of Fate of the World (Roberts, 2011), the number of scientific inaccuracies would be numerous due to the sheer number of topics and systems that would need to be depicted. It would also likely require a tremendous effort from the design team, needing input from a vast audience of interdisciplinary environmental scientists, and might also seem overwhelming to its audience due to the amount of considerations needed to micromanage the game's multitude of components (Waddington & Fennewald, 2018). However, illustrating limited or individual environmental systems in-depth (such as by providing a detailed narrative surrounding topics such as species conservation, extreme weather, glacial melting, or oceanic life) appears to show some promise in overcoming this barrier (Sandbrook et al., 2015).

6.3 Connecting the findings to the dominating models of behavioral change

Previously in this chapter, the core findings of the three research articles constituting the Green Gaming Project have been discussed in light of the theoretical foundation presented in chapters 3 and 4. Strengths and barriers to using games as tools for environmental education have also been highlighted. However, merely providing a superficial understanding of these strengths and barriers is insufficient in making firm conclusions as to how serious environmental games can be used to instigate change in their players. To conclude this chapter of the thesis, the findings from the Green Gaming Project will be connected to the central behavioral change models presented in chapter 3 in order to deepen the discussion surrounding the use of games in promoting environmental literacy. Preliminary suggestions as to how serious environmental games could help nudge or motivate pro-environmental behavior are also introduced, with special emphasis on the psychological factors (knowledge, attitudes, norms, values, beliefs, and habits) that were introduced alongside the core model frameworks in chapter 3.

6.3.1 Environmental games and the theory of planned behavior (TPB)

The theory of planned behavior (Ajzen, 1985), or TPB, remains the most-cited model of pro-environmental behavioral change (Klöckner, 2015, p.70), and one of the psychological models with the highest degree of explanatory power in regard to general ecological behavior (e.g., Fielding et al., 2008; Kaiser & Gutscher, 2003; Kaiser et al., 2005; Maichum et al.,

2016). The core components of the TPB – attitudes towards the behavior in question, subjective norms, and perceived behavioral control (PBC) (Ajzen, 1991, p.182) – are interesting to consider in regard to the use of environmental games, although there is little empirical evidence to explicitly demonstrate that playing games can directly affect personal behavioral attitudes and norms. Although it is shown that playing games can motivate real-life behavior (e.g., Sestir & Green, 2010), the exact mechanisms underlying such decisions to act are contingent on very specific in-game elements such as a very deep and immersive narrative featuring highly relatable characters, and generally remain vaguely defined in the research literature. Playing a game with a certain degree of personal relevance, however, such as observing the workout behavior of an avatar that is physically similar to one's real-life self, has been shown to lead to behavioral mimicry (Yee et al., 2009). By playing such games, the player can both 1) observe and relate to a character and a setting that they might feel a personal connection with (Green & Brock, 2004), and 2) they can simultaneously observe and gain an understanding of how to perform a behavior (e.g., strenuous physical activity, energy conservation practices, or food waste prevention) that they might otherwise not consider doing. This form of gameplay could, in turn, increase the player's degree of PBC by visualizing the resources, opportunities and abilities a person might have to perform the behavior in question (Fjællingsdal & Klöckner, 2017; Klöckner, 2015, p.70), and present this in an engaging (Hafner & Jansz, 2018; Jackson et al., 2018; Lu, 2015), immersive (Brown & Cairns, 2004; Sweetser & Wyeth, 2005), experimental (Rieber, 1996; Zimmermann, 1990), safe (García-Barros et al., 2015; McGonigal, 2012, p.303), and interactive manner (Costikyan, 2002; Elson et al., 2014; Green & Jenkins, 2014). As such, it is safe to conclude that games can be used as tools to increase a person's PBC by eco-visualizing human behavior through a virtual, interactive perspective (Fjællingsdal & Klöckner, 2017).

Regarding the remaining two variables of the TPB – personal attitudes towards the behavior and subjective norms – the findings from the Green Gaming Project are limited. Although some of the respondents showed a greater degree of appreciation with the gameplay sessions while playing with a group rather than playing alone (Fjællingsdal & Klöckner, 2019), one of the core motivators of gameplay (Bartle, 1996; Fjællingsdal & Klöckner, 2017; Fu et al., 2009, Sweetser & Wyeth, 2005), this did not appear to affect their attitudes towards the game's topic to any significant degree. As many of the players initially described themselves as environmentally literate and performed a variety of pro-environmental behaviors even before the gameplay session started (Fjællingsdal & Klöckner, 2017, 2019, 2020), they noted that the game served as a tool that *reinforced* or *recontextualized* something

they already knew or acted upon. As the quality and amount of information a person possesses is known to facilitate behavioral intentions and subsequent behavioral actions (Ajzen, 1989, p.258), it is therefore highly likely that game-based learning can, on a longitudinal level, be a promising tool to drive future behavior. Some also stated that they had memberships in certain pro-environmental organizations before gameplay was initiated (Fjællingsdal & Klöckner, 2020). This finding suggests that individuals who already exhibit pro-environmental attitudes are more likely to seek out games with an environmental theme (Fjællingsdal & Klöckner, 2017), and that games are more apt to reinforce pre-existing environmental attitudes rather than generate new ones. Games that do not capture their players' interest are unlikely to be played in the first place (Sweetser & Wyeth, 2005), and individuals that do not possess a basic interest in environmental topics are therefore unlikely to engage with a game that features such topics very heavily. Environmental games thus stand the risk of not reaching their intended audience (i.e., individuals with a low degree of environmental literacy), and are more likely to appeal to individuals who already exhibit pro-environmental attitudes and behaviors – although they can be useful for filling any holes that may exist in the players' knowledge structures surrounding the environment (Fjællingsdal & Klöckner, 2019, 2020) or serve as a priming agent for future pro-environmental behavior (Gifford, 2014). It is therefore important that future environmental game design features elements that appeal to a wider media audience, such as the ability to explore vast worlds, compete and collaborate, obtain achievements and powerful resources and socialize with other players (Bartle, 1996), and that these elements are emphasized in the promotion and marketing of the game.

6.3.2 Environmental games and the norm-activation model (NAM)

The norm-activation model, or NAM, was originally designed to explain what causes altruistic behavior – actions that are conducted out of interest for the welfare of others rather than the self (Klöckner, 2015, p.76; Schwartz & Howard, 1981; Trivers, 1971). As many of the games utilized in the Green Gaming Project often enabled and even actively encouraged sabotage and competition between their players (Fjællingsdal & Klöckner, 2019, 2020), cooperation and altruistic behavior was only rarely observed during the gameplay sessions. Also, in the Eco study (Fjællingsdal & Klöckner, 2019), several of the players played alone, thus leaving little opportunity for social comparisons. In the later board game study (Fjællingsdal & Klöckner, 2020), the games tended to rely on so-called *zero-sum victories* where there could only be one clear winner (Fennewald & Kievit-Kylar, 2013), thus

necessitating the players' use of competitive rather than cooperative strategies. As a result, the Green Gaming Project did not contribute significantly towards the understanding of how serious environmental games can facilitate and motivate prosocial behavior towards others. It did, however, result in a core finding of particular relevance to the remaining two subcomponents of the NAM and future research on normative behavior in serious environmental games.

As environmental games are shown to have interactive and eco-visual properties that can illustrate the players' individual impacts on the in-game environment (Fjællingsdal & Klöckner, 2019, 2020), they can likely be utilized to influence the players' awareness of consequences (AC) as well as ascription of responsibility (AR) – two core variables of the NAM (de Groot & Steg, 2009). As the players in the Green Gaming Project's empirical studies noted, playing games helped them better understand how their in-game actions would affect their own and their fellow players' situations (Fjællingsdal & Klöckner, 2019, 2020). If the project had utilized a stricter approach to guiding the gameplay sessions, such as by encouraging the players to emphasize collaboration rather than competition, normative factors such as social acceptance of pro-environmental practices (Cialdini et al., 1991; Smith et al., 2012) or how groups establish rules regarding how the environment should be managed (Johnson & Johnson, 2009, p.17) could be studied in-depth. However, it should be noted that directing gameplay sessions in such a way is both limiting to the players and highly didactic, thus potentially undermining the benefits of the degrees of freedom and experimental learning opportunities that the gameplay arena might provide (Kolb et al., 2000; Schell, 2008, p.284; Sweetser & Wyeth, 2005). Additionally, it is worth considering that certain games are simply designed to be played in a competitive manner. It is therefore likely that the games utilized in the Green Gaming Project are unsuitable for studying normative behavior directly, especially in the case of prosocial norms, although a structured playthrough session with a special emphasis on social acceptability in group-based environmental management represents an interesting future research venue.

6.3.3 Environmental games and the value-belief-norm theory (VBN)

The value-belief-norm theory, or VBN, adds a chain of commonly held values (egoistic, altruistic and biospheric) to the previously mentioned NAM framework (Stern, 2000). These values directly influence a person's general environmental paradigm belief system, or NEP, which describes the growing tendency that humans are beginning to understand the impact of their actions on the environment (Dunlap et al., 2000; Stern et al., 1999). As values represent

guiding principles in a person's life (Schwartz, 1992), they commonly influence how a person makes choices and act on what they consider to be subjects of importance (de Groot & Thøgersen, 2013; Johnson et al., 2004; Martin & Czellar, 2017; Nguyen et al., 2016; Ojea & Loureiro, 2007; Pooley & O'Connor, 2000; Stern, 2000; Stern & Dietz, 1994; van der Werff et al., 2013). They also affect a person's degree of understanding surrounding their own environmental impact or footprint, as well as their perceived ability to reduce what they consider to be threats to the environment they live in (Stern, 2000). Values are also, however, extremely resistant to change (Jacobs et al., 2013, p.80) and only occasionally drive behavior (Verplanken & Holland, 2002), and it is therefore unlikely that casually playing environmental games can completely alter a person's values, NEP and subsequent behavioral patterns. They are, however, capable of involving a variety of stakeholders and enabling the collective envisioning of alternate futures (Foltz et al., 2019; Wu & Lee, 2015), and allow the individual player to consider the worldviews, values, beliefs, and ideologies of the other players. Some games used in the Green Gaming Project, such as Keep Cool (Eisenack & Petschel-Held, 2004; Fjællingsdal & Klöckner, 2020) are specifically designed to provide an arena for discussion and inter-stakeholder negotiation. By enabling debate between varied worldviews and value orientations, environmental games can generate a deeper understanding of other stakeholders' viewpoints surrounding core environmental topics (Illingworth & Wake, 2019). As such, environmental games might not be sufficient to alter a person's value and belief system, but they are fully capable of illustrating it to other players and making others' values and beliefs more salient.

Perhaps the most intriguing finding from the Green Gaming Project in relation to the subcomponents of the VBN theory, however, is that games serve to enhance the perceived adverse consequences for valued objects (Stern, 2000, p.412). As humans are loss-averse (Arkes & Hutzel, 2000; Knox & Inkster, 1968) and tend to experience negative emotional activation when something is suddenly considered to be either lost or about to become unavailable (Cialdini, 2007, p.238), environmental games can be utilized to illustrate a possible future scenario where certain precious and desirable resources, such as clean air and water, are gone forever. A contemporary example of games being used in this way is the World Without Oil project, where approximately 2000 project participants were enrolled in a virtual world where they were forced to consider the ramifications and consequences of an oil shortage – ranging from brownouts from oil-dependent power companies to cancelled airline flights (McGonigal, 2012, p.303). People from all walks of life were encouraged to collaborate and collectively ruminate over some of the core challenges related to an eventual

oil shortage, and come up with creative solutions for any issues they could think of that would likely appear as the oil ran out. This illustrates, as in the case of the Green Gaming Project (Fjællingsdal & Klöckner, 2020), that games can be used as a shared arena for cooperation and interdisciplinary brainstorming, as well as allowing for the sharing and constructive criticism of intriguing thoughts and ideas that may be founded in varying values and beliefs.

6.3.4 Environmental games and the goal-framing theory (GFT)

The goal-framing theory, or GFT, contends that human behavior is guided by a set of goal frames – overarching sets of personal motivations ranging from a desire to feel good in the moment (the hedonic goal frame), to a desire to maintain or otherwise upkeep personal resources (the gain goal frame), and a desire to act and behave appropriately with regard to both one's own values as well as the formative social context (the normative goal frame) (Lindenberg & Steg, 2007). Several of these goal frames may be active simultaneously, and their relative strengths contribute towards whether a certain behavior will be performed or not (Lindenberg & Steg, 2013). As such, in any given context, a person will perform a pro-environmental behavior if the correct goal frames are focal and strong enough (Klöckner, 2015, p.83). In general, the goal frame that is most heavily associated with pro-environmental behavior is the normative goal frame, where personal interests and gains are pushed aside in favor of socially appropriate actions (Lindenberg & Steg, 2007) – i.e., actions that benefit the collective rather than the individual. To perform such behaviors, people need information and knowledge that enables and clarifies the behavior in question (Lindenberg & Steg, 2007). Environmental information and knowledge, weak predictors of pro-environmental behavior on their own (Abrahamse et al., 2007; Deci & Flaste, 1995, p.36; Finger, 1994; Frick et al., 2004; Geller, 1981; Hines et al., 1987; Jensen, 2002; Johnson & Johnson, 2009, p.50; Keeble, 1988; Kollmuss & Agyeman, 2002; Moser, 2010; Roth, 1992; Staats et al., 1996), are shown to be highly effective when combined with a normative goal frame to act in accordance with what the social collective considers to be desirable (Lindenberg & Steg, 2007). As previously detailed, environmental games are highly effective in increasing and recontextualizing knowledge and information about a variety of topics related to the field of environment and sustainability (Fjællingsdal & Klöckner, 2017, 2019, 2020). They might therefore serve an important role as drivers of socially acceptable pro-environmental behavior by visualizing it in an interactive, safe, and experimental arena.

Goal-framing was not a focal point in the Green Gaming Project, as the main purpose and intent was to allow the players the freedom and autonomy to unfold themselves in the

game worlds at their own leisure – an element of game enjoyment identified by a multitude of game scholars and -designers (e.g., Huizinga, 1950, p.13; McGonigal, 2012, p.21; Rieber, 1996; Sweetser & Wyeth, 2005; Upton, 2015, p.15; Zimmermann, 1990). Activating normative goal frames, however, might be an interesting angle for future researchers to consider in their implementation of serious games for environmental education, especially considering that the normative goal frame is associated with enacting pro-environmental behaviors (Lindenberg & Steg, 2007). To activate goal frames using environmental games, game-based priming appears to be a promising venue. Priming is a psychological process where certain stimuli (such as words or pictures) influence the response to a later stimulus (Klöckner, 2015, p.86). By introducing the player to novel sustainability concepts early in the game, or by tasking the players to perform a specific form of pro-environmental behavior, it is possible to generate a goal frame that the players can act within. One example of this could be to encourage players in a game of Eco (Fjællingsdal & Klöckner, 2019; Strange Loop Games, 2020) to construct a building solely based on a text- or image-based prompt (such as the word "sustainability" or "green"), and then conduct a post-gameplay session where their finished construction can be scrutinized and discussed. During the construction process, an instructor could observe the players' progress, ask questions about the decisions the players make, and provide feedback on what is being built. These forms of instructor-based feedback have been shown to be highly effective at promoting certain pro-environmental practices, such as energy saving (Abrahamse et al., 2007) and recycling (Schultz, 1999), and the provision of feedback after a game session can be both individual and group-based; individual feedback allows people to compare their performance with their own personal goals, whereas group-based feedback might activate the normative goal frame by triggering comparisons between one's own behavior and that of others (Lindenberg & Steg, 2007).

While the premise of using games to activate goal frames is an interesting future research arena, the goal frames that are activated through gameplay largely depend on how the game is designed. Many environmental games are zero-sum victories – meaning that there can only ever be one clear winner (Fennewald & Kievit-Kylar, 2013). This, in turn, would therefore largely activate hedonic and gain goals (Lindenberg & Steg, 2007) due to how the individual player has nothing to gain or lose by defeating or sabotaging the other players. However, there are some cases where maintaining a balance in the game together is pertinent to collective victories. Consider, for example, how Eco (Strange Loop Games, 2020) requires collaboration between the different player roles to shoot down the incoming meteor and maintain balance in the game's ecosystem (Fjællingsdal & Klöckner, 2019), or how parts of

the island of Catan starts sinking in the Oil Springs scenario if someone disturbs the balance in the game world (Assadourian & Hansen, 2011). For the activation of normative goal frames, it would be interesting to focus on designing games such as these in the future or modifying existing commercial games to include collaborative elements (Illingworth & Wake, 2019). It would, however, also take away from the sabotage aspect which a lot of players enjoy (Bartle, 1996).

6.3.5 Environmental games and the motivation-opportunity-ability model (MOA)

The final behavioral model presented in chapter 3 was the motivation-opportunity-ability model, or MOA. This model states that a person's pro-environmental behavior is contingent on their motivation to perform the behavior in question, personal and contextual opportunities through which the behavior can be performed, as well as the actor's cognitive, physical, and financial abilities to take action (Ölander & Thøgersen, 1995; Thøgersen, 2010). The model furthermore states that the pro-environmental behavior in question needs to be perceived as realistic or manageable when compared to the less desirable, environmentally hostile behavioral alternative (Klöckner, 2015, p.22), and that it will not be enacted if one or more of the model's subcomponents (motivation, opportunity, ability) are absent (Pieters, 1991; van Geffen et al., 2020). By contrast to the previously introduced psychological models, the MOA also considers how the individual makes decisions and acts within a given context, and that a person is apt to make different decisions based on the physical environment they are situated in (Boulstridge & Carrigan, 2000; Kollmuss & Agyeman, 2002; Thøgersen, 2010).

For the first subcomponent of the MOA, the motivation to act, games are known to be highly motivational and engaging learning tools (Fu et al., 2009; Jackson et al., 2018; Sweetser & Wyeth, 2005). By providing the player with immersive, thought-provoking, and profound experiences (Bopp et al., 2016; Fjællingsdal & Klöckner, 2017; Marsh & Costello, 2012; Odenweller et al., 1998), games are, in some cases, shown to motivate real-life behavior that would otherwise be perceived as tedious or difficult – such as physical exercise (Baranowski et al., 2008; Yee et al., 2009). In other cases, serious games are shown to increase their players' interest and awareness in various subjects (Aoki et al., 2004; Gerling et al., 2014; Williams & Williams, 1987), which could motivate them to seek out further information about these topics voluntarily. Although the Green Gaming Project showed that the majority of the players were already involved in pro-environmental behaviors (Fjællingsdal & Klöckner, 2019, 2020), they also stated that the games inspired them to maintain the behavior they were already exhibiting. The respondents also noted that the

games provided them with new knowledge and information that they were not previously aware of, such as how rapidly a species population could decline when subjected to human activity (Fjællingsdal & Klöckner, 2019), or how visual elements in the game were used to aid the players' understanding of their carbon footprint size (Fjællingsdal & Klöckner, 2020). The players would frequently describe such in-game events as both surprising and 'eye-opening', although they would also note that most of the information provided by the games was already known to them. Several of the respondents would add their own suggestions as to who they could imagine the games were extra suitable for, and that they clearly saw the motivational potential in using games for environmental education (Fjællingsdal & Klöckner, 2017, 2019, 2020). Although it is yet unclear to what degree the motivation to play environmental games translates into the motivation to enact pro-environmental behavior in a real-life setting, a fundamental game-based learning problem caused by the simulation gap (Bogost, 2010, p.43), games certainly show potential towards generating interest and awareness towards a variety of environmental topics.

The second subcomponent of the MOA concerns the number of opportunities a person has to act pro-environmentally, and includes situational contexts such as the degree of access to organic foods and price differences between environmentally friendly and environmentally hostile produce (Thøgersen, 2010). However, as environmental games generally contain strong fantasy elements (Malone & Lepper, 1987), and situate the players in unrealistic situations, it is easy to discredit their role in teaching useful skills that can be applied to problem-solving in the real world. While the level of realism in serious games and simulations generally has little effect on their educational effectiveness (e.g., Feinstein & Cannon, 2002; Norman et al., 2012; Schwartz, 2006), and most who choose to play games are willing to overlook realistic flaws in the games they play in favor of enjoying the gameplay experience as a whole (Holland, 2003), the games that were utilized in the Green Gaming Project largely revolved around game mechanics that very rarely situated their players in realistic situations. In Fate of the World (Roberts, 2011), for example, the player is put in charge of the entire globe – tasked with preventing anything from natural disasters to civil war (Fjællingsdal & Klöckner, 2017; Klöckner, 2015, p.199). In Keep Cool (Eisenack & Petschel-Held, 2004) and Evolution: Climate (Crapuchettes, 2016), the players are put in charge of high-level climate negotiations and preserving several species of animals (Fjællingsdal & Klöckner, 2020), both of which are unlikely scenarios to encounter in a real-life setting. This suggests a disconnect between the role the player enters in the game world and the roles they enact in a real-life setting (Klöckner, 2015, p.211), as well as putting little to no emphasis on the power of

individual action in more realistic, everyday situations. Eco (Strange Loop Games, 2020) was perhaps the game with the strongest emphasis on personal environmental impact, and despite containing several fantasy elements (such as a meteor threatening to obliterate the planet in 30 days), it also featured situations in which the player's personal choices had a lasting, noticeable impact while simultaneously not being perceived as too unrealistic (Fjællingsdal & Klöckner, 2019). As Eco features numerous environmental themes and topics that are connected with daily life, ranging from the energy types and -usage of household appliances to pollution from various incorrectly disposed human waste products, playing Eco together with skilled facilitators could help the players by logically connecting their in-game actions to situations they experience in their day-to-day living (Skaug et al., 2020) as well as providing a clearer image of the opportunities they have at their disposal to conduct a variety of everyday pro-environmental actions.

The third and final subcomponent of the MOA concerns the abilities a person has to act pro-environmentally, and includes personal resources such as knowledge, time, and money (Thøgersen, 2010). Throughout the Green Gaming Project, the most concise finding was that playing environmental games can both 1) provide the players with new information and knowledge, as well as 2) recontextualize and reinforce knowledge that they already possessed (Fjællingsdal & Klöckner, 2017, 2019, 2020). The fact that the respondents often reported that they already understood most of the information contained in the game is hardly surprising, as most environmental games cover their topics on a very superficial level (Reckien & Eisenack, 2013). It does, however, raise the question of which type of knowledge that is prioritized in the game's design. As explained in chapter 3, human knowledge is often divided into four categories: conceptual, situational, procedural, and strategic (Alexander & Judy, 1988; de Jong & Ferguson-Hessler, 1996). Most serious (environmental) games are designed to increase their players' declarative or conceptual knowledge (den Haan & Van der Voort, 2018; Klöckner, 2015, p.203; Reckien & Eisenack, 2013; Turnin et al., 2001), such as the basics of how certain animal species adapt to changing climates or how oil is a valuable, yet environmentally harmful resource (Fjællingsdal & Klöckner, 2020). However, most environmental games on the market today put far less emphasis on the types of knowledge that are associated with human behavior. Human behavior rarely results from a simple conceptual understanding of the task or issue that needs to be handled. One needs to understand both how the task is supposed to be done (procedural knowledge), which elements the task consists of and how they interact in a given setting (situational knowledge), and which plan of action is the most effective to reach a satisfying conclusion to the task (strategic

knowledge) (de Jong & Ferguson-Hessler, 1996). As games provide interactive and experimental arenas for learning (García-Barros et al., 2015; McGonigal, 2012, p.303; Rieber, 1996; Zimmermann, 1990) that appeal and respond to a variety of our senses and human functionalities (Burn, 2008), they are uniquely suited to teach these varied forms of knowledge to their players.

6.4 Concluding remarks

As the scientific insight into how human activity impacts the environment becomes clearer (e.g., Cook et al., 2013, 2016; Houghton, 2015; IPCC, 2013), it is more important than ever before to involve the public in partaking in pro-environmental action. As a result of this increasing emphasis on public involvement, innovative and sometimes even playful approaches to environmental communication interventions are being developed in order to motivate, empower, transform, and engage various audiences in the battle against anthropogenic climate effects (e.g., Klöckner, 2015). One such approach comes in the form of games, which have been shown to be highly effective with regard to both their educational effectiveness (Aoki et al., 2004; Annetta et al., 2009; Baranowski et al., 2008; Gerling et al., 2014; Williams & Williams, 1987; Yee et al., 2009) as well as their inherent properties of fun (Connolly et al., 2012; Salen & Zimmerman, 2004, p.334; Sweetser & Wyeth, 2005), immersion (Hamari et al., 2016; Pourabdollahian et al., 2012; Rumore et al., 2016), challenge (Bartle, 1996; Waddington & Fennewald, 2018), thought-provoking elements (Bopp et al, 2016; Marsh & Costello, 2012; Odenweller et al., 1998), multi-stakeholder participation opportunities (Bartle, 1996; Dieleman & Huisingh, 2006; Eisenack, 2013), multimodality (Burn, 2008) and ability to simplify complex systems and topics (Egenfeldt-Nielsen et al., 2013, p.237; Gee, 2007, p.59; Waddington & Fennewald, 2018), just to name a few. Despite their promising implications for environmental communication, empirical studies of environmental games remain very scarce (Hallinger et al., 2019; Klöckner, 2015, p.200/205) regardless of the growing scientific interest in them (Reckien & Eisenack, 2013). The three empirical studies contained in this thesis, the Green Gaming Project, seek to provide a preliminary answer to the call for more scientific insight into the use of games to promote environmental literacy (Fjællingsdal & Klöckner, 2017, 2019, 2020). For this purpose, a tool has been constructed for any future game designers wishing to create environmental games capable of striking the chord between fun and learning (Fjællingsdal & Klöckner, 2017). Potential strengths and weaknesses of using environmental games in sustainability education have been presented, and the research findings have been connected to the most dominant

models of behavioral change within the field of psychology (Ajzen, 1985, 1991; Lindenberg & Steg, 2007, 2013; Ölander & Thøgersen, 1995; Schwartz & Howard, 1981; Stern, 2000). Despite promising dawning evidence for the effectiveness of games in promoting environmental literacy, however, the road to using games on a regular basis in education remains long and arduous. Several pitfalls still exist in the field, ranging from the implementation opportunities of games in classrooms to the role of the learners, teachers, and researchers in determining the game's effectiveness as a learning tool (e.g., Skaug et al., 2020). As a final conclusion, therefore, it is strongly recommended to continue future research into the use of games for environmental education, and to direct the scope towards the use of games in the promotion and empowerment of core psychological variables connected to behavioral change.

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Appendices

Appendix 1 – NSD approval forms

These are screenshots of the NSD approval forms for the Eco study (Fjællingsdal & Klöckner, 2019) and the board game study (Fjællingsdal & Klöckner, 2020). Please note that the Eco study has been reported with a different name, and that this name changed for the final draft of the project.

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

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Kristoffer Skomsøy Fjællingsdal
Psykologisk institutt NTNU

7491 TRONDHEIM

Vår dato: 29.03.2016 Vår ref: 47409 / 3 / HIT Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 15.02.2016. All nødvendig informasjon om prosjektet forelå i sin helhet 23.03.2016. Meldingen gjelder prosjektet:

47409	*ENED-GEM: The ENvironmental EDucational Game Enjoyment Model and its potential for application in game design*
Behandlingsansvarlig	*NTNU, ved institusjonens øverste leder*
Daglig ansvarlig	*Kristoffer Skomsøy Fjællingsdal*

Etter gjennomgang av opplysninger gitt i meldeskjemaet og øvrig dokumentasjon, finner vi at prosjektet ikke medfører meldeplikt eller konsesjonsplikt etter personopplysningslovens §§ 31 og 33.

Dersom prosjektopplegget endres i forhold til de opplysninger som ligger til grunn for vår vurdering, skal prosjektet meldes på nytt. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html.

Vedlagt følger vår begrunnelse for hvorfor prosjektet ikke er meldepliktig.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Hildur Thorarensen

Kontaktperson: Audun Løvlie tlf: 55 58 23 07
Vedlegg: Prosjektvurdering

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 47409

Prosjektet skal analysere anmeldelser og omtaler av et spill på to forskjellige internettplatformer for dataspill. Disse platformene/nettsidene vil anvendes og refereres til som literære kilder, ikke som et utvalg av anmeldere.

Basert på epost korrespondanse med prosjektleder 22. og 23. mars 2016 kan vi ikke se at det behandles personopplysninger med elektroniske hjelpemidler, eller at det opprettes manuelt personregister som inneholder sensitive personopplysninger. Prosjektet vil dermed ikke omfattes av meldeplikten etter personopplysningsloven.

Det ligger til grunn for vår vurdering at alle opplysninger som behandles elektronisk i forbindelse med prosjektet er anonyme.

Med anonyme opplysninger forstås opplysninger som ikke på noe vis kan identifisere enkeltpersoner i et datamateriale, verken:
-direkte via personentydige kjennetegn (som navn, personnummer, epostadresse el.)
-indirekte via kombinasjon av bakgrunnsvariabler (som bosted/institusjon, kjønn, alder osv.)
-via kode og koblingsnøkkel som viser til personopplysninger (f.eks. en navneliste)
-eller via gjenkjennelige ansikter e.l. på bilde eller videoopptak.

Personvernombudet anbefaler av forskningsetiske hensyn at forsker informerer utvalget på nettforum og nettsider der dette er mulig.

Viser for øvrig til NESH sine forskningsetiske retningslinjer: https://www.etikkom.no/forskningsetiske-retningslinjer/Samfunnsvitenskap-jus-og-humaniora/

NSD Approval 1 – The ENED-GEM study

Kristoffer Skomsøy Fjællingsdal

7491 TRONDHEIM

Vår dato: 04.08.2017 Vår ref: 54685 / 3 / LAR Deres dato: Deres ref:

Tilbakemelding på melding om behandling av personopplysninger

Vi viser til melding om behandling av personopplysninger, mottatt 08.06.2017.
Meldingen gjelder prosjektet:

54685	*The Green Journal: A Study of Environmental Gaming and its Psychological Effects*
Behandlingsansvarlig	*NTNU, ved institusjonens øverste leder*
Daglig ansvarlig	*Kristoffer Skomsøy Fjællingsdal*

Personvernombudet har vurdert prosjektet, og finner at behandlingen av personopplysninger vil være regulert av § 7-27 i personopplysningsforskriften. Personvernombudet tilrår at prosjektet gjennomføres.

Personvernombudets tilråding forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database.

Personvernombudet vil ved prosjektets avslutning, 01.01.2018, rette en henvendelse angående status for behandlingen av personopplysninger.

Dersom noe er uklart ta gjerne kontakt over telefon.

Vennlig hilsen

Katrine Utaaker Segadal

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

Marine Strand Schlichtmann

NSD – Norsk senter for forskningsdata AS Harald Hårfagres gate 29 Tel: +47-55 58 21 17 nsd@nsd.no Org.nr. 985 321 884
NSD – Norwegian Centre for Research Data NO-5007 Bergen, NORWAY Faks: +47-55 58 96 50 www.nsd.no

NSD Approval 2 – The Eco study

Kristoffer Skomsøy Fjællingsdal

7491 TRONDHEIM

Vår dato: 20.04.2018 Vår ref: 59993 / 3 / AMS Deres dato: Deres ref:

Vurdering fra NSD Personvernombudet for forskning § 31

Personvernombudet for forskning viser til meldeskjema mottatt 21.03.2018 for prosjektet:

59993	*All A-board: Investigating the potential of green boardgames in sustainability education*
Behandlingsansvarlig	*NTNU, ved institusjonens øverste leder*
Daglig ansvarlig	*Kristoffer Skomsøy Fjællingsdal*

Vurdering

Etter gjennomgang av opplysningene i meldeskjemaet og øvrig dokumentasjon finner vi at prosjektet er meldepliktig og at personopplysningene som blir samlet inn i dette prosjektet er regulert av personopplysningsloven § 31. På den neste siden er vår vurdering av prosjektopplegget slik det er meldt til oss. Du kan nå gå i gang med å behandle personopplysninger.

Vilkår for vår anbefaling

Vår anbefaling forutsetter at du gjennomfører prosjektet i tråd med:

- opplysningene gitt i meldeskjemaet og øvrig dokumentasjon
- vår prosjektvurdering, se side 2
- eventuell korrespondanse med oss

Vi forutsetter at du ikke innhenter sensitive personopplysninger.

Meld fra hvis du gjør vesentlige endringer i prosjektet

Dersom prosjektet endrer seg, kan det være nødvendig å sende inn endringsmelding. På våre nettsider finner du svar på hvilke endringer du må melde, samt endringsskjema.

Opplysninger om prosjektet blir lagt ut på våre nettsider og i Meldingsarkivet

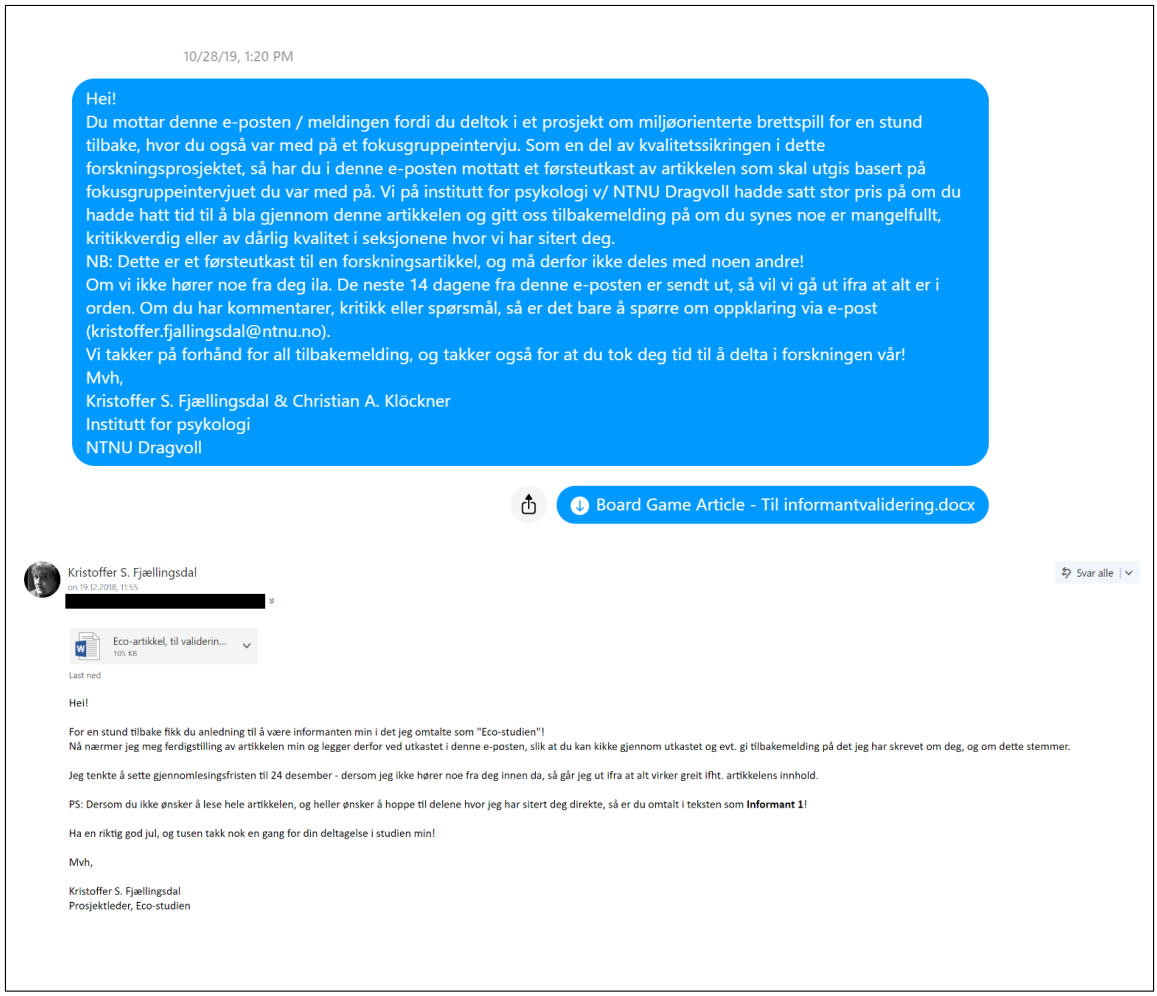
Vi har lagt ut opplysninger om prosjektet på nettsidene våre. Alle våre institusjoner har også tilgang til egne prosjekter i Meldingsarkivet.

Vi tar kontakt om status for behandling av personopplysninger ved prosjektslutt

Ved prosjektslutt 31.12.2018 vil vi ta kontakt for å avklare status for behandlingen av

NSD Approval 3 – The board game study

Appendix 2 – Game evaluation emails and messages



Screengrabs of example messages sent to respondents

These are screengrabs of example messages sent to respondents to both the board game study (top) and the Eco study (bottom). The top screengrab is from a Facebook Messenger conversation, whereas the bottom screengrab is from NTNU's email client at the time of the study. The respondents' names have been omitted due to ethical guidelines and personal protection. Both messages contain a copy of the respective articles for validation. A translation of the messages follows here:

Top message (Board game study): "Hello! You are receiving this e-mail / message because you participated in a project about environmentally-oriented board games a while back, where you also participated in a focus group interview. As part of the quality assurance in this research project, you have received a first draft of the article that will be published based on the focus group interview you participated in. We at the Department of Psychology at NTNU Dragvoll would greatly appreciate if you could take some time and browse through this

article and provide us with feedback if you think anything is lacking, worthy of critique or of poor quality in the sections where we have quoted you. NB: This is a first draft for a research article, and must therefore not be shared with others! If we do not hear from you in the next 14 days from this email has been sent out, we will assume that everything is in order. If you have comments, criticism or questions, please ask about clarification through email (kristoffer.fjallingsdal@ntnu.no). We thank you in advance for all your feedback, and we also thank you for taking time to participate in our research!

Best regards,

Kristoffer S. Fjællingsdal & Christian A. Klöckner
Department of Psychology
NTNU Dragvoll"

Bottom message (Eco study): "Hello! A while back you had the opportunity to be my respondent in what I spoke of as the "Eco study"! I am nearing completion of my article, and therefore added the draft in this email so that you can look through it and possibly provide feedback on what I have written about you, and if this is correct. I was thinking I would set the perusal deadline to December 24th – if I do not hear from you by then, I will assume that everything seems okay in regard to the contents of the article.

PS: If you do not want to read the entire article, and would rather skip to the parts where I have quoted you directly, you are designated as **Informant 1** in the text.

Have a very merry Christmas, and thank you again for participating in my study!

Best regards,

Kristoffer S. Fjællingsdal
Project leader, the Eco study"

Appendix 3 – Interview guides

This section includes the interview guides that were used in papers 2 (Fjællingsdal & Klöckner, 2019) and 3 (Fjællingsdal & Klöckner, 2020). Both studies utilized a semi-structured interview design, and some variations in how the questions were asked (as well as certain context-specific sub-questions) are omitted.

Do you consider yourself an environmentally conscious person?

What are your thoughts on using games like Eco in an educational setting?

Do you feel that you have learned something about the environment from playing Eco?

Is there anything about Eco you would describe as particularly good?

Is there anything about Eco you would describe as particularly bad?

Could you describe how you felt while playing Eco?

Do you feel that Eco has changed your view of the environment?

Do you feel that Eco has taught you something about how to circumvent environmental issues?

What are your thoughts about the level of difficulty in Eco?

Do you have any other thoughts or comments about the Eco project?

Interview guide 1 – Eco study

1. What are your thoughts on using games for educational purposes?
2. Why did you choose the game you ended up playing?
3. What, in your opinion, is the main theme or topic of the game?
4. Were the rules easy to understand?
5. Was there anything about the game that you perceived as particularly good?
6. Was there anything about the game that you perceived as particularly bad?
7. What do you think about the relationship between cooperation and competition in the game?
8. Do you feel that the game has taught you anything about our environment?
9. Do you feel that the game gave you a greater degree of insight into how our environment works?
10. Do you feel that the game has inspired you to do something positive for the environment in the near future? In that case; what?
11. How do you feel the game has provided you with insight into how you can circumvent environmental issues?
12. Do you have any other comments about the game session?

Interview guide 2 – Board game study

Appendix 4 – Information sheets for respondents

This section includes the information sheets that each respondent received before the research processes were initialized. They were intended to generate an understanding for the background of each project, as well as to provide the respondents with their informed consent, as to adhere to ethical guidelines.

Kristoffer S. Fjællingsdal
PhD-stipendiat, miljøpsykologi
NTNU Dragvoll – Institutt for psykologi
Trondheim, Norge
E-post: kristoffer.fjallingsdal@ntnu.no

Invitasjon til deltagelse i Eco-prosjektet

Hei!

Navnet mitt er Kristoffer Fjællingsdal, stipendiat i miljøpsykologi ved NTNU i Trondheim, og jeg inviterer dere herved til å inngå i et spennende og fremtidsrettet forskningsprosjekt innen feltet *miljø og læring*.

Bakgrunn og formål:
For tiden driver jeg og min kollega Christian A. Klöckner (professor i miljøpsykologi) med rekruttering til å delta i et spillbasert prosjekt hvor vi ønsker å se om det å spille dataspill kan lære bort noe om miljøet vårt. Som kjent står verden ovenfor en stor belastning når det kommer til miljøproblemer som forurensning, forsøpling og havforsuring, bare for å nevne noen av dem, og NTNU har etablert bærekraft som en av våre sentrale satsningsområder for årene framover. Ihht. det internasjonale samarbeidet som har oppstått siden Parisavtalen ble nedfelt, har interessen for miljøorientert forskning vokst, og nye arenaer tas nå i bruk for å utdanne og informere allmennheten om miljøproblemer vi står ovenfor. Det er i denne sammenheng at forskningsprosjektet vårt er igangsatt – nemlig for å lære unge mennesker om miljøet vårt via bruken av en forholdsvis ny og høyst engasjerende medieplattform, *dataspill*!

Spillet vi ønsker å benytte oss av, *Eco*, introduserer spillerne til et stort utvalg av ulike miljøproblemer som de er nødt til å løse. Spillsesjonene vil basere seg i at spillerne får utfolde seg i en fargerik virtuell verden der de må samarbeide om å fordele begrensede ressurser seg imellom og bygge et teknologisk avansert samfunn der miljøproblemer som forurensning og karbonutslipp vil være med på å gjøre tilværelsen heller utrivelig.

Dere finner en kjapp gjennomgang av spillets mål og mening i følgende YouTube-lenke:
https://www.youtube.com/watch?v=EzGpWWX0rXU

Vi samarbeider forholdsvis tett med Ecos utviklere, Strangeloop Games.

Dersom dette virker interessant, så vil jeg svært gjerne komme i kontakt med dere så raskt som mulig. Jeg håper at dere har lyst til å være med oss, og sikre at dere får innsikt i en problematikk som påvirker oss på globalt nivå.

Hva innebærer deltakelse i studien?
Om dere ønsker å delta i Eco-studien, vil dere få utdelt brukernavn og passord til Eco-spillet via e-post. Herfra vil dere fritt kunne laste ned spillet. Dere vil imidlertid først bli bedt om å gi informasjon om spillsesjonene deres via totalt to digitale spørreskjema, hvor formålet vil være å se etter potensielle endringer i kunnskapsnivå og atferdsfaktorer relatert til miljøet. Spørreskjema 1 må dere besvare for å få tilgang til spillfilene, og spørreskjema nummer 2 får dere ettersendt av meg ved en senere anledning. Dere vil også få tildelt en digital dagbok, *Den Grønne Journalen*, hvor dere kan skrive ned hendelser i spillet som dere selv oppfatter som viktige, kule eller morsomme (eller grusomt irriterende!). Denne dagboken vil jeg etterspørre senere, og all informasjon om deg vil bli

anonymisert. De som ønsker det vil også bli invitert til å delta på intervju med prosjektlederen om hva de syntes om spillet og de læringsmekanismene som finnes i det.

Hva skjer med informasjonen om oss dersom vi velger å delta?
All informasjon om dere som samles inn vil anonymiseres når studien skal utgis. All personidentifiserende informasjon vil i løpet av prosjektet anonymiseres / krypteres for å beskytte identitetene deres.

Frivillig deltagelse!
Deltagelse i prosjektet er fullstendig frivillig, og dere som deltar har full rett til å trekke dere fra studien når dere måtte ønske det. Dersom dere trekker dere, vil samtlige opplysninger om dere anonymiseres og fjernes fra studien.

Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med prosjektleder Kristoffer S. Fjællingsdal på e-post (se under).

Mvh,

Kristoffer S. Fjællingsdal
PhD-stipendiat, miljøpsykologi
NTNU Dragvoll – Institutt for psykologi
Trondheim, NorgeE-post:
kristoffer.fjallingsdal@ntnu.no

NTNU
Kunnskap for en bedre verden

Information sheet 1 – The Eco study

Forespørsel om deltakelse i forskningsprosjekt

"All A-board: Investigating the potential of green boardgames in sustainability education."

Bakgrunn og formål

Formålet med denne doktorgradsstudien er å avdekke om brettspill kan være med på å øke kunnskapen og forståelsen vår av miljøet vårt. Prosjektet gjennomføres av PhD-stipendiat Kristoffer S. Fjællingsdal og professor Christian Klöckner fra Institutt for psykologi v/ NTNU Dragvoll, og er en del av NTNUs tematiske satsningsområde "NTNU Bærekraft".

Hva innebærer deltakelse i studien?

Om du velger å delta i denne studien, vil du få anledning til å være med på brettspillsesjoner arrangert av prosjektlederne. Underveis mens du spiller vil det foretas videoopptak av deg, slik at vi kan få et bedre bilde av hvordan du selv opplever spillsesjonen din. Du vil også få mulighet til å gjennomføre et intervju med prosjektlederen, hvor det vil fokuseres på hva du evt. lærte av å spille spillet. Spillene som benyttes vil primært ha miljø som tema.

Hva skjer med informasjonen om deg?

Alle personopplysninger vil bli behandlet konfidensielt. Opplysningene som sankes om deg, både videoopptak og informasjon fra intervju, vil behandles konfidensielt av prosjektgruppen til Fjællingsdal og Klöckner. I praksis betyr dette at all informasjon om deg vil bli anonymisert, og vil ikke kunne spores tilbake til deg. Opplysningene du gir til prosjektlederne vil oppbevares på passordbeskyttede enheter.

Prosjektet skal etter planen avsluttes i slutten av desember, 2018. Innen da vil alle opplysninger om deg være anonymisert.

Frivillig deltakelse

Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert.

Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med Kristoffer S. Fjællingsdal via følgende e-post: kristoffer.fjallingsdal@ntnu.no.

Studien er meldt til Personvernombudet for forskning, NSD - Norsk senter for forskningsdata AS.

Samtykke til deltakelse i studien

Jeg samtykker i å delta på:

Spillsesjoner med videoopptak

Intervju

Jeg har mottatt informasjon om studien, og er villig til å delta

---

(Signert av prosjektdeltaker, dato)

Information sheet 2 – The board game study

Appendix 5 – Norwegian Environmental Attitudes Inventory (EAI) Questionnaire

This is a complete version of the questionnaire received by the respondents in the Eco study, and is intended to gather personal information as well as ascertain their pro-environmental tendencies before initiating gameplay. Each of the questions are direct translations of Milfont and Duckitt's original 2010 article (Milfont & Duckitt, 2010).

Generell informasjon

Tusen takk for at du har tid og lyst til å delta i dette forskningseksperimentet. Foran deg nå har du et spørreskjema basert på holdninger du har til miljøet vårt, og spørsmålene finner du på de påfølgende sidene i dette skjemaet.

Først ønsker vi å få litt bakgrunnsinformasjon om deg. Svarene dine vil bli helt anonymiserte, og informasjonen om deg vil behandles konfidensielt.

Dette prosjektet er godkjent av NSD (Norsk senter for forskningsdata).

Vi takker igjen for at du tar deg tid til å besvare spørsmålene våre!

1. Kjønn:*
   - ◯ Mann
   - ◯ Kvinne
   - ◯ Ønsker ikke å oppgi kjønn

2. Alder (år):*
   - ◯ 0 - 15
   - ◯ 16 - 20
   - ◯ 21 - 25
   - ◯ 26 - 30
   - ◯ 31+

3. Hvor lenge har du spilt videospill?*
   - ◯ Jeg har aldri spilt videospill før jeg spilte Eco

- 1 - 5 år
- 6 - 10 år
- 11 - 15 år
- Over 15 år

4. Hvor ofte spiller du dataspill i løpet av en uke?*
   - Jeg spiller ikke dataspill
   - 1 - 2 ganger i uken
   - 3 - 4 ganger i uken
   - 5 - 6 ganger i uken
   - Mer enn 6 ganger i uken

5. Når du spiller videospill, hvor lenge spiller du vanligvis i løpet av en dag?*
   - Jeg har aldri spilt videospill før jeg spilte Eco
   - Under 1 time
   - 1 - 2 timer
   - 3 - 4 timer
   - 5 - 6 timer
   - Over 6 timer

6. Jeg synes at det å tilbringe tid i naturen er kjedelig.*
   - Svært enig
   - Enig
   - Nøytral
   - Uenig
   - Svært uenig

7. Jeg er IKKE den type person som liker å tilbringe tid i villmarken.*
   - Svært enig
   - Enig
   - Nøytral
   - Uenig

- Svært uenig

8. Jeg liker svært godt å gå tur i naturskjønne omgivelser, som i skogen eller marka.*
   - Svært enig
   - Enig
   - Nøytral
   - Uenig
   - Svært uenig

9. Jeg tror IKKE at folk som bor i industriland er nødt til å tilpasse seg en mer miljøvennlig livsstil i fremtiden.*
   - Svært enig
   - Enig
   - Nøytral
   - Uenig
   - Svært uenig

10. Jeg er imot at regjeringer kontrollerer og regulerer måten råmaterialer behandles for å få dem til å vare lengre.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

11. Folk som bor i industriland blir nødt til å tilpasse seg en mer miljøvennlig livsstil i fremtiden.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

12. Jeg vil IKKE involvere meg med noen som helst form for miljøorganisasjon.*
    - Svært enig
    - Enig

- Nøytral
- Uenig
- Svært uenig

13. Jeg prøver ofte å overbevise andre om at miljøet er viktig.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

14. Jeg har lyst til å bli med og delta aktivt i en aktivistgruppe for miljøet.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

15. Vi må holde elver og innsjøer rene for å beskytte miljøet, og IKKE for at mennesker skal få mulighet til å drive med vannsport.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

16. Miljøvern er viktig selv om det senker menneskenes levestandard.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

17. En av de viktigste grunnene til å holde innsjøer og elver rene er at mennesker skal få mulighet til å drive med ulike former for vannsport.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

18. Moderne vitenskap vil IKKE være i stand til å løse miljøproblemene våre.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

19. Mennesker vil til slutt lære hvordan naturen fungerer, slik at den kan kontrolleres.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

20. Moderne vitenskap vil løse miljøproblemene våre.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

21. Jeg tror IKKE at miljøet vårt har blitt skadet av menneskelig aktivitet.*

- Svært enig
- Enig
- Nøytral

- Uenig
- Svært uenig

22. Jorda er som et romskip med veldig begrenset plass og ressurser.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

23. Menneskelig aktivitet kan være svært skadelig for miljøet.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

24. Jeg foretrekker en hage som er vill og utemmet framfor en hage som er velholdt og vedlikeholdt av mennesker.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

25. Jeg synes IKKE at villmarksområder bør fjernes, uansett hvor stor økonomist gevinst dette kan medføre.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

26. Jeg foretrekker heller en hage som er velholdt og vedlikeholdt enn en vill og utemmet hage.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

27. Jeg er IKKE den type person som til daglig forsøker å spare på naturressurser.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

28. I dagliglivet mitt er jeg IKKE interessert i å spare vann og/eller elektrisitet.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

29. Når det er mulig, forsøker jeg så godt jeg kan å spare på naturressurser.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

30. Mennesker er skapt til å utvikle eller dominere resten av naturen.*

- Svært enig
- Enig
- Nøytral
- Uenig

- Svært uenig

31. Mennesker er en del av økosystemet på lik linje med andre dyr.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

32. Jeg tror IKKE at mennesker ble skapt for å utvikle eller dominere resten av naturen.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

33. Det å beskytte jobbene til folk er viktigere enn å beskytte miljøet.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

34. Folk er ikke oppmerksomme nok på hvordan menneskelig utvikling har skadet miljøet vårt.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

35. Det å beskytte miljøet er viktigere enn å beskytte jobbene til folk.*

- Svært enig
- Enig

- Nøytral
- Uenig
- Svært uenig

36. Det gjør meg trist å se at skog blir fjernet for å gi grunnlag for jordbruk.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

37. Naturen er en verdi i seg selv.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

38. Jeg blir IKKE trist når jeg ser at naturområder blir ødelagt.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

39. Familier bør oppmuntres til å få to barn eller mindre.*
    - Svært enig
    - Enig
    - Nøytral
    - Uenig
    - Svært uenig

40. Folk som sier at overbefolkning er et problem tar fullstendig feil.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

41. Et gift par bør kunne ha så mange barn de ønsker, såfremt de er i stand til å ta seg av dem.*

- Svært enig
- Enig
- Nøytral
- Uenig
- Svært uenig

Appendix 6 – Eco installation and gameplay guide

This is a copy of the installation and gameplay guide received by the respondents who answered the preliminary questionnaire administered by the lead researcher. The document contains instructions on how to download and install the game, as well as how to unlock access to it by providing a unique 5-digit user-ID and a password. The document also contains information about the intent behind the Green Journal (see next Appendix).

Hei!

Takk for at du besvarte det første av to spørreskjema i Eco-studien!
Da er det bare for meg å ønske deg velkommen til prosjektet!
Her er instruksjoner for hvordan du får tilgang på spillet:

Gå først inn på https://ecoauth.strangeloopgames.com/registration, og fyll inn feltene som dukker opp der.
Gå deretter inn på https://ecoauth.strangeloopgames.com/login
I feltet "Username or Email" skriver du inn **den femsifrede tallkoden** som du finner senere i denne e-posten (dvs., **ikke** e-postadressen din). Denne tallkoden (bruker-ID) er unik for deg, og begynner med tallet **X**.
I feltet "Password" skriver du **XXXXXX**
Trykk "Enter".
Du skal nå være innlogget, og kan laste ned spillfilene fra fanen "**Options**" og "**Eco Download**". Jeg vil også anbefale at du går inn på "**Account**" og trykker **Edit** - herfra kan du endre bruker-ID og passord til noe det er lettere for deg å huske til du skal logge deg inn neste gang.

Bruker-IDen din er: **XXXXX**
Passordet ditt er: **XXXXXX** (Dette kan du endre på senere til et passord som du liker bedre, ved å gå inn på "Account" og trykke "Edit").

Herfra står du helt fritt til å spille!

Vedlagt i denne e-posten finner du også et dokument kalt "Den Grønne Journalen". Det er en liten digital dagbok hvor jeg oppfordrer deg til å skrive ned ulike ting og tang som du opplever mens du spiller, og ikke minst ting du føler at spillet lærer deg! Denne vil jeg gjerne at du leverer tilbake ved en senere anledning, da den kan gi meg en del verdifull informasjon om spillopplevelsen din. :)

Støter du på problemer i prosessen, er det bare å ta kontakt. Dette gjelder også hvis du har spørsmål underveis. Etter en stund vil du få tilgang til spørreskjema nummer 2, samt forespørsel om du vil delta på intervju hvor du kan være med å vinne premier!

Jeg har fortsatt ekstrakopier av spillet liggende, så om du har venner / familie som kunne tenke seg å være med så er det bare å henvende dem til meg.

Da gjenstår det bare for meg å ønske deg en god spillesesjon, så hører du fra meg etterhvert!

Mvh,

Kristoffer S. Fjællingsdal

Appendix 7 – The Green Journal

This is a copy of the Green Journal, a document intended for the players to write down and reflect upon their in-game experiences while playing Eco.

Takk for at du ønsker å delta i forskningsprosjektet vårt!

Navnene våre er Kristoffer S. Fjællingsdal og Christian A. Klöckner, og vi arbeider ved *Institutt for psykologi* på *NTNU Dragvoll* i Trondheim.

Et av våre hovedprosjekter nå for tiden er innenfor feltet som kalles *innovativ miljøkommunikasjon*, og dette feltet omfatter bl.a. bruken av spill. Det er her du kommer inn, og hvor du forhåpentligvis kan hjelpe oss med din deltagelse.

Per dags dato skal du nå ha fått utdelt en digital kopi av spillet *Eco*, utviklet av Strangeloop Games. I dette spillet vil du kunne utfolde deg i en rikholdig verden av ulike planter og dyr fordelt over ulike biomer, bygge hus og andre konstruksjoner og samarbeide med andre spillere for å kunne vedlikeholde balansen som naturen trenger for å bestå.

I *Eco* er ressursene du får tildelt svært begrensede, og mislykkes dere å vedlikeholde balansen i naturen vil dere oppleve at ulike dyre- og plantearter forsvinner. Som i det virkelige liv er det slik at når disse ulike dyre- og planteartene er borte, da forblir de borte – de kommer altså *ikke* tilbake!

Oppdraget deres blir å vedlikeholde naturen så godt dere overhodet kan, og å fordele ressursene rettferdig mellom hverandre. Dersom noen blir veldig grådige og ønsker å beholde alle ressursene for seg selv, har dere mulighet til å innføre ulike *lover* hvor dere kan stemme på hvilke dyre- og plantearter som det er lov å benytte seg av og ikke.

For at dere skal kunne greie å holde oversikt over framgangen deres i *Eco* har dere nå fått utdelt dette dokumentet; *dagboken deres*. Her kan dere skrive ned hva dere har gjort i løpet av spilletiden deres, tanker og grublinger om spillet og hva dere synes om det, morsomme eller uforutsette opplevelser dere har hatt på serveren; mulighetene er mange! Dagboken skal dere sende tilbake til prosjektlederne ved prosjektslutt.

Det viktigste er selvfølgelig at dere har det gøy mens dere holder på, og vi gir dere fritt leide til å eksperimentere og utforske slik dere selv vil. Dersom dere trenger litt hjelp til å komme i gang, så kan dere benytte dere av den offisielle *Eco-Wikien* som dere finner via følgende lenke:

http://eco.gamepedia.com/ECO_Wiki

Skulle det oppstå andre spørsmål som dere trenger svar på, så er det bare å kontakte prosjektleder Kristoffer S. Fjællingsdal på e-post (kristoffer.fjallingsdal@ntnu.no).

Nok en gang; takk for deltagelsen, og lykke til!

Mvh,

Kristoffer S. Fjællingsdal
PhD-stipendiat, miljøpsykologi
Institutt for psykologi

Christian A. Klöckner
Professor, miljøpsykologi
Institutt for psykologi

NTNU Dragvoll
Trondheim

NTNU Dragvoll
Trondheim

Før du begynner å spille:

Bruk gjerne denne dagboken aktivt! Skriv ned ting du kommer over og opplever som du synes er interessant!

I Eco er det viktig at man tilegner seg ulike ferdigheter, og etterhvert som du spiller vil du få poeng som du kan investere i å forbedre de ferdighetene du allerede har, eller tilegne deg nye!

Nøyaktig hva du velger å investere poeng i er helt og holdent opp til deg, men...

...prøv å tenke litt over hvilke ferdigheter de andre på serveren har.

Bruk den offisielle Eco-wikien aktivt hvis du lurer på noe (http://eco.gamepedia.com/ECO_Wiki).

Følg nøye med på dyre- og plantebestanden på serveren.

En balansert diett er viktig, også for ditt digitale jeg! Det er viktig for ferdighetsøkningen din at du benytter deg av ulike matsorter i Eco – selvfølgelig uten at balansen i naturen forstyrres!

Grunnleggende instruksjoner (engelsk):

https://www.youtube.com/watch?v=bgnwbdiS9HQ

Litt om deg selv:

For at vi prosjektlederne (Kristoffer og Christian) skal få oversikt over hvem som er hvem i prosjektet, så hadde vi satt stor pris på om du kan *si litt om deg selv*! Den personlige informasjonen du oppgir i dette dokumentet vil kun være tilgjengelig for prosjektlederne! Skriv svarene dine i tekstboksen under!

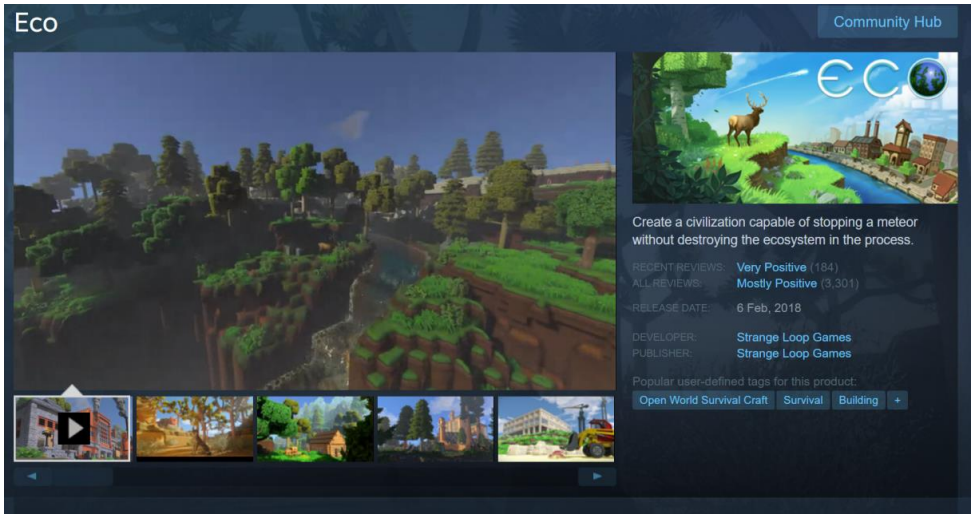
Kallenavn (navnet du bruker når du spiller Eco):
Alder:
Kjønn:
Nasjonalitet:
Hobbyer:

I tillegg til litt personlig informasjon, hadde vi også satt pris på om du kan si litt om din tidligere erfaring med dataspill. Og fortvil ikke; om du ikke har spilt dataspill før, så er ikke det noe problem. Da hopper du bare over de spørsmålene som du ikke føler at du kan besvare. Skriv svarene dine i tekstboksen under!

Hvor lenge har du spilt dataspill?
Hva er favorittspillene dine?
Har du noen favorittspillsjanger (skytespill, rollespill, strategispill...)?
Hvorfor synes du at det er morsomt å spille dataspill?
Hva er de verste spillene du noensinne har spilt?
Bruker du et kallenavn (nickname) i Eco? I så fall, oppgi det her:
Herfra kan du begynne å skrive!

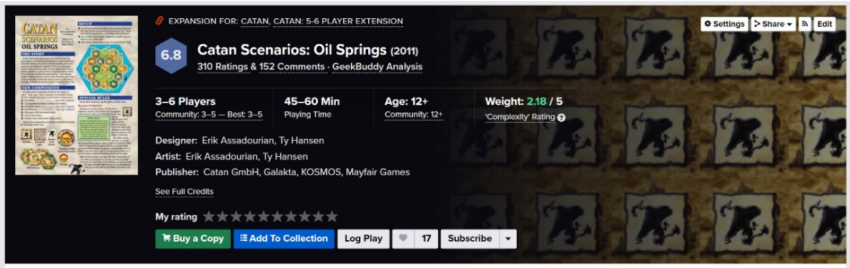
Appendix 8 – Screengrabs of average game ratings

These are screengrabs from the major gaming platforms Steam and BoardGameGeek, showcasing the average ratings of the games used for the studies in this thesis. Steam utilizes a grading scale based on the average number of positive versus negative reviews of a game, and also has a separate section pertaining to recent reviews of a game (for instances in which a game is available in early-access and has seen significant changes since its initial release, for example). BoardGameGeek operates with a grading scale from 1 (bad) to 10 (good). Both Steam and BoardGameGeek have open review forums where users can browse reviews and see the number of ratings the games have received.

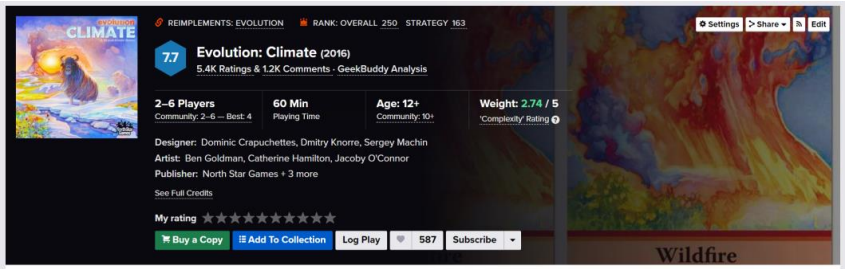


Steam Review Page for Eco (Strange Loop Games, 2020), retrieved on April 20th, 2020. Based on 3301 ratings.

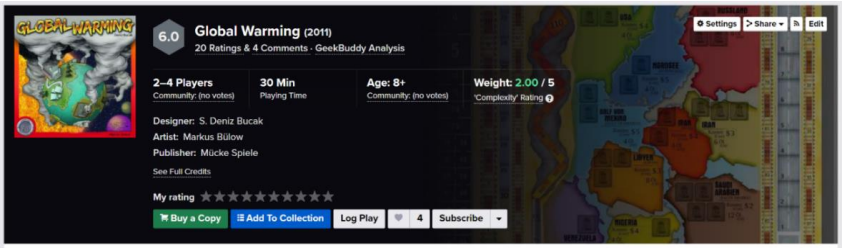
Steam Review Page for Fate of the World (Roberts, 2011), retrieved on April 20th, 2020. Based on 317 ratings.



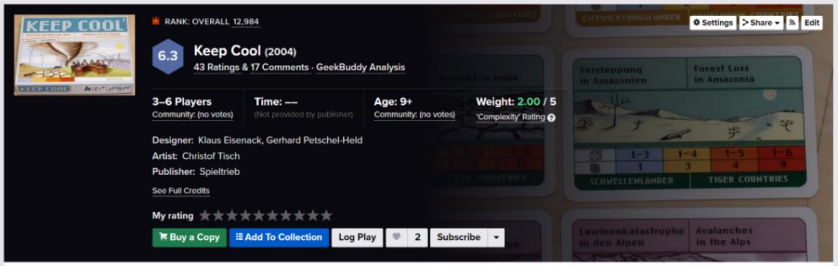
BoardGameGeek Review Page for Catan: Oil Springs (Assadourian & Hansen, 2011), retrieved on April 20th, 2020. Based on 310 ratings.



BoardGameGeek Review Page for Evolution: Climate (Crapuchettes, 2016), retrieved on April 20th, 2020. Based on 5375 ratings.



BoardGameGeek Review Page for Global Warming (Bucak, 2011), retrieved on April 20th, 2020. Based on 20 ratings.



BoardGameGeek Review Page for Keep Cool (Eisenack & Petschel-Held, 2004), retrieved on April 20th, 2020. Based on 43 ratings.

Appendix 9 – Examples of environmental information campaigns and adverts

These are examples of environmental campaigns used by the WWF, Greenpeace and TckTckTck to stop climate change.

Example campaign image from Greenpeace and TckTckTck's information campaign, targeting the lack of action from central world leaders at the time. Retrieved from https://www.theguardian.com/global-development-professionals-network/2013/nov/15/top-10-climate-change-campaigns

Example campaign image from WWF's 2008 campaign to stop climate change. Retrieved from https://www.theguardian.com/global-development-professionals-network/2013/nov/15/top-10-climate-change-campaigns

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