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4. A Dynamic Engagement Model to Provide Ecological Awareness of the Climate Crisis through Video Games

Thomas Bjørner and Henrik Schønau-Fog

Abstract

We present an overview of elements that contribute to making successful video games that promote critical engagement with climate threats and sustainable futures. Major challenges exist in how to design engaging, serious games that target the climate crisis, including, for example, motivation, flow, learning outcomes, or even behavioral changes. Building on past research and different “ecological” games, we suggest a dynamic engagement model (DEM) that outlines four stages of engagement for video games, including before, during, and after gameplay and dis- or reengagement. We argue that more work should be spent on studying a holistic perspective of engagement, including the importance of engagement in the four stages, to improve our understanding of motivational factors for playing ecological games.

Keywords: persuasive games, behavioral change, motivation, types of engagement, holistic perspective

Video games with ecological themes, or simply ecological games, have developed quickly during the last decade (Bjørner 2021; Chang 2019; Galván-Pérez et al. 2018; Neset et al. 2020; Ouariachi et al. 2019; Raessens 2019; Rossano, Roselli, and Calvano 2017; Stanitsas, Kirytopoulos, and Vareilles 2019). Most of the currently developed ecological games propose enhancing comprehensive knowledge related to the climate crisis by providing new learning and awareness opportunities. Ecological games are often categorized as so-called “games for change” (Burak and Parker 2017) because they not

only try to contribute to ecological thought, but also to encourage people to become more environmentally active. Ecological games exhibit huge variations, both as serious games for specific learning purposes and as games for entertainment. There is no consensus on the definition of serious games, and they are used in divergent ways, focusing on various perspectives depending on their purpose, players' goals, and content. Previous definitions have emphasized that serious games are applications designed not simply for fun or with the intention to be more than entertainment (Ritterfeld, Cody, and Vorderer 2009). However, there remain some unsolved categorical challenges regarding what constitutes a serious game and what it means for them to aspire to more than entertainment. Furthermore, some categorical problems often exist within the terminology associated with serious games, gamification, and their connection to ecological games.

Take, for example, *Cities: Skylines* (Colossal Order 2015). This game has been Paradox's best-selling published title and has more than six million units sold across all platforms (McGregor 2019). But is it an ecological game, an entertainment game, a game with a purpose for more than entertainment, or something else? The expansion *Cities: Skylines–Green Cities* (Colossal Order 2017) adds new ways for players to build ecofriendly cities. The *Green Cities* expansion includes more than 350 new assets to the core game, adding a massive selection of green options and policies, complete with ecofriendly buildings, organic shops, green electricity (e.g., solar and geothermal power), ecofriendly transportation (e.g., biofuel buses, electric vehicles, bicycles), sustainable gardens, new technologies designed to make pollution a quaint notion of the past (e.g., various eco water treatment plants), various types of recycling, and climate research centers. Players can create more diversified cities or try to go completely green as the urban population grows.

One could argue that *Cities: Skylines–Green Cities* is an ecological game with serious content and context. It is a game for change because it not only seeks to contribute to ecological thought but can also turn players into ecological citizens (Raessens 2019). This perspective is supported by Alenda Chang (2019), who suggests several ways to rethink existing game taxonomies and how commercial ecological games can go beyond the realm of entertainment to do something serious. Increasingly, commercial games such as *Cities: Skylines–Green Cities* and *The Sims 4: Eco Lifestyle* (DLC) (Maxis, The Sims Studio 2020) encourage support, sympathy, and action for various ecological issues (Raessens 2019). One could also argue for *Cities: Skylines–Green Cities* as an example of a simulation video game that emphasizes *paidia* (Caillois 2001; Frasca 2013), as there is no immediate objective. *Cities: Skylines–Green Cities* places much emphasis on *paidic*

gameplay because the player is free to create an aesthetically beautiful city with sustainable housing and city planning using green energy and to achieve freely chosen ecological objectives. *Paidia* contrasts with *ludus* (Caillois 2001; Frasca 2013), where activity is organized under a system of rules that defines a victory or a defeat, a gain or a loss. Much has changed in aesthetics, number of assets, mods, and player choices since Barry Atkins (2003) described how other city-building games like *SimCity* (Maxis 2013) work as both a game and as a narrative. Despite these changes Atkins' reflections on the biases behind the utopian framing of these city builders, and the ways in which they might clash with the player's ideas of what makes a good—indeed green—city, remain relevant.

How to conceptualize and design for engagement in ecological games

Some general agreement exists on the requirements for making a potentially successful serious game (Caserman et al. 2020; Ritterfeld, Cody, and Vorderer 2009). This includes complex reciprocities of engagement. However, engagement should not only be implemented as in-game engagement, but it is important to emphasize the importance of engagement before, during, and after gameplay, and also the moment of dis- or reengagement. Our inspiration in this regard comes from Heather O'Brien and Elaine Toms (2008), who, in the context of human–computer interaction, critically deconstruct and demonstrate various definitions of engagement and suggest that we look at engagement as a process comprised of four stages: a point of engagement, a period of sustained engagement, disengagement, and reengagement. Furthermore, they suggest various attributes of engagement that pertain to the user/player, the system, and user–system interaction. O'Brien and Toms' framework for engagement as an ongoing process is a good starting point, although its attributes are very general, and their model focuses very much on intrinsic motivation. Furthermore, we are also inspired by Gordon Calleja's (2011) work and his six-dimensional measure of player involvement, which is largely focused on immersion. However, we would like to contribute to a holistic understanding of games, including dynamic gameplay with different types of engagement. Consequently, to describe and explore how video games provide engagement with and raise awareness of the climate crisis, we propose a circular model (see Figure 4.1) called the dynamic engagement model (DEM), which focuses on engagement elements and their features. The basic tenet in the DEM is that players go

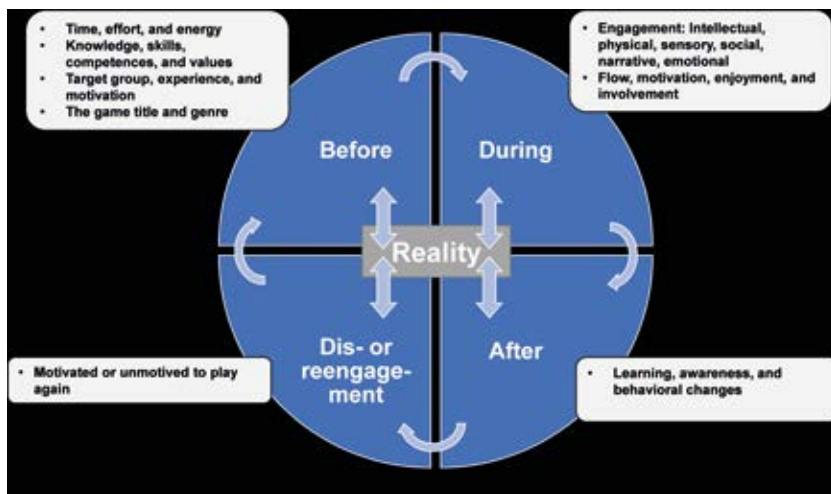


Figure 4.1: Dynamic engagement model (DEM).

through a dynamic progression of different engagement stages: before, during, after, and moments of dis- or reengagement. At all stages, there is also the possibility of carrying over knowledge and practice to reality, in ways that the game designer may or may not have intended.

Reality

A player typically begins at the level of physical reality, meaning that, before players even pick up a game to play, they find themselves in real situations and surroundings. The reality construct in the context of video games and other media is very complex and used in many ways. We define reality as the level at which the player has total awareness of the surroundings and is not involved with the game. Eduard Siou-Hao Tan (2008) has also described this as the executive space, and Rick Busselle and Helena Bilandzic (2009) have described this as the actual world, although both are described in a broader media context. Richard Bartle (2004) has described the complexity of the relationship between the real world and the virtual world, and he defines the virtual world as an environment that its inhabitants regard as self-contained. However, players do not always have full control over their environments, and they may be disturbed or distracted during play (and forced back into reality), for example, by social acts (e.g., by their parents, friends, or dog). The included reality factor also emphasizes that the ecological game is not an isolated medium but can be merged or used

in complex interactions with other media, for example, chats, text messages, books, films, or transmedia storytelling (Kalogeris 2014). In all four engagement stages, the player can return (voluntarily or not) to a total awareness of the surroundings again and a state of not being engaged with the ecological game.

Before: Motivating players to play

Time, effort, and energy: The players' starting point from reality comes with many different variables. One important factor is the player's motivation to start playing the game and spend their time, effort, and energy on it (Brown and Cairns 2004). Hence, players' intentions to interact with the ecological game are crucial.

Knowledge, skills, competences, and values: Ecological games' success in raising awareness or achieving behavioral change depends on players' knowledge, skills, competences, and environmental values, as well as different levels of experience with gaming. For this reason, successful ecological games need to be adjusted to, or adjustable for different players to have a good initial experience of the game. Furthermore, it is important to start with a good briefing to have the player understand the game's purpose, framework, and controls, which can be included as an introduction or tutorial. The briefing is to be matched accordingly to the players' knowledge, skills, competences, and values.

Target group, experience, and motivation: Before starting the design of an ecological game, it is important to consider the target group in terms of age, gender, culture, geography, and other demographic variables. Past research has shown gender-based differences between preferences for some types of video games. Kristen Lucas and John Sherry (2004) show that women and girls tend to prefer games that convey the experience of the successful completion of challenges compared with those that impart a sense of domination over others. Previous game experiences are also crucial in the before stage (Udeozor et al. 2022). When players have mastered specific challenges, they develop a greater level of skill that can be used and improved with increasingly complex challenges in other levels or games (De Jans et al. 2019). Such a positive history might increase intrinsic motivation for playing an ecological game (Wouters et al. 2013). When a player is intrinsically engaged, they will start playing the ecological game voluntarily, without the promise of rewards, external constraints, or teacher/educational demands. Ecological games (especially with a focus on learning)

in general may need to focus more on such intrinsic motivation because “green” learning materials need to invoke curiosity, flow (i.e., the interplay between challenges and skills), be fun and enjoyable, and eventually allow the player to gain new knowledge about or attitudes to sustainability. Before the gameplay, it might be necessary to clarify what the ecological game can provide in terms of gained knowledge, what kinds of experience it offers, and what it helps players accomplish.

The game title and genre: Game titles should be appealing, but also provide some insight into the game’s plot and premise. Take, for example, the educational ecological game *EnvironMan* (Dane Falk Mortensen et al. 2021), which is to be used in the context of the plastic crisis in social science subjects that target high school students, teachers criticized the title for being too broad (and for not focusing on the plastic crisis), and some female students criticized the game title for not including women. Lastly, in the before stage of the DEM, another important aspect to consider is the genre, which can be tailored to provide a good match for a specific target group. Previous research has shown that apart from socio-demographics, individual and content-related gratifications are relevant engagement factors for genre preferences (Scharkow et al. 2015).

During: Maintaining engagement during gameplay

Based on a literature review, we (Schønau-Fog and Bjørner 2012) suggest six types of engagement that motivate players so much that they want to continue playing, and we follow an engagement mapping method to validate the theory. The six types of engagement are *intellectual*, *physical*, *sensory*, *social*, *narrative*, and *emotional*. These six types of engagement can be dependent on one another and they might change during gameplay, thus creating for the player a dynamic, fluctuating experience. We outline these six types of engagement below and provide specific examples within an ecological game context.

Intellectual engagement concerns intellectual challenges, activities, and creativity, and can result from a player’s motivation to keep playing in order to solve puzzles and face challenges that demand the use of intellect. *Cities: Skylines–Green Cities* also invites intellectual engagement when it requires players to balance in-game demands, such as education health care, police, fire fighting, green solutions and much more, along with the city’s economy system. The intellectual stimulation in *Cities: Skylines* can result in what Frans Mäyrä and Laura Ermi (2011) describe as challenge-based immersion,

related to mental skills, such as strategic thinking or logical problem solving, or, as what Calleja (2011) describe, as ludic involvement, which include the strategic choices made in the game and those choices' repercussions.

Physical engagement in ecological games, such as haptic feedback, can be utilized in various aspects of, for example, virtual reality (VR). With emerging technologies in VR, mixed reality, and haptic suits, the potential of physical engagement is expected to increase. An ecological game with much emphasis on physical engagement is *SpaceBuzz* (Media.Monks 2018), which is a VR educational program for children inspired by astronauts' missions. The VR experience takes place inside of an actual rocket ship. The rocket ship is placed on a big truck trailer to make it mobile for visiting different schools. The primary activity of *SpaceBuzz* is to inspire and educate with a view of astronauts on planet Earth and to create ambassadors of planet Earth (Van Limpt-Broers et al. 2020).

Sensory engagement is related to stimulating the senses during gameplay. This form of engagement can be provoked when sensory inputs mediated by the game support players' game experience in such a way that they want to prolong and explore the sensory experience. *SpaceBuzz* also includes much emphasis on sensory engagement, such as being present in an actual rocket ship, and it uses 4D simulations. The children are sent into orbit around planet Earth, guided on their trip by a virtual recording of the astronaut André Kuipers (Van Limpt-Broers et al. 2020). *SpaceBuzz* is an embodied experience in VR that involves sensory engagement so that the children are able to see, hear, and feel experiences as if they were really happening (Ahn 2021).

Social engagement in ecological games comes with huge variations. For example, in the online multiplayer survival simulation game *Eco* (Strange Loop Games 2018) players have to work together to create a sustainable civilization on a virtual planet. The players have the option to build a player-run government and economy, and to advance down a technology tree to stop a meteor that is on a collision course with the planet. The social engagement elements in *Eco* correlate with interaction among the other players, both during gameplay and in real life, for example, within an educational classroom setting. No matter how strong or real these interpersonal relationships are, the ability to play with other players is one of the primary engagement factors to play online games (Yee 2006). Examples of causes that can result in social engagement are quests, challenges, and puzzles that can only be solved when players collaborate. Fame, acceptance from others, a sense of belonging, opportunities to brag, compete, cooperate, and share experiences with others evoke social engagement and the motivation

to continue playing (although social engagement in ecogames might also involve sabotage and so-called griefing, see Op de Beke 2022).

Narrative engagement is related to the story experienced while playing the game and may result in imaginative immersion (Mäyrä and Ermi 2011), narrative involvement (Calleja 2011), and narrative immersion (Adams and Rollings 2007). *The Sims 4: Eco Lifestyle* is an example of an ecogame that provokes narrative engagement. *The Sims 4: Eco Lifestyle* challenges players to make a difference in the fictional Evergreen Harbor community. For example, it is possible to help, watch, and transform your neighbors to be more ecofriendly. The desire to know how the story is going to unfold in Evergreen Harbor may create curiosity, suspense, and excitement, and thus make the player want to continue playing (Schønau-Fog 2011). This type of desire to keep playing might then result in narrative engagement. The characters in *The Sims 4: Eco Lifestyle* may also support narrative engagement when the player begins to involve themselves in the character that they are playing, as well as how the other characters are developing in the narrative.

Emotional engagement in ecological games could be an important factor. This factor incorporates forms of engagement to positively (interest) and negatively (boredom, climate anxiety, anger) affect the player's engagement. Emotional engagement can be the result of the player's own emotions during gameplay, feelings toward other players, empathy toward nonplayer characters, or elements that spark player involvement (Schønau-Fog 2011). In ecological games, events like environmental disasters, the actions of other players or nonplayer characters, or the attributes of an in-game asset can create emotional engagement. Examples of such emotions encountered during gameplay could include, for example, anger, frustration, affection, remorse, relief, and tension. Other types of engagement, such as narrative engagement, which occurs when players feel a strong tie to the game's characters, process, narrative, and story, can also cause emotional engagement. The literature also supports this close relationship between emotional and narrative engagement with explanations of emotional involvement in games that refer to, for instance, their descriptions of imaginative immersion, identification, or affective involvement (Calleja 2011). One way to garner emotional engagement could be to include in-game surprises, which scholars have shown to have some positive learning effects (Van der Spek, Van Oostendorp, and Meyer 2013; Wouters et al. 2017; Zhonggen 2019). In ecological games, surprises can be implemented, stimulating cognitive activity and high arousal, by means of sudden disasters, sudden insects flying with loud sounds, or other fun or surprising elements.

Flow, motivation, enjoyment, and involvement: Scholars have developed various suggestions to increase players' engagement, by keeping them in the flow, providing motivation, enjoyment, and involvement (Calleja 2011; Csíkszentmihályi 1997; Ouariachi et al. 2019; Sweetser and Wyeth 2005). Penelope Sweetser and Peta Wyeth (2005) drew together various heuristics (game interface, mechanics, narrative) into a concise model of enjoyment in games building on flow theory. Their model includes an overall goal and a set of central criteria used to design and evaluate games with respect to player enjoyment: concentration, challenge, player skills, clear goals, feedback, immersion, and social interaction.

After: Engagement after gameplay

Learning, awareness, and behavioral changes: The ideal effects of gameplay are learning, awareness, or even sustainable behavioral change. However, some general problems exist in measuring these effects. Measuring ecological engagement after gameplay can be difficult to define because it includes complex dynamic processes that might take time and can take many shapes (Kapp 2012; Laurenceau et al. 2007). Furthermore, players each have their own unique set of cognitions, habits, and contexts that influence processes of change; consequently, the scope of change will also differ between individual users (Van der Kooij et al. 2015). Therefore, the reliability of the correlation between gameplay and behavioral change decreases the more time is spent between play and the measurement of behavioral change. Additionally, a potential correlation does not necessarily imply causality. Meaning that even if some positive correlation effects can be measured (e.g., learning, awareness, behavioral change), based on specific ecological games, this does not mean that the ecological game causes these effects; there could be many other variables involved. That said, past research has found potential positive effects of serious gaming in terms of communication and collaboration (Guillén-Nieto and Aleson-Carbonell 2012; Hummel et al. 2011; Jacobs and Jansz 2021).

Dis- or reengagement

Motivated or unmotivated to play again: Disengagement (the lack of motivation to play again) and reengagement (motivation to play again) involve complex elements of motivation to play. This stage is not the same as the

after stage, as that stage does not necessarily involve the motivation to play again. It is also not the same as the before stage because players are already familiar with the game, and thus they may skip the briefing. The game experience will not be the same; however, there remain elements of both intrinsic and extrinsic motivation at play. For example, the motivation to play *Cities: Skylines* again (reengagement) might involve the desire to gain more knowledge for specific ecofriendly building activities, to experience further sustainable building assets in the workshop, or to accomplish specific goals for reducing pollution. The motivation to resume playing could also involve more extrinsic motivation, including competitive elements, for example, competitions with friends to raise citizen happiness to more than 90 percent within two hours. Reengagement is not dependent on the pleasantness of the previous experience, because even unpleasant elements (e.g., having lost a game) can intensify the attractiveness of playing again. The lack of motivation to resume play can stem from aspects like interrupted smoothness and availability (O'Brien and Toms 2008) because of updates, downloads, bugs, or computer incompatibility. Alternatively, interruptions or distractions in the players' environment, as well as the lack of or intensity of the challenge, could cause players to disengage from a game.

Discussion and conclusion

The popularity of serious games with environmental themes seems relatively small compared to that of games intended for fun and entertainment. However, both serious games and entertainment games can play an important part in learning about ecological science and politics. Moreover, the serious gaming industry is expected to increase (Adkins 2019), including games with sustainability themes. The expected growth is especially favorable for learning purposes and correlates to the coming of age of a generation of digital natives with greater adaptability to technological change (Adkins 2019; Burner 2018) and ongoing innovations integrated into next-generation serious games, including advances in psychometrics, neuroscience, augmented reality, and artificial intelligence. These new game and media innovations could make room for ecological games, where the imaginary meets the real in even more complex interactions as well as within new contexts.

Much research exists on various aspects of ecological games. However, there could still be more focus on improving methods of evaluation. Previous studies have mainly used posttest surveys and questionnaires, observations, and interviews (Ibarra et al. 2020; Vandercruysse, Vandewaetere,

and Clarebout 2012) to evaluate serious games with learning purposes. We argue that there should be more work spent on gaining a holistic perspective on engagement, including the importance of engagement before, during, after gameplay, and during dis- or reengagement. This holistic perspective could also improve our understanding of motivational and engagement factors for playing ecological games. Such a perspective could, for example, include work on the role of teachers in involvement throughout the entire design process (from game idea to evaluation), pilot testing, target group analysis, and genre evaluation. Especially when evaluating serious games with ecological messages it is important not to neglect the challenge of matching the participants to the games that may change them.

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