

# Avatar Identities and Climate Change Action in Video Games: Analysis of Mitigation and Adaptation Practices

Daniel Fernández Galeote  
Nikoletta-Zampeta Legaki

Juho Hamari  
daniel.fernandezgaleote@tuni.fi  
zampeta.legaki@tuni.fi  
juho.hamari@tuni.fi

Gamification Group, Faculty of Information Technology and Communication Sciences, Tampere University  
Tampere, Finland

## ABSTRACT

Games are considered promising for engaging people with climate change. In virtual worlds, players can adopt empowering roles to mitigate greenhouse gas emissions and/or adapt to climate impacts. However, the lack of a comprehensive exploration of existing climate-related identities and actions prevents understanding their potential. Here, we analyze 80 video games and classify avatar identities, or expected player roles, into six types. Climate selves encourage direct life changes; climate citizens are easy to identify with and imitate; climate heroes are inspirational figures upholding environmental values; empowered individuals deliberate to avoid a tragedy of the commons; authorities should consider stakeholders and the environment; and faction leaders engage in bi- or multi-lateral relations. Adaptation is often for decision-making profiles, while empowered individuals, authorities, and faction leaders usually face conflicting objectives. We discuss our results in relation to avatar research and provide suggestions for researchers, designers, and educators.

## CCS CONCEPTS

• **Applied computing** → **Computer games; Environmental sciences; Media arts.**

## KEYWORDS

games, gamification, game-based learning, avatars, identity, role, climate change engagement, global warming, mitigation, adaptation, sustainability

## ACM Reference Format:

Daniel Fernández Galeote, Nikoletta-Zampeta Legaki, and Juho Hamari. 2022. Avatar Identities and Climate Change Action in Video Games: Analysis of Mitigation and Adaptation Practices. In *CHI Conference on Human Factors in Computing Systems (CHI '22)*, April 29-May 5, 2022, New Orleans, LA, USA. ACM, New York, NY, USA, 18 pages. <https://doi.org/10.1145/3491102.3517438>



This work is licensed under a Creative Commons Attribution International 4.0 License.

CHI '22, April 29-May 5, 2022, New Orleans, LA, USA  
© 2022 Copyright held by the owner/author(s).  
ACM ISBN 978-1-4503-9157-3/22/04.  
<https://doi.org/10.1145/3491102.3517438>

## 1 INTRODUCTION

The current climate crisis poses a global threat to biodiversity and societies [101] and questions the sustainability of fossil fuel-dependent societies [33]. A broad and profound cultural shift is needed to limit greenhouse gas emissions as much as possible while reducing the risk of fatal impacts [149]. This includes behavioral change regarding consumption and widespread advocacy for effective climate policies, adequate technological research, and an environmentally and socially sustainable economic system [104]. Achieving societal engagement with climate change is necessary to shape mitigation and adaptation, the two complementary approaches for reducing and managing climate risks recognized by the Intergovernmental Panel on Climate Change (IPCC) [35]. Nevertheless, lack of engagement, which goes beyond mere knowledge of the problem [100], remains a pervasive problem in effectively responding to climate change.

Among the methods proposed to foster climate change engagement, games and gamification have been highlighted as capable of promoting deep connection and interaction with issues such as adaptation and sustainable consumption [53, 73]. In the area of climate change, empirical research has shown that game-based interventions can result in cognitive, affective, and behavioral engagement [51]. Digital games in particular have advantages such as interactive and multimedia capabilities, popularity, ease of access through conventional devices, and flexibility of use beyond player co-location. However, digital gaming requires radical changes to become sustainable, given production models with embedded social inequality and environmental costs [80], consumption requiring significant energy use [103], and disposal creating hazardous e-waste [122]. The benefits of digital games are thus inseparable from the issues that they entail, from which affluent consumers are insulated. This makes climate change-engaging design, which we focus on here, only one step towards truly environmentally and socially sustainable digital games.

A crucial element for player engagement is the avatar, the figure through which players exist in digital game worlds [10]. Avatars are the primary identity cue for players [163], i.e., the main element used by designers to encourage players to take a role. The relationship that forms between player and avatar has potential attitudinal and behavioral effects [127, 164], which has been leveraged to improve health habits [8, 98, 145, 155], educational engagement [48, 85, 128], prosocial behavior [72, 120, 133], and environmental

attitudes [6], among other goals. However, little is known about avatars and climate action in existing digital games and how climate change problems and solutions are presented.

In this study, we analyze 80 digital games where players can act to mitigate or adapt to climate change. We aim to answer three research questions:

- (1) What avatar identity types can be found in games that include climate action, and what features relevant to previous scholarship do avatars present?
- (2) What climate issues do players tackle through these different identities, and how?
- (3) How does addressing climate issues relate to the game's ultimate goal?

In our results, we classify avatar identities into six types according to their goals and expected ways of behaving: **climate selves**, when players' actions directly impact the real world; **climate citizens**, when they are encouraged to incarnate fictional characters that address climate change through quotidian actions; **climate heroes**, or avatars who address climate change issues using specialized or supernatural means; **empowered individuals**, who engage in individual and collective action that can negatively impact the virtual world if short-term and personal gains are prioritized; **authorities**, who lead communities or businesses but face climate challenges and conflicting interests; and **faction leaders**, who rule a collective amidst tension with external actors and environmental issues. We also examine elements of interest based on previous avatar scholarship, such as bodies, developed characters, and customization. Next, we report how avatar identities address climate change, and if doing so represents the game's goal. We then discuss potential climate change engagement opportunities provided by avatar design and their in-game integration.

This work joins ongoing multidisciplinary efforts to understand human agency and empowerment in the face of climate change, which include games [51] but lack focus on how identities (i.e., who the avatar is, their main role in the virtual world), actions (i.e., what they do), and goals (i.e., for what purpose) may shape players' relationship to climate change through different perspectives and understandings. The study adds to recent HCI games scholarship contributions (e.g., [28, 82, 106, 108, 147]) that explore how games and technology can foster human engagement with the climate crisis. We also join the HCI community's efforts to understand the role and effects of game avatars (e.g., [8, 14, 18, 41, 48, 85, 92, 127, 146, 155, 164]) by extending them to the area of climate change.

Our contributions aim to guide empirical questions for future research; include design observations for developers based on the potential of avatar identities and other features; and provide a basis for educators teaching with games to prioritize specific identities and actions according to their pedagogical interests.

## 2 BACKGROUND

In this section, we introduce the central topics that concern this study: climate change and engagement with it, particularly actions that constitute mitigation and adaptation; games and gamification, especially their potential for climate change engagement; avatars and identities; and fundamental avatar aspects according to existing research.

### 2.1 Climate change and engagement

Climate change is a wicked problem due to its indefiniteness and lack of a definitive solution; the multiple components involved in it, including the environment, society, technology, and science; and its multiple stakeholders, whose values and beliefs play a fundamental role in determining the adequacy of proposed solutions [81]. Multiple psychological and social barriers preclude understanding climate change and turning knowledge into effective action, such as limited cognition, ideology, the force of habits, distrust of experts and authorities, and inadequate behavioral change [70, 159]. Cognition, or assimilating knowledge, does not suffice to engage with climate change. Engagement requires a deeper connection that includes affective and behavioral components as well; in other words, caring, being motivated, and taking action [100]. Engagement can manifest in the private and public spheres [159], including activism, consumption, and professional practices [142], and comprises both mitigation, i.e., reducing greenhouse gas emissions or enhancing sinks, and adaptation actions, defined as adjusting to climate risks and impacts [35].

Climate change can deeply challenge identity [110] and effective communication campaigns require an explicit discussion and rethinking of economic and political citizen roles [160]. To meaningfully contribute to address climate change, citizens need not only long-term habit change or to develop new skills, but also to be allowed to participate in decision-making [116]. Opportunities for active participation can be promoted from the top, but a public mandate is important to open and accelerate such processes. At the same time, individual engagement depends largely on the person's social and institutional context [100]. Thus, individual involvement and the opportunities provided by and perceived in the environment influence each other in complex ways, with political and socioeconomic factors playing a significant role.

### 2.2 Games and gamification

This article is concerned with gamification understood as the societal, cultural, economic, and technological adoption of gameful systems and practices as forms of leisure but also as methods to educate, motivate, and shape behaviors [74]. Following this definition, we pay attention to climate change in systems that use game elements in non-game contexts [38], serious games, and video games intended for entertainment. From now on, the noun "game" (or "digital game," given the technological scope of this article) will be used broadly to define the artifacts at the root of the gamification process. In doing so, we take into account recent calls to expand traditional boundaries of the term [68].

Previous literature has highlighted the potential of games for cognitive, affective, behavioral, and sociocultural engagement through elements such as mechanics, content, visual aesthetics, narratives, and musical score [123]. Arguments commonly given for using games to yield outcomes beyond entertainment include (1) visual worlds which facilitate climate change communication [139] and enhance clarity and conceptual understanding [53]; (2) interactivity in safe spaces [123] that allow players to learn through experience and inquiry and construct their knowledge, mechanisms that have been hailed as promising for climate change education [105], and gain knowledge of systems, other actors, and themselves [39]; (3) social

interaction in multiplayer systems, considered an effective strategy in game-based learning [161] and climate change education in particular [105]; (4) emotional engagement through narratives that support character attachment [23], role-taking and other features that can engage learners [12] and promote empathy [13, 17, 22, 152]; (5) adaptability to player performance, providing scaffolding and facilitating experiences of flow by maintaining an adequate challenge level [123]; and (6) motivation through incentive structures such as rewards or activities that players find intrinsically rewarding [123].

Regarding intrinsic motivation, games can support people's three basic psychological needs as postulated by self-determination theory: competence, autonomy, and relatedness [134]. Various features have been found to satisfy these needs (see [162]). For example, competence satisfaction has been associated with intuitive controls and immersion [134], as well as dynamic difficulty and achievements [121]; autonomy, with avatar customization and choices affecting character and narrative development [121]; and relatedness, with social interaction [134]. Single-player games may also promote relatedness, but more research is needed [148]. Need satisfaction seems to predict game enjoyment [134], but it is especially important in utilitarian contexts such as climate change engagement and pro-environmental behavior (PEB). Empirical research has shown that people who engage in PEB tend to present self-determined motivation, which is supported by competence, autonomy, and relatedness satisfaction [34]. Therefore, games that satisfy these needs in relation to climate-related PEB, and thus support internalizing motivation, could increase real-world PEB [34]. More specifically, need-satisfying game features motivate playing a particular climate change game (with its particular climate-related identities, actions, and goals), but can also influence contextual motivation towards the climate as well (see recursive relationships in [151]), driving cognitive, affective, and behavioral outcomes.

Games have been found to effectively promote cognitive, affective, and behavioral climate change engagement in multiple contexts [51, 53]. Given that a sustainable future requires fundamental changes amounting to a "system-wide transformation" [149, p. 15], gamification can help promote values aligned with this pursuit. However, existing interventions have tended to ignore relevant audiences such as primary school students and citizens in developing economies, and typically address only some climate change impacts such as floods and droughts [51]. Design-wise, issues such as insufficient graphic quality and lack of interaction [113], excessive difficulty [156], or a slow pacing [52] have precluded engagement in some cases. In addition, research rarely comments on the importance of in-game identities.

Although most games research focuses on a limited canon of digital games [68], the arguments reviewed above can be largely applied to analog games, which can provide, e.g., immersive experiences [49] similarly to digital games [75]. However, each medium has advantages and drawbacks. For example, digital games can integrate tutorials interactively, making play easier and more immediate, and use attractive multimedia effects such as music, animation, and 3D visualization; meanwhile, board games tend to facilitate player-to-player communication [46]. In this study, we focus on digital games for various reasons—many are easily accessible with domestic equipment, namely a computer or phone, they are immediately playable if digitally acquired, some are free, and the ubiquity of

single-player or online modes makes them suitable for people who cannot physically meet. Echoing others [42, 114], we also recognize their unique popularity, especially among the young, and potential to convey complex topics in novel and memorable ways.

Consequently, HCI and games scholarship has expressed interest in digital games and play for environmental issues, sometimes inspired by previous designs. Such is the case of playful technology used to engage university students with PEB [82] and student-led climate science game design [147]. Other climate change game designs have everyday actions as a core element [15] or aim to combat grief through in-game action and to support learning through need satisfaction [28]. Given that the player's perspective in a serious game is often crucial to support its central argument and desired effect (e.g., [20, 28, 106, 108]), highlighting the point of view through which reality is experienced in games through the avatar identity appears to be a valuable extension of previous work.

Despite their advantages, digital games cannot be completely appraised without their material qualities [9], including a production model that entails inequalities in both software and hardware production, with outsourced manufacturing done under exhausting and hazardous work conditions and environmental costs externalized to countries with permissive laws [80]. While the use and reuse of analog games can be virtually emission-free, the technological development associated with digital gaming involves increasing energy demand from games, devices, networks and data centers [103], with the Jevons paradox questioning the advantages of solutions based purely on technical efficiency [79]. The obsolescence of older devices results in e-waste, which threatens human health and is seldom recycled [122]. For these reasons, major game industry companies, together with the UN Environment Programme, established the Playing For The Planet alliance which includes commitments to reduce the environmental impact of gaming operations, use, and waste [7]. The organization also aims to bring climate-aware themes to mainstream games with hundreds of millions of players to counter superficial and extractive representations of nature traditionally associated with games [3, 29].

Given the importance of diverse game features for engagement and motivation, and of knowing existing games to devise interventions and develop new games, past content reviews have broadly analyzed games on climate change [114, 129] or sustainability [87, 97, 141]. More recent analyses have classified digital and analog climate change games [69] and compared the engagement potential of serious and entertainment digital games [50]. Our study complements these efforts by analyzing avatar identities involved in climate action.

### 2.3 Avatars and identities

This study is primarily concerned with game avatars. This debated concept can be understood, for example, as the mediator of the player's agency, a form of visual representation, a character, a customizable persona, or a vehicle providing embodied presence [83]. Others consider the avatar's stricter meaning to be that of the interface technique connecting the computer and the user's body and actions on-screen [10]. The avatar summons and represents the player, and it is through the avatar that the player integrates into the game world [10]. In other words, the player learns how to act in

and inhabit the world of the game through the avatar. We take this approach (that the avatar locates the player visually and spatially on the screen and in the world of the game) in order to include games where users act upon the digital world but no personality separate from theirs exists (for example, in gamified social media apps) or characters are implied through the action (e.g., a mobile game where players touch the screen to recycle waste, or strategy games where players lack a digital body).

Having established that the avatar is the element through which the player exists in the game, we turn to the concept of identity. Identities can be seen as complex, multiple, and mutable [86], and are defined and studied differently depending on the theoretical approach adopted [158]. Here, we take identity to mean a role identity, or "the system that reflects the meaning of [formally or informally] occupying a certain social position in a particular social-cultural context" [86, p. 12]. Roles, which can pertain to work, domestic life, or any other social sphere, indicate socially expected behaviors [158] and thus provide a frame to interpret events and decide how to act [86]. However, roles also have a component of personal interpretation [27]. The self, or who one is, can be understood as a combination of role identities, some more relevant, some less so [24], in addition to the core definition of the subjectivity of experience, the perception of reality in the first person [166].

Here, we address avatars' identity, meaning that we examine not the identity of players themselves, but the one that they are invited to assume. While playing, a subjective identity separate from the player's, the ludic subject, emerges [153]. This is not too dissimilar from a projective identity [67], or the avatar understood as the mix between player and character. Given our interest in game avatars, throughout our analysis the player will remain implied according to the expectations that the game has of them [1]. Any real player may embrace the role as the designers intend, reinterpret it, reject it, and be influenced by game experiences or not.

Human identity involves a complex system of associated beliefs, goals, self-perceptions, and perceived action possibilities [86]. In games, various authors have proposed methods to disentangle players' perspectives, too. In line with role identities having a set of expectations to guide behaviors, [67] proposes the concept of "avatar as identity." The avatar's identity is defined through their goals (what they should achieve in the game) and associated norms (the rules and guidelines that determine or influence how they should achieve it) [66]. Thus, avatars frame what players expect to be asked to do and how to achieve their goals, which are core elements of their game experience [138]. For precision, we further identify the avatar's goal with the game's ultimate goal, or how players win, finish, or prolong the game [165]. In addition, given that behavior is linked to a role identity to the point that it can be seen as its end [86], we are interested in examining what actions are associated with avatar identity roles.

Contrary to real humans' complex relationship between their self and its integrating role identities, "most games construct representations of individuated, unified subjects for players to adopt within the game world" [154, p. 94] to achieve a defined objective. Therefore, even in the event that players are offered multiple role identities in a game, it is reasonable to expect that one will be identifiable as the most salient to achieve the game's goal.

## 2.4 Related avatar research

Facilitating the intended game experience for players is a core design issue where role-taking is central [46]. In other words, since the avatar represents a way of being in the world [66], it mediates the game experience. However, little is known of how games formally allow players to exist in game worlds [153]. This study focuses on role-taking as discursively constructed [67] and reinforced through in-game interaction and communication [46]. Interaction can occur between players and entities in the game world, with other players, and with the avatar itself, for example through customization. The game may communicate with players through instructions and narration or displaying aspects of the avatar's appearance [138], and players may also enact avatar identity features in their interactions and conversation with other players. Beyond the game itself, the player's experience involves, as is known in market research, the time before and after the encounter [90], including developer-issued messaging and participation in communities of practice [66]. Previous literature on game-based climate change engagement has recommended making use of identities that are relevant to players and their aspirations. Reflecting the human side of climate change would favor achieving an emotional connection between player and avatar, with customization being hailed as a mechanism that increases personal connection [115].

The avatar is central when considering the potential of games for learning and attitude and behavior change. The avatar is the main identity cue guiding behavior [163] which can lead to the Proteus effect, or player behavior being affected by avatar characteristics such as height or self-perceived attractiveness [163, 164]. Various explanations have been proposed for this, including a synthesis of (a) self-perception theory, or people behaving as they think others would expect them to [163], and (b) schema activation, or self-concepts becoming associated with the avatar's characteristics in a way that influences user actions even after using the avatar [127]. The Proteus effect appears to be one of the most reliable digital media effects [127], but it has been argued that the closer the player feels to the avatar the stronger the effect will be [127].

While identification with characters occurs in other media, interactivity and the fact that players solve tasks themselves can result in closer identification between player and avatar, even unconsciously, and temporally change player identity [91, 92]. Identification has been understood in various ways. Some have taken it to mean how much players see themselves as the avatar, and considered it one of the factors determining the player-avatar relationship together with attachment and instrumentality [14]. Others have expanded the term to include not only feeling as the avatar, but also with the avatar as an other, and deemed it to involve physical likeness; value similarity, actual and desired; perspective-taking; liking; and avatar embodiment [41]. Players may identify with characters that are similar to them, but also dissimilar, for example as who they should or would want to be [146]. Depending on the situation, identification may be sought after via similarity, embodiment, or wishfulness [18]. Thus, identification involves not only avatar characteristics, but also who the player is, who they like, and their aspirations.

As said, taking another's role can change both attitudes and behaviors outside of the fictional frame [164]. Avatar-based interventions have fruitfully changed health habits [8, 98, 145, 155] and

created positive experiences in education [48, 85, 128]. Adopting heroic identities, having superpowers or simply showing caring behavior in games has been shown to affect prosocial behavior after play [72, 120, 133]. Embodying animals in VR can positively affect environmental attitudes [6]. Accordingly, whether avatars should be similar to the player (e.g., through customization) depends on the context and can have different effects depending on player characteristics [155]. Given the promise shown by avatars in existing literature, our analysis aims to provide a first approximation to their climate change engagement potential.

### 3 METHODS

To answer the three research questions, we followed a process consisting of (a) game search and screening and (b) content analysis focused on aspects of interest, listed later in this section. These procedures were completed by the first author. Four aspects of their background, which may affect how they acquire and interpret knowledge, should be disclosed. First, as a researcher specialized in games and climate change, the analyst has a deep concern for the climate crisis and an interest in games as a form of engagement with it. Being conscious of this predisposition, partly fuelled by generally promising results found in previous literature [51], they aim to maintain a skeptical attitude while conducting research. They also have previous knowledge of some of the games in the sample, which provides a degree of familiarity but mandates an effort to come to the same level of understanding with the rest. Second, the analyst has professional experience as a game designer and developer. This allows for a more intimate knowledge of the inner workings of games and can provide a fast and systemic insight as a player, but requires being vigilant against prejudice and premature conclusions. Assumptions and reading between the lines are avoided in favor of tangible examples. Third, they have undergraduate training and professional experience as a journalist, including journalistic game analysis, and in corporate communication, which provides a perspective of discourse from the sender's viewpoint and considering their intentions for the receiver. Fourth, the analyst has over twenty years of experience as a frequent player of multiple game genres, but has preferences for specific mechanics, stories, and visual aesthetics. In this study, these user biases are consciously monitored and data collected thoroughly independently of game characteristics, instead of e.g. shortening data collection due to the game being perceived as tedious.

#### 3.1 Search and screening process

To identify the current corpus of digital games that include climate action, three different sources were used:

- (1) A personal collection of climate change-related games, curated between April 2019 and August 2020.
- (2) The results of a Google search in August 2020 using the string (*game OR gamification*) AND ("*climate change*" OR "*global warming*" OR "*climate impact*" OR *greenhouse* OR *CO2* OR *emissions* OR *footprint* OR *mitigation* OR *adaptation*).
- (3) The results of a parallel search in 21 potentially related game databases, distribution platforms, and websites (for the full list, see supplementary file 1). Search tool differences imposed custom adaptations on the search string above.

The results obtained were subjected to a primary filtering that excluded those whose title, description and graphic materials did not show any connection to climate change or climate action. The remainder were screened against the following inclusion criteria; for inclusion, the game needed to be:

- Digital
- Available for computers (Windows PC, Mac, and/or Linux) or Android/iOS and fully functioning
- In English
- Explicitly mentioning climate change, global warming, and/or greenhouse gas emissions, irrespective of the game world being factual or speculative.
- Engaging the player-avatar directly in mitigation, i.e., reducing greenhouse gas emissions or enhancing sinks, or adaptation, i.e., adjusting to climate risks and impacts [35].

The screening process, summarized in Figure 1, uncovered 80 games. Supplementary file 2 contains the complete list and thus acts as a ludography where all can be found.

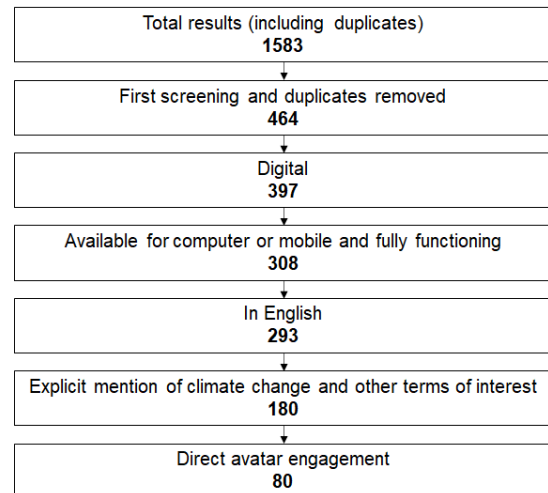


Figure 1: Game screening process.

#### 3.2 Content analysis process

Next, we conducted a qualitative text analysis, a form of content analysis adequate for multiple cultural artifacts [93]. Its aim is to engage with the game as the "distinctive discursive moment between encoding and decoding" [55, p. 238] in order to explore its structure, symbols, and persuasive potential [55]. As the chosen method suggests, this study is concerned with games and their avatar identities rather than their audiences' reception. Although the analyst acted as a player when interacting with the games, the background detailed above tinted their experience, and their goal differed substantially from that of any implicit player. Elucidating which roles and actions are encouraged in climate change games transcends specific audience (mis)understandings or appropriations [55]. However, our discussion contextualizes our findings within other research to anticipate how the corpus of games and the ways that they represent climate action can potentially engage players.

The object of analysis includes the games themselves and paratexts surrounding them—e.g., game manuals, gameplay videos, and forum posts by players—to complement our first-hand understanding of the games. Specifically, we focused on:

- **Avatar identity**, defined by behavior-guiding norms and ultimate goals, or the states in which players win, finish, or can prolong the game [165].
- **Avatar characteristics**, including **body**, if there is one; **character**, or a separate personality from the player's; and **customization** possibilities.
- **Climate actions**, or the ways in which the avatar enacts mitigation (reducing greenhouse gas emissions or enhancing sinks) or adaptation to climate risks and impacts [35].
- **Climate issues**, either to mitigate or adapt to, and whether addressing them is the game's ultimate goal.
- **Number of players**, single player or multiplayer.
- **Spatial context**, or where the player's actions take place.

Different qualitative text analysis methods were used depending on the aspect of interest. To classify avatar identities, a type-building text analysis was conducted [94]. Given the lack of precedent regarding identity classification in climate change games, this analysis did not depart from a pre-existing taxonomy. While the literature broadly distinguishes public engagement (be it as consumers, voters, workers, etc. [160]) from the role of various decision-makers (e.g., water managers, urban planners, politicians), identities in games do not neatly map onto a binary distinction, as will be shown. Additional aspects specific to games, such as the coexistence of gamified systems proposing real-world actions and games with entirely virtual worlds, further complicate adapting these.

Therefore, we based our analysis method on Gee's argument that an identity is defined both by what they aim to achieve (or, we may say, their end) and what is the prescribed way to do so (or the adequate means) [66]. In this way, game identities with a similar goal are not necessarily comparable if the norms that they abide by are fundamentally different, and vice versa. We examined norms in relation to our particular focus of interest and purpose—e.g., does the game mention, encourage or prescribe behaviors typical of any citizen versus specific occupations; does it focus on personal versus collective action and influence; and do behaviors explicitly impact the real world. Regarding the goal, we considered if pursuing it requires climate action and, if not, whether it involves general progress and development or victory over others.

In type-building text analysis, elements, or games in this case, are clustered according to their similarities regarding relevant attributes—here, norms and ultimate goal. This results in types containing similar cases [94]. This process begins by determining the purpose of building types; in our case, our interest lies in identifying their potential for climate change engagement, which is related to (a) their similarity to the player's real identity (assumedly, that of an average citizen), (b) their potential to elicit inspiration for new action, and (c) their portrayal of the motives and perspectives of those that are dissimilar from the average citizen. Second, the attribute space (here, norms and ultimate goals) is defined, as well as the data to be assessed (verbal messages, both in-game and in paratexts, and gameplay experience of what the player can and should do in order to progress towards the goal). Third, the data is

coded thematically, including messages from the games and other texts and ad-hoc descriptions of gameplay actions. Fourth, a specific method to build types is chosen. Given our need for inductive analysis, we selected polythetic type-building, which uses the empirical data directly and results in types that group games that are not absolutely equal but similar, and certainly more so than games from other groups. The resulting types are thus deemed "natural" due to their construction being based on the data. Fifth, all cases are assigned to types, which are finally described and presented.

For climate actions, we performed a thematic qualitative text analysis. First, data was coded along two main categories, mitigation and adaptation [35]. Next, the mitigation actions found were organized according to existing mitigation models and literature [32, 118, 144, 160]. For observed actions that did not fit any category, an inductive process of category building was followed, grouping multiple single observations by similarity. It is common for categories to be constructed through a mix of induction and deduction [94]. Categories and their data were re-read and contrasted multiple times to ensure that they were adequate and useful for the study, and all cases represented their categories' basic characteristics. Finally, the results were analyzed and presented.

Defining the rest of the variables required simpler processes. The player is either represented through a body or not; the presence of a character can be ascertained from a narrative background or decision-making autonomous from the player; and customization reflects whether players can freely alter any aspect of their avatar. Climate issues are determined by the avatar's climate actions—games that contain mitigation present a mitigation issue, while games in which players adapt to climate risks present an adaptation challenge. We also examined if addressing these issues is required to attain the ultimate goal. The number of players is also a dichotomous variable. Finally, the spatial context is classified inductively according to proximity to the player. Therefore, we record if the actions previously found occur in the real world or the virtual one, and if the spatial scope is personal (including the household), local (including small businesses), regional, or global.

Playing and note-taking took two hours per game on average, although this varied greatly—some required under an hour, others multiple sessions. In games in which climate change was exclusively or especially present in some parts, specific game modes were analyzed (e.g., *Power & Revolution 2019 Edition*'s [47] Global Warming scenario).

## 4 RESULTS

This section presents the results from the analysis, organized according to the question that they contribute to answer.

### 4.1 What avatar identity types can be found in games that include climate action, and what features relevant to avatar scholarship do they present?

To answer this question, we first detail the avatar identity type-building process and results, followed by other observed avatar representation concepts.



**4.1.1 Avatar identity types in climate change action games.** The core of the avatar identity type-building process, described at a higher level in the methods, involved five tasks [94]. First, the analyst defined the attribute space values for each game's primary avatar identity using gameplay notes and direct quotations from the games and other official sources, and joined them in a short summary. Second, they clustered case summaries by similarity, which resulted in 23 groups of games.

This clustering process involved reading one case summary at a time and reordering them in a table, placing them close to others according to how players were asked to act and to what end. Considering the purposes of our type-building, described in the methods, clusters did not mix cases where norms portrayed avatars as regular citizens with those with decision-makers, managers, leaders, or other specialists. Beyond this basic distinction, remarkably different norms and goals informing action were clustered separately. For example, in citizen-like cases, avatars encouraged to engage with different economic and political perspectives (from carbon offsetting to habit change, from voting to activism) were considered separately. The same occurred with citizen-like identities that faced mitigation versus adaptation goals. Beyond citizens, unrealistic approaches to solving environmental issues were clustered separately from those advocating the use of plausible tools, for example. Leadership identities were clustered according to the contexts that shaped their perspectives, from geographical scope to relevant stakeholders. Notably, one cluster did not lend itself to being separated according to similarity to the implied player, a delimited normative frame, and a single perspective on climate action. This cluster, the empowered individual, ended up forming its own type in the next step. These 23 clusters were given a distinct descriptive name and short phrases refining their cases' commonalities in terms of norms and goal. Given that practical relevance is a core aspect of type-building [93], this first clustering was used as an intermediate step towards a grouping that, while meaningful, was easier to apply and discuss. Supplementary file 2 contains the steps throughout the process, from game-specific norms, goals and summaries to the first clustering and the final result.

After this preliminary clustering, the third step consisted of building the final types (Table 1). This final clustering took into account the purpose of the study as well. Accordingly, the analyst grouped the newly refined norms and goals into similar groups once again taking into account citizen similarity, inspiration of new behavior, and depiction of non-citizen perspectives. This resulted in six distinct types, each of which was given a creative and descriptive name as recommended [94]. We describe them next, along with representative examples.

Nine games have **climate self** identities. Here, the implied player is expected to commit to or take actions with an environmental impact in the real world. In line with both understandings of the self described, action occurs in and as the first person and is expected to involve the player's own identity system, since their own real behavior accomplishes the goal. In other words, their life is gamified through, e.g., habits to reduce their carbon footprint (*Earth Hero* [78]) or offset their emissions (*Capture* [31]), participation in a social community (*We Don't Have Time* [2]), or the opportunity to vote for political priorities (*Mission 1.5* [124]). In all cases, the actions proposed make use of commonly accepted social,

economic, and political democratic channels. For example, *We Don't Have Time's* [2] terms of use ban violent and abusive content and request adherence to "applicable law."

Four games include a **climate citizen** identity in a fictional world. Their goals require quotidian actions requiring no special skill or status such as recycling, saving energy at home, having conversations, or emigrating after extreme climate impacts have made life too difficult (*The Climate Trail* [59]). The main norm regulating their behavior is their use of tools that are available to common citizens, no matter how imaginary or metaphorical the situation is. For example, the avatar in *Overcome Your Weaker Self* [84] must chase their weaker self, a ghost who turns on lights and drops trash. While the situation is surreal, the player just turns lights off again and collects waste.

Avatars in the next 21 games are **climate heroes**, that is, individuals who must attain climate-related goals using specialized tools (tools which a professional would have access to and know how to use but a layperson would not, such as an airplane) or supernatural powers. Even the most average-looking heroes, such as *Mad Parallax: Jumpy Road's* [56] teenage protagonist, have access to special means and skills. In other games, diverse professionals achieve mundane goals by using uncommon expertise or fantastic skills, such as throwing light bulbs out of a plane, traveling back in time, or communicating with animals. Finally, one avatar (*Zero Carbon, Zero Tolerance* [157]) uses an armed plane to take down private jets and oil company balloons.

Three games have **empowered individuals**, who operate in multiplayer sandbox-like environments where they act as individual citizens (having, for example, private property) but can also engage in productive activity and make political decisions that influence community life. In *New Shores* [54], players win by obtaining points through actions that develop their status and that of the community. In *Eco* [65], players must develop society and technology to stop a meteorite that will collide with the planet in 30 days. In *Minecraft GlobalWarming mod* [126], players prolong the game by mining, crafting and surviving hunger and monster attacks. However, in all three cases, selfishness in production and consumption, and lack of cooperation, can lead to a tragedy of the commons [77]. Excessive greenhouse gas emissions result in rising sea levels and other climate impacts, such as ecosystem deterioration, which stall player progress and ultimately lead to pyrrhic victories. The normative frame, which encourages a balance between the individual, the community, and their environment, is largely procedural [19]—the game allows unsustainable actions, but they lead to undesirable consequences (including between-players punishment mechanisms).

The last two categories are closely tied to ample resource management and leadership. The 34 **authority** games put players in power as leaders and decision-makers in defined territories, from towns to entire planets, although they can have internal opposing forces (e.g., rival political parties, or citizens with particular interests). Although their ultimate goals are varied, from growing a business (*Oil Eco Factory Tycoon* [96]) to decarbonizing major world economies (*Power & Revolution 2019 Edition* [47]) or winning a referendum (*Deal: A Green New Election* [43]), economic growth or citizens' well-being are conditioned by mitigation or adaptation challenges affecting a community or company. Norms indicate that

**Table 1: Avatar identity types**

Group (n)	Norms	Goal
Climate self (9)	Real-world citizen-like behavior, including democratically available mechanisms.	Address real-world climate challenges.
Climate citizen (4)	Citizen-like behavior in a fictional world, including democratically available mechanisms.	Address climate challenges in the game world.
Climate hero (21)	Access to specialized or superhuman means, focus on the individual agent's behavior.	Address climate challenges in the game world.
Empowered individual (3)	Combination of citizen-like norms, such as action through consumption, and specialized ones, such as goods production and political influence. The avatar is an individual agent but is encouraged to negotiate with others and to protect the environment, which is affected by player action.	Pursue individual and/or collective development, in some cases leading to victory over/with others.
Authority (34)	Specialized means giving large power over a collective or organization. The power is limited by multiple interests and/or environmental issues.	Pursue community or business development. In most cases, this requires directly addressing mitigation and/or adaptation challenges.
Faction leader (9)	Specialized means giving large power over a collective or organization. The power is limited by tensions with other leaders (addressed peacefully or not) and environmental issues.	Reach victory over/with similar external entities.

players should attain their goals through decision-making powers vested on them and/or skillful resource management.

Finally, the nine **faction leaders** are encouraged to seek victory over opposing external forces. In these games, players lead a community, often a unique civilization, to rise over rivals of similar force and capabilities. These games typically contain one or more of the 4X that define the eponymous strategy games sub-genre—norms allow them to explore, expand, exploit, and/or exterminate. Despite this, goals do not always depend on conflict: diplomacy and even peace agreements are common, and some games do not include direct aggression as a tool to solve disputes.

**4.1.2 Bodies, characters, and customization as relevant avatar features.** While avatar identities can be categorized in the preceding six types, we now pay attention to three aspects that define how these avatars are presented—bodies, characters as separate personalities from the player, and customization—and multiplayer features.

It is not always the case that the avatar's body is explicit in the analyzed games. This is most clear in **climate self** games, where the action largely occurs in the real world and only profile images at most represent players' presence in the virtual world. **Climate citizens** do not always have a body, either; one character is visible, but two are only described, and one is implied through player actions. Conversely, most **climate heroes** have visible and controllable bodies, although they can be hidden within a glider or given a name by the player despite having one predefined appearance. Still, many do not provide a visible corporeal interface for the players' actions. Two **empowered individuals** have a body for third- or first-person play. Of the 34 **authorities**, two are verbally described and one gives the player a body only in secondary action segments of the game, while the rest only have a portrait at most. Finally, as

is usual in strategy games, no **faction leader** performs through a body, but five games provide preexisting character portraits.

Across the sample, very few games offer more in terms of character than an empty husk. By definition, **climate selves** have no character background separate from the players' themselves. Neither do **climate citizens** nor **empowered individuals**. Only six **climate hero** games offer a significant character background story and narrative autonomy from the player. Three **authority**-type identities include passing references to the avatar's past or personality, while two **faction leader** games (*Civilization III* [61] and *Civilization VI* [62]) offer the option of incarnating a historical figure, and each *Alpha Centauri* [60] faction has a charismatic leader.

It is worth noting that overall, 14 games (four with a **climate self** identity, all three that have an **empowered individual**, and seven with a **faction leader**) have multiplayer features. Avatar customization options are most common in these three groups, although they rarely go beyond names and limited aesthetic choices. Some **climate self** games allow players to choose usernames or portraits. The avatar's name can be chosen in just one **climate citizen** game, and two **climate hero** games allow players to enter a name or color. Empowered individuals in *Eco* [65] and *Minecraft* [126] can customize in detail their appearance and in-game capabilities. While **authority** games typically allow players to express themselves through decision-making, only 10 include explicit avatar customization options. Meanwhile, all but one **faction leader** can be given a name, a portrait and even a civilization to lead, and players usually have multiple options to choose their actions.



## 4.2 What climate issues do players tackle through these different identities, and how?

We now focus exclusively on the environmental problems represented in the games analyzed and the climate actions that players can take to confront them. In the sample, we find both mitigation, when avatars act to reduce sources of greenhouse gas emissions or enhance sinks (here, we include public advocacy as well), and adaptation issues, when they can adjust to climate impacts [35]. Figure 1 in supplementary file 3 displays the divide between mitigation, framed as a problem that requires citizen and decision-maker action alike, and adaptation, which **empowered individuals**, **authorities**, and **faction leaders** are more likely to face.

**4.2.1 Climate action: mitigation and adaptation.** Our thematic analysis of identity tools and skills resulted in seven categories of mitigation actions (70 games, see figure 2 in supplementary file 3), which we list with supporting resources when they have not been formed entirely inductively:

- Lifestyle, related to personal transportation, home, diet, or offsetting of personal emissions [118, 144, 160].
- Public participation, or bottom-up or peer-to-peer discussion processes [160].
- Technology, or the implementation of technical improvements in transport, buildings, manufacturing, food production, and carbon capture and sequestration [118, 144].
- Energy, or the use of reduced greenhouse gas emitting methods, such as renewable energies [118, 144].
- Policymaking, including taxes, incentives, emission quotas and targets, other policies, and diplomacy [144].
- Nature-based solutions, or "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" [32, p. 5] (e.g., forest protection, green infrastructure).
- Violence, when mitigation uses harmful (to people, physically or psychologically), unwanted, intentional (in some cases, even without intent to harm), and nonessential (e.g., not in self-defense) behavior [76].

**Climate self** games focus player efforts predominantly on personal lifestyle choices, with two of them (*CO2 Cards* [25] and *Capture* [31]) offering offsetting schemes for users to donate to real-world projects that reduce greenhouse emissions via technology, energy, and nature-based solutions. Other games proposed direct technological actions (acquiring an electric vehicle) or generating renewable energy at home. Seven of these games also propose planting trees. One game, *Mission 1.5* [124], allows players to vote on mitigation actions that they would like to see implemented in the real world. This is one of five games in this group that propose real public participation and social organization mechanisms. Meanwhile, the three **climate citizens** can either act on their consumption (by recycling and saving household energy) or practice public advocacy (*World Saver* [117]), while **climate heroes** complement measures seen in the previous two categories (including heroes who may save the world by recycling) with the implementation and promotion of technological and energy solutions. **Empowered individuals**,

due to their dual role as citizens and decision-makers, present versatile skills covering both individual actions (mainly in the form of restraint in consumption) and policy-like mechanisms such as negotiation, laws, taxes, and sanctions for polluting. **Authorities** and **faction leaders** present technical, energy, and policy-related mitigation tools, and it is more common for **authorities** to implement nature-based solutions (typically, afforestation).

The use of violence for mitigation, present in five games, stands out as distinct from other categories. One **climate hero** game (*Zero Carbon, Zero Tolerance* [157]) proposes violence against polluters, as do three **authorities**. In *Global Warming Strategy Game* [57], players can use military resources to cause political regime changes, *Climate, Please!* [125] players can pick up citizens to make them bike or eat vegetarian food, and *Fate of the World: Tipping Point* [131] allows players to become villains by secretly sterilizing the population or release viruses to commit mass murder. Although violent conflict is permitted and even encouraged for many **faction leaders**, it is rarely a direct mitigation tool. Players in *Alpha Centauri* [60] and the *Civilization* saga can go to war to stop polluting rivals, but only *Call to Power II* [4] features extensive brute force mechanisms to curb emissions and punish unsustainable behaviors.

Adaptation is represented in 34 games, and practically missing from the first three identity types (see figure 1 in supplementary file 3). The only **climate self** featuring adaptation (*Mission 1.5* [124]) frames it as a matter of policy, a **climate citizen** game (*The Climate Trail* [59]) depicts a migration, and one **climate hero** (*World Rescue* [40]) addresses agricultural adaptation through measures such as new farming practices and technology. All **empowered individual** avatars can adapt to climate impacts by devising, producing and using physical defenses or purchasing protection, while open communication and commerce features allow dynamic and peer to peer collaboration. Most **authorities** can adapt their communities through political decision-making and research, and in some cases players can act to protect animals to cope with climate impacts. Finally, **faction leaders** directly produce adaptation defenses and can often remediate degraded environments, although one (*Anno 2070* [132]) cannot explicitly protect its faction from climate impacts.

**4.2.2 Spatial scale of climate action.** Of the 80 identities, 36% engage in personal or household-level behavior, 42% act locally, 44% regionally, and 52% globally, with 52% combining at least two of these and 38% specifically including both personal or local actions and regional or global ones (see supplementary file 2). All nine games where the player embodies their **climate self** propose mitigation action in the real world, always at the individual or household level but in five games complemented with international collective organization or direct impacts beyond the player's immediate environment (e.g., offsetting projects). The only game featuring adaptation to climate risks does so by proposing national-level policies (*Mission 1.5* [124]). Of the four **climate citizen** games, two portray realistic individual actions, one combines local and global advocacy, and one simulates a regional migration. Twelve **climate heroes** mitigate at the individual level, nine at the local level, four address particular regional concerns, and 67% show explicit global consequences. All **empowered individuals** can engage in individual mitigation behaviors, but the consequences are felt across

the virtual world, either islands or entire planets. Meanwhile, **authorities** act typically over local, regional, or global spaces that they control, often combining global and region-specific actions. **Faction leaders** usually operate in large spaces where decisions can affect particular cities, regional ecosystems, and global climate change. In general, we observed that actions at higher levels (e.g., region-wide regulations in [130]) tend to impact or target lower levels (e.g., household activities and their carbon emissions).

### 4.3 How does addressing climate issues relate to the game's ultimate goal?

Games vary in their identification between ultimate goals and climate action. In all of the games that have a **climate self**, **citizen** or **hero** identity, the goal is directly connected to either mitigation or adaptation, and failure to comply results in halting progress, preventing the player from finishing, or defeat. For **empowered individuals**, however, living sustainably is not a necessary condition to win; rather, unsustainable activities are punished via climate impacts that stand in the way of achieving goals, but do not make them impossible. Indeed, *New Shores* [54] players are expected to balance private and public thriving to win without destroying the environment in the process, while *Minecraft GlobalWarming mod* [126] players can materially progress, but overshooting results in collective loss. *Eco* [65] players need to progress their economy enough so they have technologies that allow them to stop a meteor, so maintaining the well-being of ecosystems and the sea level at bay is not enforced. In all three cases, the developers state in game instructions and guides that the expectation is for players to realize that disregarding ecology leads to undesirable consequences.

Meanwhile, 82% of **authorities** formally require players to address climate change issues to win. They may, however, be permitted to enact non-sustainable policies or ignore adaptation temporarily, but they can be ultimately defeated or receive a bad rating as a consequence. For example, players can finish *Climate Challenge* [130] with a low environmental score, but receiving a final message that reads "You've left the Earth in grim condition" can be hardly seen as a victory. Even in **authority** games where climate action can be ignored, climate-related issues still significantly affect the gameplay experience. It is also worth noting that various **authority** games include influential agents that dispute eager climate action, either private corporations (*Project AURA* [64], *Climate, Please!* [125]), voters (*Democracy 3* [63], *Climate Challenge* [130], *Climate, Please!* [125]), newspapers (*Climate Challenge* [130]), denialist constituents (*Adaptive Futures* [109]), consumerist or materialist populations (*Fate of the World: Tipping Point* [131]), or political parties (*Power & Revolution 2019 Edition* [47]). These diverging opinions can impose moderation lest players be ousted, and represent the need to balance conflicting goals, usually some form of economic or social prosperity while taking care of the environment.

**Faction leaders'** pro-environmental behavior depends on their own judgment, and in narrative terms, certain factions favour environmental sustainability more than others. Growth brings victory closer, but it tends to increase climate change through, for example, industrial and urban development or cheap, productive, or easily accessible fossil fuel energy. Although negative consequences include climate impacts and antagonistic public opinion, these have

different degrees of importance. In *Keep Cool Mobile* [26], high emissions lead to serious consequences for everyone, while *Call to Power II* [4] allows players to deactivate pollution altogether. In other games, climate impacts can even be beneficial if they affect an unprepared rival (*Alpha Centauri* [60]), and even be overcome altogether through perverted logic: in *Something Something Climate Change* [37], players can agree to halt climate impacts or outpace sea level rise indefinitely by building infinitely tall towers.

## 5 DISCUSSION

In this section, we explore the identity types, actions and issues' potential for climate change engagement, discuss our findings' implications for researchers, developers and educators, and acknowledge the limitations of this study.

### 5.1 The potential of climate change avatar identities

Games have been found to support both motivation [134] and climate change engagement [51], but the role of the identities adopted by players is an understudied area. Given the potential of avatars for player attitude and behavior influence, including the provision of new perspectives [137] and practice of "mastery and control" [67, p. 98], adopting different identities would allow players to internalize their motivation towards the climate in different ways, since each one has different values, capabilities, and goals. Our study provides a first stepping stone for future researchers wishing to empirically examine and compare how players experience different climate identities. While some of the games in this sample have already been empirically studied [11, 45, 52, 102, 107], we lack detailed knowledge on the cognitive, affective, and behavioral climate change engagement effects of the rest, and of identities in general. According to observations from prior literature, all six primary avatar identity types identified contain potential benefits in terms of climate change engagement that should be studied further.

**Climate self** identities represent the most immediate connection between players and avatars. These games directly encourage players—the titular self—to make changes in their daily lives and often include mechanisms that could ameliorate players' environmental amotivation, such as autonomy and aid in integrating behaviors in their daily lives. Other avatar identity types could also foster a sense of competence through specific knowledge and skills [119]. However, this should be closely studied and games would need to reach those who are not already motivated. Similarly, most players should be able to readily understand **climate citizens**, their norms, and their pro-environmental goals. Future research should take into account to what extent players identify with these and consider transferring their in-game actions to their lives.

Although **climate heroes'** behavior cannot normally be imitated in daily life, realistic heroes often take action that people could do as part of their professional lives [142]. Even when dissimilar from the player, empirical research on heroes suggests that they can still inspire and motivate to uphold the values that they represent [89]. In the area of climate action, familiarity with Greta Thunberg has been shown to predict efficacy and intention to engage in activism [135], which has been dubbed "the Greta Thunberg

Effect." What and how video game **climate heroes** can inspire players to do more for the environment is also an open question. For this to occur, these games should also become highly popular.

In a different way, **empowered individual** identities also resist an immediate identification with the norms and goals of plain citizenship, but their combination of individual actions and multi-player deliberation can be adopted by anyone living in a democratic society [160]. Through their focus on simulating the tragedy of the commons [77], these games can bring players closer to ecosystem exploitation issues. They are also especially suitable for education, since they can be accommodated in ways that increase their effectiveness—combined with other instructional methods and played in multiple sessions [161]. Still, educators may also be interested in other identities depending on their topics of interest.

This leads to **authorities** and **faction leaders**, who often belong to larger organizations. While they are the furthest away from the individual sphere, players can explore issues of diverging interests in complex social and physical scenarios and the need to reach agreements, as previous climate change games that favor perspective-taking and the understanding of others do [51, 53]. While **authorities** emphasize negotiation between a leader and subordinate stakeholders, **faction leaders** present bi- or multilateral relations as typically seen in international negotiations. As with **empowered individuals**, exploring how multi-stakeholder situations affect player cognition and affect towards climate change would be a valuable research avenue. Similarly to **climate heroes**, future research may also focus on how these identities connect to some players' professional roles or fulfill desires for idealism, which increases task engagement and enjoyment [136].

Considering growing attention towards climate anxiety/grief [30], and despite the incipience of its research, it is important to mention that the participation of **climate selves** in gamified social networks could help players who experience negative emotions express their feelings and feel understood, especially if their immediate social environments are not receptive, which may be a beneficial way of coping [30]. Direct engagement in climate action through **climate selves**, and imitable actions from other avatar identities, could also ameliorate affective issues, although it may not help those greatly upset [30]. Future games combining virtual worlds and experiences in nature may also ameliorate distress [30]. It has also been observed that children positively cope with climate anxiety through, for example, trust in societal actors such as scientists [111], which has implications for **climate hero** identities, and hope based on solutions [112], which is relevant for any game where they can engage in climate action. At least one existing game-based research project (involving an **authority**-type identity, as we interpret from the text) aims to ameliorate climate anxiety, but we lack empirical data [28].

This study also provides commentary on pre-existing designs that the growing number of climate-interested developers [150] can consider and build upon if they have climate change engagement in mind. Given the scarcity of **climate citizens** and **empowered individuals**, we issue a call to explore how these identities could provide engaging game experiences. We understand that in the case of **empowered individuals**, having to develop a complex multi-player ecosystem (or agents with artificial intelligence) may be a

barrier, but *Minecraft GlobalWarming mod* [126] suggests that existing games can be modified and *New Shores* [54] demonstrates that 2D graphics can be used. Game creators may also attempt to break free from the observed types by hybridizing them or envisioning new perspectives.

## 5.2 Mitigation and adaptation in games

In terms of mitigation, it is encouraging to see that **climate selves** engage in a multiplicity of actions represented in the public engagement literature [142, 160], rather than just being framed as consumers. Nonetheless, the small number of **climate citizens** and variety in their actions points to gaps when it comes to representing "regular people" identities in climate action games. Meanwhile, examples of most mitigation action categories can be found in the rest of identity types, which once again is encouraging for educators seeking particular representations in games. On a different note, researchers are encouraged to examine in more detail the portrayal of salient climate actions such as policy, violence, technology, and nature conservation, for example regarding their level of scientific fidelity and the degree of choice allowed for action and strategy. This can even include games that feature pro-environmental topics but do not frame them explicitly as addressing the climate crisis.

The explicit use of violence as a tool to support mitigation is a rare albeit intriguing discovery. Given the use of terms such as "eco-terrorism" for actions that, while illegal, target property and financial loss [99], the exploration of these topics through video games can play a role in clarifying players' interpretation and positioning towards different forms of climate activism. For example, players of *Animal Club* [143], a mobile game for children, must stop tree logging by tapping on chainsaws to save an Amazonian sloth. This action, reminiscent of civil disobedience actions such as tree sitting, could result in arrest in the real world, but does not constitute violence according to our definition. The nature of military conflict connected to adaptation in the form of competition over dwindling resources, as can occur in most **faction leader** games, is also worth debating. We should also mention *The Carbon Neutral Republic of Novaya Zemlya (Inc.)* [58], where players fight the Russian state to establish a colony of climate refugees in its territory. Is Russian aggression to defend its sovereignty essential, or are the activists using essential force to protect refugees' lives? By facing wicked moral problems [140] in the context of wicked climate change, players can explore the ethical tensions related to climate action, which will rarely produce an immediate, incontrovertible, and unique solution, and where even good-willed action can have unforeseen negative ramifications. According to Goerger [71], the morality of violent games can be evaluated through their content, especially what values are cultivated or disrespected, and the social context of violent acts (for example, whether it is similar to real situations or not). Given the transient nature of values, games should be debated individually and taking into account the social context that gives meaning to the violence, although the violation of social norms should not be automatically viewed as violent [76].

Regarding adaptation, we observe a similar presence in an analysis of 52 serious digital and analog climate change games published in 2013 [129] and ours. While the samples are not entirely comparable, we found similar proportions of games depicting mitigation

(over 85% versus our 87.5%) and adaptation (38.46% versus 45%). A recent analysis of digital and analog games [69] found an even smaller percentage of adaptation games, 20%, despite the growing importance of adaptation to climate risks. Furthermore, the aggregate data suggests that in virtual worlds, adaptation is largely associated with those in charge, while multiple profiles and communities can benefit from game-based engagement with adaptation [53]. Therefore, game developers are invited to conceptualize adaptation stories where the citizen point of view can be adopted meaningfully, for example as local community member.

According to Sheppard [139], effective climate change communication should be local, visual, and connected (linking issues and solutions, the local and the remote, the past and the future). The fact that 68% of identities engage in personal and/or local actions, and 38% combine personal or local actions with regional or global ones, suggests that multiple existing games have potential for local and connected messaging, apart from the obvious fact that almost all offer visual representations of climate change. Games can make tangible the abstract and the distant, two major climate change features that hinder engagement, and thus combat apathy and paralysis [29].

Finally, we observed that neither **empowered individuals** nor **action leaders**, nor a few **authorities**, made fighting climate change the winning condition. This offers players a larger degree of agency and provides information rather than enforcing a certain behavior, which can not only support autonomy [88, 134] but also still constitute a persuasive argument [19] for climate action. In the board game version of *Keep Cool*, it was found that players who chose climate-damaging technologies in the game became more politically optimistic, which suggests that open experimentation instead of a single normative path to victory can lead to learning and attitude change [102]. Notably, players adopting an identity different than their real one may have supported learning [102]. Developers should take into account that enforcing pro-environmental behavior in games is only one possible choice to support climate change engagement, and not necessarily always the best one.

### 5.3 Contributions to avatar scholarship and implications for researchers, designers, and educators

Next, we discuss the implications of the avatar representation concepts examined—bodies, characters and customization—, comment on the applicability of our results beyond digital climate change games, and summarize recommendations for researchers, designers, and educators.

Previous literature typically conceptualizes the avatar as the user's visual representation and examines effects based on its appearance [127]. Although this study does not focus on representational aspects to build its types, and in fact considers a broader definition of avatar altogether [10, 83, 153], we have noted the presence of bodies in the games analyzed. The scarcity of playable figures in climate change games, most of which are **climate heroes**, reveals a potential difficulty for studying Proteus effect-style media effects involving various avatar identities. However, other games offer portraits which are also visual representations, albeit not controllable bodies, and can be used as identity cues. Bodies and portraits could be compared to a total absence of visual identity cuing to better

understand their effects. In fact, conventional perspective-taking role-playing is cited as an antecedent to the Proteus effect [164]. Also importantly, only two games were available for VR (*Trash Time* [16], *Cleanopolis* [44]). Future research could compare the effects of avatar identities in VR and traditional screens.

Having a character narrative background is another relevant factor for avatar use in HCI. Again, very few avatars have a developed personality outside of the player's. Given that avatar identity can be communicated through narrative elements besides appearance [138], it is important to establish how self-perception occurs when identity cues are not visual but, for example, verbal. Future studies can explore these, while acknowledging that avatar identity narratives will result in different degrees of identification/perceived closeness by different players.

Furthermore, even without an explicit character-establishing narrative, avatars can be perceived as representing a role that players recognize, e.g., a soldier or a car pilot, which already can have an effect on them [92]. Indeed, abilities may be enough to suggest who the player is, driving norm-appropriate behavior [120]. This suggests that conventionally recognizable roles and skills are relevant avatar concepts together with identities, bodies, technological immersion, and narrative background.

Avatar customization has been highlighted as fostering personal connection [115] and promoting game enjoyment through autonomy and control [88]. Aspects such as customization and gender consistency affect perceived closeness [127], which has been qualitatively linked to Proteus effect strength [127]. However, most **climate citizen**, **climate hero**, and **authority** avatars lack customization options. We suggest a more extensive use and comparison of customization options in connection with various climate-relevant avatar identities in research and design.

Embodiment and customization can augment the Proteus effect [127], but user-avatar closeness can also be fostered through emotional connection. Identification can occur without customization or even interaction [91, 92], and even without similarity with who the player is at the moment [41]. These aspects of avatar personality, which can be communicated and enacted in visual or verbal ways, can have important implications if we take identification as a broad phenomenon involving concepts such as desired value similarity and liking, as suggested by some [41, 146]. Furthermore, similarity and dissimilarity can have desired or undesired effects depending on the situation [155], which leaves an open door for all identity types to have a role in engaging with climate change.

Overall, this discussion points to the fact that avatar identities, regardless of their representation modes and similarity to players, can have effects that should be explored further, in the area of climate change games and beyond. Given frequent conceptual openness, future empirical studies should define precisely what is meant by avatar and important keywords such as identification, and identify clearly the elements at play in constructing the avatar identity. Since the user-avatar relationship depends largely on the player, it is also important to carefully understand who the player is, or at least whether they see themselves as similar, identify with, and/or feel close to the avatar. While reflections about our avatar identity types and their potential for connection with players can be climate change-specific, generic aspects such as bodies, characters, and customization are rather universal.

In fact, these types may be tested in game contexts outside of climate change. Confronting a real-world issue through real-world actions, virtual citizen action, heroically or using special skills, as a versatile actor, or as a decision-maker, either in a contained space (however complex) or among other self-interested similar forces, hardly applies to climate change or environmental issues alone. The use of these types in other contexts offer exciting opportunities to discuss how the role identities suggested in games could persuade of how issues should be addressed.

In addition, given digital games' environmental impact, we encourage researchers to investigate when their creation and use may be truly justified, for example through media comparisons involving role identities in analog formats and avatars in digital worlds. Environmental burdens can remain largely invisible to players; thus, it is crucial to question whether and how digital games can do more good through engagement or altruistic schemes than harm in terms of environmental and societal sustainability. With explicit mentions of analog role-playing as affecting self-perception and grounding Proteus effect research [164], and the many relationships that role-players establish with their characters [21], the potential of tabletop and live-action modalities may not be too dissimilar from digital avatar-based play. However, irrespective of the medium chosen, a sustainable future requires fundamental technological, economic, and sociopolitical changes [149]. Gamification can only be a tool towards this goal and designers should be mindful of the changes required beyond incremental improvements, and the need to involve audiences beyond Western adults [51].

To conclude our discussion of the results, we summarize contributions and implications for researchers, designers, and educators. For researchers, we have provided six types of avatar identity and a dataset detailing climate action in existing games. These tools can help them address the following recommendations:

- In empirical studies of climate change game effects, consider the contribution of avatar identities to game experience and engagement, either in isolation or by encouraging players to face the same issue from different perspectives. This can include cognitive, affective, and motivational-behavioral aspects. Some possible questions are:
  - Do **climate selves** have motivational and behavioral engagement potential? In what conditions, and for whom?
  - Can **climate citizens** articulate relatable experiences in a safe space for players to learn and rehearse? How can this knowledge transfer outside of games?
  - Do **climate heroes** promote inspiration and wishful identification, and if so, how?
  - How can **empowered individuals** help understand the opportunities and challenges of deliberation to address common ecological problems?
  - Do **authorities** help players understand the position of the decision-maker who must consider stakeholders?
  - Do **faction leaders** effectively represent multi-lateral negotiation and affect views such as confidence in politics?
- Further explore the role that variables such as body, narrative character development, or customization in climate change games can have. What are the climate change engagement

effects of different forms of identity cuing and degrees of self-similarity?

- Investigate player views on the role of violence in polarized and polarizing topics. Can games become proving grounds for experiencing and discussing authoritarian and radical approaches to wicked problems? What can games reveal of player values, and how do they affect them?
- Notice that almost no **authorities**, and neither **empowered individuals** nor **faction leaders**, must address climate change to achieve goals. How do player perceptions change when they are enforced to successfully face a climate crisis versus when they are not?
- Be mindful of games with multiplayer modes and different spatial configurations. What are the effects of playing among humans versus alone? What are the effects of games with different geographical scopes, from the local to the global?
- Finally, we suggest two further explorations of these avatar identities. Can they be meaningfully applied beyond climate change games? Can they be used beyond digital games?

Designers can also use the types and dataset to:

- Derive inspiration and, if designing a game with utilitarian purposes, consider the potential of each identity type.
- Address the existing scarcity of **climate citizens** and **empowered individuals**. For example, how can meaningful game experiences that are closer to the citizens' be designed?
- Explore avatar representations that make use of bodies, narratives, and customization options, both because of their engaging qualities and because of their potential for effects beyond entertainment.
- Consider if more adaptation-centered games can be created from the point of view of the citizen, given the increasing need for disaster readiness.
- Design with under-represented tools and perspectives in mind. For example, participation is rarely used as a mitigation tool, and wicked situations are by definition too troublesome and complex to be addressed through only one perspective or way of acting. In this sense, mixing avatar identities in the same game can be enriching.
- Consider what the added value of using a digital medium is and ways to minimize the impact of game production, use, and disposal, including environmental sustainability but also societal concerns. Be wary of advocating for incremental change exclusively.

Similarly, the types and dataset can be used by educators to:

- Select the games that they want to use based on the avatar identity, actions, number of players, and scope of interest.
- Identify games for learning, but also for discussing attitudes, affective relationships to issues, responses, places, and people, and to experience and discuss their motivational effect or intention. What do students think about topics and identities, the games themselves and their use for serious purposes?

## 5.4 Limitations

One important limitation of this study has been the use of a single analyst. While in qualitative text analysis it is recommended to use two or more coders [94], we argue that the position of the analyst

as a player, researcher, journalist and designer of climate change games provides a valuable perspective. While idiosyncratic, this particular collection of identities, to use our topic’s term, should be able to offer a comprehensive and coherent observation and interpretation of games’ discursive attempts to position players within the game world and persuade them to participate as intended. On the flip side, to address the inherent limitations of using a single perspective, we paid special attention to our category definitions and the explanatory examples used, as advised [94]. We also used additional strategies [36] adapted to the analysis of games [95] to ensure the accuracy of the data and our analysis, including examples and detailed descriptions of the concepts presented, as well as possible exceptions, to support the decisions made. We also acknowledged the analyst’s background and how it could influence the research process. Time was dedicated to each game according to its level of complexity. For example, games that presented a clear narrative progression were experienced or seen until the end, and complex strategy and simulation games were played and explored at length including a full reading of in-game encyclopedias, option menus and manuals, as well as use of forums and videos. In all cases, we triangulated our observations from the gameplay with other sources. In addition, notes were updated multiple times during the analysis and writing process for cohesiveness.

Although we built the avatar identity types using a systematic type-building process, we did not aim to create a canonical and highly abstracted classification, but rather an empirically grounded one [94]. The resulting types are polythetic, meaning that the cases within each type are similar but not always exactly the same in their norms and goals. Divergences can be found within types—some **empowered individuals** and **authorities** have different goals to otherwise similar cases—but also commonalities between them—**climate selves**, **climate citizens** and **climate heroes** have largely comparable goals, although they differ in their means; **empowered individuals** combine citizen and specialized behaviors, thus having overlapping norms with other types; and **authorities** and **faction leaders** follow similar norms while diverging in their goals. Yet, our classification has prioritized a level of abstraction both practical and insightful.

The presence of edge cases and games presenting mixed identities has been resolved by considering their main perceived ethos. This has been the case in the **climate self** game *Mission 1.5* [124], where players can make decisions within a simulated world but the ultimate goal involves real-world political demands, or *Climate, Please!* [125], where a lobbyist can nudge people to change with their own hands, although this secondary activity does not contribute to the game goal and thinly extends the norm-enforcing role. Some games, especially in the strategy genre, present multiple game modes with different ultimate goals and norms, but in these cases we have analyzed only specific scenarios focused on climate action. It is important to restate that these are types of avatar identity, not of game, so we encourage future games to mix different identity roles in single or multiple avatars in novel and interesting ways beyond what games usually present [154].

By adopting an ample understanding of what games are, using the lens of gamification, we have been able to provide a type of avatar identity, **climate selves**, not typically found in traditional games, where action is exclusive to the virtual world. Although

there is no reason that games would not be able to mix in-game actions with real-world ones, as seen in, e.g., *Mission 1.5* [124], the concept of real-world behavior seems naturally associated with gamification. A study of other game and play forms, from live-action role-playing to gambling to toys, may result in other relevant phenomena emerging. However, given our focus on role identities enacting climate action given particular norms and goals, we assume that the conclusions of this analysis would be largely applicable to, e.g., most analog games.

This study has used content analysis as the method of inquiry. Therefore, it has focused on games and surrounding texts, rather than players themselves, to examine concepts such as avatar identities and climate actions and hypothesize about their potential for engagement. Disentangling the ways in which avatar identities can be realized in gameplay and interact with the players’ selves requires examining a relationship involving actual players beyond an implied one. Future studies can use the relevant aspects presented in the results and discussion to explore empirically how that potential can be realized or contested.

Finally, the tendency of smaller games to disappear from the internet, and of popular games to be regularly updated, must be acknowledged. An example of this is Adobe Flash Player’s end of life [5], which may have rendered some of the games analyzed here inaccessible after December 2020.

## 6 CONCLUSIONS

This article presented a qualitative text analysis of 80 video games where players explicitly engage in climate change mitigation and adaptation. We first sought to understand what identities could be found in these games, classifying our findings in six groups—**climate selves**, **climate citizens**, **climate heroes**, **empowered individuals**, **authorities**, and **faction leaders**. The potential of these avatar identity types for climate change engagement and avatar representation aspects were discussed.

Second, we focused on climate issues and actions to address them, observing that adaptation is often left for decision-making profiles, while mitigation actions are numerous in all six groups but addressed using different tools. We recommend climate actions such as policy, violence, technology, and nature-based solutions for future close study. More broadly, we encourage developers to address uncommon identities, i.e., **climate citizens** and **empowered individuals**, more often.

Third, we examined climate issues and their relationship to ultimate goals. We observed a tendency to have a single climate-related goal in games with **climate selves**, **climate citizens**, and **climate heroes**, contrasting with the more complex conflicting goals in other games. Building on recent research, researchers and developers should consider that enforcing pro-environmental behavior in games may not be necessary to support climate change engagement.

In sum, our study provided a basis for future researchers to study and compare how players experience climate identities and their climate change engagement effects. We also interpreted our findings in light of previous avatar-related work. We highlighted key aspects for developers to consider, as well as games for educators to select depending on their needs. Given the environmental impact of digital

games, we call for research that explores climate identity in analog games, and encourage developers to critically assess the advantages of digital games while minimizing their negative impacts.

## ACKNOWLEDGMENTS

This work was supported by the Finnish Cultural Foundation (Grant 00200246), the Nessling Foundation (Project 202100217), the Academy of Finland Flagship Programme (337653 Forest-Human-Machine Interplay (UNITE)), and the European Union's Horizon 2020 program through the Marie Skłodowska-Curie Actions Individual Fellowship (ID 840809).

## REFERENCES

- [1] Espen Aarseth. 2007. I fought the law: Transgressive play and the implied player. In *Proceedings of DiGRA 2007 Conference*. Digital Games Research Association (DiGRA), Finland, 130–133.
- [2] WeDontHaveTime AB. 2019. *We Don't Have Time*. Social network [Android, iOS]. WeDontHaveTime AB, Stockholm, Sweden..
- [3] Benjamin Abraham and Darshana Jayemanne. 2017. Where are all the climate change games? Locating digital games' response to climate change. *Transformations* 30 (2017), 74–94.
- [4] Activision. 2000. *Call to Power II*. Game [PC]. Activision, Santa Monica, California..
- [5] Adobe. 2021. *Adobe Flash Player End of Life*. Adobe. <https://www.adobe.com/products/flashplayer/end-of-life.html>
- [6] Sun Joo Ahn, Joshua Bostick, Elise Ogle, Kristine L Nowak, Kara T McGillicuddy, and Jeremy N Bailenson. 2016. Experiencing nature: Embodying animals in immersive virtual environments increases inclusion of nature in self and involvement with nature. *Journal of Computer-Mediated Communication* 21, 6 (2016), 399–419.
- [7] Playing For The Planet Alliance. 2019. *Members - Playing4theplanet*. Playing For The Planet Alliance. <https://playing4theplanet.org/members/>
- [8] Lawrence C An, Michele RS Demers, Matthias A Kirch, Shannon Considine-Dunn, Vijay Nair, Kohinoor Dasgupta, Naveen Narisetty, Ken Resnicow, and Jasjit Ahluwalia. 2013. A randomized trial of an avatar-hosted multiple behavior change intervention for young adult smokers. *Journal of the National Cancer Institute Monographs* 2013, 47 (2013), 209–215.
- [9] Thomas Apperley and Darshana Jayemane. 2012. Game studies' material turn. *Westminster Papers in Communication and Culture* 9, 1 (2012), 5–25.
- [10] Thomas H Apperley and Justin Clemens. 2017. Flipping out: Avatars and identity. In *Boundaries of Self and Reality Online*. Elsevier, Amsterdam, The Netherlands, 41–56.
- [11] Therese Asplund. 2020. Credibility aspects of research-based gaming in science communication.: The case of The Maladaptation Game. *JCOM-Journal of Science Communication* 19, 1 (2020), A01.
- [12] Isabella Aura, Lobna Hassan, and Juho Hamari. 2021. Teaching within a Story: Understanding storification of pedagogy. *International Journal of Educational Research* 106 (2021), 101728.
- [13] Christine M Bachen, Pedro F Hernández-Ramos, and Chad Raphael. 2012. Simulating REAL LIVES: Promoting global empathy and interest in learning through simulation games. *Simulation & Gaming* 43, 4 (2012), 437–460.
- [14] Jaime Banks. 2015. Object, me, symbiote, other: A social typology of player-avatar relationships. *First Monday* 20, 2 (2015).
- [15] Jorge Barcena-Vazquez and Karina Caro. 2019. Designing a video game to support climate change awareness in a museum exhibition context. In *Proceedings of the IX Latin American Conference on Human Computer Interaction*. Association for Computing Machinery, New York, NY, 1–4.
- [16] Dalibor Bartoš. 2019. *Trash Time*. Game [PC]. Dalibor Bartoš and TEDI Games, Slovakia..
- [17] Jonathan Belman and Mary Flanagan. 2010. Designing games to foster empathy. *International Journal of Cognitive Technology* 15, 1 (2010), 11.
- [18] Max V Birk, Cheralyn Atkins, Jason T Bowey, and Regan L Mandryk. 2016. Fostering intrinsic motivation through avatar identification in digital games. In *Proceedings of the 2016 CHI conference on human factors in computing systems*. Association for Computing Machinery, New York, NY, 2982–2995.
- [19] Ian Bogost. 2007. *Persuasive games*. Vol. 5. MIT Press, Cambridge, MA.
- [20] Maxime Boudreault, Bruno Bouchard, Kevin Bouchard, and Sébastien Gaboury. 2018. Maximizing Player Engagement in a Global Warming Sensitization Video Game Through Reinforcement Learning. In *Proceedings of the 4th EAI International Conference on Smart Objects and Technologies for Social Good*. Association for Computing Machinery, New York, NY, 196–201.
- [21] Sarah Lynne Bowman. 2010. *The functions of role-playing games: How participants create community, solve problems and explore identity*. McFarland, Jefferson, NC.
- [22] Mila Bujčić, Mikko Salminen, Joseph Macey, and Juho Hamari. 2020. "Empathy machine": how virtual reality affects human rights attitudes. *Internet Research* 30, 5 (2020), 1407–1425.
- [23] Jacqueline Burgess and Christian Jones. 2020. "I Harbour Strong Feelings for Tali Despite Her Being a Fictional Character": Investigating Videogame Players' Emotional Attachments to Non-Player Characters. *Game Studies* 20, 1 (2020).
- [24] Peter L Callero. 1985. Role-identity salience. *Social Psychology Quarterly* 48, 3 (1985), 203–215.
- [25] CO2 Cards. 2019. *CO2 Cards - Play & reduce real-life CO2 emissions!* Game [Android]. CO2 Cards, Sofia, Bulgaria..
- [26] Carl von Ossietzky Universität Oldenburg and Bornholdt Lee GmbH. 2016. *Keep Cool Mobile*. Game [browser]. Carl von Ossietzky Universität Oldenburg, Oldenburg, Germany..
- [27] Michael J Carter and Hannah Mangum. 2020. Role identities: Measurement and outcomes of conventional vs. idiosyncratic balance. *Current Psychology* 2020 (2020), 1–12.
- [28] Tina Chan and Adam Leung. 2020. Illuminate: A Simulation Game to Instill Grounded Hope in Youth for Climate Action. In *Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play*. Association for Computing Machinery, New York, NY, 47–49.
- [29] Alenda Y Chang. 2019. *Playing nature: Ecology in video games*. Vol. 58. U of Minnesota Press, Minneapolis, MN.
- [30] Susan Clayton. 2020. Climate anxiety: Psychological responses to climate change. *Journal of Anxiety Disorders* 74 (2020), 102263.
- [31] The Capture Club. 2020. *Capture (Carbon footprint & CO2 tracker)*. Game [PC]. The Capture Club, Raffles Place, Singapore..
- [32] Emmanuelle Cohen-Shacham, Gretchen Walters, Christine Janzen, and Stewart Maginnis. 2016. *Nature-based solutions to address global societal challenges*. Vol. 97. IUCN, Gland, Switzerland.
- [33] David A Collings. 2014. *Stolen future, broken present: the human significance of climate change*. Open Humanities Press, London, England.
- [34] Anna N Cooke, Kelly S Fielding, and Winnifred R Louis. 2016. Environmentally active people: The role of autonomy, relatedness, competence and self-determined motivation. *Environmental Education Research* 22, 5 (2016), 631–657.
- [35] Rajendra KP Core Writing Team. 2014. Climate change 2014: Synthesis Report. *Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change* 27 (2014), 408.
- [36] John W Creswell and J David Creswell. 2013. *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE Publications, London, England.
- [37] Philipp Überbacher Daniela Bruns and denoivare. 2019. *Something Something Climate Change*. Game [browser].
- [38] Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. From game design elements to gamefulness: defining "gamification". In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*. Association for Computing Machinery, New York, NY, 9–15.
- [39] Hans Dieleman and Don Huisingh. 2006. Games by which to learn and teach about sustainable development: exploring the relevance of games and experiential learning for sustainability. *Journal of Cleaner Production* 14, 9–11 (2006), 837–847.
- [40] ZU Digital. 2017. *World Rescue*. Game [Android]. ZU Digital, Budapest, Hungary..
- [41] Edward Downs, Nicholas D Bowman, and Jaime Banks. 2019. A polythetic model of player-avatar identification: Synthesizing multiple mechanisms. *Psychology of Popular Media Culture* 8, 3 (2019), 269.
- [42] Anthony Dudo, Vincent Cicchirillo, Lucy Atkinson, and Samantha Marx. 2014. Portrayals of technoscience in video games: A potential avenue for informal science learning. *Science Communication* 36, 2 (2014), 219–247.
- [43] EarthGames. 2019. *Deal: A Green New Election*. Game [Android, browser].
- [44] EDF. 2015. *Cleanopolis VR*. Game [iOS]. EDF, London, UK..
- [45] Klaus Eisenack. 2013. A climate change board game for interdisciplinary communication and education. *Simulation & Gaming* 44, 2-3 (2013), 328–348.
- [46] Ulrike Erb. 2015. Possibilities and limitations of transferring an educational simulation game to a digital platform. *Simulation & Gaming* 46, 6 (2015), 817–837.
- [47] Eversim. 2019. *Power & Revolution 2019 Edition*. Game [PC]. Eversim, Lognes, France..
- [48] Garry Falloon. 2010. Using avatars and virtual environments in learning: What do they have to offer? *British Journal of Educational Technology* 41, 1 (2010), 108–122.
- [49] Timea Farkas, Sarah Wiseman, Paul Cairns, and Rebecca Fiebrink. 2020. A Grounded Analysis of Player-Described Board Game Immersion. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. Association for Computing Machinery, New York, NY, 427–437.
- [50] Daniel Fernández Galeote and Juho Hamari. 2021. Game-based Climate Change Engagement: Analyzing the Potential of Entertainment and Serious Games. *Proceedings of the ACM on Human-Computer Interaction* 5, CHI PLAY (2021), 1–21.



- [51] Daniel Fernández Galeote, Mikko Rajanen, Dorina Rajanen, Nikolett Z. Legaki, David J. Langley, and Juho Hamari. 2021. Gamification for climate change engagement: review of corpus and future agenda. *Environmental Research Letters* 16, 6 (2021), 1–50. <http://iopscience.iop.org/article/10.1088/1748-9326/abec05>
- [52] Kristoffer S Fjællingsdal and Christian A Klöckner. 2019. Gaming Green: The Educational Potential of Eco—A Digital Simulated Ecosystem. *Frontiers in psychology* 10 (2019), 2846.
- [53] Stephen Flood, Nicholas A Craddock-Henry, Paula Blackett, and Peter Edwards. 2018. Adaptive and interactive climate futures: systematic review of ‘serious games’ for engagement and decision-making. *Environmental Research Letters* 13, 6 (2018), 063005.
- [54] Centre for System Solutions. 2018. *New Shores*. Game [browser]. Centre for System Solutions, Wrocław, Poland..
- [55] Elfriede Fursich. 2009. In defense of textual analysis. *Journalism studies* 10, 2 (2009), 238–252.
- [56] Alastor Games. 2019. *Mad Parallax: Jumpy Road*. Game [browser]. Alastor Games, France..
- [57] Africa Cross Games. 2019. *Global Warming Strategy Game*. Game [browser]. Africa Cross Games, New Jersey..
- [58] Africa Cross Games. 2019. *The Carbon Neutral Republic of Novaya Zemlya (Inc.)*. Game [browser]. Africa Cross Games, New Jersey..
- [59] Deep State Games. 2019. *The Climate Trail*. Game [PC, Android, iOS].
- [60] Firaxis Games. 1999. *Sid Meier’s Alpha Centauri*. Game [PC]. Electronic Arts, Redwood City, California..
- [61] Firaxis Games. 2001. *Sid Meier’s Civilization III*. Game [PC]. Infogrames, Paris, France..
- [62] Firaxis Games. 2019. *Sid Meier’s Civilization VI: Gathering Storm*. Game [PC]. 2K Games, Novato, California..
- [63] Positech Games. 2013. *Democracy 3*. Game [PC]. Positech Games, UK..
- [64] Pixel Quality Games. 2018. *Project AURA*. Game [PC].
- [65] Strange Loop Games. 2018. *Eco*. Game [PC]. Strange Loop Games, Seattle, Washington..
- [66] James Paul Gee. 2008. Learning and Games. In *The ecology of games: Connecting youth, games, and learning*, Katie Salen Tekinbaş (Ed.). MIT Press, Cambridge, MA, 21–40. <https://mitpress.mit.edu/books/ecology-games>
- [67] James Paul Gee. 2014. *Unified discourse analysis: Language, reality, virtual worlds and video games*. Routledge, Abingdon, England.
- [68] Alex Gekker. 2021. Against game studies. *Media and Communication* 9, 1 (2021), 73–83.
- [69] Andreas Gerber, Markus Ulrich, Flurin X Wäger, Marta Roca-Puigròs, João SV Gonçalves, and Patrick Wäger. 2021. Games on Climate Change: Identifying Development Potentials through Advanced Classification and Game Characteristics Mapping. *Sustainability* 13, 4 (2021), 1997.
- [70] Robert Gifford. 2011. The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. *American psychologist* 66, 4 (2011), 290.
- [71] Michael Goerger. 2017. Value, violence, and the ethics of gaming. *Ethics and Information Technology* 19, 2 (2017), 95–105.
- [72] Tobias Greitemeyer and Silvia Osswald. 2010. Effects of prosocial video games on prosocial behavior. *Journal of personality and social psychology* 98, 2 (2010), 211.
- [73] Georgina Guillen M, Juho Hamari, and Jaco Quist. 2021. Gamification of Sustainable Consumption: a systematic literature review. In *Proceedings of the 54th Hawaii International Conference on System Sciences*. HICSS, Hawaii, 1345.
- [74] Juho Hamari. 2019. Gamification. In *The Blackwell Encyclopedia of Sociology*. John Wiley & Sons, Hoboken, NJ, 1–3.
- [75] Juho Hamari, David J Shernoff, Elizabeth Rowe, Brianno Coller, Jodi Asbell-Clarke, and Teon Edwards. 2016. Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in human behavior* 54 (2016), 170–179.
- [76] Sherry Hamby. 2017. On defining violence, and why it matters [Editorial]. *Psychology of Violence* 7, 2 (2017), 167–180. <https://doi.org/10.1037/vio0000117>
- [77] Garrett Hardin. 1968. The tragedy of the commons. *Science* 162, 3859 (1968), 1243–1248.
- [78] Earth Hero. 2020. *Earth Hero: Climate Change*. Game [Android, iOS].
- [79] Lorenz Hilty, Wolfgang Lohmann, and Elaine M Huang. 2011. Sustainability and ICT—an overview of the field. *Notizie di POLITELA* 27, 104 (2011), 13–28.
- [80] Nina Huntemann and Ben Aslinger. 2013. *Gaming globally: Production, play, and place*. Springer, New York, NY.
- [81] Frank P Incropera. 2016. *Climate change: a wicked problem: complexity and uncertainty at the intersection of science, economics, politics, and human behavior*. Cambridge University Press, Cambridge, England.
- [82] Charlene Jennett, Ioanna Iacovides, Anna L Cox, Anastasia Vikhanova, Emily Weigold, Layla Mostaghimi, Geraint Jones, James Jenkins, Sarah Gallacher, and Yvonne Rogers. 2016. Squeezing Green Balls: Promoting Environmental Awareness through Playful Interactions. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*. Association for Computing Machinery, New York, NY, 389–400.
- [83] Jesper Juul and Rune Klevjer. 2016. Avatar. In *The International Encyclopedia of Communication Theory and Philosophy*. John Wiley & Sons, Hoboken, NJ, 1–5.
- [84] Leonie Kallabis. 2020. *Overcome Your Weaker Self*. Game [browser]. Leonie Kallabis, Cologne, Germany..
- [85] Dominic Kao and D Fox Harrell. 2015. Exploring the impact of role model avatars on game experience in educational games. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*. Association for Computing Machinery, New York, NY, 571–576.
- [86] Avi Kaplan and Joanna K Garner. 2017. A complex dynamic systems perspective on identity and its development: The dynamic systems model of role identity. *Developmental psychology* 53, 11 (2017), 2036.
- [87] Korina Katsaliaki and Navonil Mustafee. 2015. Edutainment for sustainable development: A survey of games in the field. *Simulation & Gaming* 46, 6 (2015), 647–672.
- [88] Keunyeong Kim, Michael G Schmierbach, Mun-Young Chung, Julia Daisy Fraustino, Frank Dardis, Lee Ahern, et al. 2015. Is it a sense of autonomy, control, or attachment? Exploring the effects of in-game customization on game enjoyment. *Computers in Human Behavior* 48 (2015), 695–705.
- [89] Elaine L Kinsella, Timothy D Ritchie, and Eric R Igou. 2015. Lay perspectives on the social and psychological functions of heroes. *Frontiers in psychology* 6 (2015), 130.
- [90] Philipp ‘Phil’ Klaus and Stan Maklan. 2013. Towards a better measure of customer experience. *International Journal of Market Research* 55, 2 (2013), 227–246.
- [91] Christoph Klimmt, Dorothee Hefner, and Peter Vorderer. 2009. The video game experience as “true” identification: A theory of enjoyable alterations of players’ self-perception. *Communication theory* 19, 4 (2009), 351–373.
- [92] Christoph Klimmt, Dorothee Hefner, Peter Vorderer, Christian Roth, and Christopher Blake. 2010. Identification with video game characters as automatic shift of self-perceptions. *Media Psychology* 13, 4 (2010), 323–338.
- [93] Udo Kuckartz. 2013. *Qualitative text analysis: A guide to methods, practice and using software*. SAGE Publications, London, England.
- [94] Udo Kuckartz. 2014. Three basic methods of qualitative text analysis. In *Qualitative text analysis: A guide to methods, practice and using software*. SAGE Publications, London, England, 65–120.
- [95] Petri Lankoski and Staffan Björk. 2015. Formal analysis of gameplay. In *Game Research Methods*. ETC Press, Pittsburgh, PA, 23–35.
- [96] Lanthanum. 2020. *Oil Eco Factory Tycoon*. Game [PC]. Lanthanum, Corrèze, France..
- [97] Georgia Liarakou, Eleni Sakka, Costas Gavrilakis, and Costas Tsolakidis. 2012. Evaluation of serious games, as a tool for education for sustainable development. *European Journal of Open, Distance and E-learning* 15, 2 (2012), 96–110.
- [98] Christine Lisetti, Reza Amini, Ugan Yasavur, and Naphtali Rische. 2013. I can help you change! an empathic virtual agent delivers behavior change health interventions. *ACM Transactions on Management Information Systems (TMIS)* 4, 4 (2013), 1–28.
- [99] Michael Loadenthal. 2017. “Eco-Terrorism”: An Incident-Driven History of Attack (1973–2010). *Journal for the Study of Radicalism* 11, 2 (2017), 1–34.
- [100] Irene Lorenzoni, Sophie Nicholson-Cole, and Lorraine Whitmarsh. 2007. Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global environmental change* 17, 3–4 (2007), 445–459.
- [101] Valérie Masson-Delmotte, Panmao Zhai, Hans-Otto Pörtner, Debra Roberts, Jim Skea, Priyadarshi R Shukla, Anna Pirani, W Moufouma-Okia, C Péan, R Pidcock, et al. 2018. Global warming of 1.5 C. *An IPCC Special Report on the impacts of global warming of 1 (2018)*, 1–9.
- [102] Jasper N Meya and Klaus Eisenack. 2018. Effectiveness of gaming for communicating and teaching climate change. *Climatic change* 149, 3 (2018), 319–333.
- [103] Evan Mills, Norman Bourassa, Leo Rainer, Jimmy Mai, Arman Shehabi, and Nathaniel Mills. 2019. Toward greener gaming: Estimating national energy use and energy efficiency potential. *The Computer Games Journal* 8, 3 (2019), 157–178.
- [104] Joel Millward-Hopkins, Julia K Steinberger, Narasimha D Rao, and Yannick Oswald. 2020. Providing decent living with minimum energy: A global scenario. *Global Environmental Change* 65 (2020), 102168.
- [105] Martha C Monroe, Richard R Plate, Annie Oxarart, Alison Bowers, and Willandia A Chaves. 2019. Identifying effective climate change education strategies: a systematic review of the research. *Environmental Education Research* 25, 6 (2019), 791–812.
- [106] Vicki Moulder, Lorna R Boschman, Ron Wakkary, Carman Neustaedter, and Hiroki Hill Kobayashi. 2018. HCI interventions for science communication. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, 1–9.
- [107] Tina-Simone Neset, Sirkku Juhola, Lotten Wiréhn, Janina Käyhkö, Carlo Navarra, Therese Asplund, Erik Glaas, Victoria Wibeck, and Björn-Ola Linnér. 2020. Supporting dialogue and analysis on trade-offs in climate adaptation research with the Maladaptation Game. *Simulation & Gaming* 51, 3 (2020), 378–399.
- [108] Isabel Newsome. 2020. An Educational Game Bringing Awareness to Declining Insect Populations. In *Extended Abstracts of the 2020 Annual Symposium on*

- Computer-Human Interaction in Play*. Association for Computing Machinery, New York, NY, 326–329.
- [109] NIWA Taihoro Nukurangi and Manaaki Whenua Landcare Research. 2019. *Adaptive Futures*. Game [browser]. NIWA Taihoro Nukurangi and Manaaki Whenua Landcare Research, Auckland and Lincoln, New Zealand.
- [110] Kari Marie Norgaard. 2011. *Living in denial: Climate change, emotions, and everyday life*. mit Press, Cambridge, MA.
- [111] Maria Ojala. 2012. How do children cope with global climate change? Coping strategies, engagement, and well-being. *Journal of Environmental Psychology* 32, 3 (2012), 225–233.
- [112] Maria Ojala. 2015. Hope in the face of climate change: Associations with environmental engagement and student perceptions of teachers' emotion communication style and future orientation. *The Journal of Environmental Education* 46, 3 (2015), 133–148.
- [113] Tania Ouariachi, José Gutiérrez-Pérez, and María-Dolores Olvera-Lobo. 2018. Can serious games help to mitigate climate change? Exploring their influence on Spanish and American teenagers' attitudes/¿ Pueden los serious games ayudar a mitigar el cambio climático? Una exploración de su influencia sobre las actitudes de los adolescentes españoles y estadounidenses. *Psycology* 9, 3 (2018), 365–395.
- [114] Tania Ouariachi, María Dolores Olvera-Lobo, and José Gutiérrez-Pérez. 2017. Analyzing climate change communication through online games: Development and application of validated criteria. *Science Communication* 39, 1 (2017), 10–44.
- [115] Tania Ouariachi, María Dolores Olvera-Lobo, José Gutiérrez-Pérez, and Edward Maibach. 2019. A framework for climate change engagement through video games. *Environmental Education Research* 25, 5 (2019), 701–716.
- [116] Leslie Paas. 2016. *Action for Climate Empowerment: Guidelines for accelerating solutions through education, training and public awareness*. UNESCO Publishing, Paris, France.
- [117] Hunter Parcells. 2018. *World Saver*. Game [browser].
- [118] Paris Reinforce. 2021. I2AMPARIS - Dynamic Documentation. [http://paris-reinforce.epu.ntua.gr/dynamic\\_doc/](http://paris-reinforce.epu.ntua.gr/dynamic_doc/) [Online; accessed 15-February-2021].
- [119] Luc G Pelletier, Stephanie Dion, Kim Tuson, and Isabelle Green-Demers. 1999. Why do people fail to adopt environmental protective behaviors? Toward a taxonomy of environmental amotivation 1. *Journal of applied social psychology* 29, 12 (1999), 2481–2504.
- [120] Jorge Peña and Meng Chen. 2017. With great power comes great responsibility: Superhero primes and expansive poses influence prosocial behavior after a motion-controlled game task. *Computers in Human Behavior* 76 (2017), 378–385.
- [121] Wei Peng, Jih-Hsuan Lin, Karin A Pfeiffer, and Brian Winn. 2012. Need satisfaction supportive game features as motivational determinants: An experimental study of a self-determination theory guided exergame. *Media Psychology* 15, 2 (2012), 175–196.
- [122] Devin N Perkins, Marie-Noel Brune Drisse, Tapiwa Nxele, and Peter D Sly. 2014. E-waste: a global hazard. *Annals of global health* 80, 4 (2014), 286–295.
- [123] Jan L Plass, Bruce D Homer, and Charles K Kinzer. 2015. Foundations of game-based learning. *Educational Psychologist* 50, 4 (2015), 258–283.
- [124] PlayMob. 2019. *Mission 1.5*. Game [browser]. United Nations Development Programme, New York, New York.
- [125] Poolo and Sarry. 2019. *Climate, Please!* Game [PC].
- [126] Nick Porillo. 2018. *Minecraft GlobalWarming*. Game [PC]. Nick Porillo, Rochester, New York.
- [127] Rabindra Ratan, David Beyea, Benjamin J Li, and Luis Graciano. 2020. Avatar characteristics induce users' behavioral conformity with small-to-medium effect sizes: A meta-analysis of the proteus effect. *Media Psychology* 23, 5 (2020), 651–675.
- [128] Rabindra Ratan, RV Rikard, Celina Wanek, Madison McKinley, Lee Johnson, and Young June Sah. 2016. Introducing Avatarification: An experimental examination of how avatars influence student motivation. In *49th Hawaii International Conference on System Sciences (HICSS)*. IEEE Computer Society, Washington, D.C., US, 51–59.
- [129] Diana Reckien and Klaus Eisenack. 2013. Climate change gaming on board and screen: A review. *Simulation & Gaming* 44, 2-3 (2013), 253–271.
- [130] Red Redemption. 2006. *Climate Challenge*. Game [browser]. Red Redemption, Oxford, UK.
- [131] Red Redemption. 2011. *Fate of the World: Tipping Point*. Game [PC]. Red Redemption, Oxford, UK.
- [132] Related Designs and Bluebyte. 2011. *Anno 2070*. Game [PC]. Ubisoft, Paris, France.
- [133] Robin S Rosenberg, Shawnee L Baughman, and Jeremy N Bailenson. 2013. Virtual superheroes: Using superpowers in virtual reality to encourage prosocial behavior. *PLoS one* 8, 1 (2013), e55003.
- [134] Richard M Ryan, C Scott Rigby, and Andrew Przybylski. 2006. The motivational pull of video games: A self-determination theory approach. *Motivation and emotion* 30, 4 (2006), 344–360.
- [135] Anandita Sabherwal, Matthew T Ballew, Sander van Der Linden, Abel Gustafson, Matthew H Goldberg, Edward W Maibach, John E Kotcher, Janet K Swim, Seth A Rosenthal, and Anthony Leiserowitz. 2021. The Greta Thunberg Effect: Familiarity with Greta Thunberg predicts intentions to engage in climate activism in the United States. *Journal of Applied Social Psychology* 51, 4 (2021), 321–333.
- [136] Owen Schaffer and Xiaowen Fang. 2020. The Impact of Fulfilling a Desire for Idealism on Task Engagement and Enjoyment in Digital Games. In *International Conference on Human-Computer Interaction*. Springer, New York, NY, 162–178.
- [137] David W Shaffer. 2006. Epistemic frames for epistemic games. *Computers & education* 46, 3 (2006), 223–234.
- [138] John Sharp. 2014. Perspective. In *The Routledge Companion to Video Game Studies*, M.J.P. Wolf and B. Perron (Eds.). Routledge, Abingdon, England, 107–116.
- [139] Stephen RJ Sheppard. 2012. *Visualizing climate change: a guide to visual communication of climate change and developing local solutions*. Routledge, Abingdon, England.
- [140] Miguel Sicart. 2013. *Beyond choices: The design of ethical gameplay*. MIT Press, Cambridge, MA.
- [141] Marios Stanitsas, Konstantinos Kirytopoulos, and Elise Vareilles. 2019. Facilitating sustainability transition through serious games: A systematic literature review. *Journal of cleaner production* 208 (2019), 924–936.
- [142] Paul C Stern. 2000. New environmental theories: toward a coherent theory of environmentally significant behavior. *Journal of social issues* 56, 3 (2000), 407–424.
- [143] TapTapTales. 2018. *Animal Club: Play to save the Polar Bear*. Game [Android]. TapTapTales, Barcelona, Spain.
- [144] The Global Calculator. 2020. The Global Calculator. <http://tool.globalcalculator.org/> [Online; accessed 15-February-2021].
- [145] Debbe Thompson. 2012. Designing serious video games for health behavior change: current status and future directions. *Journal of diabetes science and technology* 6, 4 (2012), 807–811.
- [146] Sabine Trepte and Leonard Reinecke. 2010. Avatar creation and video game enjoyment. *Journal of Media Psychology* 22 (2010), 171–184.
- [147] Giovanni Maria Troiano, Dylan Schouten, Michael Cassidy, Eli Tucker-Raymond, Gillian Puttick, and Casper Hartevelde. 2020. Ice Paddles, CO2 Invaders, and Exploding Planets: How Young Students Transform Climate Science Into Serious Games. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. Association for Computing Machinery, New York, NY, 534–548.
- [148] April Tyack and Peta Wyeth. 2017. Exploring relatedness in single-player video game play. In *Proceedings of the 29th Australian Conference on Computer-Human Interaction*. Association for Computing Machinery, New York, NY, 422–427.
- [149] United Nations Environment Programme (UNEP). 2021. *Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies*. UNEP. <https://www.unep.org/resources/making-peace-nature>
- [150] United Nations Development Programme, GRID-Arendal. 2019. Video Games Industry Levels Up in Fight Against Climate Change. <https://www.unep.org/news-and-stories/press-release/video-games-industry-levels-fight-against-climate-change> [Online; accessed 15-February-2021].
- [151] Robert J Vallerand. 1997. Toward a hierarchical model of intrinsic and extrinsic motivation. *Advances in experimental social psychology* 29 (1997), 271–360.
- [152] Austin van Loon, Jeremy Bailenson, Jamil Zaki, Joshua Bostick, and Robb Willer. 2018. Virtual reality perspective-taking increases cognitive empathy for specific others. *PLoS one* 13, 8 (2018), e0202442.
- [153] Daniel Vella. 2016. "Who Am I in the Game?": A Typology of the Modes of Ludic Subjectivity.. In *Proceedings of 1st International Joint Conference of DiGRA and FDG*. DiGRA and FDG, Finland, 1–16.
- [154] Daniel Vella and Magdalena Cielecka. 2021. "You Won't Even Know Who You Are Anymore": Bakhtinian Polyphony and the Challenge to the Ludic Subject in Disco Elysium. *Baltic Screen Media Review* 9, 1 (2021), 90–104.
- [155] T Franklin Waddell, S Shyam Sundar, and Joshua Auriemma. 2015. Can customizing an avatar motivate exercise intentions and health behaviors among those with low health ideals? *Cyberpsychology, Behavior, and Social Networking* 18, 11 (2015), 687–690.
- [156] David I Waddington and Thomas Fennwald. 2018. Grim FATE: Learning about systems thinking in an in-depth climate change simulation. *Simulation & gaming* 49, 2 (2018), 168–194.
- [157] Alexander Walmsley. 2019. *Zero Carbon, Zero Tolerance*. Game [PC]. Alexander Walmsley, Berlin, Germany.
- [158] Peter Weinreich and Wendy Saunderson. 2005. *Analysing identity: Cross-cultural, societal and clinical contexts*. Routledge, Abingdon, England.
- [159] Lorraine Whitmarsh, Irene Lorenzoni, and Saffron O'Neill. 2012. *Engaging the public with climate change: Behaviour change and communication*. Routledge, Abingdon, England.
- [160] Victoria Wibeck. 2014. Enhancing learning, communication and public engagement about climate change—some lessons from recent literature. *Environmental Education Research* 20, 3 (2014), 387–411.
- [161] Pieter Wouters, Christof Van Nimwegen, Herre Van Oostendorp, and Erik D Van Der Spek. 2013. A meta-analysis of the cognitive and motivational effects of serious games. *Journal of educational psychology* 105, 2 (2013), 249.

- [162] Nannan Xi and Juho Hamari. 2019. Does gamification satisfy needs? A study on the relationship between gamification features and intrinsic need satisfaction. *International Journal of Information Management* 46 (2019), 210–221.
- [163] Nick Yee and Jeremy Bailenson. 2007. The Proteus effect: The effect of transformed self-representation on behavior. *Human communication research* 33, 3 (2007), 271–290.
- [164] Nick Yee, Jeremy N Bailenson, and Nicolas Ducheneaut. 2009. The Proteus effect: Implications of transformed digital self-representation on online and offline behavior. *Communication Research* 36, 2 (2009), 285–312.
- [165] José P Zagal, Michael S Debus, and Rogelio E Cardona-Rivera. 2019. On the ultimate goals of games: Winning, finishing, and prolonging. In *Proceedings of the 13th International Philosophy of Computer Games Conference*, Vol. 11. Game Philosophy Network and Centre for Media Philosophy and Laboratory for Computer Games Research, St. Petersburg, Russia, 1–11.
- [166] Dan Zahavi. 2008. *Subjectivity and selfhood: Investigating the first-person perspective*. MIT Press, Cambridge, MA.