Exploration through video games

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2 Perspectives on Games, Curiosity, and Exploration

This chapter introduces literature from game research, game studies, and behavioral psychology in the context of curiosity. These areas form the theoretical foundation of the larger investigation into games that elicit curiosity for exploration and the strategies that are employed in doing so.

The chapter defines "games" as a medium. It discusses using games for purposes beyond entertainment (i.e., applied games), such as motivating curiosity for a topic through games, teaching with games, or using games as research artifacts.

Subsequently, terminology and definitions surrounding the concept of curiosity and how scholars have operationalized it in prior studies are discussed. The chapter concludes with the author's work on the intersection of these topics.

2.1 Defining Games

Games are commonly considered "fun" activities, providing entertainment through the engagement of involved participants: the players. As a medium, games may provide that entertainment through different means, such as providing pleasure through appealing aesthetics, surmountable challenges, or agency in how narrative events unfold, to name a few. Formal definitions of games focus on describing the conceptual artifact in its physical or virtual manifestation rather than the emotional impact it creates in a player. Avedon and Sutton-Smith's book *The Study of Games* (2015) defines games as:

> "… an exercise of voluntary control systems, in which there is a contest between powers, confined by rules in order to produce a disequilibrial outcome."

In Jesse Schell's book for aspiring game designers *The Art of Game Design* (2008), this definition is unpacked and compared to definitions from other scholars, ending with a simplified definition by Schell that introduces the emotional aspect (i.e., playfulness) that is often associated with games:

> "A game is a problem-solving activity, approached with a playful attitude."

Schell's definition of games foregoes specifying the systems and circumstances outlined by Avedon and Sutton-Smith, focusing instead on the affective state of players. Rather than understanding these definitions as competing assessments on the nature of games, they reflect different focus points and are meant to illustrate that the formal definition of games remains in active discussion. However, both definitions describe games as ontological entities, as conceptual systems that are framed as constituting a game in the mind of potential participants.

What is less explicitly mentioned but implicit in the notion of rules and activities is the involvement of one or more game designers. As a profession, game designers define the actions that players can take, the actions that are carried out by elements in the game, and the aesthetic through which these actions are communicated to players. Designers may further frame these actions through narrative structures to contextualize the game's actions and emotionally engage the player.

Although playful activities can and do emerge without intentional design (Salen and Zimmerman 2005), games are authored with a purpose and involve strategies that support the realization of that purpose. For many games, that purpose is to entertain players for the duration of their involvement with the game. The entertainment value drives the perception of games being "fun" despite involving a wide range of affective states that can, at least in the moment, be considered negative (Lazzaro 2009; Bopp, Mekler, and Opwis 2016). Games frequently present players with challenging tasks requiring physical dexterity or involve narrative elements that convey sadness or fear. Providing entertainment in this context is thus not necessarily a moment-to-moment goal but rather the subsequent appraisal of a player's time with a game.

In this work, games are defined as *intentionally bounded systems, designed to facilitate cognitively or affectively engaging scenarios through interaction.* This understanding builds on the earlier definitions, with a more explicit focus on authorial intent.

Inherent in this way of understanding games is *the existence of purposeful authorship during the creation of scenarios and the realization of purpose through interaction in a manner that invokes the attention of players.*

The definition of video games is necessarily based on the definition of games while further specifying how a game is played and presented. Tavinor (2008) argues that:

> "X is a videogame if it is an artefact in a digital visual medium, is intended primarily as an object of entertainment, and is intended to provide such entertainment through the employment of one or both of the following modes of engagement: rule-bound gameplay or interactive fiction."

While Tavinor's definition of games as involving rule-bound gameplay or interactive fiction is another perspective that partially overlaps with what has been discussed previously, it emphasizes the use of a digital display as a significant part of video games. Video games, in turn, can be considered a subgroup of "digital games", which also covers games that do not output to a video display. Examples include physical chess boards with digital components (Square Off, Inc 2022), hybrid board games (Rogerson, Sparrow, and Gibbs 2021) or audio-based exercise games such as *Zombies, Run!* (Six to Start 2012). However, the work presented in this thesis is focused on video games as they all involve the presentation through a digital visual medium.

The development of video games started as single-person projects and creations of a small group of authors exploring the capabilities of nascent personal computers (Williams 2017; Wolf 2008). As video games became commercial products, companies started to emerge and professionalize the development of video games (Wolf 2012). Especially the creation of video games for home consoles (specialized personal computers meant to run video games) required access to specialized development equipment unavailable to the general public.

Video game development has been influenced by both software development and creative industries such as movie production (Engström et al. 2018). However, the

combination of tasks involved in game development, including coding, storyboarding, world-building, and user-testing among other tasks, presents unique challenges that require specialized expertise. Unlike movie productions, games pose "second-order design problems" (Salen Tekinbaş and Zimmerman 2003), which arise from the interaction between players and the designed game system. Unlike software development, this interaction is not purely utilitarian, but is also expected to be emotionally engaging and entertaining.

Over time, the tools to make video games have become more accessible regarding the necessary equipment and required programming knowledge (Nicoll and Keogh 2019; Nicoll 2019). This has, once again, made commercial game development viable for small teams and individuals (Iuppa and Borst 2012). Similarly, it has enabled the creation of games as tools for purposes other than entertainment (Wilkinson 2016).

2.2 Applied Games, Serious Games, and Gamification

Outside the entertainment industry, "serious" games are frequently created with a non-entertainment purpose, e.g., to impart information or collect data through game elements. Such games may still be experienced as entertaining; in fact, the potential entertainment value remains an essential quality for the efficacy of serious games (e.g., Ritterfeld, Cody, and Vorderer 2009; Klopfer, Osterweil, and Salen 2009) as it directly relates to how motivating or engaging the game is expected to be. However, entertainment plays a supporting role for the primary purpose, often in the form of providing training or experiential simulations of hypothetical scenarios (Bogost 2007). With the notion of "seriousness" not necessarily matching the aesthetics or apparent design of a game that has been created for non-entertainment purposes, other labels such as "applied games" or "gameful design" have been proposed and are frequently used in the related literature (Deterding et al. 2011).

In this work, the term serious games should be understood as synonymous with "applied games"; a term that is more apt in describing how games are employed. "Serious" refers here to *applying games in settings that are otherwise not considered to involve games.*

Applied games can be considered an umbrella term for several subfields that involve the use of games. Game-Based Learning (GBL) and educational games in general (Tobias, Fletcher, and Wind 2014) deal with the use of games to support formal education and lifelong learning efforts (Berg Marklund 2015). "Games for Health" (Wattanasoontorn et al. 2013) are intended to promote activities and provide information to influence health care positively. "Exergames" (Sinclair, Hingston, and Masek 2007) are created to improve players' physical performance and related lifestyle behaviors. "Advergames" (Terlutter and Capella 2013) are created to promote awareness or evaluate products and companies.

Explicitly excluded under this umbrella is the area of "gamification", following Deterding et al.'s (2011) definition of gamification as …

> "… the use of game design **elements** in **non-game contexts**" (emphasis added)

Applied games are defined by their purpose while maintaining a game-like context. By this definition, a context can involve gamification or be an applied game, but not both simultaneously. A gamified banking application, for example, may employ terminology associated with games (e.g., achievements, levels, and points), but it does not present itself as a game; the applied context is dominant over the game elements that are employed within it. On a practical level, what separates gamification from applied gaming is the amount and necessity of game design elements and the framing of these elements in the context in which they are used.

2.2.1 Game-Based Learning (GBL)

GBL, one of the subfields mentioned earlier, deserves further elaboration as it is the context of a case study presented in Chapter 3. GBL promises to motivate players through commonly used game elements, such as involving a clearly defined goal, providing rewards, and delivering frequent feedback (Kickmeier-Rust et al. 2011). The interactivity offered in GBL is intended to support the understanding of subject matter, ideally through active experimentation instead of relying on passive absorption of knowledge (Ko 2002).

From the perspective of many proponents of game-based learning, games are viewed as a medium in which the current generation of students, who grew up with games and

technology as easily accessible consumer products, excels (Bellotti et al. 2009; McClarty et al. 2012). Children are said to easily navigate game environments, regularly employ problem-solving methods, engage in advanced collaborative efforts, and communicate complex concepts to one another during their private gaming sessions at home (Bogost 2007; Egenfeldt-Nielsen 2006; Gee 2003). Seeing young students relish in activities that are seen as fundamentally analogous to what teachers work hard to interest them in is a catalyst for wanting to harness "the power of games" for educational purposes (Kickmeier-Rust et al. 2011; McClarty et al. 2012; Shapley et al. 2011).

However, even though the discourse and interest surrounding GBL is continuously growing, the type of widespread implementation that has long been predicted and anticipated is yet to happen (Egenfeldt-Nielsen 2010). One reason might be that games, on their own, do not facilitate learning as effectively or automatically as one might hope. For example, game designer Raph Koster (2014) has defined games as systems that teach but adds that they ultimately only teach the player to identify game patterns and to hone the skills necessary to perform well in the confines of those patterns. This, in essence, is the focal point for the continuously ongoing debate regarding the transfer of acquired knowledge in serious games and game-based learning (e.g., Tobias et al. 2011).

While games can encourage students to become intrinsically motivated learners beyond only imparting and testing knowledge or training skills (Mozelius 2014; Bullard 2016), this approach is currently not the most common for games used in classrooms. A survey of 700 US teachers showed that the primary reasons for using (digital) games in classrooms are to teach new material, to practice already learned material, and to reward or give a break to students (Takeuchi and Vaala 2014). The survey also shows that games used in classrooms tend to focus on a specific subject (e.g., literacy or math). This is understandable, as educational content is time consuming and expensive to make, but it also limits the use of a single game. The resulting games can be predictable and lack variation (Lopes 2010). While more intricate, commercial games, such as *Roller Coaster Tycoon* (Sawyer 1999; Kirriemuir and McFarlane 2003) can provide educational experiences on a range of topics (e.g., economics and physics), they pose other challenges in incorporating them into the curriculum (Kirriemuir and McFarlane 2003; Wagner and Wernbacher 2013).

In addition to integrating fixed, educational content (W. Ryan and Charsky 2013), the emphasis is also often placed on the game and the student. While teachers may use gameplay as a starting point for discussion, devise quizzes around a game, or gather data from built-in assessment tools (Takeuchi and Vaala 2014), the teacher is rarely involved in the play experience. Changing this may, in part, help to increase the perceived usefulness of games as classroom tools, a lack of which forms a barrier to teachers adopting games in their practice (Proctor and Marks 2013).

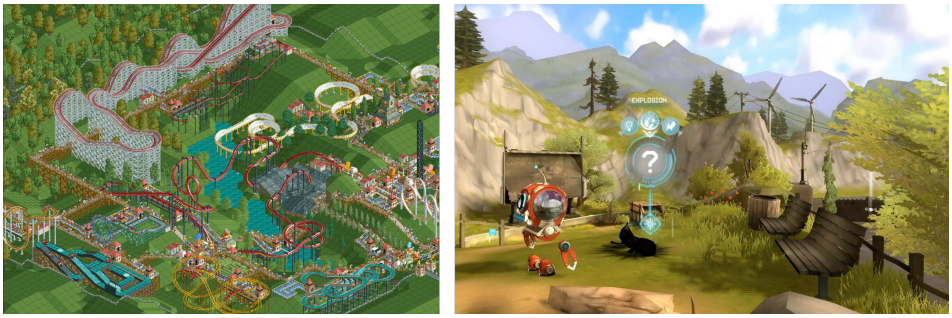

Figure 2.1: Screenshots of games used in GBL contexts. Left: *Roller Coaster Tycoon*, right: *Ludwig*.

While GBL has potential, the development of educational games remains a challenge. Aside from ensuring technical functionality and meeting the expected level of audio-visual fidelity, they are expected to have a demonstrable impact on a player's educational progress. The example of *Ludwig* (see figure 2.1), an educational game created to teach students about renewable energy production in the classroom, serves as a case study that successfully afforded the transfer of knowledge (Wagner and Wernbacher 2013). At the same time, the authors note that the learning progress requires the active involvement of teachers: "Classroom learning, in particular at the elementary and middle school levels, is driven by the interaction between the teacher and the students" (Wagner and Wernbacher 2013). This is noteworthy because the design of *Ludwig* does not address the involvement of a teacher or the use within the classroom. Despite this, the authors note that it succeeded in making students curious and motivated them to learn.

Despite the challenges, previous work has often found a balance between featuring educational and engaging content (Egenfeldt-Nielsen 2011; McClarty et al. 2012; Young et al. 2012).

2.3 Curiosity and Exploratory Behavior

Prior research efforts into curiosity have taken place predominantly in the fields of philosophy (Inan 2013; Schmitt and Lahroodi 2008) and psychology (Dewey 1910; Berlyne 1954). Inherent in this past is that definitions of curiosity vary, ranging from accounts of human aspirations to describing it as a stimulant for interaction with the environment.

Curiosity can be understood as an intrinsic motivation for pursuing new knowledge and experiences that are accompanied by pleasure and excitement. This understanding of curiosity is based on a meta-review of academic articles which aimed to find commonalities in prior research (Grossnickle 2016). In the review, the author discusses different research lenses through which curiosity has been studied. These lenses do not necessarily contradict each other but focus on different aspects of curiosity. One view of curiosity, for example, is to consider it a primal drive that requires satisfaction (Berlyne 1954, 1960), not unlike satisfying hunger (Schmitt and Lahroodi 2008).

Another view is to see curiosity as a need to fill gaps in knowledge (Loewenstein 1994), requiring both existing knowledge to be aware of such a gap, as well as the evaluation that the gap is neither too wide nor too insignificant to be filled (Spielberger and Starr 1994). The "information gap theory" focuses on the cognitive circumstances that elicit curiosity in broad terms. Loewenstein (1994) writes that …

> "[…] the information-gap theory views curiosity as arising when attention becomes focused on a gap in one's knowledge. Such information gaps produce the feeling of deprivation labeled curiosity. The curious individual is motivated to obtain the missing information to reduce or eliminate the feeling of deprivation."

For curiosity to arise under the information gap theory, an individual must perceive that an information gap exists. It further notes that the motivation to obtain missing information is greater if the gap is experienced as potentially surmountable. In other

words, curiosity arises when someone is aware that there is something to understand, and there appears to be a possibility for understanding it, given actions that could be taken.

While the information gap theory looks at the *state of curiosity* as an "in-the-moment" drive for exploratory behavior (Loewenstein 1994), the focus can also be on a person's likelihood of becoming curious, i.e., *understanding curiosity as a personality trait*. Trait curiosity is an individual's tendency or disposition to become curious and is considered a relatively stable personality trait (Litman and Silvia 2006). It should be noted that studies have shown a correlating relationship between trait and state curiosity (Litman, Collins, and Spielberger 2005; Kashdan and Roberts 2004; Reio and Callahan 2004). The "I/D" model of curiosity (Litman and Jimerson 2004) describes curiosity as a trait that consists of two motivational parts for acquiring information. Closing an information gap to reduce the feeling of deprivation is the "D" part of the I/D model. It is in contrast to the "I" part, which describes being motivated by an interest in acquiring information. The two types are described as a continuum between "Needing to know" and "Wondering about".

Another lens through which curiosity can be conceptualized is by the modes of exploration that are perceived as likely to satisfy it, as described by child psychologists Kreitler et al. (1975a), who posit five factors of understanding through curiosity:

1. Manipulatory curiosity – through physical interaction
2. Perceptual curiosity – through perceptual stimuli (e.g., touch, sight, or sound)
3. Conceptual curiosity – through the epistemic nature of stimuli
4. Curiosity about the complex – through contradictory or multidimensional stimuli
5. Adjustive-reactive curiosity – through the verification of expectations

While curiosity can be felt without leading to exploration, it is externalized through exploratory actions. Thus, exploration can be understood as the behavioral expression of the emotional sensation of feeling a desire for novel information or feeling a strong lack of specific information. This makes exploration a distinct phenomenon that is nevertheless closely intertwined with the experience of curiosity. As such, it is also frequently what is being measured in efforts of quantifying curiosity as a state (e.g., Jirout and Klahr 2012).

The term "exploration" can refer to the actual traversal of physical space to gain information (and thus to satisfy curiosity), but it can also refer to covering a conceptual space of possible actions or cognitive interpretations of information. It can also be part of a dynamic that is directed towards the curiosity and exploratory behavior of others, thus exploring a social space.

These three domains of exploration — spatial, conceptual, and social — can involve different modes of exploration and are further impacted by someone's overall disposition of becoming curious, i.e., their trait curiosity.

Much of the current work in quantifying curiosity is concerned with measuring trait curiosity (Litman and Jimerson 2004; Litman 2008) or related personality traits, such as intrinsic motivation (Day 1971; McAuley, Duncan, and Tammen 1989) or sensation seeking (Zuckerman 2007). One of the more recent efforts is the curiosity model proposed by Kashdan et al., which suggests the involvement of five dimensions to describe an individual's disposition to become curious (Kashdan et al. 2018). The dimensions are:

1. Joyous exploration – being motivated by novelty
2. Deprivation sensitivity – having a need for resolution
3. Stress tolerance – the ability to cope with uncertainty
4. Social curiosity – wanting to know about others
5. Thrill seeking – taking pleasure in managed anxiety

The individual dimensions were selected based on preceding work and validated through three surveys. The result of their study is the Five-Dimensional Curiosity Scale (5DC), which quantifies trait curiosity through a validated questionnaire. This thesis further builds upon this work in Chapter 4 by using the 5DC to examine what types of games are best at eliciting various types of exploration.

2.3.1 Curiosity and Exploration in Games

While many things can elicit curiosity, games present one of the more focused efforts in making people feel curious and act on their curiosities. Costikyan's work regarding the role of uncertainty in games, for example, involves curiosity and describes it as an essential motivator to engage in gameplay (Costikyan 2013). For Klimmt (2003), curiosity is part of a conceptual model for player engagement, i.e., why people choose to play games.

Studies into player profiling seek to establish player archetypes that involve personality traits and motivations, including curiosity (Schaekermann et al. 2017). Interestingly, such player archetypes can directly mirror aspects of Kashdan et al.'s aforementioned curiosity model. The *BrainHex* model (Nacke, Bateman, and Mandryk 2011) features seven archetypes that match the characteristics of different dimensions of curiosity. For example, the "daredevil" archetype is defined as taking pleasure in taking and overcoming risks, matching the "Thrill Seeking" dimension in the 5DC. In these cases, however, curiosity is not studied on its own but is mentioned as a contributing factor.

Games have been proposed as instruments for measuring curiosity, as was done in a study from 2012 to measure scientific curiosity in children (Jirout and Klahr 2012). In that experiment, players' performance within an exploration game served as a behavioral measure instead of relying on self-report through a questionnaire.

An improved understanding of curiosity also benefits efforts in understanding player experience and can inform game development. To et al. (2016) investigated how video game designers elicit players' curiosity. In their study, they provide examples from commercial games that are designed to trigger and satisfy different modes of curiosity based on Kreitler et al., as described before.

These works show that games, whether in physical form or as video games, can elicit curiosity as an intentional part of their design. However, prior work has not investigated the development and design processes that promote player exploration. This makes it difficult to know how the promise of eliciting curiosity through games can be realized in practice.

2.4 Conclusion

The work presented in this thesis seeks to expand on the present literature through the practice of designing for curiosity and exploration. This chapter introduced the necessary fundamental concepts and relevant perspectives that the practical work in the following chapters is based on.

The chapter described the medium of study in this thesis: video games. It further specified the notion of applied games (i.e., games with purposes other than pure entertainment) and, more specifically, game-based learning. It then presented notable literature

on curiosity, its various forms, and the exploratory behavior it motivates. Finally, it provided an overview of literature where the study of video games and curiosity overlap and showed how much is still unknown about how curiosity is elicited in games.

This thesis further builds upon the knowledge presented in this chapter. This work investigates games as a medium through which curiosity and the resulting exploration behavior are elicited. Chapter 3 presents the first practical case study, *CURIO*, an example of an applied game designed to elicit curiosity for new topics in school children that builds upon previous literature on game-based learning.

Next, Chapter 4 builds upon the 5DC questionnaire (Kashdan et al. 2018), examining connections between different types of games and forms of curiosity. Chapter 5 then discusses the formulation of "design patterns" (further explained in that chapter) based on these different types of games and the curiosity they elicit.

The second game developed within the context of this work, *Shinobi Valley*, presented in Chapters 6 and 7), is an example of an applied game created for research purposes. It aims to elicit exploratory behavior that may be measured and studied, further building upon the existing literature on curiosity within games.

Finally, informed by the work that came before it, Chapter 8 continues to build upon the applied game literature by defining a new sub-type of applied game: academic games, i.e., games employed as tools for satisfying academic curiosity.