Exploration through video games

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8 Academic Exploration Through Games

As discussed in Chapter 2, video games are frequently developed to fulfill an applied purpose beyond focusing on entertaining an audience of players. Indeed, the games developed in the studies described in Chapters 3 and 6 are such applied games. In the case of *CURIO*, the game can be considered fulfilling two different, if related, applied purposes: to serve as a Game-Based Learning (GBL) game for young students and teachers and to serve as a research tool for academics studying GBL or curiosity. *Shinobi Valley*, in turn, was entirely created to fulfill a research purpose. For games like these, this chapter proposes the term "academic games", as a way to describe the broader landscape of video games that have been developed or used in an academic context.

The research question guiding this chapter's work is:
How can games be used as tools for academic exploration?

Many participant-based experiments already resemble the formal structure of a game, involving tasks, goals, and measures for success, making games naturally suited as experiment tools (Washburn 2003). In some cases, this has led to the direct involvement of games in research projects. An early example is the game *Space Fortress*, which was used to attract participants and collect data that would be difficult to obtain without using a game (Mané and Donchin 1989).

In this chapter, academic games are understood as a sub-field of applied games and, more specifically, as *games that are used and developed within academic institutions for the generation, evaluation, or dissemination of knowledge*. Note that, with this definition, the focus is not on educational games, i.e., games that aim to teach or train the

player in particular knowledge or skills. While academic games can have educational aspects or intentions, they are not required. The definition also does not focus on research about individual game titles, efforts that analyze their cultural impact, or matters of improving the player experience of specific game titles.

Although the literature on applied game (Schmidt, Emmerich, and Schmidt 2015) development is extensive, studies of games used for research purposes are sparse. This may be because such games were instrumental in researching "something else", making them less evident as objects of study. Therefore, this chapter focuses on such games and the academic context in which they are developed.

Firstly, the aim is to determine the fundamental purposes for using academic games. Insight into these purposes is critical for shaping informed guidelines and best practices for developing academic games and enabling a more targeted discourse for evaluating their efficacy. Four purposes are defined and further described: using games as *stimulus*, as *intervention*, as *incentive*, or to *model* processes.

Secondly, the chapter describes facets of game involvement. While the purpose describes *why* a game is involved, facets describe *how* that game interfaces with the academic context. The formulation of purposes and facets is based both on the study of existing work and on the authors' prior development and research experience across different academic fields. Case studies are discussed as illustrations and argumentative foundation for defining commonalities, differences, and how such games have been used. The described facets are *information flow*, *artifact dependency*, and *specificity requirements*.

The following sections elaborate on the definition of academic games, discuss what constitutes an academic context based on prior work, and outline the purposes and facets of game involvement in academic efforts. In presenting an initial inventory of both purposes for academic games and facets of their involvement, the chapter concludes with the foundation for a research agenda to improve the use and development of games for academic purposes.

Chapter Publications

Work presented in this chapter has been published in this peer-reviewed venue:

- **International Conference on the Foundations of Digital Games (FDG) – 2022**
  "Academic Games — Mapping the Use of Video Games in Academic Contexts"
  (M. Gómez-Maureira et al. 2022)

The chapter further references the following related work (co-)published by the author:

- **PLOS One – 2019**
  "A serious game to explore human foraging in a 3D environment" (Prpic et al. 2019)
- **International Conference on Entertainment Computing (ICEC Conference) – 2022**
  "Through Troubled Waters: A Narrative Game for Anger Regulation" (Li et al. 2022)

8.1 Defining Academic Games

Defining what is or is not a game is notoriously difficult (Arjoranta 2014), and this difficulty extends to the area of academic games. As discussed in Chapter 2, in this manuscript *games* are considered *intentionally bounded systems, designed to facilitate cognitively or affectively engaging scenarios through interaction.*

The view taken as part of defining academic games is that *the separation between what is or is not a game depends on whether a task or activity is framed as a game*. This framing exists separate from academically formal definitions of what constitutes a game and concerns what an involved stakeholder perceives as a game or expects from that framing. An activity might include many elements that suggest that a game is being played without being referred to as such.

Playing a game has been described as entering a "magic circle", a conceptual space and time shaped by a consensus of its participants to establish rules and rituals that apply within it. Within game studies, the metaphor of the magic circle, coined by Johan Huizinga (Huizinga 1971), is frequently used to discuss how a game context differs from the surrounding context; in essence, the "real world" in which a game is played. It is, in part, the framing of the context that shapes its perception. This explains why similar activities can, at times, be experienced as enjoyable or not, simply by changing the

framing of the activity (Lieberoth 2015). As a result, academic games are, in a way, a part of many research projects, even if the researchers behind them do not necessarily explicitly mention that framing.

In experimental psychology, participants are frequently asked to carry out tasks within an intentionally bounded system (the lab setting) designed to cognitively or affectively engage them through interaction. Following various formal definitions (e.g., Avedon and Sutton-Smith 2015; Schell 2008; Salen Tekinbaş and Zimmerman 2003), such tasks could be seen as games. Emphasizing that framing can be beneficial for recruiting participants or can make mundane tasks more engaging.

What might contribute to game-like tasks being more commonly referred to as *experiment tasks* rather than academic games is that researchers might not consider themselves game designers. However, while game development often involves the work of dedicated game designers, *game design takes place whenever activities are carried out to develop a game, regardless of whether someone claims the title of designer.* Academics who involve games in their research may find themselves in the role of a game designer without realizing it, especially if participants conceptualize experiment tasks as a game or experience them as such.

As a result, academic games are not defined by specific attributes shaped by a game designer but rather by the overall perception of all stakeholders involved in an activity that takes place in an academic context. Intentional design can strengthen that perception by using design elements commonly associated with video games (e.g., referring to participants as players; notions of a high score, winning or losing). However, it is ultimately the framing of an activity that defines it as part of a game and the broader context that makes it “academic”.

8.2 Demarcating the Academic Context

With the popularization of video games as a medium for entertainment and beyond, academic endeavors have also increased their use for their purposes. In disciplines such as psychology or computer science, digital games are increasingly involved as research artifacts (Carlier et al. 2019; Levy et al. 2018; Risi and Preuss 2020); used to enable or support research goals that are not intrinsically connected to digital games

as a medium. In these contexts, games fulfill the role of a research tool that, while potentially very effective, could be substituted with different approaches (e.g., a physical experiment). This stands in contrast to digital games as the object of study, as is often the case in *game studies*, a specialization within humanities and cultural studies (F. Mäyrä 2008), where games could not be substituted with other types of objects. The same holds for research in which games are both a research artifact and object of study, which can be the case in Game User Research (GUR), which seeks to generate knowledge from games as research artifacts for the benefit of games as a medium (Seif El-Nasr et al. 2012).

The academic context discussed in this chapter focuses on the utilitarian aspects of involving video games in research efforts that are not about the game itself. This includes research that can contribute to understanding player behavior, game experience, or technical advancements in general. However, it excludes efforts that analyze existing games regarding their cultural impact or matters of improving their own experience for players. The intention behind this omission is to understand the contribution that games can make to other academic efforts.

Earlier work by Ivory (2013) has proposed a typology of video game research approaches for studying the role of video games in social science contexts. They differentiate between "video games as stimulus" (effects on psychological states and behaviors), "video games as avocation" (motivations and personal consequences of playing games), "video games as skill" (game impact on perception, cognition, and motor skills), and "video games as social environment" (player interactions and relationships within games). While some of Ivory's proposed types can fit a focus on the utilitarian aspect of games for academic purposes, they are formulated with an emphasis on understanding video games as a medium. The demarcation of the academic context in this work argues that academic games are not confined to fields that study the medium but also use games as a tool for inquiry.

Video games created within an academic context are thus necessarily considered fulfilling non-entertainment purposes. Even when employing games developed initially to entertain, their use in an academic context renders them essentially "applied", regardless of the entertainment value that might be experienced when they are played. As such, the use of video games in academic contexts should be understood as a more

closely defined use-case within the area of games for non-entertainment purposes, i.e., applied games.

An academic context is established if involved *stakeholders conduct their work as part of education and research institutions to develop knowledge.* This context does not require that game involvement itself needs to be part of developing knowledge. Games might be created or used to disseminate knowledge developed within those institutions. This is because the academic context does not only consist of activities that are epistemic in nature. *It also consists of the discourse surrounding such activities, as well as logistical, political, and financial efforts to improve the conditions of academic institutions.*

Games are widely seen as a medium that provides enjoyment and entertaining experiences. This can make the involvement of games enticing for shaping public perception about a field of research or connected institutions. An example is the use of *Minecraft* (Mojang 2011) for demonstrating archeological sites (Politopoulos et al. 2019). Simply put, if games are fun, perhaps they can make any connected activity seem fun as well. Such cases share considerable similarities with advergames, only with the use-case being part of academic institutions instead of for-profit corporations.

Game involvement as part of supporting institutional efforts, such as shaping public discourse, necessarily depends on the existence of an institution to support. Equivalent cases could be considered as the corporate use of games, such as business-to-business games (Michaud and Alvarez 2008), but fall outside the academic context. However, the efforts of corporations can and do enter the academic context when intellectual output is created for academic purposes (such as through peer-reviewed publications).

8.3 Purposes for Involving Games in Academic Contexts

Research involving games often takes place within interdisciplinary teams and thus tends to involve varying intentions and perspectives of individual stakeholders. Such differences, if left unaddressed, can impact the project in unexpected ways. The value in determining the purpose of game involvement is to align perspectives and better shape the subsequent game development efforts and goals.

This section describes four proposed *fundamental purposes* for involving video games in academic contexts: *stimulus*, *intervention*, *incentive*, and *modeling*. These purposes are informed by case studies in contemporary literature and studies carried out in previous chapters. The qualification of a purpose being fundamental is meant to hint at the fact that purposes are not entirely mutually exclusive. Multiple purposes can and do co-exist. However, while research efforts might include multiple fundamental purposes, this can present challenges in ensuring the game lives up to all of them.

Each purpose is first described in terms of what defines it and how it differs from other fundamental purposes. This is followed by prior work that exemplifies the purpose. Examples might explicitly mention the purpose or are ascribed to one of the purposes based on the properties of the work.

8.3.1 As Stimulus

Playing a video game often requires attention and navigational skills or invokes emotions such as happiness, anger, or curiosity. It causes a reaction in the player based on the scenario established by the game. *Whenever a game is used to cause a measurable reaction or change in the player, and the research context is interested in monitoring and measuring that change, the game's purpose is to use it as a stimulus*. In such a case, the game is ideally selected or specifically created to maximize the likelihood of eliciting the intended reaction.

When a game acts as a stimulus, players generate data through their actions in the game or by having played the game before measures are taken. A defining aspect of games as stimuli is that data depends on the specific game context and is created due to a change occurring within the player. A change in the game can therefore result in a change in the measure, based not only on the quality of the game implementation but also on how it is designed.

One example of a stimulus game is *Squirrel Away* (Prpic et al. 2019), a single-player tablet game for studying human foraging behavior. In the game, players take control of a squirrel gathering food in a virtual park from a first-person perspective. Players are tasked with collecting "target" objects among "distractor" objects, both scattered across the virtual environment. The game allows researchers to replace the images

Figure 8.1: Screenshots of example stimulus games, from left to right: *Squirrel Away* (first two images), and *Affective Pacman*.

used for target and distractor objects, as well as modify the ratio and overall amount in the game.

Another example that illustrates the use of a game as an experiment stimulus is *Affective Pacman* (Reuderink, Nijholt, and Poel 2009), a modified version of the classic arcade game designed to study the impact of frustration on brain activity (EEG measures). For the study, the researchers created a version of *Pacman* in which the game randomly ignores part of their input, and visual output is randomly withheld for a few frames. The modification is designed to appear as a technical issue instead of an intentional stimulus. Although these issues are triggered randomly, they are controlled, can be tracked, and thus allow for analyzing the impact on brain activity. The game could also be used in studies investigating affective responses and illustrates the use of video games as emotion elicitors (Karpouzis and Yannakakis 2016).

Using games as stimuli is common in psychology and related fields (Porter 1995; Gray 2017), given that the focus is on changes in the player caused by a game artifact. Compared to non-game stimuli, games are lauded for their potential to increase motivation and performance for completing research tasks (Donchin 1995). Games are also considered to have the potential to act as ecologically valid experimental environments (Järvelä et al. 2015), partly because framing a task as a game makes it more likely for participants to discount aspects that are not part of the game space.

Studies about cognitive or emotional states, for example, typically require participants to enter such states in a lab environment that may not be conducive to eliciting them naturally. Invoking familiar properties of games that mark the transition into a “magic circle”, i.e., into a make-believe space, helps participants enter the states of interest for

the study. In doing so, games act as a stimulus for a change in the psycho-physiological state.

> The game *Shinobi Valley*, developed as part of studies described in the Chapters 6 and 7, is an example of an academic game that was created to serve as a stimulus.

8.3.2 As Intervention

While stimulus games are concerned with inducing a short-term response in the player, specifically to be measured for research purposes, interventions are concerned with causing a long-term change in the player *for their benefit*. This type of game has also been described as "transformational"; as games designed to change players (Culyba 2018). The *Transformational Framework* describes types of transformation, such as *knowledge*, *disposition*, *physical*, or *behavior*, to name a few. However, in this thesis, a game designed to change behavior falls under a different type of academic game than one designed to study it, as is the case for stimulus games. Examples of academic games designed to act as intervention include those made for therapy purposes (e.g., in health care Kato 2010) or supporting habit changes.

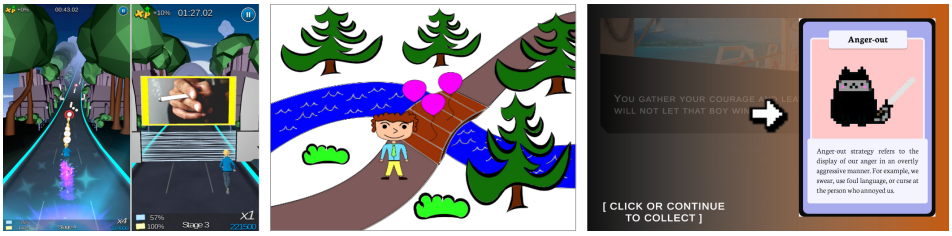

Figure 8.2: Screenshots of example stimulus games, from left to right: *HitnRun* (first two images), *Speech Adventure*, and *Through Troubled Waters*.

An example of an intervention game is *HitnRun* (Scholten, Luijten, and Granic 2019), a single-player mobile game based on "endless runner" games such as *Temple Run* (Imangi Studios 2011). The game incorporates target and distractor objects showing smoking-related or neutral images. The game's goal is to decrease the desire to smoke by creating a negative association with smoking-related imagery.

Another example is *Speech Adventure* (Rubin and Kurniawan 2013), a speech training game for children with a cleft palate or cleft lip. The game features speech recognition capable of discerning mispronunciations due to cleft speech problems. The game takes the form of an interactive storybook in which words must be pronounced correctly in order to progress.

Another example of an intervention game is *Through Troubled Waters* (Li et al. 2022), a branching narrative game that shows players different ways of dealing with anger in everyday life situations. The game supports players by providing labels for anger-related emotions. It introduces them to different coping mechanisms they can use as part of the game narrative to see how situations might resolve.

A game might act as a catalyst for change, but the game does not exist in order to measure the change for research purposes; instead, it exists to elicit it for the player's benefit. However, to develop games that can act in such a capacity, measures must assess whether the intended change is taking place and whether the extent of the change justifies the effort compared to non-game interventions. Projects with the eventual aim to develop a treatment or intervention are thus likely to start with laboratory experiments in which the game or parts thereof act as a stimulus. In most cases, it is not the academic partners in such projects that will eventually release the game. Instead, this happens with the collaboration of industry partners once the game has been proven effective.

> The game *CURIO*, developed as part of the study described in Chapter 3, is an example of an academic game serving an intervention purpose.

8.3.3 As Incentive

Another fundamental purpose for involving games is to tap into the widely held perception that games are entertaining. For those who enjoy playing games, executing an otherwise undesirable task might appear appealing if it is framed in the context of a game. In such cases, games are involved for their potential to incentivize as a reward for executing a task.

This might involve collecting measures that are created as part of the game. In contrast to pure stimulus games, however, the collected data results from a task being exe-

cuted rather than a change in the player specifically elicited through the game's design. Changes in the game may impact how effective the game is in its ability to incentivize players to perform a task. However, it does not meaningfully impact the data that is being generated.

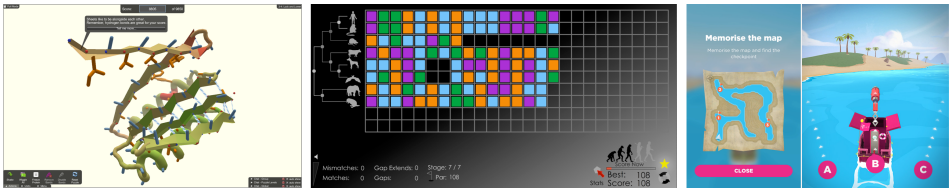

Figure 8.3: Screenshots of example incentive games, from left to right: *Foldit*, *Phylo*, and *Sea Hero Quest* (last two images).

Games can be used as an incentive to collect or process data. Citizen science games are good examples where gameplay provides an incentive for executing scientifically valuable tasks. The game *Foldit* (UW Center for Game Science 2008) tasks players with optimization puzzles based on the real-world protein folding process. Rules in the game are designed to work analogous to the biochemical reactions that impact the three-dimensional structure of proteins. By playing the game, players are working on organizing protein structures in a manner that is meant to predict how a protein structure would fold, given its amino acid sequence. In doing so, they create data that can be used to train computational strategies and highlight structures that warrant more detailed research.

A similar example can be found in the game *Phylo* (Kawrykow et al. 2012) for multiple sequence alignment optimization in DNA sequences or in *Sea Hero Quest* (Spiers, Coutrot, and Hornberger 2021) for collecting data on navigation behavior for researching Alzheimer's disease. In these examples, participants are tasked with processing or creating data on a large scale. By framing tasks as a game, participants, now players, are given an incentive to complete a task. Their participation provides a service for scientific studies. However, in the short term, they are incentivized by progressing a game narrative, competing against other players, or by game-based feedback, such as an in-game scoring system, to improve their performance. The tasks could, however, be executed through other incentives, such as monetary rewards, as is the case in crowd-

sourcing platforms such as *Amazon Mechanical Turk* (Shank 2016). Although the game context holds the promise of establishing an intrinsic motivation (Rheinberg and Engeser 2018) for task completion, it depends on the participant's interest in the context and their ability to enter and leave the context freely. If participants are not interested in the game context or perceive it as a chore that must be completed, the game context risks becoming little more than a work task with extraneous elements attached to it. It is worth noting that even if a task is experienced as being enjoyable, its completion quality might not necessarily improve (Hawkins et al. 2013).

Another use case for involving games as incentives is educational games developed within academic contexts. The topics of such games are likely to target specific topics that are not covered by commercially available education games. Games in which the education material exists to a large extent separately from the game mechanics use the medium of games as an incentive to play. In such cases, the material does not uniquely benefit from being conveyed through a game but makes it more likely for players to engage with it.

One example is the mobile game *Herbopolis* (Ee, Yap, and Yap 2018), which aims to educate players about herbal medicine. In the game, players are tasked with operating the business of growing, processing, and selling herbal medicine. The game's purpose is to educate players about the appearance of herbs and concepts of potency and dosage. Additional aspects, such as managing a business, exist to facilitate (prolonged) engagement with the game. The purpose of educating about the appearance, potency, and dosage of herbs could be communicated without using a game. Most actions in the game are arguably more synonymous with the tasks and challenges of running a farming business. However, the game frequently exposes players to educational content, even if the game's mechanics are more likely to educate them about business principles. The game mechanics thus provide an incentive to engage with the educational content.

Education games that seek to incentivize players by their game context are often aimed at children to make educational content appear more palatable. However, educational games can be designed to convey educational content through play. In such a case, games are not only (and perhaps not even primarily) used for their ability to incentivize

but to make a subject experientially understandable. This purpose is closer to *modeling*, which is described in more detail in the following subsection.

8.3.4 For Modeling Purposes

The involvement of a game can be motivated by the desire to understand a phenomenon by constructing or experiencing it through a game. Modeling can take place on a conceptual level or be an attempt to simulate a topic of interest as accurately as possible. When involving a game to model phenomena, the game's processes are the study object. It concerns the evaluation of the sum of actions that happen as part of the game that is being played. This purpose differs from the previous three in that the research focus tends to lie with the system more than the player or that no player is required at all.

Within technologically-minded sciences, modeling usually refers to the practice of simulating processes with computer algorithms. For categorizing the fundamental purpose of involving games, modeling should be understood more broadly. It refers to the process of building knowledge by observing or interacting with a simplified artifact that acts as a representation of a more complex phenomenon. That artifact can be actual, such as a physical miniature or a virtual representation of a physical environment. It can also be conceptual, such as a hypothetical thought experiment, as in the game *Something Something Soup Something* (Gualeni 2017, 2018), which asks players to reflect on the mutable nature of definitions. In the case of academic games, modeling primarily means to create or modify a game and thus make it an actual artifact, even when used as a thought experiment.

Games, especially well-known ones, can provide an experiential understanding for interpreting results or implementing modeling parameters. It allows researchers to use game-specific terminology to explain and understand modeling outcomes. Optimizing parameters can, for example, be framed as winning or losing. Interactions in the game, especially those of individual entities, can be discussed through the metaphor of incentives, goals, and desires. By using games, such features can be communicated so that other researchers and the general audience understand more easily. Enemies compete with a player character; collectibles such as coins or food are objects of desire; deep pits pose a danger for the player but can be surmounted; and so on.

Figure 8.4: Left: Screenshot showing the game *Something Something Soup Something*. Right: Freeze frame image of the *AlphaStar* agent visualization.

Examples of using games for modeling are often found within computer science and related fields, such as artificial intelligence research. Efforts to solve games, i.e., identifying the most optimal decision a rational actor can take, provide testing grounds for computational strategies in uncertain or complex environments.

The development of *AlphaStar* (Vinyals et al. 2019) involves the real-time strategy game *Starcraft II* (Blizzard Entertainment 2010) in which multiple entities are controlled as virtual armies to fight against other players with their armies in complex virtual terrain. Due to the real-time nature of the game, the state of the game changes from moment to moment, thereby restricting the amount of time that can be taken to evaluate optimal actions. The purpose of involving *Star Craft II* in this example is to study and improve the development of intelligent programs through a complex environment. Using a game that can be played against a human player allows for evaluating the program, not on individual parameters, but given its performance through the sum of actions in the game.

The use of games for modeling purposes might not even require a player's participation in the traditional sense. Instead, a game serves as a simplified testing ground, such as using Atari games like *Pong* (Atari 1972) to train and compare computational models (Tampuu et al. 2017; Cui et al. 2020). Instead of attempting to solve such relatively simple games, they serve as a benchmark. A game artifact is involved because it provides a clear, comparable experimental condition. The only player in such a case is the

computational system, playing with (or against) itself, resulting in a sort of "zero-player game" (Björk and Juul 2012).

As mentioned in the previous subsection, educational games may be motivated by a desire to make content more memorable by allowing players to engage with it playfully. Sandbox games such as *Minecraft* provide players with large environments and rule-based interaction mechanics that can be used for a wide range of educational topics. Based on this, the game is available as *Education Edition* (Mojang Studios 2016), giving educators a tool for shaping educational experiences in which players learn through their engagement with the game. That is not to say that all educational content mediated through *Minecraft* is automatically so connected to it that the game is an integral part of understanding a phenomenon. One can conceive a *Minecraft* environment littered with signs that educate players on a topic by having them read through all of them to convey knowledge. Doing so uses *Minecraft* as an incentive to read the content but does not require meaningful engagement to understand it better.

Figure 8.5: Screenshots of *Minecraft*, from left to right: *Minecraft Education Edition* (first two images) using the science kit and code builder; *RoMeincraft* (last image) showing the Roman fort in modern-day Leiden in The Netherlands.

A counterexample of this use of *Minecraft* can be found in the game project *RoMeincraft* which uses *Minecraft* as a platform for collaborative play between archaeologists and members of the public (Politopoulos et al. 2019). The project reconstructs Roman architecture by using the virtual space of *Minecraft*, providing players with a space to explore and expand it. Rather than educate specific points of knowledge, the project seeks to encourage interest in Roman heritage, using *Minecraft* as a tool to induce curiosity about the topic. Although the context of the game surely acts as an incentive to engage, the purpose of involving *Minecraft* is to gain an experiential understanding by playing it.

8.4 Facets of Games in Academic Contexts

Whereas the previous section outlined why a game might be used, this section focuses on how it interfaces with the academic context. Three facets are described:

- Information flow between game facilitators and players
- Dependency of the academic context on the game artifact
- How specific an artifact needs to be

These facets are not meant to cover all ontological features in any academic endeavor involving games. However, they are considered critical topics for discussion when planning to use games for academic purposes.

8.4.1 Information Flow

Every game used in an academic context involves an exchange of information. Players receive information, such as how the game is played, what actions can be executed, or are introduced to out-of-game information using the game as a medium (for example, in text boxes overlaying the game interface). Facilitators of the game (e.g., researchers, educators, game developers) may receive information through the act of it being played; either during the activity itself (through the logging of play data) or through a subsequent activity that is impacted by the game artifact (e.g., a survey or interview).

The *information flow* facet concerns what information is exchanged through a game artifact and which direction is dominant for each piece of information. Additionally, a sum could be made of the overall direction for the entire game.

Not all information exchanged through a game relates to the fundamental purpose of the game. For example, while information on game controls is necessary for the player to receive, it is generally not specific to the academic context. However, this information can affect the research outcomes. This was indeed one of the findings of the study involving *Shinobi Valley*; discussed in Chapter 7. As such, there is a scale of relevance to the academic context for all information passed through the game. The framing of the game's purpose and related information is considered critical, while functional information (e.g., controls) is generally less important. Nevertheless, both potentially influence how the game is perceived and eventually played.

Information flow towards a game facilitator is *information acquisition*. A game used to acquire information can collect data generated by playing it or eliciting a reaction in players that provides information. Games such as the aforementioned *Foldit*, *Phylo*, or *Sea Hero Quest* (see section 8.3.3) are examples developed to acquire data from players. While they might impart some knowledge to players, this is motivated by the desire to capture as much data from players as possible and ensure that the quality of that data meets the project's requirements.

Information flow coming from a game facilitator should be considered a form of *information dissemination*. In such cases, a game is used primarily to educate players or to communicate an argument. Additionally, it can be to instruct players as to how a game is meant to be played.

It may involve measures regarding the efficacy of the dissemination effort, still emphasizing that the leading intention is to disseminate information rather than to collect it. Game-based learning initiatives such as *Ludwig* (ovos realtime3D GmbH 2013; Wagner and Wernbacher 2013) or *CURIO* (discussed in Chapter 3) are examples of games that disseminate information. These games inform about a topic (as with *Ludwig*) or inform educators through a teaching toolkit (as in *CURIO*). Games meant to fulfill therapeutic purposes should also be considered as disseminating information in terms of their development purpose (requiring data acquisition primarily to validate their efficacy). As mentioned in section 8.3.4, games can also serve as artifacts for thought experiments. Here too, information is primarily directed toward a player rather than a game facilitator.

It is important to note that information flow may not always land squarely on either acquisition or dissemination. Games may be used for both purposes. *Sea Hero Quest*, for example, can also be considered as disseminating information by raising awareness about dementia research. Likewise, games created to impart information may require significant data acquisition to evaluate whether that goal is met. The value in thinking about information flow is to shape the development of a game (or its purposeful modification) accordingly.

In practice, even if a game is meant to acquire data, it might not require much development effort to provide additional information about the research context beyond the need of acquisition efforts. This may not only be in the interest of research transparency

but also argue for the importance of the research field it is part of. On the other hand, game development (including the modification of games) is resource intensive. It thus warrants intentional emphasis on whether an artifact is meant to acquire or provide information.

8.4.2 Artifact Dependency

While some academic efforts may entirely depend on a specific game, in other cases, it may be that the use of games makes it easier to attract a larger number of participants. Games can be a valuable addition to research projects, even when they do not fully depend on them. However, being aware of their importance and reaching an agreement about that among all stakeholders helps to ensure that development resources are well distributed.

The involvement of a game can range from being mere *supportive* to being *catalytic* for an academic effort. As a catalyst, a game guides the design of the academic context just as much the other way around. For instance, studying exploratory behavior in video game environments, as in *Shinobi Valley*, is dependent on the involvement of a game in which participants can be observed while exploring such an environment. Research into virtual foraging behavior using a video game, for example (Prpic et al. 2019), could be considered somewhere between the two ends of the spectrum, given that a virtual environment does not entirely necessitate a game context. Studies may require using virtual environments to create experiment circumstances that can be easily replicated. Other times they are needed to elicit and observe behavior in scenarios that would be unethical, dangerous, or impossible to expose participants to in reality. Such virtual environments or simulations can be designed or framed as games. Often, however, the simulation of the situation is the study focus rather than the elements that make it a game.

Games are in a supportive role if the task or measure they are part of could be carried out without their involvement. This may be because a game artifact acts as a form of incentive for participation that could be fulfilled through financial compensation or other extrinsic rewards without significantly impacting the quality of the research. This is not to say that supportive games are involved arbitrarily. Using a game might, for example, attract more participants than a non-game implementation and thus add real value.

8.4.3 Specificity Requirements

Aside from the question of how dependent a project is on the involvement of a game artifact; it is also essential to consider how specific it should be. If an existing game can be used with little or no modifications, its specificity requirements for the academic context are low. The specificity, in this case, does not depend on a wide range of possible options. Instead, it regards how much design and development effort will be required to involve a game artifact in the academic project.

A high degree of specificity is warranted if few existing games could be modified to fit a research task or if it is in the interest of the project goals to create a specialized game artifact. This could be to avoid pre-conceived ideas if a known game is modified, to gain complete control over all parameters, or to promote an academic endeavor through an original game, as might have been the case in *Sea Hero Quest*.

While creating a game specifically for an academic effort can be tempting, doing so comes with additional challenges. Although game development has become increasingly more accessible, it remains a time-consuming activity in which not all tasks directly benefit the larger academic context. The effort required just to implement basic functionality such as virtual camera control, or player-character controls is easily overlooked. Minor imperfections in the execution of academic games can also be harder to ignore for participants if they compare them to more sophisticated commercial implementations. This is especially noteworthy if a game is meant to act as an incentive, as the perception of what games are and ought to be necessarily exists in context with what games are commonly available.

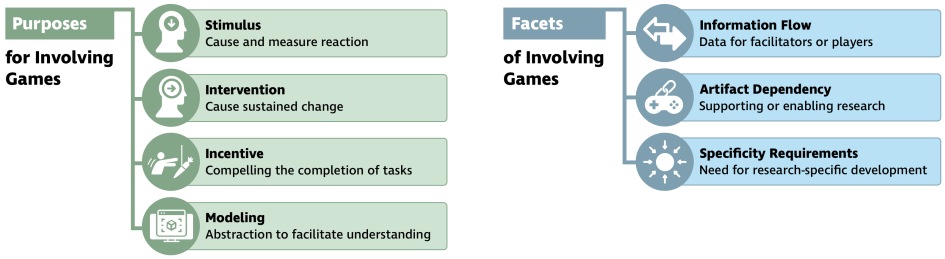

Figure 8.6: Diagram of fundamental purposes and facets for involving games in academic contexts.

8.5 Towards a Research Agenda

The purposes and facets defined in this chapter, visually summarized in figure 8.6, are meant to support early discussions and decisions in academic efforts, especially when several stakeholders are working together. Periodic evaluation of whether the facets are still used as initially intended can also be helpful. As a project develops, new ideas and considerations can enter the development process, possibly moving it in another direction. Although this does not necessarily pose a problem, practitioners must be aware of such changes, how they may impact the game artifact, and, in turn, the research effort.

At this stage, the proposed purposes and facets do not comprise the full extent of all considerations that come into play when games are used in academic contexts. However, they are defined on the basis that all academic efforts should be able to address them before moving on to more concrete development steps. Additional development support can be found in frameworks that are meant to aid with the creation of applied games (Tsita and Satratzemi 2019; Ávila-Pesántez, Rivera, and Alban 2017), although future work should aim to examine which approaches are more or less valid for academic contexts. Previous work has made strides in outlining challenges and guidelines for developing stimulus games (Järvelä et al. 2015) or identifying fitting games (Raffert, Zaharia, and Griffiths 2012; Mohseni, Liebold, and Pietschmann 2015), so a basis exists from which to expand the field of academic games further.

The analysis and identification of fundamental purposes and facets of game involvement in this chapter form the foundation for a research agenda to improve the use and development of games for academic purposes.

Future work on this agenda should investigate:

- To what extent prior work on applied games and game design requires specialization to fit the academic context better.
- How different academic fields approach the involvement of games for research purposes, e.g., through the mapping, discussing, and combining (individual) case studies.
- What stakeholders are most often involved in the use and creation of academic games, what they expect from the use of games, and how they influence decision-making.
- The formulation of development guidelines, frameworks, and tool-kits aimed at academic games.

As games increasingly involve user-generated content, e.g., in *Roblox* (Roblox Corporation 2006) or *Super Mario Maker* (Nintendo EAD 2015), and development tools continue to become more accessible, the use of games for non-entertainment purposes will likely continue to grow. Whether research or education, the academic context has already benefited from this trend. As this trend continues, academics will find themselves filling roles that are new to them. This chapter documents some of the efforts that have been conducted on this path and argues for the need to create knowledge specific to using games in the academic context. Rather than turning academics into professional game developers, the aim is to establish a better understanding of using the medium of games and shape it to their specific needs.

Ultimately, academic games are similar to entertainment games, and much of the lessons that apply to one will also apply to the other. The academic context does not turn them into an entirely different medium. Nevertheless, the context that games are a part of impacts their creation and those who play them. After all, the "magic circle" metaphor does not describe a hard border defined by metaphysical rules but rather one shaped by the surrounding context. Ignoring this risks losing the *magic* that is the experience of playing games. Addressing and embracing that context, on the other hand, can help improve discourse, bridge efforts across fields, and lead to professionalizing academic game development.

8.6 Conclusion

This chapter defined the use of games for academic contexts ("academic games") as a sub-field of applied games shaped by a purpose and the involvement of stakeholders from research and education institutions. Based on examples of prior work in that context, four fundamental purposes for using games are identified:

- as a psycho-physiological stimulus
- as an intervention mechanism
- as an incentive for completing tasks
- as a modeling platform to facilitate understanding

Making the purpose for game involvement explicit is especially important in the planning stages of an academic endeavor. Game development requires the collaboration of several stakeholders, some of whom might be more attuned to the academic content, while others focus more on technical or logistical considerations. In such cases, it is crucial to explain why a game is created or modified and to discuss these assumptions openly among all stakeholders. Indeed, the complexity of game development and research design can easily focus too quickly on more detailed matters, bypassing an explicit, shared agreement.

In addition to purposes, facets of game involvement are defined based on how games interface with the academic context that they are a part of: *the flow of information, dependency of an academic effort on a game artifact, and the specificity of the game artifact for the academic effort.* These facets are defined to provide a basis for making decisions on how to develop, select, or modify a game artifact to fulfill the purpose of its involvement.

This chapter contributes to the study of applied games and any field that may use games as tools for academic exploration. It has proposed academic games as a new sub-field of applied games, formulated the purposes and facets of academic games, and provided directions for their future study. It thus addresses the primary research question: *How can games be used as tools for academic exploration?* In doing so, it forms the basis for the professionalization of using games for academic study across disciplines.