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Exploration through video games

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9 Conclusion

Video games have become a medium of considerable cultural importance capable of many affordances, including enticing players into various forms of exploration. With these possibilities, they have become objects of study and tools for studying other subjects. This thesis investigated different forms of exploration in and through video games, laying a foundation for further study of this subject.

Initially, this work started as an investigation of curiosity and how it may be elicited purposefully through games (referring to "video games" specifically and used as a short form for brevity in this thesis). Over time, that question led to many others surrounding the topic of curiosity and the accompanying exploration behavior. Each turned out to be a multifaceted topic in its own right, further complicated by their interaction with the multidisciplinary nature of video games as a medium, shaped by aspects of, e.g., player psychology, design, art, and technology. As investigations into these topics progressed, another observation was made: namely, that the games created to study this topic were, in themselves, facilitating exploration for the researcher as well.

This process resulted in the different topics that this thesis encompasses. Research is not a straight line from start to finish but a road with twists and turns through changing circumstances and discoveries. This cannot always be acknowledged in separate publications, where the focus lies on presenting results under repeatable conditions within a maximum page count. However, it is vital to note this in the context of this thesis. While a straight-lined approach might have resulted in more actionable knowledge for game designers, the broader perspective taken in this thesis provides a first comprehensive look at the topic of curiosity-driven exploration through games in its many forms and complexities. It serves as a starting point for academics of many backgrounds interested in using games for their academic pursuits and provides a solid foundation to create actionable, generalizable knowledge.

9.1 Research Questions Revisited

The thesis aimed to answer the main research question: *How do games facilitate exploration?* The following sections will discuss the subquestions, after which the main question is addressed.

9.1.1 Conceptual Exploration

The first research question was: *How can a game facilitate conceptual exploration?* This question was the starting point for a practical investigation of game design focused on a particular notion: whether and how a game could elicit a player to become curious about a topic, with the external expression of that curiosity being the exploratory behavior of asking questions.

Chapter 3 answered the first research question with the design and implementation of the *CURIO* gamekit, in which players must ask critical and original questions through a narrative context. Through discussion, they are then encouraged to consider those questions more deeply. This case study illustrates how games can facilitate conceptual exploration.

With the case study of *CURIO*, the potential of games to stimulate questions and thought becomes explicit. It also showed how important it is to "manage" the information gap when designing for curiosity. While this responsibility was delegated to the teacher in the case of *CURIO*, it would usually rest with the game designer. *CURIO* could serve as a testing tool for further examination into where the balance in this lies (i.e., too much versus too little information).

Other areas of investigation could relate to different implementations of game designs. Such designs could include questions and discussion as core mechanics, investigating games with meta-narratives that promote reflection, or mechanics that cause the player to think critically.

CURIO formed the starting point of further investigations into curiosity. While this project focused on conceptual curiosity, it quickly became apparent that, within game design, different forms of curiosity are unlikely to exist in a vacuum. Thus, this case study formed the basis for further investigation of game types and the next research question.

9.1.2 Game Types

While the first question formed a starting point for the investigation of exploration through games, it was also a purposefully simplified implementation of exploration in a primary education context. Thus, Chapter 4 expanded the view on games and exploration by answering research sub-question 2: *What types of games elicit exploration?*

This question was addressed through an extensive survey in which players could rank and suggest games based on how curious they made them feel. Popular releases of the past years were ranked against each other, providing an idea of what type of gameplay is considered the most successful at eliciting curiosity. Connections were also made with the Five-Dimensional Curiosity Scale (5DC) questionnaire to group games under specific types of curiosity and allow players to suggest specific titles for certain types of curiosity. This study established a corpus of games players considered successful at eliciting various forms of curiosity.

The result shows that the answer to the research question is multifaceted, as games are complex systems that may elicit curiosity (and the resulting behavior of exploration) in various ways through design. The study found that the games *Zelda: Breath of the Wild*, *Elder Scrolls: Skyrim*, and *Portal* were ranked as the most successful in eliciting curiosity. Within these, the genre labels *Exploration*, *RPG*, and *Puzzle* are most representative of what activities in the game elicit curiosity. Among games suggested by participants, the genres *Social Sim*, *Collecting*, *RPG*, and *Exploration* ranked the highest and thus provided evidence that the potential of *Puzzle* games to elicit curiosity is highly dependent on the game. It was also established that what makes a player curious in a game is not necessarily related to their trait curiosity. Finally, while factors of age and gender may influence curiosity in games, individual game titles were similarly received despite these factors.

In answer to the research question, it was hypothesized that games that strike a balance between uncertainty and structure tend to rank high in eliciting curiosity. In contrast, highly deterministic games (requiring only cognitive or physical aptitude) or dependent entirely on chance tend to rank lower in curiosity. Exploration, in turn, requires a combination of guidance through game design and agency to shape one's own experi-

ence. What kind of exploration occurs and whether it is expressed through measurable behavior in the game or on a conceptual level depends on the game's design.

9.1.3 Design Patterns

After assessing what games players consider particularly effective in eliciting curiosity, Chapter 5 further analyzed these games in how they operationalize curiosity to result in exploration. This was done by understanding "design patterns", addressing research question 3: *What design patterns can be hypothesized for games that elicit exploration?*

Three types of curiosity-based exploration were examined in more detail, using game titles suggested in the survey study: conceptual, social, and spatial exploration.

Conceptual exploration was best comprehended through the genre of puzzle games, which invoke the notion of being able to solve a given problem within a set of rules and circumstances. While this can elicit conceptual exploration by aiming to solve the problem within the given design space, game designers can inspire further reflection by playing with the framing of such issues. For example, by unexpectedly changing the rules, a player may further wonder about information being withheld from them. Such conceptual exploration may also come from wondering about the consequences of actions or the meaning of choices in a game's narrative.

Social exploration behavior results from a curiosity for other players or virtual characters, examining their responses to situations, or building stories around them. Strategies discussed for eliciting such curiosity were, for example, performing mundane tasks giving a glimpse into a character's world, offering or restricting communication with other players, or building and shaping a personal character.

Spatial exploration refers to how a player is guided into traversing a virtual environment. For this exploration, five design patterns were defined for further study. These patterns are: *Reaching Extreme Points*, *Resolving Visual Obstructions*, *Out of Place Elements*, *Understanding Spatial Connections*, and *Desired Object Foraging*. These five patterns were not formulated to provide an exhaustive list of design strategies but rather as a step toward the empirical study that can assess the efficacy of hypothesized patterns.

9.1.4 Design Pattern Implementation and Validation

The previously formulated design patterns formed the basis for an empirical study assessing their efficacy in eliciting spatial exploration in Chapters 6 and 7. For the patterns to be tested in this manner, they first had to be implemented in a research game that could be used to measure and log player behavior. This process of implementation and validation served to answer research questions 4 and 5: *How can design patterns for exploration be implemented for validation?* and *How do design patterns for exploration influence player behavior and experience?*

These research questions were addressed by creating a research game designed to implement the design patterns for testing variations in level design and empirically measuring how they affected player behavior. The game had to provide opportunities for gathering behavioral data and operate reliably for use in an experimental study. Most importantly, it had to be successfully validated in its efficacy to motivate exploration through patterns. To this end, a pilot study was conducted that examined all these aspects.

Following the pilot study, an empirical study was conducted where the focus was on the empirical evaluation of the design patterns for spatial exploration. Design patterns were hypothesized to elicit more exploratory behavior (compared to if they were not present) and positively affect the player's emotional experience. It was further hypothesized that having an explicit goal would reduce exploration and that players with a higher predisposition for curiosity would explore more.

All patterns were shown to be effective at eliciting exploratory behavior. Participants were most engaged in curiosity-driven exploration when patterns in the environment provided opportunities, and the game's goal was left sufficiently ambiguous to pay attention to the larger environment. While players understood exploration to be a core part of the game, a lack of acknowledgment during exploration could negatively impact their experience. Whether or not players explored was not linked to their predisposition to become curious.

9.1.5 Games for Academic Exploration

The work performed to study exploration in video games also required the development of two games created to pursue academic knowledge. This form of "exploration"

through games thus examined research question 6: *How are games used as tools for academic exploration?*

This part of the work proposed a definition for "academic games" as games used and developed within academic institutions to generate, evaluate, or disseminate knowledge. Four fundamental purposes were identified in using games for these endeavors: games as a stimulus, intervention, incentive, and modeling. Stimulus games cause a measurable reaction or change in the player, while the research context is interested in monitoring and measuring that change. Intervention games intend to drive a long-term transformation in players for their benefit, as opposed to that of a researcher. Incentive games motivate participants to perform a particular task, the execution of which results in data collection. Finally, modeling games are used to model phenomena to study the resulting processes. The two academic games underlying this thesis — *CURIO*, a gamekit for teachers and students aimed at eliciting conceptual exploration, and *Shinobi Valley*, a game created to measure and study player behavior as it was influenced by level design — exemplify games as intervention and stimulus respectively.

In addition to fundamental purposes, three facets of academic games were established. These relate to information flow (i.e., how information is transferred between participants and researchers), dependency (i.e., how reliant the academic context is on the game artifact), and specificity (i.e., how specific a game's design needs to be to serve the academic purpose).

Awareness of these terms and making them explicit may help in planning and conducting academic research involving games as research tools. They support discussions and decisions in research projects, especially when multiple stakeholders work together. As the practical work in this thesis illustrates, exploring through games can be complicated and requires knowledge from various disciplines. The formulation of purposes for and facets of academic games aims to help practitioners make informed decisions and professionalize the ongoing practice of academic exploration through games.

9.1.6 Games Facilitating Exploration

The work presented in this thesis addresses the main research question it examines: *How do games facilitate exploration?*

The thesis answers this question by examining exploration *in and through* games from various perspectives. These perspectives were investigated through the sub-questions discussed above. In answer to the main research question, it is evident that exploration in video games occurs in various forms as the result of careful design. Conceptual, social, and spatial exploration were examined in closer detail. The thesis provides insight into how such exploration may be elicited purposefully through design patterns for exploration, purposeful and repeatable implementations of creative decisions meant to evoke different forms of curiosity, and their corresponding exploratory behavior. The thesis also presents a blueprint for how such patterns may be formed, implemented, and evaluated. In addition, the thesis identifies a new form of applied game, i.e., academic games: games used and developed within academic institutions for the generation, evaluation, or dissemination of knowledge.

By combining these perspectives, the thesis offers solid contributions (further discussed in the following section) to the existing literature and a foundation for future research efforts further examining exploration in and through games.

9.2 Contributions

This thesis contributes to the understanding of exploration in and through games. It examined a dominant motivator of exploration — the state of curiosity — and how it relates to games in various forms. The contributions of this work are both theoretical and practical. The theoretical contributions concern the creation of a corpus of games known to stimulate multiple forms of curiosity for future study. It also formulates the foundation for potential game design patterns that elicit certain forms of curiosity and concrete design patterns for spatial exploration. It presents a classification of games used for academic exploration and the facets that define them. The practical perspective lies in the presentation of two case studies. Together, these studies illustrate the practical aspects of designing and developing video games for exploration. The first focused on the general complexities in designing for conceptual exploration. The second showed how design patterns were implemented in a stimulus game for research and the design and execution of an empirical study to validate those patterns. This can form an example for the further study of design patterns for exploration.

In summary, the main contributions of this thesis are:

1. **The CURIO gamekit (Chapter 3):** The *CURIO* case study illustrates the intricacies of designing, in a most transparent manner, for conceptual curiosity and exploration. It shows the importance of balancing the player's knowledge gap, and its design may be used as a blueprint to create testing tools that can further examine this topic. *CURIO* may also be used as an example for other game-based learning projects, inspiring them to aim beyond testing prior knowledge and encourage learning through curiosity and exploration.

2. **A corpus of games for the further study of curiosity and exploration in games (Chapter 4):** Through the suggestions of survey participants, a list of 15 selected game titles was ranked by their potential to elicit curiosity. This selection was extended by participants' suggestions based on proposed game genres. The study found a selection of games that were particularly successful at stimulating curiosity in different ways, characterized by the genres of *Exploration*, *RPG*, *Puzzle*, *Social Sim*, and *Collecting*. Overall, the study's results provide evidence for the theory that games that strike a balance between uncertainty and structure tend to rank high. In contrast, highly deterministic games (requiring only cognitive or physical aptitude) or highly random tend to rank lower in curiosity. The list of games and genres provides a starting point for considering what game titles and genres should be analyzed regarding their potential to elicit curiosity.

3. **A well-defined set of strategies for conceptual, social, and spatial exploration (Chapter 5):** Through an analysis of games provided by participants and similar titles, strategies were formulated for how these types of games elicit conceptual, social, and spatial exploration. These strategies can form the based for the formulation of design patterns for games that stimulate these types of exploration. Five design patterns for spatial exploration were devised through an analysis of games and existing game design patterns.

4. **A blueprint of a research game for the empirical study of design patterns for exploration and well-defined models of measures and their analysis (Chapters 6 and 7):** Design patterns for spatial exploration were implemented into a research game and validated in an empirical study. The study provides a pioneering quantitative assessment of design patterns. It shows the complexities of ex-

ploratory behavior and how it is influenced by the presence of patterns, an in-game goal, and other factors. Additionally, the study design serves as a blueprint for future studies with similar aims.

5. **A classification of games for academic exploration (Chapter 8):** A definition was presented for "academic games", a sub-field of applied games that is shaped by a purpose and the involvement of stakeholders from research and education institutions. Four fundamental purposes for academic games were identified: stimulus, intervention, incentive, and model. Facets of game involvement were furthermore defined based on how games interface with the academic context they are in: information flow, dependency, and specificity. The formulation of these purposes and facets can help professionalize the practice of "exploration through games" and provides a basis for a future research agenda.

This thesis combined disciplines and knowledge from various fields, including philosophy, psychology, applied games, game-based learning, game user research, and game design. It provides a comprehensive overview of exploration in and through games, making it relevant to academics that include games in their practice. This is also reflected in the venues in which separate papers have been published (e.g., multidisciplinary conferences) and the levels at which implementations have been tested and disseminated: schools in Malta and the Netherlands and academic circles in different disciplines.

9.3 Future Work

This thesis contributes to the budding field of curiosity and exploration in games. Although it is a topic that is implicitly discussed and understood to be important, it has seen relatively little formal and empirical study. Similarly, games are increasingly often used in research and educational contexts, even as they are not fully understood. Although many individual studies have come before, this work presents a necessary bridging of perspectives and suggests a way forward toward a more professionalized practice. Based on the insights of this research, the following directions can be considered for future studies:

- **Further study the corpus of games:** The thesis presented a start for the further study of games and game genres and how they elicit exploration. This, however, is only the beginning. The corpus of games can form the start for further explorations, analyzing the games on the list and using them as a starting point for gathering similar titles through which the notions of curiosity and exploratory behavior can be better understood. Obvious directions are conceptual and social exploration, as the two genres are considered most successful at eliciting curiosity besides spatial exploration. However, other types of games may also be analyzed further.
- **Formulate, implement, and validate design patterns for exploration:** The thesis formulated five design patterns for spatial exploration, implementing and validating four of those patterns through an empirical study. These were formulated as a step toward empirical research that can assess the efficacy of hypothesized patterns. Their formulation and implementation into stimulus games, as well as the detailed description of research considerations and study design, can serve as a blueprint for further studies. Many more design patterns for the various forms of exploration discussed in this thesis may be formulated. Their empirical study can not only result in generalizable design knowledge but also further help understand player psychology and behavior.
- **Professionalize the practice of academic exploration through games:** This thesis formed a foundation for a research agenda regarding the use of games in academic contexts. Starting from the proposed classification of purposes and facets, prior work on applied games and game design could further be examined on whether it requires specialization to fit the academic context better. Further study could also involve how different academic fields approach the involvement of games for research purposes, e.g., strategic review of (individual case studies). The mapping of stakeholders often involved in the use and creation of academic games could help to understand the various forces that shape the practice of academic exploration through games, e.g., in regard to expectations depending on professional background and their influence on decision-making. This could lead to the formulation of design guidelines, frameworks, and toolkits aimed at the creation of academic games.