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Kniestedt, I.

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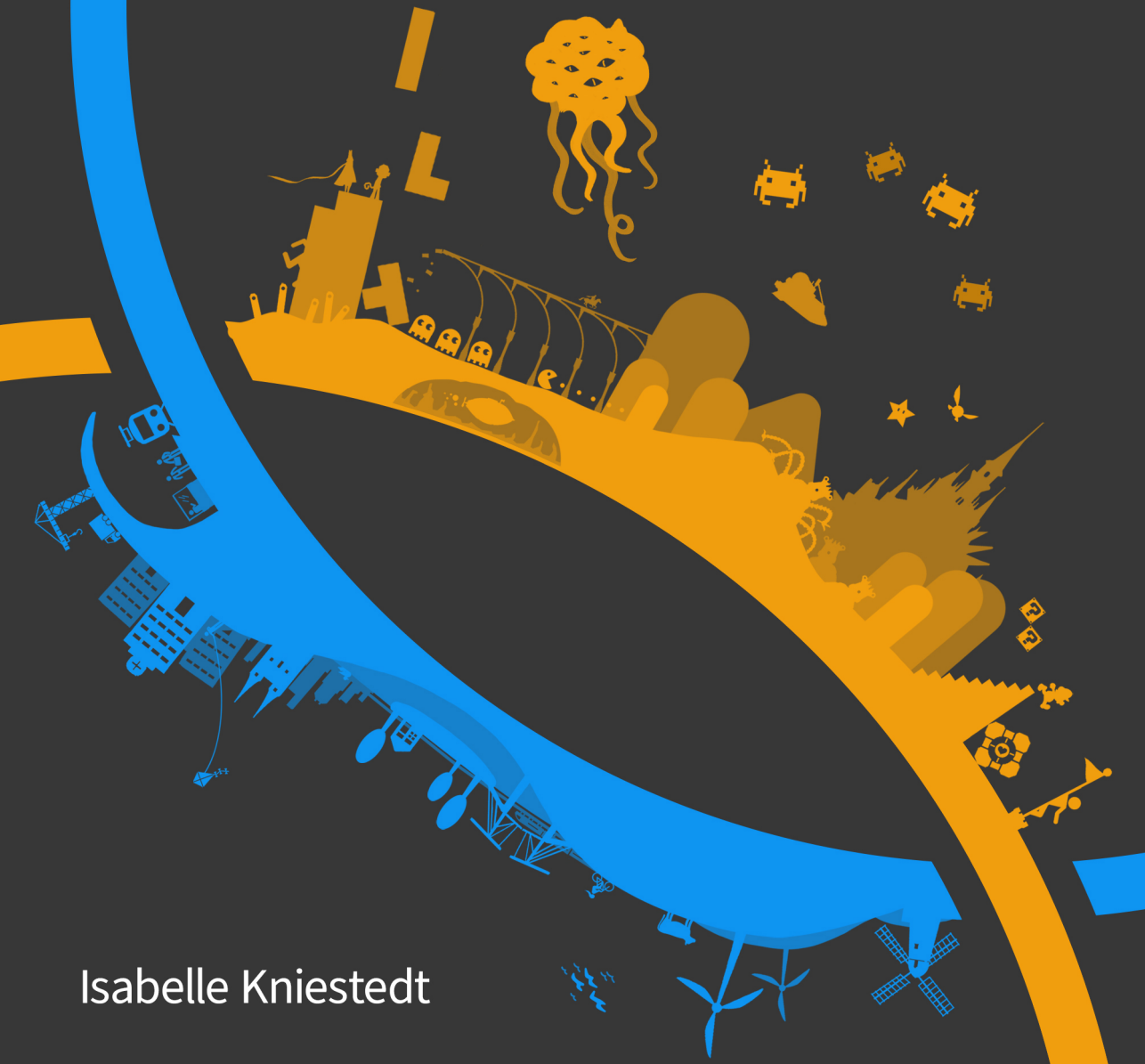
Engagement in Applied Games



Isabelle Kniestedt

Engagement in Applied Games

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Engagement in Applied Games

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
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chair of the Board for Doctorates
to be defended publicly on
Monday 26 June 2023 at
17:30 o'clock

by

Isabelle KNIESTEDT
Master of Science in Digital Games, University of Malta, Malta
born in Zoetermeer, The Netherlands

This dissertation has been approved by the promotors.

Composition of the doctoral committee:

Rector Magnificus	chairperson
Prof. dr. F.M. Brazier	Delft University of Technology, *promotor*
Prof. dr. S. Lukosch	University of Canterbury, New Zealand, *promotor*
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Prof. dr. M.E. Warnier	Delft University of Technology, *reserve member*

Systems Engineering Group
Faculty of Technology, Policy and Management
Delft University of Technology
The Netherlands

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Dedicated to my life partner and fellow unicorn
Marcello Gómez Maureira

About the Author

Isabelle Kniestedt is an independent game developer with an affinity for research. She is drawn to the many creative processes in game development, including coding, art, and writing to make impactful products that move and inspire. She has found her passion in education, where games can be used to interest young people, particularly girls, in learning and entering technical professions.

Isabelle was born in 1989 in Zoetermeer, The Netherlands, where she resides with her long-time partner Maro and their two cats. While it may seem like she has never left, her return is relatively recent. She obtained a Bachelor of Engineering in Game Architecture and Design (2013) at Breda University of Applied Sciences, a Master of Design in Animation (2014) at Avans University of Applied Sciences, and a Master of Science in Digital Games (2017) at the University of Malta. She has co-authored 16 internationally peer-reviewed publications and successfully acquired scholarships, seed investments, and academic funding throughout her career. Next to her academic endeavours, she has worked as a commercial (applied) game artist and developer. She teaches at Grafisch Lyceum Utrecht and continues creating games through her company "Dandy Unicorns". In her spare time, she gets persuaded to go on hiking and mountain-biking adventures, explores all manner of crafts, and channels her dramatics into writing *Dragon Age* fan fiction.

Summary

Games are often applied to purposes other than pure entertainment because they are 'engaging'. However, what it means for games to be 'engaging' is still being determined. The commonly accepted understanding of game engagement focuses on the outcomes of being engaged (e.g., measurable behaviour and emotional states), resulting in a lack of clarity that limits how the engagement process and how it is influenced by design can be discussed. Thus, the primary focus of this dissertation is to form a conceptualisation of game engagement that can guide the analysis and design of applied games.

The primary research question of the dissertation is: *How can game engagement be conceptualised to guide the analysis and design of applied games?* It investigates this question through a combination of research methods and design practice, structured along four sub-questions.

The first sub-question relates to the issues with the commonly accepted understanding of game engagement and what requirements a conceptualisation of applied game engagement should meet to address these issues. The sub-question addressed is: *What are the requirements for conceptualising applied game engagement?* Through an analysis of three applied gaming projects and an in-depth empirical study examining combinations of game mechanics in an applied game, six requirements are identified to form the basis of a conceptualisation of game engagement.

The second sub-question continues from the identified requirements and regards the conceptualisation of applied game engagement. The question addressed is: *How can applied game engagement be conceptualised?* The six requirements form the basis of a multidisciplinary literature review, from which a conceptualisation of applied game engagement is constructed. The result is the Applied Games Engagement Model (AGEM), which forms the basis for the remainder of the thesis. It posits engagement as the pro-

cess of focusing attention on a task. Attention, in turn, shifts between extra-diegetic purpose ('applied') elements and diegetic ('game') systems of the applied game through purposeful design.

The third sub-question seeks to examine the practical use of the AGEM in the analysis of applied games. Thus, the following question was addressed: *How can the conceptualisation of applied game engagement be used to analyse applied games?* This question is answered through analysis and discussion of the three applied gaming projects previously investigated for formulating requirements using the AGEM, thus showing how the model can be used in applied game analysis.

The final consideration of this dissertation lies in whether the understanding of applied game engagement can aid in applied game design. The fourth sub-question, therefore, asks: *How can analysis of applied game engagement be incorporated into applied game design?* The dissertation extends the AGEM with relevant knowledge from game design practice. Both are then tested in small-scale game development projects and two applied game design case studies. This process results in the Lens of Engagement for Applied Games, which provides a unique perspective on an applied game's design and a practical, workable version of the AGEM theory.

Previously, applied game engagement was a complex subject in which related concepts were often conflated or used interchangeably. This dissertation offers a comprehensive and extended perspective on applied game engagement, refocusing it on the consideration of attention and its close connection to game design. The theory and tools it provides can be of use to anyone seeking to create or do research with applied games.

Samenvatting

Digitale spellen worden vaak voor andere doeleinden gebruikt dan puur vermaak omdat ze boeiend ('engaging') zijn. Wat het betekent voor games om boeiend te zijn, is echter niet helemaal duidelijk. De algemeen geaccepteerde opvatting van spelbetrokkenheid ('game engagement') richt zich op resultaten van betrokkenheid, bijvoorbeeld meetbaar gedrag en emotionele toestanden. Dit leidt tot een gebrek aan duidelijkheid dat beperkt hoe het proces van spelbetrokkenheid, en hoe dit wordt beïnvloed door game ontwerp, kan worden besproken. Daarom is de primaire focus van dit proefschrift om een conceptueel begrip van spelbetrokkenheid te vormen dat de analyse en het ontwerp van toegepaste ('applied') spellen kan begeleiden.

Het proefschrift richt zich op de belangrijkste onderzoeksvraag: *Hoe kan spelbetrokkenheid worden geconceptualiseerd om de analyse en het ontwerp van toegepaste spellen te begeleiden?* Dit gebeurt door middel van een combinatie van onderzoeksmethoden en ontwerppraktijk, gestructureerd langs vier sub-vragen.

De eerste vraag heeft betrekking op de problemen met de algemeen aanvaarde opvatting van spelbetrokkenheid en aan welke vereisten een conceptualisering van toegepaste spelbetrokkenheid moet voldoen om deze problemen aan te pakken. De onderzoeksvraag die wordt aangepakt, is: *Wat zijn de vereisten voor het conceptualiseren van toegepaste spelbetrokkenheid?* Door middel van een analyse van drie toegepaste spelprojecten en een diepgaande empirische studie waarin combinaties van spelmechanieken in een toegepast spel worden onderzocht, worden zes vereisten geïdentificeerd om de basis te vormen voor een conceptualisering van spelbetrokkenheid.

De tweede vraag gaat verder op de geïdentificeerde vereisten en betreft de conceptualisering van toegepaste spelbetrokkenheid. De vraag die wordt aangepakt, is: *Hoe kan*

toegepaste spelbetrokkenheid worden geconceptualiseerd? De zes vereisten vormen de basis van een multidisciplinaire literatuurstudie, waaruit een begrip van toegepaste spelbetrokkenheid wordt opgebouwd. Het resultaat is het 'Applied Games Engagement Model' (AGEM), dat de basis vormt voor de rest van het proefschrift. Het stelt betrokkenheid voor als het proces van het richten van de aandacht op een taak. Aandacht verschuift op zijn beurt tussen extra-diegetische doel ('toegepaste') elementen en diegetische ('spel') systemen van het toegepaste spel, en kan actief worden gericht door middel van ontwerp.

De derde vraag beoogt het praktische gebruik van AGEM te onderzoeken bij de analyse van toegepaste spellen. De volgende vraag luidt: *Hoe kan de conceptualisering van toegepaste spelbetrokkenheid worden gebruikt om toegepaste spellen te analyseren?* Deze vraag wordt beantwoord door middel van een analyse en discussie van de drie toegepaste spelprojecten die eerder werden onderzocht voor de formulering van vereisten met behulp van AGEM. Hierdoor wordt aangetoond hoe het model kan worden gebruikt bij de analyse van toegepaste spellen.

De laatste overweging van dit proefschrift ligt in de vraag of het begrip van toegepaste spelbetrokkenheid kan helpen bij het ontwerpen van toegepaste spellen. De vierde onderzoeksvraag luidt daarom: *Hoe kan de analyse van toegepaste spelbetrokkenheid worden geïntegreerd in het ontwerp van toegepaste spellen?* De dissertatie breidt AGEM uit met relevante kennis uit de praktijk van spelontwerp. Beide worden vervolgens getest in kleinschalige spel-ontwikkelingsprojecten, evenals twee ontwerp casussen van toegepaste spellen. Dit proces resulteert in de 'Lens of Engagement for Applied Games', die een uniek perspectief biedt om het ontwerp van een toegepast spel te bekijken en een praktische versie van de AGEM-theorie biedt.

Voorheen werd toegepaste spelbetrokkenheid beschouwd als een complex onderwerp waarbij gerelateerde concepten vaak werden samengevoegd of onderling verwisselbaar waren. Dit proefschrift biedt een uitgebreider perspectief op toegepaste spelbetrokkenheid, waarbij het bewust richten van aandacht en de nauwe verbinding met spelontwerp centraal staan. De gepresenteerde theorie is van nut voor ieder die toegepaste games maken of onderzoeken.

Contents

1 Introduction

In February 2022, Guerilla Games released the much anticipated second instalment of their *Horizon* video game series; *Horizon: Forbidden West* (Horizon: FW) (Guerilla Games 2022). The game received largely positive reviews and proved to be the second-biggest launch for a Playstation 5 game (Dring 2022). Nevertheless, it was eclipsed in both media and fan discussion when FromSoftware, known for the *Dark Souls* (FromSoftware 2011) series, released *Elden Ring* (FromSoftware 2022) only one week later.

Critics considered *Elden Ring* a breath of fresh air that brought a new sense of wonder and agency to the 'open-world exploration' game genre (e.g., Ubisoft's *Assassin's Creed* series) (Dolen 2022; Byrd 2022). It did so partly by departing from common standards in game design, like labelling interaction possibilities on a clearly defined map, or providing detailed tracking of quests and collectables. Instead, it offered limited guidance on where to go or what to do. Game critic Ben Croshaw compared *Horizon: FW* and *Elden Ring* directly, stating that *Elden Ring* "lets its open world speak for itself", while games like *Horizon: FW* are "plastered with excessive menus, icons and GUI (game user interface) elements" to ensure the player does not miss anything (Croshaw 2022).

In response to *Elden Ring*'s praise, a Ubisoft developer took to Twitter to criticise the title for lousy user interface design. Adding on, one of *Horizon: FW's* developers similarly critiqued *Elden Ring*'s quests (Amirul Adlan 2022). While this was a minor conflict within the gaming community, it indicates a more extensive discussion on preferences for the different approaches to design. At the time of writing, user reviews of *Horizon: FW* and *Elden Ring* (PS5) aggregate to the same score (8.0/10) (Metacritic 2022a, 2022b). While many align with critics, Metacritic reviews also state that *Elden Ring* is overhyped and criticise its empty world, lacking performance and outdated graphics. For *Horizon: FW*, negative feedback pertains to overly complicated systems and excessive 'hand-holding' throughout the game.

Games are frequently described as engaging (Boyle et al. 2012), understood in this work as capturing and holding an audience's attention. However, as the example above illustrates, what makes a game engaging needs to be clarified. Some players can lose themselves in fast reflex-based shooters, while others spend hours solving puzzles or driving a virtual freight truck while listening to podcasts. Some direct large-scale battles in real-time strategy titles, while others build all manner of cities, theme parks, and houses in simulation games. At the beginning of the COVID-19 pandemic, millions found solace in *Animal Crossing: New Horizons* (Nintendo EPD 2020), a game that is ostensibly about doing nothing (King 2020). Even when games have features in common (for example, within the genre of open-world games), they can be received very differently by audiences. What makes one title 'work' for one player and not for another is a complex combination of gameplay and interface design, aesthetics, narrative and social features, and personal preferences (Tondello and Nacke 2019).

The potential of games to engage players has been a motivator for exploring their use in contexts other than entertainment. Players of games spend much time voluntarily participating in this activity. What, then, the logic goes, is the potential of using games to engage them in other types of activity as well? A famous example of this potential is that of *Pokemon Go* (Niantic Inc 2016), which motivated millions to take to the streets and exercise to catch the titular virtual creatures (Althoff, White, and Horvitz 2016). Researchers and practitioners have considered using such *applied games* for all manner of applications, e.g., education and training in various industries (R. Wang et al. 2016; Checa and Bustillo 2020; Petridis et al. 2015), spreading awareness(De Jans et al. 2017), treatment of psychological and physical conditions (Kato 2010; Pallavicini, Ferrari, and Mantovani 2018), crowdsourcing scientific data (X. Wang, Goh, and Lim 2020), and increasing neighbourhood participation (Slingerland et al. 2019). The most positive proponents of games have even gone so far as to claim that they have the potential to change the world (McGonigal 2011).

1.1 What is Game Engagement?

Although engagement is supposed to be important in games, unified terminology to discuss it is still needed. Two literature reviews examining engagement, several years apart, with one as recent as 2019, share similar conclusions — namely, that engage-

ment is a complex construct that is often confused and conflated with other terms and that more clarity is required (Boyle et al. 2012; Hookham and Nesbitt 2019). Although it is commonly cited as a motivation for developing applied games (Whitton 2011), few authors specify their use of the term (Hookham and Nesbitt 2019). This lack of specificity may partly be because it is a phrase that most people understand implicitly. However, while it is a term that is easily understood, this does not make it easy to define (O'Brien and Cairns 2016; Whitton 2011).

Prominent in the discussion on game engagement is the work of psychologist Csikszentmihályi (1990, 1997) on 'flow'. Flow refers to a state of complete absorption (being 'in the zone') that provides a sense of deep enjoyment (Hsieh, Lin, and Hou 2016; Ke and Abras 2013; Kiili and Lainema 2008). Games are particularly suitable for inducing a flow state, as they provide a player with short-term goals where a balance is struck (through game design) between skill and challenge (Ryan, Rigby, and Przybylski 2006). Even though Csikszentmihályi describes flow as a distinct state which results from engagement, the terms are often used interchangeably within the discussion of game engagement (Hookham and Nesbitt 2019). Similarly, engagement is not uncommonly conflated with other states, such as immersion and presence (Boyle et al. 2012; Hookham and Nesbitt 2019). While some consider engagement as a precursor to or 'initial stage' of such states (Brown and Cairns 2004), others use it to describe the player's entire game experience (including such states) (Procci et al. 2018). Conversely, some authors relate engagement only to precise, easily measurable behavioural outcomes (e.g., time spent on a task or number of interactions) (Annetta, Cheng, and Holmes 2010; Ferko et al. 2011; Lomas et al. 2012; Codish and Ravid 2015).

In a literature review of 107 papers measuring engagement in the context of applied games (i.e., games applied to a non-entertainment purpose), only 26 defined their use of the concept (Hookham and Nesbitt 2019). In 31 studies, engagement was conflated with, replaced by, or defined as immersion, flow, or presence components. Three uses of the term 'engagement' were found across all studies:

1. Engagement as 'use' —*the player is engaging with the game*: Describes a player's measurable behaviour, e.g., how long and how frequently they interact with the game.

2. Engagement as 'state' — *the player is engaged*: Describes the player's emotional and cognitive state, relating to various emotional and behavioural constructs.
3. Engagement as 'property' — *the game is engaging*: Used as an indicator of which element of the game influenced 'state' or 'use' engagement.

Hookham and Nesbitt (2019) found that applied game studies were most often concerned with measuring the first type of engagement, e.g., recording time spent on a task. Secondary to this was the second type of engagement, i.e., the constructs that result from interacting with the game (focusing on 'entertainment value', 'fun', 'enjoyment', or other aspects such as 'flow').

Nearly half of the reviewed cases used a single data collection technique. Among the possible techniques (including questionnaires, indirect observation, interviews, direct observation, and physiological measures), questionnaires were used the most often. Engagement as a property was rarely mentioned, with the example of "immersion as a property of a virtual environment" (Hookham and Nesbitt 2019). Engagement, as a whole, was affected by 'factors' of usability and information design, as well as player characteristics. Hookham and Nesbitt (2019) conclude their analysis by stating that further work on defining engagement is required and that it is a complex construct comprised of many others.

Applied games are generally analysed on how successfully they manage to serve their applied purpose, with engagement being an important factor in this success. The overview of previous studies outlined above shows a primary focus in applied game evaluation on the outcomes of playing the game. Such approaches do not provide clear insight into *why* a particular applied game was successful or not. The dominant understanding of engagement relies on the implicit assumption that engagement with the applied game equals engagement with the applied game's purpose. However, this supposition is not a given, as there may be many factors in the design that can (unintentionally) detract from the purpose (Kniestedt et al. 2021). Applied games have additional challenges in their design and validation by requiring a careful balance between game elements and purpose (Michael and Chen 2005). The focus on measuring proposed engagement outcomes does not consider the *process of engagement* (O'Brien and Toms 2008) and how it occurs. Additionally, it does not include the applied game's purpose or how it factors into the manifestation of engagement.

Contrast this with the example of two entertainment games being compared at the start of this chapter. Game critics and players have an extensive vocabulary to discuss the nuances in design differences between games. They use it to dissect the game and all its aspects. This thesis is founded on the idea that, in this regard, the study of applied games and engagement can learn from the entertainment industry. Thus, it proposes that the existing study and evaluation of game engagement can be extended to provide the necessary clarity and detail to understand engagement, specifically in an applied games context (Kniestedt et al. 2022).

Following the above observations, the premise of this thesis is that the dominant understanding of engagement requires further development for the practical discussion and analysis of applied games. This assertion will be closely examined in Chapters 2 and 3. The logical answer to this problem is to formulate a conceptualisation of game engagement that incorporates the needs of applied games. As such, the research objective of this thesis is as follows:

Research Objective
The research objective of this thesis is to conceptualise game engagement to guide the analysis and design of applied games.

1.2 Research Approach

Compared to other academic fields, the study of games is relatively young, resulting in a highly interdisciplinary practice in which academics bring in theory, methods and practices rooted in other academic fields (Mäyrä 2008). At the same time, games are complex systems that combine mechanics and interface, interaction and progression, sound, visuals, and cinematography to form a unique and emotional player experience (Newman 2002). As such, the object of study requires an interdisciplinary perspective to capture and understand it fully. Analysing a game as an abstract object without consideration for the emotional experience it provides would be considered insufficient, as would a study of players that disregarded the technical aspects or design of a particular game (Mäyrä 2008). Although applied games' unique nature and challenges are often emphasised (Ávila-Pesántez, Rivera, and Alban 2017), the study of applied games is

based mainly on the academic study of entertainment games. As a result, not only does the study of applied games inherit the challenges of 'regular' game studies, it adds further complexity and integration with other fields of study due to the inclusion of their non-entertainment aims.

Thus, any research examining applied games should similarly draw upon a multitude of fields and methods in order to answer its posed research questions. This thesis is the result of experience gathered over various applied gaming projects. The initial concept for the work resulted from having developed applied games and conducted validation studies similar to the ones reviewed by Hookham and Nesbitt (2019) (mentioned in Section 1.1), as well as attempting to draw generalised guidelines for design from such works. In these efforts, it became evident that, while literature focuses on specific guidelines in designing for certain audiences and using particular types of game mechanics (Ávila-Pesántez, Rivera, and Alban 2017), a universal terminology to compare and discuss engagement within a wide variety of applied games still needs to be formed.

This experience led to the meta-analysis of game engagement and its application in applied game studies. From this analysis, several factors were determined that are unaccounted for in the discussion of applied games and engagement (briefly outlined in Section 1.1). This observation formed the starting point of an extensive investigation of game engagement and how it could be understood for analysing and designing applied games. This investigation draws from two notable research fields: Game User Research (GUR) and Research through Design (RtD).

GUR has been essential and integral to the production of commercial games and to shaping players' experiences. It is the primary pathway to understanding players and how to design, build, and launch games that provide the right game user experience (UX) (Desurvire and El-Nasr 2013). Inherent to GUR is a multimodal approach to analysing user experience at various stages of development, utilising both qualitative and quantitative research methods. Depending on the stage and focus of the particular development cycle, such methods may include any combination of observation, interviews, focus groups, surveys, the recording and analysis of game metrics, and biometric measures. GUR has resulted in the basis for this thesis and provides the necessary tools to conduct the assessments discussed in this work.

RtD is an approach to conducting research using methods, practices, and processes of design practice to generate new knowledge (Zimmerman, Forlizzi, and Evenson 2007). Design is framed as a separate activity from scientific inquiry. It draws on the strength of design as a reflective practice in which a problematic situation is continually reinterpreted and reframed (Stappers and Giaccardi 2017). It allows for an investigation of the speculative future, examining what could be rather than only observing what already is. It does so systematically and with the explicit goal of generating knowledge in addition to the outcome of the design process itself.

In order to understand game engagement for the analysis and design of applied games, it is necessary to aim for what could be rather than only what already is. It requires examining the accepted standards, building upon them, and testing new assumptions. This philosophy is present throughout the thesis, starting with the generation of problem statements through the practice of previous design work and moving into the iterative implementation of the new knowledge in practice. By implementing the proposed theory and reflecting on the process of that implementation, knowledge is further refined throughout multiple iterations (Stappers and Giaccardi 2017). Each iteration aims to produce new insights, which then inform future iterations (in addition to previous experience and insights from literature). The final step is to reflect on what was learned from the process, how the findings of that reflection may best be conceptualised, and how they can inform future iterations.

1.2.1 Ethics

This thesis describes quantitative and qualitative work involving human participants. All practical research work (both online and in-person) was performed with informed consent and after being approved by the Technical University of Delft Ethics Board. Data was stored anonymously, with identifying features removed from the dataset. Where possible, data was made publicly available, and work was published in open-access venues, following open science principles (as indicated in the individual publications).

1.3 Research Questions

The main research question of this thesis is:

Main Research Question
How can game engagement be conceptualised to guide the analysis and design of applied games?

As described in Section 1.1, this thesis extends the commonly accepted interpretation of game engagement to make it specific to applied games. It uses a combination of research methods to

1. identify where the existing understanding of game engagement can be extended,
2. incorporate aspects specific to applied games to conceptualise 'applied game engagement',
3. shape and develop that knowledge through an analytical application of the conceptualisation, and
4. incorporate that analysis in design practice.

This structure leads to four sub-questions.

Research Sub-Question 1
What are the requirements for conceptualising applied game engagement?

The problem statement addressed in this thesis was formed over several years of experience in applied games. Chapter 2 introduces the practical work conducted over three applied gaming projects that underlies this thesis. It examines these projects from the existing perspective on game engagement, identifying factors that are unaccounted for in the discussion of applied game engagement and formulating the first requirements for conceptualisation.

Following this, Chapter 3 presents an empirical study that examines engagement with an applied game in detail. By dissecting and testing various aspects of the game's design, the study quantitatively shows how commonly used applied game evaluation practices should be extended to fully comprehend and discuss the applied game's design and functioning. This chapter identifies additional requirements that a conceptualisation of 'applied game engagement' should incorporate.

Research Sub-Question 2
How can applied game engagement be conceptualised?

The requirements identified from the first research question form the foundation for a literature review that brings together perspectives from multiple fields of study, including those previously not considered in the study of applied games. Through this review, Chapter 4 formulates a step-by-step conceptualisation of applied game engagement, resulting in the Applied Game Engagement Model (AGEM).

Research Sub-Question 3
How can the conceptualisation of applied game engagement be used to analyse applied games?

To evaluate the practical use of the Applied Game Engagement Model in analysing applied games, Chapter 5 re-examines the three games presented in Chapter 2 using the model. As described in Section 1.1, applied games are generally analysed in regards to how well they serve their purpose and how 'engaging' they are through post-game questionnaires. This thesis argues that such an approach does not provide sufficient insight into the applied game's design. The analysis presented in Chapter 5 illustrates the difference between the commonly accepted understanding of game engagement and the AGEM, and shows how it can provide such insight.

Research Sub-Question 4
How can analysis of applied game engagement be incorporated into applied game design?

Lastly, the thesis examines how the analysis of applied game engagement may be incorporated into design practice. Game development is traditionally an iterative process incorporating multiple cycles of conceptualisation, development, evaluation, reflection, and implementation (Lemarchand 2021). With an established conceptualisation of applied game engagement, Chapter 6 examines how applied game design may be shaped, not only by applying the theory at the end of a completed project for validation but also during the creation process.

1.4 Outline

This thesis is structured into seven chapters. Figure 1.1 illustrates how the thesis chapters are structured along a combination of design practice and research methods, as discussed in Section 1.2.

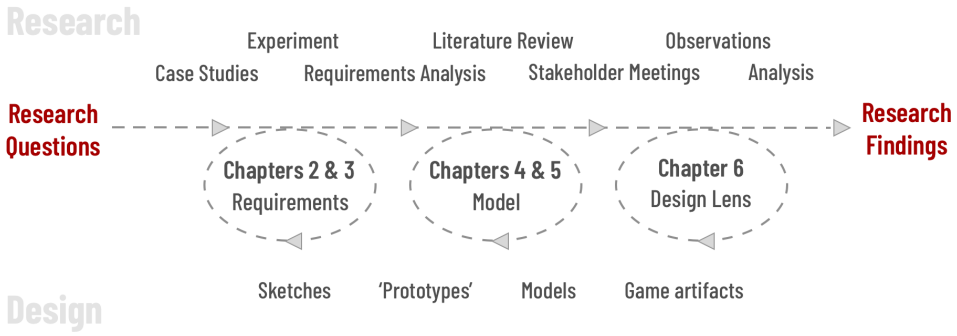


Figure 1.1: The research process. Design practice (prototypes and game artefacts) and research methods (case studies, literature review, and experiment) are combined to perform a requirements analysis for the conceptualisation of applied game engagement. This results in a model for applied game engagement, which is iterated through further case studies and analysis. Finally, the model is applied to design practice through iterative prototyping with stakeholders, which is observed and analysed.

Chapter 2 introduces the practical work that formed the basis for this thesis. It presents three applied game projects conducted throughout the research period and examines them using the commonly accepted understanding of game engagement. In doing so, it illustrates where the accepted understanding of game engagement can be extended when analysing applied games. It also identifies the first three requirements that should be incorporated in a conceptualisation of applied game engagement.

Chapter 3 goes further in the examination of game engagement with an empirical assessment of an applied game. Rather than analysing applied games as a whole, this allows for a deeper dive into the specifics of an applied game's design. This approach further illustrates where the commonly accepted understanding of engagement can be extended for analysing and evaluating applied games. This results in another three requirements for the conceptualisation of 'applied game engagement'.

The six requirements identified in the previous chapters form the basis of Chapter 4, which builds upon the theory of engagement from different fields of study. This results in the Applied Games Engagement Model (AGEM), a novel conceptualisation of applied game engagement. This model forms the foundation for the remaining chapters.

The use of applied game engagement is illustrated in Chapter 5, where the AGEM is used to discuss the designs of the three games first presented in Chapter 2. This process shows how the model allows for these games from different fields and with varying purposes and designs to be discussed using the same structure and terminology and how aspects of their design affect engagement.

Chapter 6 focuses on how the analysis of applied game engagement can be incorporated into applied game development practice. The AGEM is extended with game design knowledge. Practical use of the model is first examined through a pilot study in which students apply the theory during the development of short entertainment games. Next, the AGEM is applied in two applied gaming case studies, where it is used to guide design discussions with stakeholders. These studies further develop the AGEM into a practical design 'lens' for applied games.

Chapter 7 summarises the research findings by revisiting the research questions. It answers the main research question by providing an overview of the presented theory and findings. The thesis concludes by highlighting the work's contributions and suggesting further research directions.

1.5 Underlying Publications

Parts of this thesis are based on peer-reviewed publications: one journal article, six conference papers, and two book chapters. The list below shows an overview of these publications (ordered by publication date, starting with the most recent). Each chapter furthermore lists on which underlying publications it is based.

- Kniestedt, Isabelle, Stephan Lukosch, Milan van der Kuil, Iulia Lefter, and Frances Brazier. 2022. "Incorporating the Theory of Attention in Applied Game Design." In *International Conference on Entertainment Computing.*

- Kniestedt, Isabelle, Iulia Lefter, Stephan Lukosch, and Frances Brazier. 2022. "Re-Framing Engagement for Applied Games: A Conceptual Framework." *Entertainment Computing* 41: 100475.
- Kniestedt, Isabelle, Marcello Gómez-Maureira, Iulia Lefter, Stephan Lukosch, and Frances Brazier. 2021. "Dive Deeper: Empirical Analysis of Game Mechanics and Perceived Value in Serious Games." *Proceedings of the ACM on Human-Computer Interaction* 5 (CHIPLAY): 1–25.
- Gómez-Maureira, Marcello, Isabelle Kniestedt, Max Van Duijn, Carolien Rieffe, and Aske Plaat. 2021. "Level Design Patterns That Invoke Curiosity-Driven Exploration: An Empirical Study Across Multiple Conditions." *Proceedings of the ACM on Human-Computer Interaction* 5 (CHIPLAY): 1–32.
- Röcke, Christina, Sabrina Guye, Michele Girolami, and Isabelle Kniestedt. 2021. "Social Behaviour and Cognitive Monitoring in Healthy Ageing." In *Digital Health Technology for Better Ageing*, 103–14. Springer.
- Manferdelli, Giorgio, Alfonso Mastropietro, Enrico Denna, Isabelle Kniestedt, Marco Mauri, Marta Civiello, Stephan Lukosch, Giovanna Rizzo, and Simone Porcelli. 2021. "Physical Activity Promotion and Coaching to Support Healthy Ageing." In *Digital Health Technology for Better Ageing,* 147–60. Springer.
- Gómez-Maureira, Marcello, Isabelle Kniestedt, Sandra Dingli, Danielle M Farrugia, and Björn Berg Marklund. 2020. "CURIO 2.0: A Local Network Multiplayer Game Kit to Encourage Inquisitive Mindsets." In *15th International Conference on the Foundations of Digital Games* (FDG'20), September 15–18, 2020, Bugibba, Malta.
- Gómez Maureira, Marcello, Isabelle Kniestedt, Max J Van Duijn, Carolien Rieffe, and Aske Plaat. 2019. "Shinobi Valley: Studying Curiosity for Virtual Spatial Exploration Through a Video Game." In *Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play,* 421–28.
- Kniestedt, Isabelle, Stephan Lukosch, and Frances Brazier. 2018. "User-Centered Design of an Online Mobile Game Suite to Affect Well-Being of Older Adults." In *International Conference on Entertainment Computing*, 355–61.

2 Game Engagement: A Project Review

This chapter introduces three applied gaming projects. The games are discussed with the commonly accepted understanding of game engagement, examining the problem statement presented in Chapter 1 and identifying the first requirements for a conceptualisation of applied game engagement.

Parts of this chapter are based on the following publications:

- *"User-Centered Design of an Online Mobile Game Suite to Affect Well-Being of Older Adults."* (2018)
- *"Social Behaviour and Cognitive Monitoring in Healthy Ageing."* (2021)
- *"Physical Activity Promotion and Coaching to Support Healthy Ageing."* (2021)
- *"CURIO 2.0: A Local Network Multiplayer Game Kit to Encourage Inquisitive Mindsets."* (2020)
- *"Shinobi Valley: Studying Curiosity for Virtual Spatial Exploration Through a Video Game."* (2019)
- *"Level Design Patterns That Invoke Curiosity-Driven Exploration: An Empirical Study Across Multiple Conditions."* (2021)

2.1 Introduction

The work presented in this thesis is motivated by practical experience in applied game development and analysis. The following chapter introduces three applied gaming projects conducted throughout the research period. It describes each game in detail, including its applied purpose, its design, and how it was validated.

The projects represent a range of applied games, each representing a larger category of applied games as described in Section 2.2. Two projects (*NESTORE* and *CURIO*) were projects with financial support (H2020 and Erasmus+, respectively) involving multiple partner organisations (including universities, technology/development companies, and community stakeholders). The third project was undertaken by an independent researcher (*Shinobi Valley*) at Leiden University. The author of this thesis was involved in each project from start to finish as a designer, developer, and researcher evaluating the final product. Because of this, this thesis can analyse the projects from various angles and consider the entire design, development, and evaluation process.

The chapter ends with a requirement analysis for a conceptualisation of applied game engagement through a discussion of the projects and their validation studies. Through this analysis, the problem statement addressed in this work — namely, that the study of game engagement should be extended for discussing and analysing applied games — is illustrated and examined more closely. Essential factors of the projects are highlighted concerning the commonly accepted understanding of game engagement, either because they contradict existing theories or still need to be incorporated. As such, this chapter begins a conceptualisation for applied game engagement and sets up essential information that will be referred back to throughout the rest of the research.

In doing so, this chapter begins to answer RQ1:

> **Research Sub-Question 1**
> What are the requirements for a conceptualisation of applied game engagement?

2.2 Applied Games

Applied games (Schmidt, Emmerich, and Schmidt 2015) — also referred to as 'serious' games (Susi, Johannesson, and Backlund 2007) — are games with a purpose other than pure entertainment (Ma, Oikonomou, and Jain 2011). It is an umbrella term that describes a large variety of games that can exist within any number of industries and for just as wide a range of practical applications. For example, it may refer to games that aim to assist teachers in teaching a curriculum or that can help students train and test

their knowledge (Takeuchi and Vaala 2014). Applied games can also be physical, using motion controls to stimulate exercise for general health (Warburton et al. 2007) or rehabilitation purposes (Vieira et al. 2021). They can be simulations to study behaviour in real-life situations (Roukouni, Lukosch, and Verbraeck 2019) or to break bad habits and stimulate healthy ones (DeSmet et al. 2014). Some applied games are developed specifically with a particular goal in mind. Others start as entertainment products that are then used for another purpose, e.g., in the case of games like theme park simulation game *Roller Coaster Tycoon 3* (Frontier Developments 2004) to study physics (Sandford, Ulicsak, and Facer 2006), or *Minecraft* (Mojang 2011) for practising programming (Zorn et al. 2013).

Other terms related to, or often conflated with, applied games are edutainment (Susi, Johannesson, and Backlund 2007), 'game-based learning' (GBL) (Prensky 2003), games with a purpose (GWAP) (Von Ahn and Dabbish 2008), persuasive games (Bogost 2010), and transformational games (Culyba 2018). As mentioned earlier, there is also the term 'serious games', defined as "games that do not have entertainment, enjoyment or fun as their primary purpose" (Michael and Chen 2005). The term arose in the 70s and, since then, has been the dominant catch-all term that persists to this day. Despite its persistent popularity, 'serious games' has been critiqued for being limited in capturing the games it aims to describe (Schmidt, Emmerich, and Schmidt 2015).

The term 'applied games' is used in this thesis, as it accurately captures games — regardless of origin, field, or design — that have been applied to a purpose other than pure entertainment. Three types of applied games have been created within the context of this work and are discussed below. Based on their applied purpose, these games can be classified within the sub-categories of *intervention games*, *educational games*, and *stimulus games*. Although these sub-categories capture a considerable portion of the applied games field, they do not provide an exhaustive overview of all possible or existing applied games.

Intervention games describes games created to induce a specific, long-term change in the player that is to their benefit (Gómez-Maureira et al. 2022). They are closely aligned with 'transformational' games (Culyba 2018) and are prominent in healthcare. They may include games developed by academics interested in testing the efficacy of particular designs (e.g., (Lin et al. 2006)) and those developed by entertainment gaming

companies, such as *Dr. Kawashima's Brain Training* (Nintendo EPD 2019), aimed at training and improving cognition, or *Your Shape: Fitness Evolved* (Ubisoft Montreal 2010) to stimulate physical exercise.

Educational games are games with the purpose of training skills or transferring knowledge. Although 'learning' is an explicit part of their branding, these games only sometimes need to convey subject matter information to contribute to educational processes. Instead, they can also try to change attitudes regarding certain subjects (Gómez-Maureira et al. 2020). Although educational games are often aimed at children as the target audience (Takeuchi and Vaala 2014), their use is much more widespread, ranging from the military (DeFalco et al. 2018) to, for example, levee inspectors (Harteveld et al. 2009). They often integrate fixed educational content and include various scenarios in which that content is put to practice and performance is assessed.

Stimulus games refers to games used in academic research. Their primary purpose is to cause a measurable reaction or change in the player, where the research context is interested in monitoring and measuring that change (Gómez-Maureira et al. 2022). Examples include games such as *Squirrel Away* (Prpic et al. 2019), a tablet game for studying foraging behaviour, and *Affective Pacman* (Reuderink, Nijholt, and Poel 2009), an altered version of the original game that is designed to work unreliably to study frustration. While some stimulus games are created for specific research, entertainment games may also be repurposed for academic research. Research using games in this manner can be seen in, for example, the field of Psychology (Washburn 2003). It can be noted that many intervention games, at one point, start as stimulus games.

These sub-categories exist within various sectors, may have considerably different designs, and can even overlap. By including a range of games for discussion, the knowledge presented in this thesis allows for a broad perspective on the subject. This variety helps to understand many forms of applied games rather than only those of a specific design or purpose.

2.3 Intervention Game: NESTORE

In light of the increasing ageing population in the EU (Diaconu 2015), Novel Empowering Solutions and Technologies for Older people to Retain Everyday life activities (NESTORE) was an H2020 project to develop an at-home intervention for older adults to maintain their well-being. It was posited to be an innovative, multi-dimensional, personalised coaching system to support healthy ageing by addressing four key areas: nutrition, physical and mental health, and social interaction. It did so through a range of different technologies, resulting in a system that consisted of

1. sensors in the main rooms of the house,
2. a sleep sensor under the participant's mattress,
3. a digital scale,
4. a wearable fitness tracker,
5. beacons to attach to keychains and give to the participant's social circle,
6. a voice-controlled smart speaker ('tangible coach', similar to Amazon Echo),
7. and two mobile phone applications (apps).

The project adopted a co-design approach with the target audience of older people and aimed to include an extensive validation study (Andreoni and Mambretti 2021).

Part of the app development was the design of games to motivate activities related to maintaining physical and mental health and social interaction. The result was *NESTORE Pocket Odyssey* (NPO), an intervention game for mobile phones. Its design is based on popular mobile games, and it was created following guidelines regarding theme and complexity in line with the target audience (Gerling et al. 2012; Nap, De Kort, and IJsselsteijn 2009). The game has a nautical and travel theme, which was conceived from a survey study conducted among the target audience (Kniestedt, Lukosch, and Brazier 2018). The game, in particular, is the focus of the following sections.

2.3.1 Design

NPO consists of three components. The first is the 'Ship', the portal to other parts of the game. Additionally, it serves as a reward mechanic. The other parts are the 'Submarine' and 'Gym' mini-games. The Submarine game provides cognitive training and assessment. The Gym game is an interactive visualisation of exercise routines that guide the player in performing the exercises.

Figure 2.1: Screenshots showing the different aspects of the Ship screen. Daily reward for logging in (a). Introduction by the character Nestor (b). Tutorial to explain the game (c). Leaderboard and link to ships of friends (d). Fixing up the ship using stars (e) and choosing decor with coins (f). Language and weight settings (g), or choosing cognitive or physical training (h).

Usage and performance data are logged and sent to the NESTORE server. The game is also provided with information from the NESTORE server, e.g., the list of other players that the player has added to their friend list.

Ship, Reward System, and Social Features

The Ship is the main screen and reward system of *NPO* (Figure 2.1). The first time a player logs into the game, they are welcomed by the character Nestor, who serves as the player's guide. He informs the player that he requires their help fixing his ship. Once Nestor has established the game's premise, he guides the player through a short tutorial explaining the basic functionality.

NPO includes two reward currencies: stars and coins. This decision was based on commercially designed mobile games which include different currencies (e.g., Candy Crush Saga (King 2011)). The benefit of having multiple types of reward is the ability to pace the reward received by the player. The game aims to encourage players not just to play the game but to play it the right amount (e.g., complete a physical exercise routine). A less valuable 'currency' (coins) rewards simple interaction, while a rarer currency (stars) rewards commitment to achieving daily or weekly goals. These types of currency can be used to fix up and decorate Nestor's ship to the player's taste. In doing so, the game provides an incentive to keep up with exercise regularly. Every day the player logs into the game, they are rewarded with one of the two currencies. Additionally, players earn currencies by doing the physical and cognitive aspects of the game.

Currencies are used to fix up the ship. It is depicted from the side in a cross-section, showing the different floors and rooms. At the start, most of the ship is unfinished. The player can use stars to unlock new rooms on the ship and renovate them step-by-step. There is a total of ten rooms, each of which has an adjustable wallpaper and three objects in it. This setup means there are forty steps of progression until the ship has been fully restored. For every step, players have the choice of three decoration options. The three options each have a different cost in coins, meaning players need to play the game more to choose the more expensive options. The steps unlock linearly. The player can see the next step (e.g., "Let's add a cupboard!") and how many stars they need. While the content for the game is limited (i.e., users could 'finish' fixing up the ship), it was enough for the planned validation study. It could be expanded to prolong use over a more extended period.

The Ship screen also gives access to the Leaderboard, where the player can see the scores of any friends they have added to the NESTORE system. They can also see their friend's ship by tapping on their name. This feature is often included in commercial games, although such games usually provide some form of passive interaction between players (e.g., watering each other's crops in *Farmville* (Zynga 2009). Unfortunately, such interactions were not possible in the architecture of the NESTORE project.

Finally, the Ship gives access to the settings (each of the four languages supported in the NESTORE project and an input for the amount of weight used in physical exercises) and the other parts of the game.

Submarine Game

In the Submarine game (Figure 2.2), players are asked to memorise a route on a map with a grid. Depending on the difficulty level, the route has a certain length and therefore requires memorising a sequence of directions to turn at each juncture. Additionally, players need to steer the submarine by tilting the mobile device so they can collect treasure in the water while avoiding bombs. This part of the game was designed with input from domain experts on cognition.

After players choose the Submarine game from the main menu, they can choose to play any training level. Each level introduces the player to a different aspect of the game. Playing these levels is optional and does not reward the player with currency. The player starts the game by pressing the central play button. Doing so loads the last level that the player reached. First, the player is shown a route on a map. The difficulty of the route increases with level tiers. For example, between levels one and five, the player must complete a route with three junctions, while levels 45 to 50 consist of routes with twelve junctions. Due to time restrictions during development, the route is fixed for each level.

Once the player has memorised the route, they start the level. They are then presented with a 3D environment of a submarine moving through seaweed on an ocean floor. Coins and bombs may appear along the path, the frequency and ratio of which depend on the difficulty level. Players tilt the mobile device to steer the submarine left and right. The goal is to steer the submarine close to coins and collect them by tapping the screen to earn points. The player should not tap the screen when they are in the

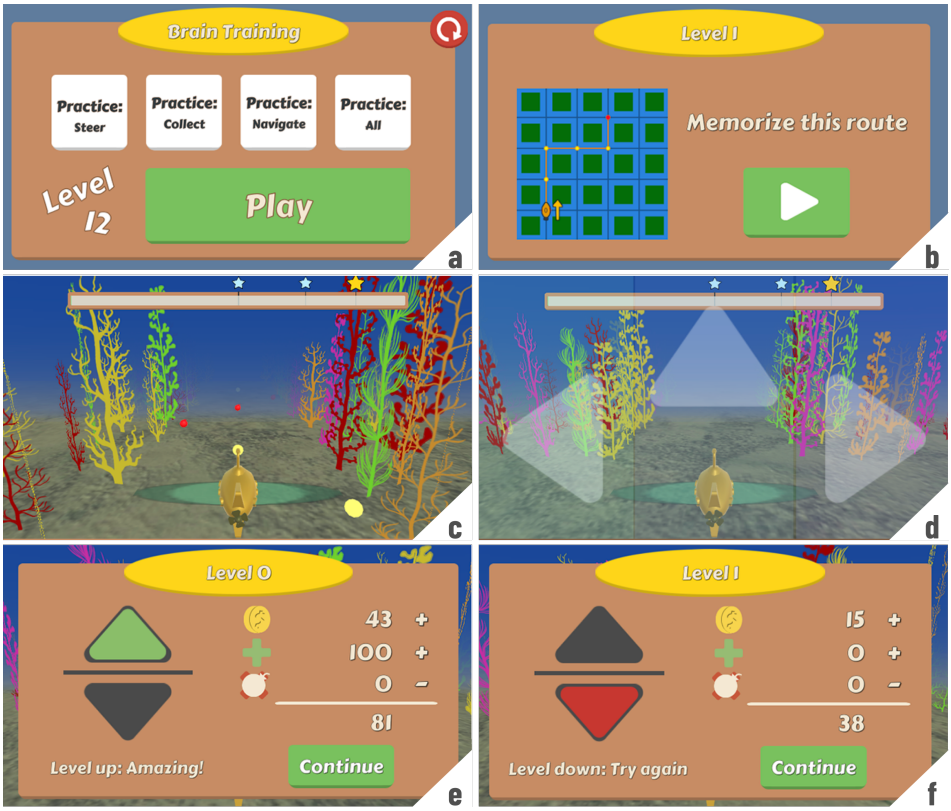


Figure 2.2: Screenshots showing the Submarine game. Submarine menu (a). The route that the player should memorise (b). Straight section with coins to collect and bombs to avoid (c). A junction where the player needs to choose the correct direction (d). The end screen showing a positive result (e) and a negative result (b).

range of a bomb, as this deducts points. This mechanic implements a 'Go/No-Go' task common in Psychology, where players must react to certain stimuli and ignore others (Gomez, Ratcliff, and Perea 2007).

Whenever the player reaches a junction, they need to remember which direction the submarine will go next and confirm their choice by tapping the corresponding button on the screen. Sound effects and a score bar inform the player of whether their choice is correct and when they collect coins or bombs. With all the game mechanics — memorising a route, directing the submarine, and picking up the treasure while ignoring the bombs — the submarine game tests players' spatial navigation skills, accuracy, and inhibition.

Players receive their score at the end of the level. When scoring above a certain percentage, they advance to the next level. If performance is average, the player needs to replay the level. When they perform poorly, they drop a level of difficulty. Every fifth level earns the player a star, while in-between or previously cleared levels earn the player coins. The player's scores (accuracy in navigation, memory, and response to Go/No-Go stimuli) are sent to the NESTORE system.

Gym Game

The Gym game (Figure 2.3) helps players follow pre-defined exercise routines. The character Nestor performs these routines on screen through timed animations. Players select the type of exercise they want — strength, flexibility, or balance. Strength training requires an additional choice for which routine the player wants to follow, after which the routine starts. Balance and flexibility have a single routine and thus start immediately. After making this choice, the player is shown an explanation for the upcoming exercise. The structure of these screens is always the same – they show the two key positions of the exercise and a textual description of the movement to be performed.

The Nestor character performs the exercise on screen. Repetitions are shown in the top-right corner, and motivational text is provided at the bottom to guide the player. If the player needs to perform the exercise on two sides (e.g., an exercise using a single arm), the game prompts the player to switch sides halfway through the repetitions. The following exercise is explained when the repetitions have been completed. This process continues until the player has performed all exercises in the routine. The game then

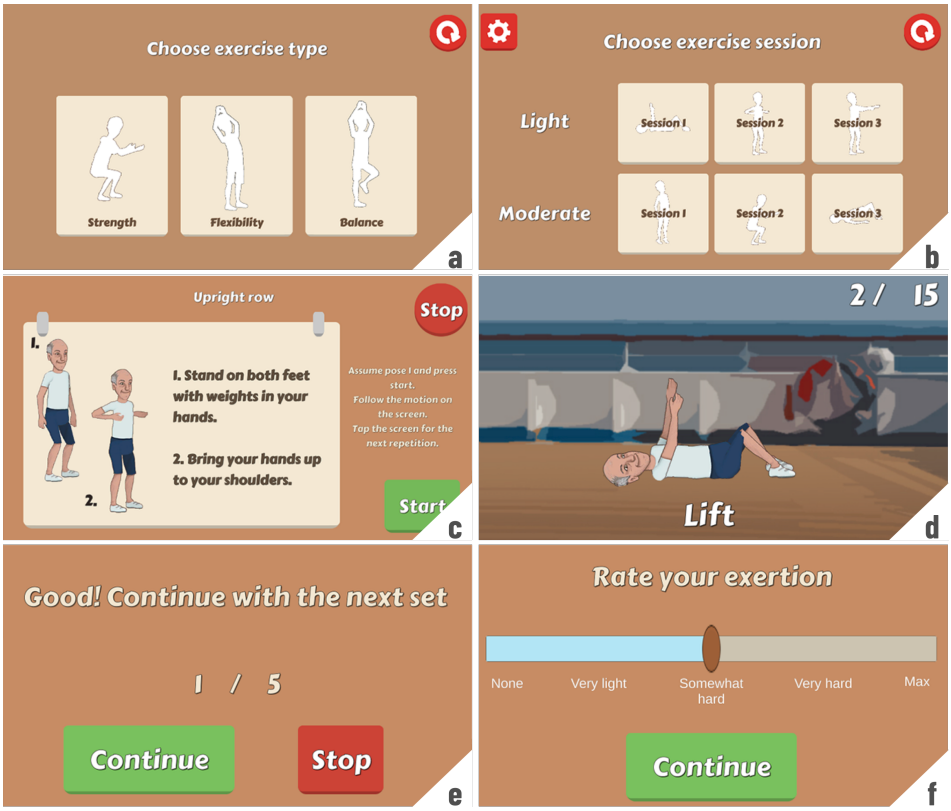


Figure 2.3: Screenshots showing the Gym game. The first menu screen with a choice between strength, flexibility, and balance (a). The second screen for strength training with different routine options (b). An example of an exercise explanation screen (c). The character Nestore shows an exercise to follow along with (d). In-between screen tracking progress (e). Exercise rating screen that logs the player's experience for the NESTORE system (f).

checks whether the player has exercised enough for that day. The player is prompted to continue with the next set if they have not. If they have, the game removes the option to continue and rewards the player. It is possible to finish a set, leave the game, and finish the required sets later. Flexibility and balance do not include a specific target. In these cases, routines only last for one set and provide a combination of movements.

At the end of their exercise, the player rates their exertion during the session. This information, including the type of exercise and amount of repetitions, is sent back to the NESTORE system.

2.3.2 Validation

The NESTORE system was tested with 24 users in Italy, Spain, and the Netherlands. Participants had the system installed in their homes by one of the local project partners and were asked to use it for several weeks. Measurements consisted of data collected by the system, a range of questionnaires (based on the System Usability Scale (SUS) (Bangor, Kortum, and Miller 2008), Technology Acceptance Model (TAM) (Holden and Karsh 2010), and User Experience Questionnaire (UEQ) (Laugwitz, Held, and Schrepp 2008)), and physical and cognitive tests that were taken both pre- and post-intervention. The data collection and installation process was spread over multiple days to limit the burden on the elderly participants.

The primary purpose of the intervention game was to foster engagement with healthy activities, i.e., cognitive training and physical exercise. Engagement (use) was therefore measured through data logging (i.e., whether and how much the game was used). Additionally, questions about the game experience were also included in the interviews and questionnaires.

Unfortunately, technical issues with the hardware impacted participants' experience of the system. Although participants were motivated to participate and patient when issues occurred, SUS ratings were in the 'not acceptable' range. Some aspects (tangible coach and coaching app) performed worse than others (wearable).

The game received an average score around the 'acceptable' range. It received above-average scores in 'satisfaction' and 'acceptance', although scores varied between different countries. Scores were lowest in Spain, where the first pilot began and, thus, where

most technical issues occurred. The game received average to above-average scores in the UEQ.

2.3.3 NPO Prototype

In contrast to the finished product of the NESTORE project, this section briefly describes a prototype for the game at an earlier stage in design and development (Kniestedt, Lukosch, and Brazier 2018). The NESTORE project began with broad purpose statements, and the intention to involve the target audience in the design process. Early on, this happened through multiple participatory sessions aimed at formulating essential values with this audience, discussing potential visual designs, and evaluating prototypes (Craig, Chamberlain, and Dulake 2018). Over the course of the project, however, physical exercises and cognitive tasks devised by the domain experts were treated with increased importance. Thus, the game ended up serving the intended purpose differently than conceived in co-design sessions with the target audience (see Figure 2.4) during which, among other things, social interaction was raised as a priority.

In the NPO prototype, players would go on expeditions and uncover mysteries as they travelled through a virtual world. This was based on existing literature (Skalsky Brown 2014) and an exploratory survey (Kniestedt, Lukosch, and Brazier 2018) in which the themes of travel, history, adventure, and mystery were aligned with user interests. Expeditions were intended to be turn-based, mystery-solving game sessions between two players. They would explore a fictional society's virtual environment, take turns moving through the world, and take action to solve a puzzle. Players would be encouraged to communicate with each other about clues they found via a chat interface. This design aimed to integrate collaborative and competitive elements and simulate a board game-like experience. Obtaining clues would have required the completion of a randomised mini-game designed to stimulate physical activity or cognitive training.

These mini-games could also be played on their own, individually or in a local multiplayer session. In the latter case, the game would be cast to a larger screen from the phone, and a random sequence of mini-games would be generated. This setup would change the game to a shared, social, co-located group experience, with players competing to get the highest score in the style of games like *WarioWare* (Nintendo EPD 2006a).

Figure 2.4: Early prototyping and co-design sessions with the target audience, where priorities were generated for a personalised well-being system and social features were tested.

It would not be correct to assume the prototype's design would have solved the game's practical issues, and it likely would have introduced others. Creating and solving mysteries and a multitude of mini-games would have been time intensive to create and difficult to automate. As such, it would have resulted in limited content within the time available for the project.

However, a significant change in the prototype compared to the final product is the focus on sociability. Ship customisation was initially intended to be more personal, making visiting someone else's ship more meaningful by extension. Additionally, the core gameplay loop of expeditions with mini-games would have connected players directly. The aim was also for the game to be projected on a larger screen and to include other co-located players in the same game experience. These could have been other NESTORE users (e.g., local users meeting in community centres) or other people in the player's vicinity, such as friends and family. Although incompatible with COVID regulations during the study, this change could have made the game more meaningful, as being social was considered an essential aspect of activities by the target audience.

2.4 Educational Game: CURIO

To address the need for better education on STEM topics in Maltese primary schools, the Erasmus+ project *CURIO* aimed to develop a game-based learning tool that could aid teachers in teaching such topics. *CURIO* is an educational multiplayer game 'kit'

that stimulates curiosity and critical thinking by encouraging students to ask questions about a topic and using those questions for class discussion.

Teachers often use educational games to distract or reward students or provide practice with a specific set of pre-defined educational content (e.g., training math problems) (Takeuchi and Vaala 2014). They are rarely directly involved in gameplay. Instead, they primarily receive student performance data (Takeuchi and Vaala 2014). Because of this, educational games' perceived lack of usefulness is a barrier to teachers adopting them in their classrooms (Proctor and Marks 2013).

CURIO is a game for the students and a teaching tool for the educator. In *CURIO*, the teacher sets the game's educational content, shaping the educational aspect of the game, and plays an active role in the gameplay. The game is subject-independent and may be used to discuss any topic. While teachers can decide how to use *CURIO* in their classroom, the game is intended to be used when introducing a new topic to the students. When used in this capacity, the game provides a playful start to the topic, helps to structure discussion, assesses prior knowledge of the students, and can form the basis of following classes.

2.4.1 Design

The premise of *CURIO* is that a fictional galaxy is threatened by the game's antagonist: the 'Haze of Confusion'. The Haze sweeps across the galaxy, draining the solar system's inhabitants of their enthusiasm for a particular educational topic. Students play on their own device (e.g., pc, tablet, or phone) but are sorted into one of three teams (blue, red and yellow). To play the game, they visit planets and ask the inhabitants questions, helping them regain interest in the topic (Figure 2.5). In the end, students face off against the Haze by answering multiple-choice questions. Once the students save the galaxy, they can decorate their spaceship in a final, celebratory moment (Figure 2.6).

The teacher prepares the scenario for each game, meaning that they determine the overall topic of the game, as well as multiple sub-topics (one per planet). They also decide the questions posed by the Haze in the final confrontation and the possible answers. Because of this, *CURIO* serves as a tool for teachers to interest students in a new topic, assess their prior knowledge, and receive input for further education on the

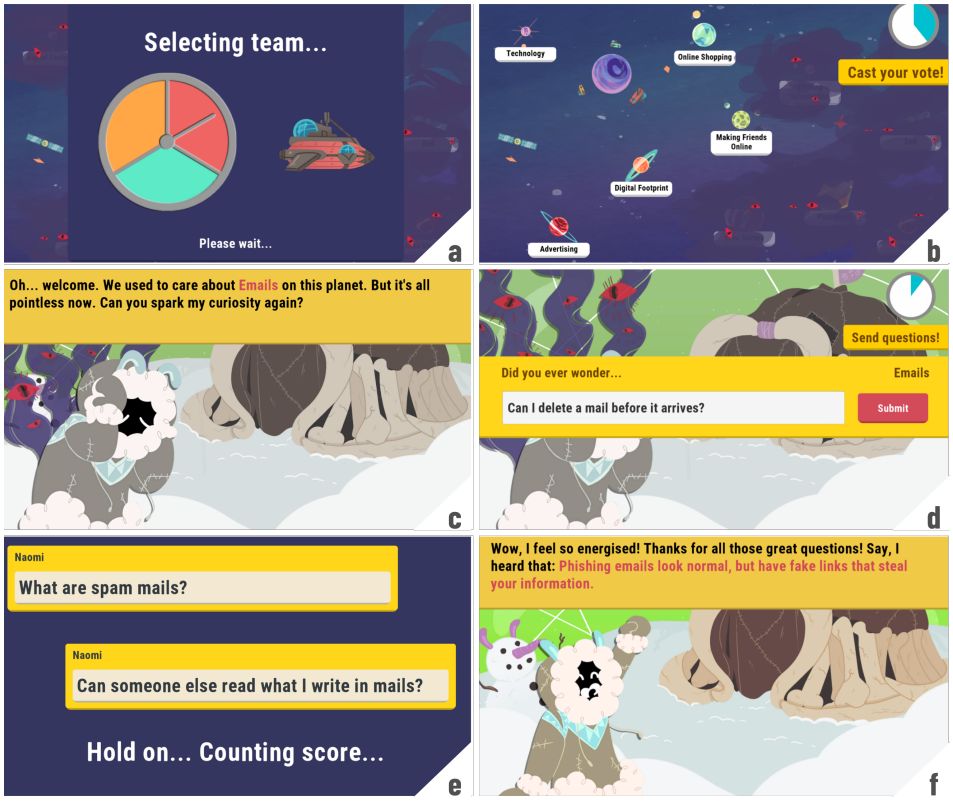


Figure 2.5: Screenshots that show the game from a student's perspective. Revealing the team (a). The voting screen with visible planets and sub-topics (b). The inhabitant of a planet in distress (c). Asking questions interface (d). Seeing valid question submissions (e). Revitalising the inhabitant, and receiving information (f).

topic. During gameplay, the teacher assumes the role of 'game master' and controls the game's progression (Figure 2.7).

Student Side

The game opens with an animation that shows the 'Haze of Confusion' spreading across a fictional galaxy. This sequence introduces students to the game's ultimate goal (i.e., defeating the Haze). Next, it is revealed to each student in which team they are sorted — red, blue, or yellow. The introduction is followed by multiple game rounds, each broken down into individual steps.

1. **Vote for destination:** The main screen shows the galaxy and the planets (i.e., sub-topics) within it. At the start of the game, most of the galaxy is covered in fog, meaning not all options are immediately available. More of the map is revealed as students visit the different planets. Students get limited time to vote for their next destination (i.e., which sub-topic they find the most interesting). Voting happens individually.
2. **Voting results:** After a moment of buildup, the students see the vote result. The planet that was chosen by the majority of students becomes the next destination. In a tie, the destination is selected randomly from the top choices. The three player ships teleport away from their current location and appear at the new location, where they land on the planet.
3. **Ask questions:** The ships land on the planet, and the view changes to the planet's surface (with a total of 7 different aesthetics). The planet's colours are initially desaturated to show the influence of the Haze, and the inhabitant that welcomes the students is lethargic. The inhabitant suggests that students can make them curious about the planet's topic again by asking questions. Students are then provided with an interface to type in questions. The goal is to ask as many valuable questions about the sub-topic as possible within the time limit.
4. **Question review:** While the teacher evaluates the questions asked, the students see questions that have already been accepted as valid. Each question also shows the name of the student who asked it.
5. **Round results:** The planet is shown again. The inhabitant will no longer be affected by the Haze of Confusion, and the planet will be revitalised. The inhabitant then thanks the students for helping and gives them some information about the

sub-topic. All students receive the same information. Depending on how well a team did (i.e., clearing a certain threshold of submitting valid questions per team), the inhabitant is happy or more neutral.

The above steps repeat until the conditions for the 'endgame' are triggered. The first way this can happen is when students vote to end the game by uncovering enough of the map and choosing the last location in the system (visualised by a space station). Secondly, the teacher may trigger the endgame during voting, causing the students' ships to travel to the space station. The camera then reveals the Haze, and the endgame begins.

1. **Answer question:** The Haze asks the students a multiple-choice question based on one of the subtopics that the students have visited. The correct answer to the question is the information the students received from the inhabitant after revitalising the planet. This game aspect checks whether students paid attention during the session and absorbed the information.
2. **Strike antagonist:** Each team shoots a rocket at the Haze. The rocket changes based on how the students of each team answered the multiple-choice question. If a majority of the students in a team answered correctly, the rocket would be visually more prominent.

These steps repeat until at least three multiple-choice questions have been answered (or fewer, in case of a short game in which fewer than three planets were visited). Once the students answer enough questions, an animation shows the Haze being defeated and fireworks to celebrate the students' victory.

Finally, the students can collaboratively decorate their team's ship using points they have earned during the session by asking valid questions and answering the Haze's questions correctly. A larger version of the spaceship appears on the screen. Students can use their earned points to buy stickers and decorate the ship. The students decorate the ship together, meaning they will see each other's stickers as they place them. This activity concludes the game session with a playful reward mechanic, while a final picture of the ship could be saved as a screen capture to provide a memento of the session.

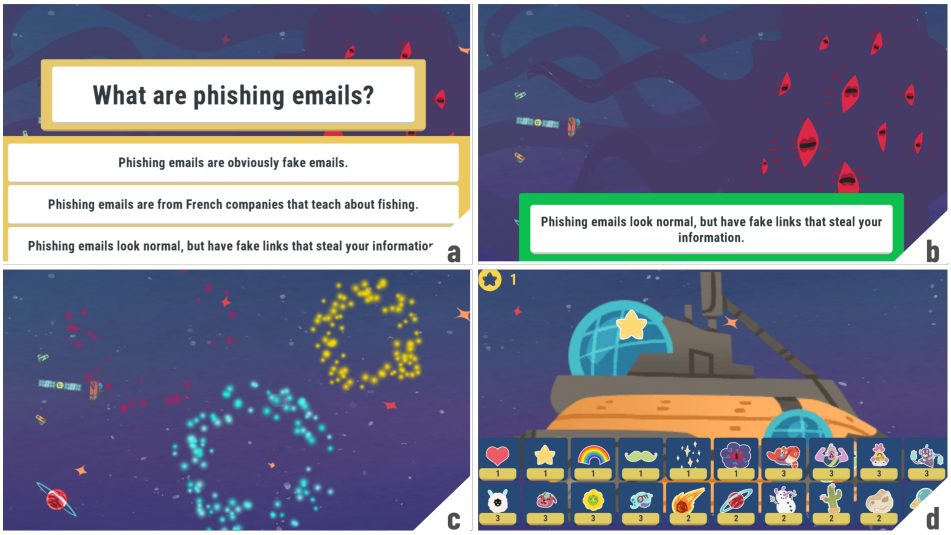


Figure 2.6: Screenshots showing the CURIO endgame. A multiple-choice question posed by the Haze (a). The correct answer is shown, and the Haze is struck (b). Celebration after defeating the Haze (c) and decorating the ship by buying stickers (d).

Teacher Side

While students play the game, the teacher controls the flow of the session. Their involvement begins with preparing a scenario, i.e., the topic, sub-topics, and information that will be integrated into the game session. The teacher has a dedicated interface on their device to manage the game files. They can create and manage scenario files, which hold all the information (i.e., topics and multiple-choice questions) for a game session, and classroom files, which store the names of the students in the class used for logging in.

To begin a session, the teacher selects a classroom and scenario file. Students can then connect to the teacher's IP address using their devices and log in using a name in the classroom file. The teacher sees a student's status change in the list when they log in and their team (red, blue, or yellow). Team sorting is random, with students being distributed across the three teams equally as they log in. The teacher can overwrite the sorting manually.

When all students have logged in, the teacher starts the game. During play, the teacher's application follows the same stages as the students'. While most steps advance automatically, some allow for or require the teacher to take action.

1. **Vote for destination:** This stage will advance automatically when the timer runs out, but the teacher can also initiate the endgame manually. Doing so will override the students' votes and send the ships to the endgame early.
2. **Ask questions / Question review:** All questions asked by the students will show up in the teacher application in the order they were asked. The teacher can accept or reject them (e.g., when a student posts a rude or unrelated message). The student and their team will earn a point for each accepted question. New questions will continue to show until no more questions are left. While the time students can pose new questions will run out automatically, the teacher decides when to advance from the 'Question Review' step. It is suggested that the teacher also pause the game here longer to initiate discussion with the students based on the questions posed.

CURIO saves the accepted questions for each session, including which student asked each question. This information can be helpful in planning upcoming lessons or hav-

ing further discussions and activities in class about the topic that the game session covered.

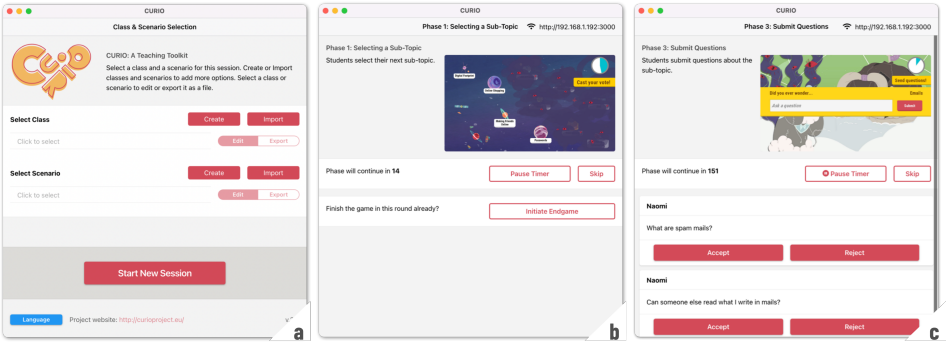


Figure 2.7: Screenshots showing the CURIO teacher interface. The opening screen where class and scenario files can be managed (a). The interface during play (b). The ability to accept or reject submitted questions (c).

2.4.2 Validation

A prototype of *CURIO* was evaluated via a study with a classroom of 25 Dutch elementary school students and through interviews with Italian and Maltese educators. The classroom study focused on engagement as 'state', i.e., the student's experience as they interacted with the game. During the interviews with educators, the focus was on the usability of the software (engagement as 'property') and how they would incorporate it into their teaching practice.

In the classroom study, data was collected in the form of observational notes, a lightly structured (group) interview, and a child-friendly game experience questionnaire (the "extended Short Feedback Questionnaire" or eSFQ) to support our evaluation efforts (Moser, Fuchsberger, and Tscheligi 2012). The eSFQ includes child-friendly presentations of Likert scale ratings and uses single-word labels that can be marked to indicate how a game is received. It uses two categories of labels, those that describe the game (e.g. "boring", "exciting") and those that remark on the experience of playing with others (e.g. "fair", "frustrating"). The authors of the eSFQ have validated the questionnaire on students aged 10 to 14 years. This age range overlapped with the target group of the pilot.

The experimenter ran the testing session with support from the class teacher. In this session, groups of four students shared one device. Another experimenter was present to observe the class. In each round, the 'asking questions' step was followed by a discussion based on the submitted questions. Students answered each other's questions, which was the starting point for further discussion.

Enjoyment was rated 3.9 out of 5 (SD=0.9) on average. When students were asked whether they would want to play the game again, 18 marked Yes (72%), five marked Maybe (20%), and two marked No (8%). The three Likert-scale questions yielded the following results (rated from 1 to 5, with 5 indicating the highest agreement): I wanted to continue playing to see more of the game — Mn = 3.9, SD = 1.1, I was curious about what would happen in the game — Mn = 3.9, SD = 1.2, and I was looking for explanations for what I encountered in the game — Mn = 3.0, SD = 1.4. Ratings of the first two statements suggest that students were focused on the task. In terms of labels that were marked, the three most frequently marked labels describing the game were Fun (80%), Easy (60%), and Great (40%), while the three least used labels were Boring (20%), Difficult (20%), and Childish (0%).

Throughout the session, students were involved in the game and invested in performing well. They understood that performance was connected to asking many questions and the quality of those questions. This understanding showed through the team discussions that emerged and was similarly observed by the teacher. It was further evident that 'something happening on-screen' was an important reminder for students to remain focused on the task. When the game informed students to wait, they became louder and more distracted.

Students noted various reasons for enjoying the game. They enjoyed coming up with questions and cared about the experimenter's opinion. The chosen topic was one that all students knew of but had yet to consider more extensively. One student commented that asking questions made her think more deeply about the topic than she would have usually done, and she also realised that she knew more about it than she had initially thought. While students generally enjoyed working in teams, at least one younger student felt overshadowed by teammates hogging the device. Overall, students did not mention competition between teams as particularly positive.

A final discussion with the class teacher highlighted the potential for the application, especially in modern teaching environments involving (mobile) computers. The teacher mentioned they would use a tool like *CURIO* in their teaching. In this particular school, the teaching method shifted towards a project-based approach, in which groups of students formulate a research question and examine it for some weeks. The teacher noted that *CURIO* would be a good fit at the start of such a project to help students come up with questions to explore. They also preferred having students control the game individually rather than in teams so that each student could think of questions at their own pace.

A similar interest in the game was shown in discussions with teachers in Malta and Italy. However, the readiness to accept *CURIO* in the classroom depended on the individual teacher's technical 'savviness' and impression of games in general (e.g., 'gaming' in Malta is by many considered synonymous with 'gambling'). Additionally, while the Dutch school was reasonably advanced with integrating technology in the classroom, schools in Malta and Italy generally were not, forming an obstacle for large-scale implementation of *CURIO*.

2.5 Stimulus Game: Shinobi Valley

Shinobi Valley is an example of a stimulus game developed to generate behaviour in players to be recorded and studied. The topic of this analysis was how players explore a virtual environment and how different factors influence their curiosity and desire to explore. Although designers have an intuitive sense that curiosity is vital to games (Schell 2008; Costikyan 2013; Klimmt 2003), how it can be purposefully invoked is not apparent and empirical study is limited. The study aimed to provide an evidence-based understanding of what invokes the desire to explore. This investigation could contribute to the study of player experience, the practice of game design, and even the development of engaging procedural environments for other purposes (e.g., training simulations).

Shinobi Valley is a single-player video game inspired by action-adventure games like *The Legend of Zelda: Breath of the Wild* (Nintendo EPD 2017). The player controls the character of a ninja (*shinobi*) monkey and explores a 3-dimensional virtual environment, i.e., a valley between mountain ranges. A path snakes through the valley from

one corner of the map to the other. At the end of this path, the monkey reunites with his ninja master and joins him in meditation. There are no enemies or specific obstacles to overcome, and the atmosphere is generally quiet and calm. The game is played in browsers to allow for online testing, using either the mouse and keyboard or purely mouse-based controls. Different game versions were tested to examine the impact of various design decisions on player behaviour and experience.

2.5.1 Design

At the start of the game, players are introduced to their character, starting on one side of the main path. After they complete a short tutorial, they are free to explore the environment. The ninja master is always on the opposite end of the path, sitting on a rock. Upon reaching the Master, the player is informed that he is meditating and to come back later. From this point on, a timer starts running. The timer is 5 minutes long, or 2.5 minutes if players have played for over 10 minutes before reaching the Master. Once the timer runs out, the Master will stand up, and the player can join him. The game ends with the player and the Master meditating together.

The intention of the waiting period between reaching the Master and finishing the game is to encourage participants to engage with the environment. Initially, players may follow the path instead of exploring the environment. The waiting period provides another occasion to stimulate exploration.

The game's primary goal is to examine the effects of level design patterns (Gómez-Maureira et al. 2021) on the player's exploratory behaviour and emotional experience. Hence, game versions with and without level design patterns were tested. Certain features of the environment are present in both versions, i.e., cliffs to keep the player inside the playable area, a chasm and a low mountain ridge to keep the player from cutting straight across, and the primary path between starting position and ninja master.

Without patterns, the valley is purposely simple. It is relatively flat and sparsely populated with trees, with little to no outstanding features. Level design patterns alter the environment significantly, adding multiple high points, objects, and spatial connections. Each pattern is implemented three times into the environment for twelve unique implementations.

Figure 2.8: Screenshots showing the Shinobi Valley environment. The monkey character walking the path (a). The monkey standing on one of the mountains (Extreme Points pattern) (b). An example of an Extreme Points pattern instance (c), and example of a Resolving Visual Obstruction instance (d). An overhead shot of the environment in nature aesthetic (e), and an overhead shot of the environment in alien aesthetic (f).

Four level design patterns are implemented in the game environment:

1. **Extreme Points:** Games that encourage exploration tend to feature locations considerably higher than the rest of the environment (e.g., towers or other tall buildings, giant creatures, or mountains).
2. **Resolving Visual Obstructions:** Parts of the game environment can be deliberately obscured to stimulate curiosity and encourage exploration, e.g., by using geometry that blocks other elements from view or visual effects such as fog.
3. **Out-of-Place Elements:** Out-of-place elements are objects that stand out in the context in which they are placed. These can be obvious, like shiny stars or other collectables, or more subtle, like a statue in a forest clearing.
4. **Understanding Spatial Connections:** Games that allow players to navigate an environment might feature complex, interconnected paths. Even when such paths are not designed to present a challenge (as in a labyrinth), exploration can be motivated by the desire to learn how spaces connect to each other.

In addition to the presence (or absence) of level design patterns, the game could also vary based on aesthetic (japan-inspired nature versus alien vegetation), the presence of a goal (being told to find the Master or not), and at which end of the path the player would start. Participants were randomly assigned a combination of variables.

2.5.2 Validation

In order to validate *Shinobi Valley* for use in an empirical experiment, the game's design had to be tested on whether it was capable of invoking the behaviour that was the subject of study. A total of 24 players took part in a pilot study (Gómez-Maureira et al. 2019), where the primary goal was to test the behaviour and experience of players (use and state engagement) in response to the level design patterns and the game as a whole. Any issues with usability (engagement as property) were also assessed. Behaviour was recorded using data logging, while the Game User Experience Satisfaction Scale (GUESS) (Phan, Keebler, and Chaparro 2016) was used to assess various elements of the game's player experience and technical qualities. These included audio aesthetics, creative freedom, enjoyment, personal gratification, play engrossment, usability, and visual aesthetics. A survey measured player demographics (e.g., age, gender) and prior game experience. Players could add open comments at the end of the question-

naire, responding to several prompts (e.g. “Did you leave the path during your gameplay session? If yes, why? If no, why not?”). Finally, in-the-moment measurements were taken through a brief in-game survey that popped up every so often during gameplay, asking the players about their experience.

Metrics were processed to visualise how the different patterns facilitated exploratory behaviour. The analysis focused on whether people deviated from the path and for what purpose. Multiple players visited all level design patterns, with Extreme Points and Out-of-Place Elements being visited most frequently and instances of Resolving Visual Obstruction the least.

All items in the GUESS survey were assessed on a Likert scale from 1 (worst) to 7 (best). Mean ratings were above the midpoint in all categories. In response to question prompts, the most common positive comments related to the game’s visual quality, while the most common negative comment regarded a lack of challenge. People frequently expressed an intention to explore the environment, noting how aspects of it stood out to them.

After the pilot, the game was used in a larger-scale empirical study (N = 389). An in-depth analysis of the different patterns and the impact of the other variables was performed. Results painted a complex picture of player experience (Gómez-Maureira et al. 2021), briefly summarised below.

The presence of patterns caused participants to venture further from the path and their destination, resulting in more dispersed overall movement. Additionally, the movement was more directed and concentrated around instances of level design patterns. Despite this behaviour change, the presence of patterns had little impact on the measures of the GUESS. On the other hand, the presence of patterns mitigated negative emotions resulting from boredom while waiting for the master ninja to stop meditating. Additionally, patterns elicited more comments from the players, suggesting they had a stronger emotional response to the game they wanted to voice. Those who played the game with patterns expressed more disappointment with the game’s lack of interaction. This difference was hypothesised to be due to the presence of the patterns raising expectations of being able to find something of meaning (e.g., a reward, puzzle, or collectable) and the disappointment that followed when there was nothing.

While the environment aesthetic had little impact on measurements, the presence of a goal and being compensated for participation did. In some circumstances, the relative impact of these factors exceeded that of level design pattern presence. Depending on the condition group, there was also a notable difference in exploratory behaviour when comparing behaviour before reaching the ninja master and while waiting for him to finish meditating. Those with a goal showed less exploratory behaviour before reaching the Master but spent more time exploring after finding him. Being presented with a goal also changed the emotional impact of the game, with those without a goal showing more emotional investment before finding the Master, possibly due to a sense of mystery in figuring out the game's goal. In addition, players who received financial compensation for participation in the study were less likely to explore once they had found the Master.

Overall, players were most engaged in curiosity-driven exploration when patterns in the environment provided opportunities and when the game's goal was left sufficiently ambiguous to pay attention to the larger environment.

2.6 Requirement Analysis

Chapter 1 outlined the commonly accepted understanding of game engagement. The above projects have been formulated and validated, at least in part, based on this understanding. The goal of this chapter is to present these projects and their validation studies, in order to examine where the commonly accepted understanding of engagement may or may not allow for such projects to be meaningfully discussed alongside each other.

The three projects discussed above are different in both applied purpose and design. Each also has a different target audience and context in which it was meant to be used. These differences, in turn, influenced the analysis methods and measurements. The research team working on *Shinobi Valley* had the most freedom in choosing its methods. It used methods aimed explicitly at assessing game experience, combined with detailed logging of player behaviour and experiment-specific questions to contextualise those findings further. The target audience was adults with a certain level of technical experience and interest in games. Such an approach was not possible in

the other projects due to the target audience or other contextual factors that influenced the project. Game-specific measures were excluded from the NESTORE project, in which the goal was to validate an entire system, and the burden on (elderly) participants was already high. In the case of *CURIO*, existing measures to validate games were unsuitable (e.g., due to length or language) or not tested for younger audiences.

Differences such as these make a direct comparison between the projects difficult. And yet, despite their differences, the underlying purpose of these three games is very much the same — each game was created to engage participants in service of the applied purpose. As such, it is possible to imagine 'engagement' being the glue that could bring disparate projects together and assess them to generate new knowledge. However, as the above aims to illustrate, the dominant understanding of game engagement does not facilitate such an analysis. In the projects, engagement was primarily measured as 'use' and 'property' — broadly speaking, one examines the measurable outcome of engagement, while the other assesses factors that might prevent it. What becomes clear is that this focus provides little insight into how engagement took place during the act of playing.

However, the one constant in each of the games is that, regardless of any other factors, they each have a player engaged in playing them. Even if the players are different, and they interact with pieces of software of varying designs and for diverging purposes under changing circumstances, at the heart of each applied game is a process of interaction and, thus, engagement with a player. Therefore, in order to formulate a conceptualisation for applied game engagement, this one constant that connects the different games should be taken as the starting point.

Requirement
A conceptualisation of applied game engagement should focus on the process of being engaged.

The commonly accepted understanding of engagement focuses on a particular player interacting with the game. Factors that hinder such interaction are thus negative. For example, these factors may be framed relating to reaching states of 'flow' and considered obstacles that would keep it from occurring. Nevertheless, this is different in many applied games. In *CURIO*, an essential aspect of the experience is the teacher's involve-

ment, who can even pause the game altogether to discuss the educational content with the class. This part of the experience, although outside of the game, still keeps students 'engaged' with its applied purpose.

Students using *CURIO* are also unlikely to reach a flow-like state due to this aspect of the game's design and the involvement of fellow students. More importantly, students reaching such a state may not even be considered desirable. Students exhibiting signs of flow (e.g., loss of sense of time and surroundings) may have difficulty focusing on the teacher for discussion. Measuring *CURIO*'s success within the traditional view of game engagement, which holds flow states as the 'ultimate experience', thus does not correctly capture what it aims to achieve.

Requirement
A conceptualisation of applied game engagement should posit the player's emotional experience as a potential design goal rather than the primary measure of success.

Another aspect that becomes clear in discussing these projects is that the context in which those projects are situated notably influences how they function. Like *CURIO*, the NESTORE game is situated in a more extensive system of different technologies. While engagement with the game is part of an overall strategy, engagement with other parts of the system is also. As such, it is counterproductive to only assess engagement with the game on its own merits. Of course, such factors can also work to the detriment of the game. NESTORE, as a project, was developed in multiple countries by different teams of varied expertise. Developing the systems as one unified whole was challenging, and, as the results show, the reception was mixed. Besides technical issues, there needed to be more synergy between the different aspects of the system. The team once intended to make the system more integrated (e.g., developing games with the 'tangible coach' or integrating them into the coaching app and making more social games). Such ideas were adjusted over time due to various circumstances in the project (e.g., each technology being developed from scratch simultaneously, making it impossible to design and develop games for them). Regardless of whether the overarching system influenced *NPO* positively or negatively in the end (and it influenced the system in return), any engagement assessment should consider such influences.

Requirement
A conceptualisation of applied game engagement should include the contextual factors influencing engagement with the game.

2.7 Conclusion

This chapter described the practical projects that formed the motivation and foundation for conceptualising game engagement for analysing and designing applied games. Each project represents a larger group of applied games, either in applied purpose or design. The projects' designs and validation studies were summarised, and each project was reflected on in the context of the commonly accepted understanding of game engagement.

The reflections show that the commonly accepted understanding of game engagement can be extended to support the evaluation and discussion of various applied games. The understanding of game engagement would not allow for a meaningful comparison between these three very different projects — each could only be discussed on its own and with a limited understanding of the games' underlying designs. Additionally, several concerns with the dominant understanding of game engagement were identified. These formed the basis for the first three requirements for conceptualising applied game engagement.

3 An Empirical Study of Game Engagement

Chapter 2 presented the first requirements for conceptualising game engagement for applied games. This chapter continues to examine those requirements through an empirical study, in which differently designed versions of an applied game are studied in detail using a combination of metrics to assess game engagement. This study results in three additional requirements for conceptualising applied game engagement.

Parts of this chapter are based on the following publication:

- *"Dive Deeper: Empirical Analysis of Game Mechanics and Perceived Value in Serious Games."* (2021)

3.1 Introduction

Applied games are games with a purpose other than pure entertainment (Ma, Oikonomou, and Jain 2011). Generally speaking, designers of applied games use game design for two primary reasons: (1) to achieve the non-entertainment purpose and (2) to drive player engagement, thereby achieving the non-entertainment purpose (Harteveld 2011). In academic literature, such games tend to be validated and evaluated *as a whole* on how engaging they are (through various metrics) and whether they fulfil their intended purpose (Vargas et al. 2014). So far, results have shown conflicting evidence for applied games' effects across different applications (Connolly et al. 2012; van der Kooij et al. 2015; DeSmet et al. 2014).

One explanation for the disparity between different studies may be the predominant focus on measuring the applied game's outcomes (i.e., engagement and game

experience). Although individual case studies help assess whether a particular combination and implementation of mechanics successfully achieved its goals, it provides little insight into how the individual mechanics contribute or detract from these goals (Lieberoth 2015). Where commercial game reviewers tend to make detailed distinctions between various aspects of a game's design and how they factor into the overall experience, such distinctions are generally lacking in applied game evaluation.

The problem statement examined in this thesis is that the dominant understanding of game engagement is insufficient in comprehensively describing engagement with applied games. This chapter aims to examine that claim empirically. In doing so, it is possible to examine where the commonly accepted understanding of engagement can be extended and what is required to conceptualise applied game engagement. This examination takes place in the form of a multimodal, empirical case study in which different versions of an applied game are tested, measuring both 'use' and 'state' engagement as defined by Hookham and Nesbitt (2019) and outlined in Section 1.1. For clarity purposes, these are referred to as 'player behaviour' (engagement as 'use', measured through data logging) and the 'game experience' (engagement as 'state', measured through questionnaires).

In performing this study, this chapter further answers RQ1:

> **Research Sub-Question 1**
> What are the requirements for conceptualising applied game engagement?

3.2 The Study

The study is based around the web-game *Pocket Odyssey*, an adaptation of the *NESTORE Pockey Odyssey* game discussed in Chapter 2). The game operates under the assumption that interaction with the game would benefit the player (i.e., provide cognitive training). Thus, its success is measured according to the commonly accepted understanding of game engagement, i.e., whether people play the game, how much they play it, and whether they would continue to play it. *Pocket Odyssey* is a representative example of a game with such a design philosophy. As such, the immediate goal of this study

is to examine the employed *game mechanics* and their effects on engagement, measured through player behaviour and game experience. Additionally, it examines *how players perceive the game, depending on the purpose they are presented with*, and how this perception affects those same measures.

Participants played one of four possible game versions. The base version of the game focuses on the cognitive task alone. In contrast, each other version presents players with supplementary game mechanics, adding up to a more diverse (and, in turn, potentially more engaging) experience. The details of these versions are described in Section 3.4.5.

In having participants play different versions of the game, monitoring their behaviour, and assessing their game experience, this study explores the following hypotheses:

Hypothesis 1 (H1): When playing a game version with supplemental game mechanics, participants will play longer and rate their experience higher.

Participants who played *the most elaborate version of the game* were also presented with *different game purposes*. These included playing the game *for their benefit*, *for the benefit of others*, or simply because *they participated in a research experiment*. With this additional data, the following hypotheses were examined:

Hypothesis 2a (H2a): When the game is presented as beneficial to the player or others, participants will value the game more and play longer, as opposed to those without an explicit purpose beyond contributing to research.

Hypothesis 2b (H2b): Players with higher awareness of the game's purpose will value the game more, play longer, and rate their experience higher.

Data was gathered using a mixed-methods approach, using surveys and game metrics to assess player behaviour and game experience. As such, comparative statistical tests were performed to assess differences between condition groups, while qualitative data provided additional context to interpret quantitative results.

Results indicate support for H2b but not for H1 or H2a. The implications of these findings are discussed in Section 3.9, resulting in three additional requirements for a conceptualisation of applied game engagement.

3.3 Theoretical Background

This study defines *game mechanics* as "methods invoked by agents, designed for interaction with the game state" (Sicart 2008). In this definition, a method is an action or behaviour available to an agent (e.g., the player) to interact with the game world. Methods are phrased as verbs, e.g., climb, take cover, shoot, or steer. They are invoked through input methods (e.g., pressing a button) and have visible effects on *game elements* (e.g., objects or characters in the game world), causing them to undergo designed changes and interact with one another. In turn, interactions are defined by the *rules* that apply to the game world (e.g., which surfaces are climbable). Individual game elements can be discerned from others via their unique properties, which "are often either rules or determined by rules" (Sicart 2008). Together, game elements and rules define the game *system* and its *sub-systems (e.g., a 'crafting' or 'cover' system)*.

Various models or frameworks exist connecting the inner workings of games to measurable effects applied games aim to achieve. Literature reviews (e.g., Grund 2015; Alexiou and Schippers 2018) provide an overview of how learning outcomes and motivation have been connected to game elements in academic literature. Though game elements have been connected to various educational theories (e.g., Bloom's taxonomy), the definition of these game elements is broad, ranging from feedback methods (e.g., points) to concepts like 'uncertainty'. Specific models (e.g., (Arnab et al. 2015; Lameras et al. 2017) suggest similar connections. However, such broad interpretations of mechanics make it difficult to relate any models to concrete game design. This approach is not unique to applied games for learning either — more generic models for evaluating applied games revolve around testing the game's 'design' in its entirety, too (Emmerich and Bockholt 2016).

Studies into the (empirical) effects of specific game aspects also exist. However, the concept of game mechanics varies here as well. For example, Parnandi and Gutierrez-Osuna (Parnandi and Gutierrez-Osuna 2015) assess the effect of manipulating properties in a racing game (speed, visibility, and steering jitter) on player arousal. Hew et al. (Hew et al. 2016) examine the effect of displaying feedback (through points, badges, and leaderboards) on motivation and assignment quality in university students. Similarly, Cantador and Marczewski (Gil, Cantador, and Marczewski 2015) examine rewards (primarily badges) in an e-learning environment. Matin et al. (Matin et al. 2020) exam-

ine the effect of a timer, top score, and leaderboard on performance and motivation in human computing games.

While examining broader game experiences is helpful, it provides limited insight into how various aspects of the game influence a player's experience. This reliance on many individual case studies of 'complete' applied games means that frameworks are built upon inconsistent and conflicting data (van der Kooij et al. 2015). Although the interactive nature of games is assumed to have a benefit over 'passive' modes of presentation (see, e.g., (Steinemann, Mekler, and Opwis 2015)), merely framing an activity as a game has also shown to be enough to increase interest and enjoyment (Lieberoth 2015) as well. As such, it is not clear how game mechanics affect player experience.

Digital games are complex systems with rules and mechanics that can interact unexpectedly and induce a wide range of emotional states in players (Yannakakis and Paiva 2014). A player's experience results from interaction with specific aspects of the game, such as its controls, aesthetics, narrative, social features, and more, depending on the game's design (Calleja 2011). Thus, this experience is influenced by many factors and may vary and be directed during interaction with a game (O'Brien and Toms 2008). Entertainment game reviewers recognise this and tend to evaluate various aspects of a game's design (e.g., individual mechanics, art, animation, sound, writing, atmosphere), as well as its mechanics and sub-systems, on how they add to or detract from the overall game experience.

In the academic evaluation of games, these distinctions are only sometimes made. Measurement instruments, such as the Game User Experience Satisfaction Survey (GUESS) (Phan, Keebler, and Chaparro 2016) and the Game Engagement Questionnaire (GEQ) (Brockmyer et al. 2009) (as well as the disputed Game Experience Questionnaire (GEQ) (Law, Brühlmann, and Mekler 2018)) tend to emphasise measuring the manifestation of emotional and behavioural states (e.g., 'losing track of time' and 'enjoyment'). Some also include items related to certain aspects of a game — the GUESS, for example, includes a module on narrative. However, instruments such as these are almost always used to evaluate an entire (applied) game. While the GUESS can indicate how rewarding a game's narrative was, details on sections of that narrative and what other aspects players found more or less enjoyable are not recorded. This approach intends to provide a generalisable instrument that can be used to evaluate a wide range of

games — individual questions relating to specific mechanics can hardly be included in a universal measuring tool. However, this means that details on the player experience inevitably get lost.

3.3.1 Game Design Rationale

Which mechanics should then be investigated? Game design is more complex than adding mechanics until the point of saturation. Ideally, games are designed around a 'core experience' (Schell 2008), with every design decision working to enforce that core experience. In practice, however, this is not always the case. Commercial game developers often repeat or copy designs that have proven successful in the past and fulfil audiences' expectations. For example, recent years have resulted in many third-person open-world exploration games with similar combat and crafting mechanics, collectables, and a photo mode (Bailey 2020). These trends are perhaps even more visible in the mobile games sector, where game designs tend to be far less complex and to copy what is successful is the norm rather than the exception. Searching for a 'Match 3' game in the iOS App Store results in many games that combine the basic design of *Bejeweled* (PopCap Games 2001) with a renovation- or decoration-simulation mechanic and narrative. Examples include *Gardenscapes* (Playrix 2016), *Match Town Makeover* (G5 Entertainment 2019), *RollerCoaster TycoonStory* (Atari 2019), and many others. Considering the time and resources involved in developing such mechanics, these additions are likely used to add diversity to an otherwise simple base mechanic (encouraging long-term play), expected by players, and necessary in distinguishing similar games in a crowded market. What sets these games apart is how well the individual parts work on their own, how well they work together, and how well a particular 'flavour' (e.g., samurai, fantasy warrior, gardener, fashionista) resonates with audiences.

Designs such as these that consist of a single core mechanic (possibly with a selection of supplemental mechanics or feedback mechanisms) are commonly seen in applied games (see (Binder et al. 2015; Vallejo et al. 2017; Byl, Süncksen, and Teistler 2018; Merriman et al. 2018; Ferreira and Menezes 2020) for some examples from recent years). Often, this simplicity is preferable over a more complex design (Michael and Chen 2005), as applied games need to be easily accessible to a broad (often non-gaming) audience, limiting their desired complexity. This accessibility is a requirement they have in common with casual games. Together with casual games' success in eliciting engagement,

the mechanics of these games are a natural fit for applied games (Madge et al. 2019). Thus, this study attempts an empirical exploration of mechanics for applied games using commonly used mechanics within this market sector. It uses *Pocket Odyssey* (described in the next section) as a game considered comparable in complexity and design to others developed for similar purposes.

The focus on measurable outcomes and the entertainment value of applied games as a whole (Ávila-Pesántez, Rivera, and Alban 2017) is valid for assessing individual games and their success. Nevertheless, applied games, even relatively simple ones, have the same complex structure of interacting sub-systems and other elements as entertainment games. Furthermore, they include a purpose interwoven with a game's structure. Considering this is the case, understanding the inner workings of an applied game, how a player is drawn to different aspects of the design, and how such aspects add to or detract from player experience becomes even more imperative. Therefore, it is desirable to examine each game's mechanics more systematically to understand how they affect the player experience and how well they support an applied game's purpose. One approach to applied games, for example, is to use game mechanics as a distraction from a (possibly unpleasant) task (e.g., in health applications such as motivating physical exercise or distracting patients from treatment (Michael and Chen 2005)). However, it has also been suggested that it may be beneficial to remind the player of the game's purpose through its framing or through the game design itself. Through a literature review, Hamari and Keronen (Hamari and Keronen 2017) established a correlation between perceived usefulness and enjoyment among people playing games. In discussing long-term engagement in games for health, Kayali et al. (Kayali et al. 2018) emphasise the importance of using game mechanics to increase the game's perceived value (e.g., by connecting game mechanics to everyday habits). Steinemann et al. (Steinemann, Mekler, and Opwis 2015) established a link between interactivity, appreciation (i.e., gratification not necessarily derived from media being 'fun', but rather thought-provoking or meaningful) and a player's inclination to donate after playing an applied game for charity. Given this body of work, and to further explore the inner workings of game mechanics in emphasising an applied game's meaning, in-depth empirical studies dissecting game design implementations are further warranted.

3.4 The Game: Pocket Odyssey

The game used in this study is *Pocket Odyssey*, a 2D game in which players buy an old boat and fix it up while hunting for treasure. It was developed to run in all modern browsers. It is an adaptation of the NESTORE game described in the previous chapter. Changes to the design were due to feedback gathered in the NESTORE project and switching from a mobile to a web-based game that could easily be played by people online and provide the necessary data-logging for this experiment.

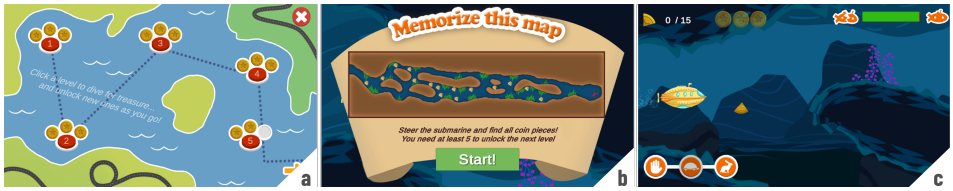


Figure 3.1: Screenshots of level select (a), level map to be memorised (b), and submarine gameplay at one of the higher levels (c).

3.4.1 Submarine

The submarine game (Figure 3.1) forms the core gameplay loop of *Pocket Odyssey*. The player goes diving for treasure and needs to direct a submarine through an underwater cave. The player chooses the level they want to play from an overarching 'map' screen. They are then shown a map of the selected level, which shows its layout and the position of 'coin fragments'. A total of fifteen coin fragments are scattered throughout a level. Five fragments combine into one coin for a maximum of three coins per level. These coins act as feedback (i.e., score) and are shown in the level select menu. The player can set the submarine's speed — a complete stop, a slow 'turtle' speed, or a faster 'rabbit' speed — which causes the submarine to move from left to right through the level. The player then navigates the level by directing the submarine up and down by clicking and dragging the mouse or using the arrow keys. Players also need to avoid obstacles that damage the submarine, such as the boundaries of the maze and seaweed. If the submarine becomes too damaged, the player loses and needs to retry the level. If the player reaches the end of the level successfully, they unlock the next level, and any complete coins they have collected will be added to their total. Coins can only be collected once (e.g., if a player finishes the level with two coins first and replays it to

get all three coins, they only get one additional coin). Levels progressively increase in challenge, and their visual design also becomes darker.

The cognitive aspects of the submarine game include accurately steering the submarine, spatial navigation, and memorising and recalling the level layout. For this study, it was primarily necessary that players could believe playing the game may be beneficial to them.

3.4.2 Ship

Figure 3.2: Screenshots of the beginning state of the ship - mostly empty (a), renovation option in the library (b), and a completely renovated ship (c).

The coins the player earns from the submarine game are used to renovate their ship. Whenever the player completes a level, they return to the view of the ship. The ship has stayed the same between this version of *Pocket Odyssey* and the version developed for the NESTORE project (described in Chapter 2). The reward system was simplified to a single currency (coins) for unlocking the next renovation step. Individual items no longer have a cost associated with them, as feedback in the NESTORE project showed players considered spending more coins on expensive options inconsequential. Instead, they are given three options for each step without additional cost to offer a sense of choice and agency. The option to change the decor of a previous choice was added to the game, and the scene received several visual updates and fixes.

3.4.3 Narrative

As players progress and unlock new parts of the ship, they are presented with story scenes. Once the player has confirmed their decoration choice, the view of the ship becomes obscured by the story view (Figure 3.3). The story is presented over fourteen scenes, each of which is told through text on the screen. Players can choose their responses through text-based buttons. The story is linear but has several ‘closed

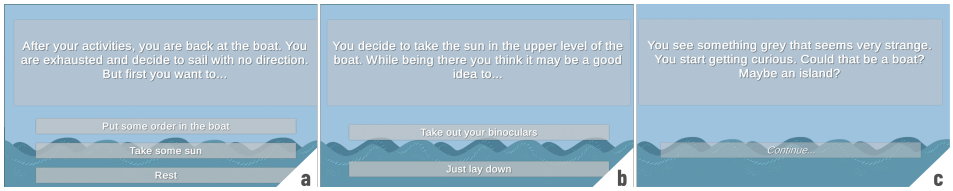


Figure 3.3: Screenshots of a story scene, showing multiple points of choice (a and b) and unfolding narrative (c).

branches' where the player's choices lead to different outcomes. The story is written from a second-person point of view, i.e., "You see something on the horizon that catches your interest". The story posits the player as someone who decides to quit their job, buy a boat, and travel the world. Joining the player is the 'guide' character, whom the player gets to know throughout the story. The story incorporates themes of family and thinking of home. Throughout the journey, the player and guide encounter different places, reminisce, and experience the dangerous sides of the ocean. It ends with a newly formed friendship between them and both characters returning home.

3.4.4 Information and Loading Screens

Players log in on the opening screen by putting in a unique code. An account is made upon the first login, and the player continues with their previously saved progress with every consecutive login. The game has a frame rate counter on this screen to show whether it runs at an acceptable rate (at least 15 frames per second). Upon logging in, the player sees an information screen while the game loads (for approximately five seconds). This screen explains the purpose of the study and includes an additional 'flavour' tagline. The text varies depending on the experiment condition (Section 3.4.5) and can be revisited from the ship or the submarine-level select menu.

A loading screen is visible whenever the player enters the submarine-level select screen until the player clicks on it to continue. The screen is visible for approximately two seconds before the player can click it. This screen shows instructions for the game and has a single encouraging line of text that relates to the game's purpose. Similar to the information screen, the tagline changes depending on the experiment condition (Section 3.4.5).

The login screen and examples of a loading and information screen can be seen in Figure 3.4.

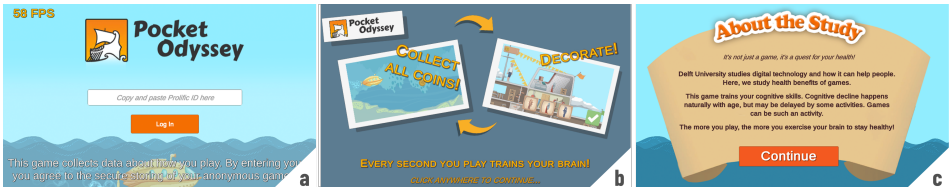


Figure 3.4: Screenshots of the login screen (left), a loading screen with submarine and decorating mechanics, and benefit to self (middle), and an information screen explaining the study and benefit to self (right).

3.4.5 Versions

For this study, players were exposed to different versions of the game. To reiterate the study's goals, they were (1) to examine the effects of supplemental game mechanics to enhance engagement and (2) to examine the effects of the applied game's purpose and players' awareness of it. As such, the versions of the game exposed players to different combinations of mechanics and adjusted the purpose of the game presented to players.

Participants played one of four possible versions of the game's mechanics, herein referred to as *Base*, *Cust*, *Narlin*, and *Narcho*:

Base: This version only includes the submarine mechanics, i.e., the core of *Pocket Odyssey*. In essence, the result could be of any applied game project when a core task (e.g., cognitive training) is gamified. The activity is broken into manageable levels, and the player is frequently rewarded with some points. It could be further expanded with other forms of feedback, but the minimum that can make the task be perceived as a game is incorporated (i.e., goal, win/lose conditions, feedback, aesthetics). In this game version, players go to the level select screen whenever they log in or finish a level instead of the ship. The loading screen shows instructions only related to the submarine game and the purpose-relevant tagline.

Cust (customise): This version includes the ship renovation mechanic and the submarine game. Players return to the ship view whenever they complete a level. They can

None	
Tagline	N/A
Information	TUD studies digital technology and its effects on people. Video games are played by millions, but their universal appeal is not yet fully understood. In this study, we examine your game experience to better understand that appeal.
Loading Line	Loading
Other	
Tagline	It's not just a game, it's a quest for good!
Information	TUD studies digital technology and how it can help people. Here, we use a game to study the human brain. This game tests your cognitive skills. Cognitive decline happens naturally with age. To understand and prevent it, it is necessary to study people's behaviour at different ages. The more you play, the more you help others by contributing to that knowledge!
Loading Line	Every second you play helps to understand our brain!
Self	
Tagline	It's not just a game, it's a quest for your health!
Information	TUD studies digital technology and how it can help people. Here, we study health benefits of games. This game trains your cognitive skills. Cognitive decline happens naturally with age, but may be delayed by some activities. Games can be such an activity. The more you play, the more you exercise your brain to stay healthy!
Loading Line	Every second you play trains your brain!

Table 3.1: Changes in text depending on purpose version. Tagline and information together formed the information screens. The loading line was shown on the loading screen in scene transitions.

use the coins they have collected to renovate the ship. However, no story will trigger as they progress. The loading screen explains both the submarine and the ship mechanics.

Narlin (narrative linear): This version includes all sub-systems (submarine, ship, and story). In the story scenes, players are given a single option, making the story entirely linear and reducing interactivity to letting players step through the narrative. The loading screen explains all sub-systems.

Narcho (narrative choice): Similar to Narlin, but provides players with choices at several points in the game's narrative scenes. Players are presented with (at most) three options, leading to differences in how the story unfolds. The loading screen is the same as for Narlin; the presentation of choices to continue the narrative is presumed to be understood without explicit explanation.

Additionally, there are three possibilities for the game's purpose as presented to players. This chapter refers to them as *None*, *Self*, and *Other*.

None: Players are reminded that they are participating in a study to examine digital games. The tagline and loading screen convey game-related information only (e.g., 'Click to continue').

Self: Players are informed that digital games can be used for cognitive training. The tagline and loading screen reminder reinforce this message.

Other: Players are informed that digital games can collect behavioural data to study cognitive decline. The tagline and loading screen reminder reinforce this message.

Each purpose changes the information shown on the menu and loading screens (Section 3.4.4). Due to the nature of the recruitment platform (see Section 3.5.1), all participants were aware that they were participating in a research study. Thus, the conditions contextualised their participation in various ways, as described below.

For example, the information in the Self condition reads: "This game trains your cognitive skills. Cognitive decline happens naturally with age but may be delayed by some activities. Games can be such an activity. The more you play, the more you exercise your brain to stay healthy!". The tagline on the loading screen read: "Every second you play trains your brain!" All possible texts are listed in Table 3.1.

With these differences in messaging, the study aims to see whether people behave differently depending on the game's purpose, assuming they are aware of said purpose. The *Self* condition best represents the intended use case for which *Pocket Odyssey* was designed, i.e., to provide individual users with a way to train their cognition. In the study context, the game's purpose is closely aligned with the *None* condition (although its description lacks specific details).

3.5 Experiment

The experiment aims to examine the effects of game mechanics (H1) and game purpose (H2a and H2b) on player perception and behaviour. The following section describes the experiment design, the measurements, the pilot study, the procedure, and how data was processed.

3.5.1 Participants and Sampling

Participants were recruited using *Prolific*, an online platform focused on recruiting research participants. Participants were compensated for their time with ≈4.20 EUR. A total of 344 participants were recruited to participate in the study (of which 204 ultimately completed the study and provided complete data sets). Participants had to be at least 40 years old and have a fluent understanding of English due to the amount of text in the game. Although *Pocket Odyssey* was developed for an older target audience (55+), the minimum age was set lower to increase the potential sample size through the recruitment platform.

Formally, quantitative studies using frequentist statistics determine an appropriate sample size through a prospective power analysis. However, such an analysis requires existing quantitative data about the research topic (Caine 2016). In Bayesian statistics (used in this study, as described in Section 3.6), the concept of statistical power does not exist in the same manner. However, previous work informs the priors used in the analysis (O'Hagan 2008). This study explores a topic with little quantitative work on which to base expectations and uses a game not previously applied in experimental studies. As such, it is difficult to determine what sample size to aim for, what effect size to expect, or what priors to use. Instead, the minimum sample size was determined using *local standards*, i.e., sample sizes from comparable user studies published within

the academic community (Caine 2016) as a guideline. Based on this information and considering the exploratory nature of this research, the choice was made to gather data from at least 30 participants per group. In the absence of well-informed (and sourced) prior beliefs, the default priors of JASP are used for statistical tests. The limitations of this approach are discussed in Section 3.8.

3.5.2 Condition Groups

Participants are divided into condition groups, each playing a different combination of game and purpose (Section 3.4.5). The two variables (four versions and three purposes) make twelve possible combinations. However, the study focuses on a subset of these, leading to a total of 6 condition groups: Base_Self, Cust_Self, Narlin_Self, Narcho_Self, Narcho_Other, and Narcho_None.

Focusing on these groups, in particular, makes it possible to run statistical tests looking at each variable in isolation while also maximising available resources (i.e., time and budget for participant compensation). The study aims to examine differences in the game versions (with the same purpose) and differences in purpose (with the same game version). Statistical tests (see Section 3.6) focus on comparing these two separate data sets.

In deciding which groups to focus resources on, the game versions with the highest ecological validity were chosen. As such, Narcho is chosen as a basis to compare purposes, as it is the most 'complete' version of the game and the version that, based on similar applied games, is likely to be used to train cognition. Similarly, the 'Self' purpose is used to compare game versions, as this accurately reflects the intended purpose the game is supposed to fulfil.

As such, H1 is examined across the conditions Base_Self, Cust_Self, Narlin_Self, and Narcho_Self. H2a and H2b are examined across Narcho_Self, Narcho_Other, and Narcho_None.

3.5.3 Pilot Study

A pilot study was conducted to test the experiment procedure (described below in Section 3.5.4). A total of 21 participants were recruited with Prolific, 52% female (n=11). Results from the pilot showed that the game was well-received, with survey results

well above the mid-point (see Section 3.5.5) and participants playing for longer than requested by the experiment instructions. This result suggested that the game was of sufficient quality to be used in the more extensive study. Performing the pilot helped to increase the clarity of instructions given to participants, as well as uncover issues with the game that were fixed before the experiment took place (e.g., varying performance depending on browser).

3.5.4 Procedure

Participants are asked to play *Pocket Odyssey* for at least five minutes per day for three days. While they must play on three different dates, the study can be completed when playing for less than the requested time. This duration was chosen based on the time it takes to complete the game content (i.e., getting perfect scores on each level), which is around 20 minutes for an experienced player playing the Base version of the game.

First, participants fill out a demographics survey and are informed about the study through step-by-step instructions for each day of participation. They are then directed to the game's website and instructed to bookmark this page for subsequent days. The experiment instructions are repeated on the game page as well. Participants are invited randomly by Prolific according to the sampling restrictions listed above, and the pre-game survey takes around a minute to complete.

Participants automatically create a new server entry when they log in for the first time with their Prolific ID. This ID is used to identify participants and connect survey and gameplay data. At this point, the server randomly assigns the participant to a condition group. The game then reads the condition from the server and changes which game mechanics are available and what text is shown to the player (Section 3.4.5). Participants proceed to play the game according to the instructions and continue to do so independently for at least three days.

Players are invited for a second post-game survey when their game data shows they have played for three days. From day four, the game's information screen shows a code. This code is required to access the post-game survey and varies depending on experiment conditions, therefore serving as an additional check to ensure data integrity. The post-game survey takes around 10 minutes to complete.

3.5.5 Measurements

Data is collected pre-, during, and post-game. Before playing the game, participants answer a general demographics pre-game survey. During gameplay, the player's in-game actions are logged and stored on the server (game metrics). Participants answer a second survey, the post-game survey, upon completing three days of gameplay. The post-game survey is made up of multiple parts. Each of the measures is described below. The surveys use a combination of open questions and those rated on a five-point Likert scale.

Pre-Game Survey

The pre-game survey covers basic demographic information. Participants report their age in years and gender ('female', 'male', 'not listed', 'prefer not to answer'). They also rate their previous experience playing games and average time spent playing (on a 5-point Likert scale, with experience ranging from 'Novice' to 'Expert' and playtime from 'Less than an hour per week' to '20+ hours per week'). Finally, they list the games they usually play as free text.

Metrics

Pocket Odyssey logs interactions the player has with the game. Each event is logged with a timestamp, an event type, and a description line. This logging makes it possible to calculate the time spent playing and group interactions of a similar type (e.g., interactions in the ship view or during the submarine game). Examples of logged events include (but are not limited to): choices taken in the game narrative, unlocking ship progress steps, ship decoration choices, instances of redecorating, starting a submarine level, finishing a submarine level, changing speed during a submarine level, picking up a coin fragment during a submarine level, failing or succeeding at a submarine level, replaying a submarine level, time spent on loading screens, and opening/closing the information screen. General player statistics are also logged, such as maximum level reached, best score per level, and the total number of coins collected. While these metrics partially allow testing the hypotheses (e.g., in showing how much time players spent playing the game), they can further provide insight into a player's experience (Gómez-Maureira et al. 2014) when combined with other measures.

Game metrics were processed through custom Python scripts using the Pandas library (McKinney 2020). An individual participant's data was connected to their Prolific ID, and the data was thus wholly anonymous.

Post-Game Survey

The post-game survey assesses the player's experience with the experiment and the game itself. It is split into three parts: game impressions and motivations, modules of the Game User Experience Satisfaction Scale (GUESS) (Phan, Keebler, and Chaparro 2016), and (depending on the condition) a questionnaire on agency in digital narratives.

Participants are reminded of the purpose of their game version. They then rate (1) how aware they were of this purpose while playing, as well as (2) how much this motivated them to play. Individual game aspects (coin collecting, ship decorating, and narrative) are similarly rated when applicable. These questions are rated using a 5-point Likert scale of 'Not at all', 'Slightly', 'Moderately', 'Very', and 'Extremely'. Participants also rate how 'beneficial' and 'useful' they considered the game using a similar 5-point scale. Finally, they rate how they experienced playing over three days and having to stop playing using a 5-point Likert scale ranging from 'Extremely negative' to 'Extremely positive'. Open questions ask participants to elaborate on their primary motivation for playing, why they did or did not play longer than the requested 5 minutes, and any other comments they have about their experience. The supplementary files provide all details of the survey.

The GUESS is a validated instrument to measure aspects of game user experience. The following modules are used in the study: Usability / Playability, Play Engrossment, Enjoyment, Personal Gratification, and Visual Aesthetics. Although the GUESS has more modules (e.g., social connectivity), these did not apply to the design of *Pocket Odyssey*. The chosen modules indicate the game's overall quality (e.g., Usability indicating that negative experiences are not due to issues or difficulties with the game's controls) and the players' subjective experience.

Participants assigned either the Narlin or Narcho conditions also answered modules of an existing survey assessing agency in interactive narratives (Roth 2016). The included modules were: Effectance (i.e., sense of being able to influence the story), Presence (i.e.,

sense of 'being there'), Character Believability, Identification (i.e., feeling like the main character), Aesthetic Pleasantness, Curiosity, Suspense, and Enjoyment. Participants were informed that these questions pertained to the story of the game.

3.6 Results

All statistical tests are performed using Bayesian methods in JASP (JASP Team 2020; Marsman and Wagenmakers 2017). The value of the Bayes Factor (BF) indicates the likeliness that a given hypothesis (H1) is not equal to its null hypothesis (H0), i.e., the assumption that different testing conditions can be considered equal. The Bayes Factor can be expressed as evidence for H1 relative to H0 (BF_{10}), or as evidence for H0 relative to H1 (BF_{01}). All BF values in this study are expressed in BF_{10} notation. A BF value of one indicates that there is an equal chance of the hypothesis being different from the null hypothesis as they are similar. A value lower than one indicates that the null hypothesis is more likely to be true. Unlike classical hypothesis testing, a Bayesian test can indicate the likeliness of the null hypothesis rather than only reject it (O'Hagan 2008). Only results with 'moderate' ($3<BF<10$) or 'strong' ($BF>10$) evidence for H1, or H0 ('moderate': $0.1<BF<0.3$; 'strong' $BF<0.1$) are reported (evidence labelling used in JASP based on (Jeffreys 1961)). In the absence of well-informed (and sourced) prior beliefs, the default priors of JASP are used and are reported for each statistical test. All results are calculated using a repeatability seed of 1 in JASP.

The following section presents results relevant to exploring the hypotheses. To reiterate, these are:

H1: When playing game versions with supplemental game mechanics, participants will play longer and rate their experience higher.

H2a: When the game is framed as beneficial to participants or others, they will value the game more and play longer.

H2b: Participants more aware of the game's purpose will value it more, play longer, and rate their experience higher.

3.6.1 Descriptive Statistics

Overall, N = 204 participants provided results for the study. A total of 344 participants started the game, with 211 of them playing for three days and completing the post-game survey. Datasets from 7 participants were found to be missing data in the submitted game log and were thus discarded. Out of the valid 204 participants, 51% identify as female (n = 104), 48.5% as male (n = 99), and 0.5% as non-binary (n = 1). The median age is 48.5 (mean = 49.7, SD = 7.7, range 40-71). Reporting game-playing frequency has a mean of 2.1, corresponding to "1 - 4 hours per week" (SD 1.2, range 1-5). Reported player experience has a mean of 2.4, corresponding to "casual" (SD = 1.1, range 1-5).

Total playing times and playing times for each day are shown in Table 3.2. Days are counted relative for each participant, meaning that participants might not have played for a day between 'Day 1' and 'Day 2'. One participant logged in on 'Day 3' without playing the game, having played 28.2 minutes overall. Data from this participant is kept due to providing play time of at least 15 minutes, despite not having played for three days.

Splitting up the playing time per game segment, the total playing time for the submarine game has a mean of 36.4 mins (SD = 36.6, range 5.42 - 335.71), playing time for the ship has a mean of 9.93 mins (SD = 7.35, range 0.0 - 56.61), and playing time for the story has a mean of 4.88 mins (SD = 4.78, range 0.0 - 38.61).

GUESS items are scored on a 1-7 Likert scale. Results per category are as follows: Usability — mean = 5.7, SD = 0.8; Play Engrossment — mean = 4.7, SD = 1.1; Enjoyment — mean = 5.1, SD = 1.3; Personal Gratification — mean = 5.4, SD = 0.9; and Visual Aesthetics — mean = 5.3, SD = 1.1.

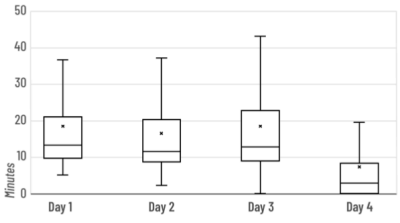
On average, players are "moderately" aware of the game's purpose (mean = 2.8, SD = 1.1), and they are "moderately" motivated by the purpose (mean = 3.0, SD = 1.0). When asked about the game mechanics, players are "moderately" to "very" motivated by collecting all coins (mean = 3.7, SD = 1.0), "moderately" motivated to fix and decorate the ship (mean = 3.1, SD = 1.3), and "slightly" to "moderately" motivated to see the story (mean = 2.7, SD = 1.2). Participants consider the game "slightly" to "moderately" beneficial to themselves or others (mean = 2.7, SD = 1.0) and "slightly" to "moderately" useful (mean = 2.7, SD = 1.0). Each of these questions is scored on a 5-point Likert scale.

Asked whether they would play the game again if it had more content, 78.9% (n = 161) answered 'yes'.

Table 3.2: Aggregate playing times over multiple days.

	Mean	Median	SD	Min	Max
Day 1	18.49	13.29	18.16	5.14	202.84
Day 2	16.47	11.55	14.64	2.28	167.90
Day 3	18.51	12.83	18.06	0.0	189.16
Day 4	7.36	2.92	16.00	0.0	145.59
Total	63.33	48.66	55.77	15.28	514.36

(a) Playing times descriptive statistics (in minutes).



(b) Box plots for playing times per day.

3.6.2 Comparisons Between Condition Groups

Participants were sorted into condition groups with the following distribution: Base_Self (n = 32), Cust_Self (n = 34), Narcho_Self (n = 35), Narcho_Other (n = 36), Narcho_None (n = 33), and Narlin_Self (n = 34). As such, the number of participants between condition groups was roughly equal and large enough to perform statistical analysis between groups.

To compare data between game versions, Bayesian ANOVA tests (with default priors of 0.5 for 'r scale fixed effects' and 1 for 'r scale random effects' (Rouder et al. 2012)) were performed between Base_Self, Cust_Self, Narcho_Self, and Narlin_Self. Players in Base condition reached a higher maximum level (mean = 14.3, SD = 1.7, BF = 8.332) than in other conditions. Except for this, all other measures show only anecdotal evidence or evidence for condition groups having no meaningful impact. For example, strong evidence is found that total playing time is not impacted by the game condition (BF = 0.141). Similarly, either moderate or strong evidence was found that GUESS categories are not impacted either (Usability — BF = 0.139, Play Engrossment — BF = 0.107, Enjoyment — BF = 0.080, Personal Gratification — BF = 0.103, Visual Aesthetics — BF = 0.193). A separate test was run between all condition groups except for Base_Self to ex-

amine progress on fixing up the ship, but results show no impact in this case either (BF = 0.063).

The same tests were performed to compare data between purpose condition groups, i.e., Narcho_Self, Narcho_Other, and Narcho_None. No measures show moderate or strong evidence for H1. In this comparison, submarine playing time, level progress, and game perception and motivation are particularly interesting. Strong evidence was found that the game condition did not impact submarine playing time (BF = 0.091) and maximum level (BF = 0.089). The same lack of impact was found for purpose awareness (BF = 0.222), GUESS Usability (BF = 0.098), Play Engrossment (BF = 0.130), Enjoyment (BF = 0.113), and Visual Aesthetics (BF = 0.145).

A Bayesian Independent Samples Student T-Test (prior Cauchy scale 0.707) was performed between the condition groups Narcho_Self and Narlin_Self to examine differences between a linear narrative and one with player choice in regards to player agency. Most results again provide evidence that there is no impact. The only exception is Effectance, which shows strong evidence for H1 (BF = 6.042).

3.6.3 Correlations

With evidence indicating that measures between testing conditions are mainly similar, pair-wise Bayesian Pearson's ρ correlations were carried out across the entire study population. The investigation of correlations was motivated by the desire to explore the potential impacts of player motivations and purpose awareness and identify metrics that should be studied in detail in future work.

Such an investigation of multiple comparisons typically involves adjustments to reduce the risk of false positives (e.g. Bonferroni correction). In Bayesian statistics, this is not necessary. Evidence for (or against) a hypothesis is expressed directly as a probability of H1 versus H0, instead of the rejection of H0 with the probability of a type I error. As such, probabilities of multiple comparisons do not accumulate to increase the likelihood of a type I error. However, multiple Bayesian correlations require the adjustments of priors, as individual comparison pairs are likely not entirely independent (Sjölander and Vansteelandt 2019).

Even in the absence of informed prior beliefs, methods for establishing them have been described in the literature (Gelman, Hill, and Yajima 2012). However, they have not yet

found their way into JASP. Thus, the correlations do not involve informed priors and treat each comparison independently. The stretched beta prior width was kept at its default of 1 in JASP, indicating uninformed priors (Van Doorn et al. 2018).

Correlations with 'strong' (BF>10), 'very strong' (BF>30), or 'decisive' (BF>100) support are reported below.

- **GUESS** Usability correlates with maximum submarine level (r = 0.225, BF>10), total collected coins (r = 0.258, BF>30), and purpose awareness (r = 0.290, BF>500). It correlates negatively to player age (r = -0.233, BF>10).

  Play engrossment correlates to total time (BF>50), time on day three (BF>50), time on day two (BF>10), maximum submarine level reached (BF>10), and number of submarine level attempts (BF>10).

  Enjoyment correlates with total submarine play time, the maximum level reached, the number of submarine level attempts (all BF>100), time on day 2 (BF>30), and total coins collected (BF>30).

  Personal gratification correlates to total submarine play time, time on day two, time on day three, maximum submarine level reached, coins collected, number of submarine level attempts and number of attempts failed (all BF>100).

  All except Visual Aesthetics correlate with purpose motivation (BF>100). All GUESS measures correlate with considering the game 'beneficial' and 'useful' (BF>100, except beneficial—Usability with BF>10). They also correlate with coin and ship motivation (all BF>100, except Usability with BF>10). Story motivation only correlates with Play Engrossment, Enjoyment, and Personal Gratification (all BF>100). Play Engrossment (r = -0.242, BF>30) and Personal Gratification (r = -0.240, BF>30) both negatively correlate with playing experience.

- **Purpose awareness** correlates with purpose motivation (r = 0.315, BF>1000), motivation for collecting all coins (r = 0.217, BF>10), considering the game beneficial (r = 0.302, BF>1000) and useful (r = 0.363, BF>100k).

- **Purpose motivation** correlates with coin (r = 0.342, BF>10k) and ship motivation (r = 0.292, BF>100), considering the game beneficial (r = 0.509, BF≫100k) and useful (r = 0.492, BF≫100k), how players experienced playing for three days

(r = 0.313, BF>1000), and the maximum submarine level reached (r = 0.227, BF>10). It also negatively correlates with having to stop playing at the end of the experiment (r = -0.339, BF>10k).

- **Considering the game 'beneficial' and 'useful'** both correlate with each other (r = 0.838, BF≫100k), playing for three days (r = 0.575, BF≫100k), and coin, ship, and story motivation (BF>1000). Both also correlated negatively with having to stop playing the game (BF>100). 'Beneficial' correlated positively with the maximum submarine level reached (r = 0.242, BF>30).
- **Game motivations:** Coin motivation correlates with ship motivation (r = 0.366, BF>10k), total time (r = 0.337, BF>10k), and total coins collected (r = 0.324, BF>1000). It correlates negatively with having to stop playing (r = -0.337, BF>10k). **Ship motivation** correlates with story motivation (r = 0.348, BF>100). All three (coin, ship, and story motivation) correlate positively to playing over three days (BF>1000).
- **Age negatively** correlates with playing experience (r = -0.328, BF>1000), playing frequency (r = -0.245, BF>30), and purpose awareness (r = -0.217, BF>10). It also positively correlates with the total amount of submarine playing time (r = 0.227, BF>10).
- **Playing experience** and **playing frequency** both negatively correlate with total times failing at a submarine level (experience: r = -0.286, BF>100; frequency: r = -0.230, BF>10), and correlate positively with each other (r = 0.705, BF≫100k).

3.6.4 Qualitative Results

Participants were asked (1) what their primary **motivation** for playing was, (2) why they played **more or less** than the requested 5 minutes, and (3) whether they had any **other comments** about their experience. They could input answers as free text. Although none of the fields was mandatory to complete the survey, all 204 participants answered the first question, 196 answered the second question, and 156 answered the third question. The primary investigator analysed the collected data, assessing comments in the three categories and coding them with recurring themes. Another researcher reviewed this classification.

Question	Theme	Count	Example
Motivation	Experiment	38	“To give good results for the test.”
	Reward	23	“Cash reward.”
	Coins	59	“It was interesting and I wanted to earn the maximum number of coins.”
	Ship	36	“To deck the ship out as much as I could!”
	Personal Gratification	95	“The challenge to collect coins and get to the next stage.”
	Enjoyment	31	“For some reason I actually enjoyed it.”
	Purpose	5	“Knowing it was to train your memory.”
More or Less	Coins (+)	34	“To retry to get the 3 coins.”
	Submarine (+)	16	“I wanted to see the evolution of the levels.”
	Ship (+)	11	“Because I wanted to finish the ship.”
	Story (+)	13	“To find out how it ended.”
	Personal Gratification (+)	88	“I wanted to complete all the levels by the end of the three days and replayed a number of stages to collect more coins.”
	Enjoyment (+)	62	“It was nice to do this when taking a short break.”
	Play Engrossment (+)	20	“Found it fun and lost track of time while playing.”
Other	Game (-)	18	“It was pretty dull and basic and reminded me of old games my kids played decades ago.”
	Story (-)	16	“The story didn’t really seem to go anywhere or have any relevance to the other elements.”
	Enjoyment (+)	48	“I never got into computer games when I was younger and I’m usually bad at them. This game was accessible and quite enjoyable.”
	Usability/Playability (-)	22	“All is good - apart from finding the submarine a little difficult to manoeuvre and not very responsive when negotiating tight places!”
	Purpose	9	“Found it really fun and did make me really think about strategy and help memory.”

Table 3.3: A selected overview of identified themes per question.

Responses were coded based on whether different game aspects (i.e., submarine navigation, coin collecting, ship decoration, story, or the game in general) were mentioned. Those related to categories of the GUESS survey (i.e., personal gratification, enjoyment, play engrossment, usability/playability, aesthetics) and those mentioning the game's purpose (e.g., training memory) were also identified.

For questions two and three, responses for each of these categories could be either positive or negative (e.g., "I found the coin collecting quite fun" or "The coins were frustrating" were labelled 'coin (+)' and 'coin (-)' respectively). To determine whether a comment related to a GUESS category, the questions of the category were used as a guideline (e.g., comments relating to a sense of achievement from improving are closely aligned with the questions from the Personal Gratification module). Additional themes were identified throughout the coding process, and comments were tagged accordingly. These themes include reflections on participation in an experiment or receiving monetary compensation (e.g., a motivation of "taking part in the experiment and earning some cash ;)") and suggestions to improve the game (e.g., "I would like to use the WASD keys").

Comments could be labelled with multiple themes. For example, "I just liked the challenge of trying to navigate the submarine and collecting the pieces. I played because of enjoyment mainly" was coded as 'coin (+)/submarine (+)/personal gratification (+)/enjoyment (+)'. At the same time, "It was not the most interesting game, so I probably would not play it again, but I enjoyed it for the short time of the study" was coded as 'game (-)/enjoyment (+)/play engrossment (-)'.

The results are summarised in Table 3.3. The primary goal in collecting qualitative data for this study was to help contextualise and better understand the quantitative findings. Frequencies of emerging themes were not used for statistical testing but to indicate how often a particular sentiment occurred among the participants.

3.7 Discussion

Overall, results suggest that the game was well received. GUESS measures were well above the mid-point, and most participants said they would play the game again if it had additional content. The weakest measure was Play Engrossment, relating to feel-

ing 'absorbed' by an activity, which makes sense for this type of 'casual' game. Even so, Play Engrossment was still above the mid-point as well. Participants considered themselves casual players and reported playing games weekly for a few hours. Negative correlations between GUESS measures and playing experience and comments made by participants suggest the game was too simplistic for more advanced players. However, the game was enjoyable for most less experienced players (i.e., the target audience for this type of design, should it be used for cognitive training).

On average, participants played the game for $\approx$60 minutes, or $\approx$48 minutes when controlling for outliers. This amount is well over the 15 minutes requested in the experiment instructions in both cases. Players were also generally aware of the game's purpose and motivated by it. Motivation to collect all coins, fix up the ship, and see the story were all around the mid-point, with coin motivation being the highest. Not surprisingly, participants who became more engrossed by the game also enjoyed it more, experienced more gratification from playing, tended to play longer, progressed further, and performed better. Older participants tended to be less aware of the game's purpose. They also tended to have less experience playing games and scored the game lower in usability. It is possible that, due to spending more time and energy understanding and mastering the game, older users had less attention for the game's purpose. However, despite difficulties, there is no evidence to suggest they played less far into the game or enjoyed the experience less.

Participants played more on day three of the experiment than on the other days. Participants commented that they wanted to finish the game, get as far as possible, or collect all the coins. Given these comments, they could have played more on this day as the experiment was about to end (despite having been informed that they could keep playing the game upon completing the final survey). Therefore, they possibly put in more time to achieve their goals while they felt they still could.

3.7.1 H1: Effects of Game Mechanics

Statistical evidence suggests that the different game conditions did not meaningfully impact most measures. The only exception is that participants in the Base condition progressed further in the game. This finding is not surprising, as the game had no other mechanics to take up time potentially. As such, participants spent the same amount of time playing but with their attention focused on a single aspect of the gameplay.

These findings go against expectations that a more elaborate game experience leads to desired player behaviour (e.g., playing longer) or enjoying the game experience more. **As such, H1 is rejected based on these results.**

Even though the submarine game is relatively simple in design, it received similar scores across GUESS categories on its own as it did with additional mechanics. One explanation is that the submarine game formed the game's core in every version – additional mechanics enriched this experience. As evidenced by the widespread use of these mechanics in commercial and applied games, collecting items or reaching a perfect score are strong motivators with widespread appeal. The questionnaire results corroborate this interpretation. Therefore, this mechanic likely takes precedence over the others, and only those interested in the other mechanics specifically appreciate them.

Why, then, do commercial games add on mechanics? It may be because they aid in long-term engagement. After all, they add variety and instil wonder about what will happen next. Although the length of this experiment was not enough to test for this, participants' comments suggest some were motivated by this (e.g., wanting to see the story unfold). Another reason could be that it allows them to stand apart from the crowd and appeal to different demographics. As stated in Section 3.3, at their core, many commercial casual games function the same.

Extra mechanics are broadly thematic and used to appeal to different groups of players. Players may search for the type of gameplay they want (e.g., a puzzle-type game), then choose one from the vast amount on offer based on graphics and theme (e.g., home make-over, garden renovation, haunted house, farming, animals). While different players may prefer specific mechanics (coin, ship, and story motivation correlated with different aspects of the GUESS in this experiment), they are not the main reason players engage with the game. Correlations between coin motivation, the number of coins collected, and the total playing time support this observation. Players collected coins primarily because they wanted to 'collect them all' rather than for what they could do with them.

Another reason the submarine game did well on its own could be that, as the core mechanic, it was considered the most beneficial aspect of the game (i.e., training/testing the players' memory). Coin motivation was the only game-related motivation that cor-

related with purpose awareness. Thus, participants perceived the submarine game as essential, and the ship and story were only additional.

Additional interactivity to the story in the form of choices had minimal impact, only showing a difference in one category of the agency questionnaire (Effectance). This difference is understandable, as Effectance measures the amount of impact users feel they have on the activity. However, this difference did not translate into different behaviour or appreciation of the game. Few people commented on wanting more interaction in the narrative, and negative comments related more to the narrative than the lack of choice. This response may have been different if choices had had more significant effects or were more tied into other aspects of the game. However, it is also possible that interactive narratives are primarily expected by those who play many games rather than by the more 'casual' players that most of our participants considered themselves to be.

3.7.2 H2a: Effects of Different Purposes

Similar to the different game versions, no statistical differences were established between different purpose conditions. Based on previous research, a more specific purpose would enhance participants' perception and appreciation of the applied game, potentially translating into measurable behaviour. However, the data does not suggest this to be the case. As it stands, **H2a is rejected.**

There are several possible reasons why no differences were found. First, all participants knew they were participating in a research study and were recruited from a platform with which they were acquainted. People who voluntarily participate in such research studies do so because they see a value in them, either to assist research or because of monetary compensation. This motivation, in itself, already establishes a particular perception of value. Adding additional messages to the game to contextualise that base value did not change it.

Second, the different purposes were too similar, indicating a study design limitation. The Other purpose could be similar to the None purpose, as it only provides a more explicit motivation for why data was being gathered. Data gathering is standard in a research study, and this small amount of purpose integration did not affect participants' behaviour. The Self condition differed most from the other two but did not lead to mea-

surable behavioural changes. *Pocket Odyssey* was not tested for cognitive benefits, but even if it had, three days of playing would not have been long enough to experience cognitive improvement. Therefore, although participants were generally aware of the game's purpose, their perception likely remained the same as they did not experience the benefits themselves.

3.7.3 H2b: Effects of Purpose Awareness and Perceived Value

Although no differences were established between different purposes, participants who were aware of and motivated by the game's purpose did consider the game more 'beneficial' and 'useful'. They also scored higher in GUESS categories. Participants aware of the purpose were more forgiving of usability issues, were more engrossed in the game, enjoyed it more, and experienced more gratification. Similarly, players who considered the game 'beneficial' and 'useful' had a more positive experience of the game. Participants who were motivated by the purpose or considered the game beneficial also progressed further in it, reaching a higher maximum level, and experienced the experiment ending more negatively. Generally, players who were more aware of the purpose also felt more motivated. These findings align with the work presented in Section 3.3 and, based on this data, **H2b is accepted**.

3.8 Limitations

The presented findings should be evaluated within the scope and limitations of the study. The mechanics of this game were not evaluated in terms of their relative quality to one another. Although participants were generally favourable towards the game, some comments suggest that primarily the story was lacking in quality. Some others mentioned that the integration between the story and the submarine gameplay could have been more meaningful. This opinion is offset by comments from other users who found the story compelling and considered it a motivation. Results could have been impacted by the simplistic presentation of the story (text only versus more 'animated' presentation modes standard in casual games) and the quality of the story itself. Performing the presented study helped to identify these issues and thus shows the usefulness of assessing aspects of applied games over evaluating them as a whole.

Purpose awareness, perceived value, and motivation were self-reported post-experiment using questions on a Likert scale. Considering the correlations found in this data, purpose awareness and perceived value should be explored further using additional methods (e.g., by examining where the game draws the player's attention and how they respond to it through biometric measures). In addition, game preferences were collected through a single question with a free-text response option. The data gathered was challenging to process meaningfully, as participants had different ways of answering the question. Some answered with specific titles, others with game genres or even broader descriptions (e.g., 'basic games on the internet').

There is no unified understanding of game genres (Clarke, Lee, and Clark 2017), and it was decided that attempting to code the gathered data with genres (to examine players' game preferences) was at risk of too much misinterpretation. Instead, the data gathered through Likert scale questions (i.e., amount of time spent playing and self-assessment of player experience) were deemed more reliable. The decision to condense previously played games to a single question was made to lessen the load on participants, who were already asked to invest time over multiple days. However, future studies should consider including additional questions to establish player preferences (e.g., following Tondello et al.'s work on player traits (Tondello et al. 2019)).

Finally, the experiment lasted for three days. As such, it is impossible to say how the tested mechanics (which, in a commercial setting, generally would be used to foster long-term engagement) would have impacted player behaviour if participants had played the game over a longer time. In an extended study, participants in the Base condition might stop playing earlier for lack of variety, while those with supplemental mechanics would continue. However, the data does not indicate this at present, as the most common motivator commented on by participants was collecting coins and finishing levels.

3.9 Requirement Analysis

The goal of this experiment was to do an extended evaluation of an applied game according to the commonly accepted understanding of game engagement. The goal of

testing multiple game versions was to assess what information is lost when evaluating a complete applied game in its entirety and focused on the extended game experience. This section builds upon the findings of this study and presents three requirements that a conceptualisation of applied game engagement should fulfil.

The commonly accepted understanding of game engagement conflates many terms into one complex construct (Hookham and Nesbitt 2019). Therefore, it was necessary to carefully dissect game engagement and specify its use regarding the player's behaviour, the game experience, the properties of the game, and factors of both the software and the intended player that influence each of those elements. Such a distinction is often absent in applied game studies (Hookham and Nesbitt 2019). Thus, uniform terminology is required to aid the further discussion and analysis of applied games.

Requirement
A conceptualisation of applied game engagement should clearly distinguish between the related concepts and provide uniform terminology.

Adding game mechanics made little measurable difference to the participants' behaviour, game experience, or perception of the game. Does it make sense for developers of applied games to add mechanics to supplement a core gameplay loop that engages players in the intended behaviour? Nothing in the data suggests that adding mechanics improves players' game experience or alters their behaviour. If anything, additional mechanics can *detract* players from progressing in the aspect of the game that is beneficial when they play for the same amount of time.

On the other hand, purpose awareness and perceived value did have a positive effect on engagement. As such, instead of being used to increase the entertainment value of the applied game, it is possible to imagine how additional mechanics could instead strengthen these elements. If additional mechanics are added to the game's core design with this intent, this may influence the player's behaviour and game experience. For example, an aesthetic theme and narrative relating to a person with memory issues (rather than a sea-faring theme) could prove more effective in strengthening *Pocket Odyssey*'s purpose.

However, the commonly accepted understanding of engagement does not include this in assessing a game's success. While applied game designers may attempt to integrate the purpose in every aspect of the game, the focus of evaluation (from an engagement perspective) is primarily on entertainment value.

Requirement
A conceptualisation of applied game engagement should include incorporating the game's purpose and how it is integrated into the various elements that make up the game.

Pocket Odyssey was created to provide a beneficial task (related to memory and navigation) in the form of a game that would motivate users to engage in this task. Assuming that the game could provide this benefit, its measure of success is whether people played it, how much they played it, and whether they would continue to play it. In this way, the game is a success for the study duration. An evaluation of the game as it was meant to be used (i.e., the Narcho_Self condition) would have shown it to be so.

Based on this, it could be suggested that including the tested mechanics is recommended for other similar projects. Such suggestions, however, would need to take important factors into account. Adding choices to a narrative (something reasonably expected with the interactive nature of games) or providing collectables (e.g., decorating choices) has limited measurable effect. As such, they did little to (1) improve the player's game experience and (2) emphasise the game's purpose and, in turn, improve perceived value or purpose awareness.

Most clearly exemplified in the trend of gamification, where game elements are 'added' to a non-gaming task or context, many applied games are designed around the notion of 'fun' parts to make the 'applied' aspects more engaging. When evaluating applied games as a whole, even if they may individually be successful in meeting their targets, how 'fun' parts add to or detract from the experience and the game's purpose may go unnoticed.

Requirement
A conceptualisation of applied game engagement should include a means to discuss the game's design.

Games are complex systems with many interacting elements (Schell 2008) — creating and evaluating them is no simple task. During gameplay, a player interacts with various aspects of the game's design. Applied games add another layer of complexity — namely, whether those aspects help the game achieve its purpose.

While some aspects can be for 'fun' or to add to the game's aesthetics, elements that take up significant portions of time should ideally be designed to contribute to the applied game's overarching goals. Such elements should be evaluated for their contribution or interaction with the rest of the game. Developers and researchers should consider which aspects of a game need close examination on a per-project basis. The presented methodology spreads participants over multiple conditions, increasing the time and resources required for attaining usable results. However, what this study shows, is that the effort is worthwhile.

3.10 Conclusion

This chapter investigated the effects of game mechanics found in casual commercial games when implemented in an applied game for cognitive training, as well as the effects of different applied game purposes and awareness of said purpose on perceived value, player behaviour, and game experience.

While it may intuitively seem that games require diversity and complexity to their mechanics to motivate player behaviour or provide a satisfying game experience, statistical evidence suggests that adding supplemental game mechanics does not necessarily impact these factors. On the other hand, awareness of the game's purpose improved players' perception. Improved perception, in turn, led to increased game experience and players progressing further in the game. Based on the results of this study, simply providing supplemental game mechanics on their own did not improve engagement with the applied game. However, if additional mechanics strengthen players' awareness of the game's purpose, they might.

The chapter summarised the observations made in the empirical study in three requirements that a conceptualisation of 'applied game engagement' should follow. These requirements are examined in more detail in the following chapter.

4 Understanding Engagement for Applied Games

The following chapter builds upon the requirements identified in Chapters 2 and 3. They guide the inclusion of relevant literature and form the foundation for conceptualising applied game engagement. The chapter concludes by proposing such a conceptualisation in the form of the Applied Games Engagement Model.

Parts of this chapter are based on the following publications:

- *"Re-framing engagement for applied games: A conceptual framework."* (2022)
- *"Incorporating the Theory of Attention in Applied Game Design."* (2022)

4.1 Introduction

The primary aim of this thesis is to conceptualise game engagement for the analysis and design of applied games. Chapters 2 and 3 established six requirements for such a reframing. They form the foundation of this chapter. They are listed in Table 4.1 in the order they will feature throughout the chapter.

The following sections address the requirements, using relevant literature to shape an understanding of game engagement for applied games. In doing so, this chapter answers RQ2:

> **Research Sub-Question 2**
> How can applied game engagement be conceptualised?

1	A conceptualisation of applied game engagement should clearly distinguish between the related concepts and provide uniform terminology.
2	A conceptualisation of applied game engagement should posit the player's emotional experience as a potential design goal rather than the primary measure of success.
3	A conceptualisation of applied game engagement should include incorporating the game's purpose and how it is integrated into the various elements that make up the game.
4	A conceptualisation of applied game engagement should include the contextual factors influencing engagement with the game.
5	A conceptualisation of applied game engagement should focus on the process of being engaged.
6	A conceptualisation of applied game engagement should include a means to discuss the game's design.

Table 4.1: The six requirements for a conceptualisation of applied game engagement, as identified in Chapters 2 and 3.

4.2 The Root of Engagement

The concept of engagement is common to (applied) games. In colloquial use, it refers to a state of involvement or participation. Its original meaning relates to pledging oneself to something, usually a moral and often legal obligation (Axelson and Flick 2010). Over time, the word's meaning changed and became more akin to *occupying the attention of*. When people are *engaged*, it means they are 'present' with their thoughts in an activity instead of somewhere else.

A seminal text associated with engagement is that of Csikszentmihályi on flow theory (Csikszentmihályi 1990). To engage with a task or activity, a person needs to focus on it with purposeful intention. Witmer and Singer (1998) refer to this concept as 'involvement', describing a "psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events". Involvement or engagement may occur in any setting or environment. However, the amount will vary according to how well a task attracts and holds a person's attention and the meaning that the person attaches to that task.

According to Csikszentmihályi, any task can be engaging as long as one intentionally focuses their attention on it (Csikszentmihályi 1997). Under the right conditions, engage-

ment can result in a 'flow' state. There are various elements to achieving such a state. There should, for example, be a balance between challenge and skill, clear goals, and immediate feedback. It follows that some tasks will be easier to engage with than others. Games, for example, with their short-term goals, feedback loops, and designed progression of difficulty, have been considered particularly suitable (Ermi and Mäyrä 2005). Flow experience has been described as a merging of action and awareness (i.e., action happening seemingly automatically), a loss of self-consciousness, and an altered perception of time. While it is generally considered to provide a positive emotional experience (Sweetser and Wyeth 2005), it has also been argued that this positivity only occurs retroactively, as the person is not necessarily aware of their flow state while they are in it (Lemarchand 2012).

While academic discourse on game engagement often refers to Csikszentmihályi's work, its focus tends to be on flow and other experiential constructs (e.g., immersion and presence) rather than attention. While the consideration of experiential constructs is essential, attention always lies at its root, as can be seen in various models Hookham and Nesbitt (2019) of game engagement. In this thesis, attention refers to a focus of cognitive resources on information while filtering extraneous information (Styles 2006) and is considered a primary function that is a precursor to all other cognitive functions. This perspective is fully in line with the general understanding in design research (e.g., Norman 2013) as 'the ability to focus on one thing while ignoring others', noting that attention spent on one thing will reduce it for another. In itself, attention can be considered a complex construct (Hommel et al. 2019). The fundamental basis of attention is comparatively less discussed in the theory on engagement with games, with its primary consideration being players reaching an 'attentional threshold', an undefined boundary at which attention turns into involvement.

Nevertheless, attention is critical in understanding how players interact with a game. The MDA (Mechanics-Dynamics-Aesthetics) framework (Hunicke et al. 2004) shows how game developers make decisions at the mechanical level of a game's design (i.e., components of the game at the level of data representation and algorithms). These mechanics result in dynamics (i.e., behaviour at runtime of the mechanics acting on player input and each other), resulting in aesthetics (i.e., the desired emotional response evoked in the player through interaction with the system. The MDA framework

has been criticised for oversimplifying this process, resulting in adjustments and extensions (e.g., Winn 2009; Ralph and Monu 2014). One such extension is the Design, Dynamics, and Experience (DDE) model (Walk, Görlich, and Barrett 2017), which expands on the three categories mentioned above to include more aspects of game design (e.g., world-building and storytelling) and player experience. However, it still illustrates how the designer's direct influence lies primarily in the first 'level' (Design) and how their influence becomes less direct when considering Dynamics and Experience. While a particular emotional experience, like flow, may be an experiential goal that designers aim to achieve, they accomplish this on the lower levels of game design, where they draw and direct the player's attention.

Furthermore crucial to understanding attention concerning games are the concepts of reflexive attention and selective attention, as well as the related term of vigilance. Reflexive attention, also known as stimulus-driven attention, describes a person's ability to respond to specific sensory stimuli (O'Donnell 2002). It is driven by the properties of objects (e.g., movement or sound) and is a largely autonomous process — attention is drawn to such stimuli whether a person wants to or not. Selective attention refers to the aspect of attentional processing that is under a person's control (Fisher and Kloos 2016). It is also essential to note that attention is a limited resource — a person cannot pay attention to everything at once or for an unlimited time. Vigilance refers to the ability to respond to events in the environment, which decreases over time due to fatigue from cognitive load (O'Donnell 2002). Techniques such as switching attention to another stimulus can mitigate these adverse effects.

The first two requirements for a conceptualisation of applied game engagement, as listed in Table 4.1, can be addressed by discussing engagement with a focus on attention rather than the experiential states that may result from it. In order to enable this change, the following terms need to be distinguished:

- **Attention:** A primary cognitive function that describes a focus of cognitive resources on information while filtering extraneous information, which may lead to other cognitive functions. It is a limited resource that can be affected by external influences and is actively directed.
- **Game Engagement:** A (sustained) state of focusing purposeful attention on playing a game.

- **Game Experience:** An umbrella term to describe a wide variety of cognitive, emotional, and behavioural states (e.g., flow, immersion, presence, positive and negative affect) that may result from game engagement. For a more specific breakdown of terms and their relation to engagement as it is understood in this work, see Table 4.2.
- **Game:** A collection of systems designed to draw and direct a player's attention, resulting in game engagement and an intended game experience.

In changing the focus of game engagement to the notion of attention and, as a result, the definition of game engagement to a state of focusing attention, the term gains clarity in understanding its functioning. A player is engaged when their attention is focused on the act of playing. As discussed later in this chapter, this state can take many forms. It is essential to consider that other states (e.g., flow) are not necessary for this state to occur, nor are they necessarily the ultimate goal. To further distinguish the terminology, the game experience refers to the various states that game designers may aim to achieve in their players through interaction with the game.

Finally, game design is how designers direct a player's attention, utilising the concepts of reflexive attention, selective attention, and vigilance to achieve a specific game experience. The game consists of systems that result from that game design process. In game design, systems are considered collections of mechanics and elements (e.g., objects, environments, characters). Sicart (2008) defines mechanics as 'actions that can be taken by the player', with a system containing particular mechanics and the elements that enable those mechanics. For example, a 'cover system' in a shooting game contains anything related to a player or non-player character taking cover behind specific objects. In entertainment, this collection of systems would be considered the game's entirety.

4.3 Integrating Purpose

While the previous section clarified the terminology concerning game engagement, the definition proposed still needs to facilitate the inclusion of an applied game's purpose. In order to address this third requirement for a conceptualisation of applied game en-

Attention	The ability to focus on a particular set of information while filtering out others. Attention to one thing comes at the cost of decreased attention to others. (Norman 2013)
Engagement	A state experienced as a consequence of focusing one's attention on a coherent set of stimuli. May involve, but does not require, other emotional and cognitive constructs. (Calleja 2011)
Involvement	Considered as synonymous to engagement.
Motivation	The predisposition of a person to focus their attention on a particular set of stimuli. Influenced by external factors and can vary over time. (O'Brien and Toms 2008)
Presence	The perception of being 'physically' present in a virtual world, being able to take actions without perceivable technological barriers (Procci et al. 2018). Implicit design goal, as technological barriers may redirect attention away from the game.
Immersion	A sense of being 'enveloped' by the game's virtual environment (Brown and Cairns 2004). A possible design goal, but not necessary for engagement.
Flow	A cognitive state of being 'absorbed' by an experience (Csikszentmihályi 1990). A possible design goal. Not necessary for engagement and, at times, inadvisable for applied games.
Affect	Emotional states that can arise from engagement with the game (Yannakakis and Paiva 2014). Can be both positive and negative. Both can be explicit design goals.

Table 4.2: An overview of commonly used and sometimes conflated terms in the discussion of engagement, and how they can be understood in the context of this work and in relation to its definition of engagement.

gagement (see Table 4.1), it is necessary to consider fields outside the study of games as well.

Engagement is a topic discussed in many academic disciplines, e.g., media studies (Sherry 2004), customer-brand relationships (Schouten, McAlexander, and Koenig 2007; Bijmolt et al. 2010), therapy (McMurran 2003), and group-work (Macgowan 1997). Although the general understanding of engagement tends to stay the same, it has also been expanded depending on the particular study area. In employee and student engagement, for example, engagement refers to intellectual absorption with the tasks performing one's job (Schaufeli 2013) or how involved students are in their learning processes (Axelson and Flick 2010). It can also relate to a feeling of social connection to direct colleagues, a company or an institution. Job engagement (i.e., involvement in performing one's work role) and organisational engagement (i.e., performing a role as a member of the organisation) are considered to be distinct conceptual experiences (Saks 2006).

Similarly, student engagement includes involvement in both academic aspects (e.g., tasks surrounding studying) and non-academic aspects of the learning experience (e.g., feeling supported by the learning environment) (Trowler 2010). This differentiation between forms of engagement exists in other fields as well, e.g., customer engagement (Bijmolt et al. 2010), public (Rowe and Frewer 2005), and civic engagement (Adler and Goggin 2005). Civic engagement, for example, describes how an active citizen participates in the life of a community in order to improve conditions for others or to help shape the community's future (Adler and Goggin 2005). Various actions are associated with this form of engagement, such as performing community service, organising collective action, being politically involved, or enacting social change. There is an overlap between engagement with these kinds of tasks and those in a corporate or school environment. The difference lies in the specific tasks one engages in and the broader context that such activities serve.

A common thread among these fields of study is that a separation is made between task engagement and context engagement. The first interpretation is that engagement is a state of focusing attention on a task. The second interpretation relates to involvement with those tasks or activities' context. Various tools and mechanisms can be used to facilitate task engagement, which in turn fosters context engagement.

For an understanding of engagement with applied games, this terminology can be repurposed. Game engagement, as previously defined, is a form of task engagement. Engagement with the purpose that an applied game is meant to serve can be considered a form of context engagement. The applied game, in this understanding, is a tool or mechanism that, through game engagement, serves engagement with the game's purpose. Thus, it is necessary to extend the terminology with the following definition:

- **Purpose Engagement:** A (sustained) state of focusing attention on the applied purpose of the game, in which the game acts as a mediating tool.

While the differentiation between game engagement and applied game engagement can help to understand the player's interaction with an applied game on a basic level, it still needs to incorporate a discussion of the game itself. To facilitate discussion on how engagement is achieved through the applied game, the various aspects that facilitate those forms of engagement require a similar distinction, i.e., the 'applied' and 'game' parts. One way to do this, which is unlikely to be confused with previous terminology, is to repurpose a term from narratology, cinema, and game studies: diegesis. Traditionally, diegesis distinguishes between elements that are part of the narrative world of a piece of fiction and those outside of it. For example, characters and objects in a video game tend to be intra-diegetic (i.e., part of the game world). At the same time, aspects of the user interface, menus, and loading screens are extra-diegetic (i.e., outside of the game world) (Prestopnik and Tang 2015). In this work, the term will distinguish between the game systems and all other elements aimed at fulfilling an intentional, non-entertainment purpose.

As such, the 'game' part of the applied game is called the **diegetic systems**. These diegetic systems are no different from the game systems that make up a pure entertainment game. In addition to these systems, however, applied games involve an **extra-diegetic purpose**. Often, this refers to a specific learning content or beneficial activity. However, it can also include other elements (e.g., the teacher, other students, and the classroom environment in *CURIO*, discussed in Chapter 2) that can engage the player. An applied game, in turn, refers to the total combination of diegetic systems and elements of extra-diegetic purpose (see Figure 4.1).

- **Applied Game:** A combination of diegetic systems and extra-diegetic purpose designed to draw and direct a player's attention, resulting in both game and pur-

pose engagement. The goal is to achieve an intended game experience and non-entertainment purpose.

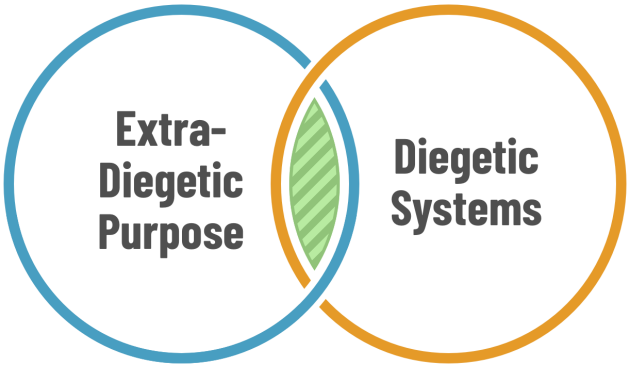


Figure 4.1: Schematic visualisation of an applied game that consists of diegetic systems (orange) and elements forming its extra diegetic purpose (blue). Overlap between the two is shown in green.

Previous approaches to applied game design and analysis have similarly made a distinction between game and applied aspects. In some cases (e.g., Michael and Chen 2005), 'game' and 'purpose' have been considered to be opposing factors where one may need to be sacrificed in service of the other. Others have proposed more holistic views. For example, Harteveld (2011) posits that 'play' and 'reality' (and a third element of 'meaning') need to be balanced, and that designers should strive to find synergies between them. Similar to the latter approach, this thesis posits that diegetic systems and extra-diegetic purpose should not be considered as opposed. Instead, by nature, applied games have both as part of their design and development process, and players engage with both in various ways as they interact with the game. Thus, extra-diegetic purpose and diegetic systems can have varying amounts of *synergetic overlap*.

The diegetic systems mediate between the player and (elements of) the extra-diegetic purpose. Certain types of games, where the extra-diegetic purpose can be integrated primarily through the diegetic systems, lend themselves to close or even fully overlapping circles. In such cases, the player engages with the diegetic systems and, through them, fully engages with the extra-diegetic purpose. It may even be a design goal for

players to be unaware of the extra-diegetic purpose during play. Examples include games for data collection in research projects (e.g., *Shinobi Valley* or *Foldit* (University of Washington 2008)) or training games that aim to distract the player from a potentially dull or unpleasant task (e.g., the submarine game in *NESTORE*). Such designs result (at least theoretically) in a complete overlap. Hence, it can be challenging to distinguish diegetic systems and extra-diegetic purposes entirely or clearly. The two can also be relatively separate, appearing almost unrelated (e.g., when the game is paused for classroom discussion in *CURIO* or the Ship reward system in *NESTORE*).

While the amount can vary, extra-diegetic purpose and diegetic systems always overlap to some degree, resulting in purpose engagement and game engagement overlapping in varying amounts throughout a play session. The extensiveness of the overlap depends on the design of any particular applied game. Diagrams illustrating the overlap (such as shown in Figures 4.1 and 4.2) can be drawn for the game in its entirety or different sections (e.g., tutorial, main gameplay loop, menu interaction). It is not necessarily (and likely rarely) that the circles overlap equally throughout the game.

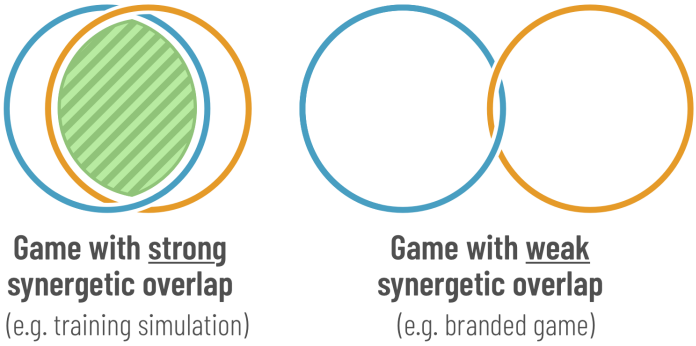


Figure 4.2: Schematic visualisation of games with varying amounts of synergetic overlap (green) between the diegetic systems (orange) and extra-diegetic purpose (blue).

Although the synergetic overlap between diegetic systems and extra-diegetic purpose varies per game, some overlap is necessary when viewing the game as a whole. In a case where diegetic systems and extra-diegetic purpose never overlap, that particular applied game project has failed according to this understanding of applied game en-

gagement. In such a situation, there is no connection between the two aspects, meaning that extra-diegetic purpose is communicated entirely outside the diegetic systems. This situation would mean that the diegetic systems essentially form a 'regular' game or, even worse, a game with no purpose or entertainment value. Note that the connection can be relatively small and still be considered successful. A game primarily meant for entertainment created for marketing purposes (e.g., by including branding) still has an extra-diegetic purpose, even if it is only very loosely integrated with the diegetic systems.

4.4 Diegetic and Extra-Diegetic Elements

From a development point of view, the entire game — diegetic systems and all elements of the extra-diegetic purpose — needs to be considered (Figure 4.3). Though it may be possible for the two to be inextricably intertwined, Chapter 2 illustrated how there might be cases in which elements external to the diegetic systems also need to be considered. Thus, the fourth requirement (Table 4.1) states that a conceptualisation of applied game engagement should include such elements.

As previously discussed, game systems are collections of mechanics and elements (Sicart 2008). Mechanics, in turn, are 'actions that can be taken by the player', with a system containing particular mechanics and the elements that enable those mechanics. Other common elements that make up diegetic systems are environments in which the game action takes place, a narrative, visuals or sound. In entertainment games, this collection of systems and elements would be considered the entirety of the game.

The extra-diegetic purpose includes various elements that shape the applied game outside the diegetic systems. Of particular note is the player, who has been categorised as part of the extra-diegetic purpose. The project's applied purpose often determines the target audience of an applied game. For example, an intervention game usually has a specific player in mind (e.g., of a certain age or with a specific health need). Who this target audience is will, in turn, affect the game's design. In the most general case of a target audience (e.g., a game to raise awareness among the general population), the target player will be less defined than in most applied gaming projects.

Other elements (e.g., actors, other media, and the physical environment) that the player can also engage with are included in the extra-diegetic purpose. As previously stated, the 'applied game' refers to the whole combination of both diegetic systems and extra-diegetic purposes. It is highly dependent on the applied gaming project, which elements are included, and how important they are to achieving the project's goals. For a non-exhaustive overview of elements in each area, see Table 4.3.

Proper attention needs to be given to these elements during development. Otherwise, developers risk creating games that fail to mediate the interaction between player and extra-diegetic purpose to the best of their ability. Elements of extra-diegetic purpose may (unintentionally) draw or direct attention, potentially contributing to or undermining the efforts of the game designer in creating a game that serves the applied purpose. One such example can be seen in the *NESTORE* project, where the inclusion of various technologies and software applications impacted how each other element (including the game) was received.

4.5 Attributes and Values

In order to properly include the contextual factors that influence engagement (requirement 4 in Table 4.1), it is necessary to define them further. Previous examinations of game engagement considered that an 'attentional threshold' needs to be cleared. It also identified various factors designers should minimise to lower the 'attentional barrier' to engagement (Brown and Cairns 2004).

The focus in studies such as these has been to map potential hurdles to clear the threshold. The intended player, for example, is a person defined by attributes like age, socioeconomic background, technical literacy, motivations for playing, and game preferences (O'Brien and Toms 2008). These may impact the likelihood that a player is interested or willing to focus their attention on a game and the meaning they attach to it. Such attributes matter before the player even interacts with the game and during that interaction.

Further attention has been given to aspects of the game that may impact engagement, focusing on usability and information design to make a game easily accessible (Hookham and Nesbitt 2019). While it was previously established that, based on this

Extra-diegetic	Impact on Engagement
Target Player	The ideal intended player who will interact with the applied game. Is defined by demographic information, previous experience, interests, and motivation.
Facilitator	Mediates the player's experience. Can serve as a 'background' guide in service of interaction with the diegetic systems, or take a more active role integrated with the game experience.
Observer	Common in research projects. Generally meant to not impact engagement as a 'background' presence, but possibly sensitive to influencing engagement depending on experiment setup.
Actors	Other people influencing the player's experience, either by proximity (e.g., playing in a public space) or intentionally (additional players, active audience). Divert attention from game systems, unless meaningfully integrated.
Additional media	Catches a player's initial intention (e.g., marketing material/trailer). Can further explore and emphasise the extra-diegetic purpose, though challenging to integrate with diegetic systems.
Physical space	The area in which the game takes place. Can be shaped to aid in focusing attention on diegetic systems, or integrated into the game experience. Prone to divert attention.
Diegetic	**Impact on Engagement**
Mechanics	Define interaction possibilities in the game that (ideally) align with extra-diegetic purpose. Clarity and usability are important to sustaining engagement. Can capture initial attention and maintain engagement (e.g., through rapid feedback).
Environments	Representation of game spaces, often visual. Can catch attention and maintain it through offering exploration, vistas, and places of interest.
Controls	Essential in certain projects to serve the extra-diegetic purpose (e.g., physical rehabilitation games). In other cases, important to test and develop for usability, as poor controls take up unwanted attention or may lead to unintentional disengagement.
Characters	Non-player entities, or other players with visual representation in the diegetic systems. Draw attention well, although challenging to develop for maintained engagement (e.g., writing an interesting, well-rounded character, and getting to know a character is time-intensive). Other players can help engagement, but are unpredictable.
Narrative	Narratives easily catch attention, and can be a strong motivator to maintain engagement. However, similar to characters, 'good' narratives are challenging to create. Suitable for integration with many extra-diegetic purposes.
Visuals/Music/SFX	The audio-visual presentation of the game forms a major factor in engagement of entertainment games. Often less considered in applied games (e.g., due to budget and time restrictions), but important in enforcing the extra-diegetic purpose, especially when aiming to influence the player emotionally.

Table 4.3: A non-exhaustive overview of elements making up the extra-diegetic purpose and diegetic systems, and their hypothesised impact on engagement. The importance of individual elements is expected to vary between projects.

understanding of engagement, states like flow are optional to achieve, they can impact engagement. A game for which achieving such a state makes sense (e.g., the *NESTORE* game that should motivate users to partake in an activity) could make it part of their design aims, as reaching such a state might extend the amount of time a player is willing to engage.

Both aspects of diegetic systems, extra-diegetic purpose, and the player, have previously been labelled as attributes (e.g., (O'Brien and Toms 2008)). While this may be adequate for academic discussion purposes when analysing a finished applied game, it needs to be clarified when considering their design (further discussed in Chapter 6). After all, predispositions of a player or defining characteristics of a physical environment (e.g., a school or a lab setting) are generally fixed qualities that the designer cannot change. Instead, they are factors that need to be considered before game development takes place that will influence design decisions. On the other hand, qualities of the game, such as accessibility and usability, can be actively directed and influenced during the design process. Thus, the following terms can be distinguished:

- **Attribute:** A defining characteristic of an extra-diegetic purpose element, including the intended player, that may influence the applied game's function and design.
- **Value:** An intentional, specifically designed characteristic of the diegetic systems, often based on the applied purpose and the presence of extra-diegetic elements, the intended player, and their attributes.

Attributes describe aspects of the player or any other extra-diegetic elements involved in the game experience. Attributes are less based on design and more on choice and availability. For example, a designer may wish for a specific type of physical space but may be influenced by the limitations of the project. Similarly, the involvement of other actors (e.g., a teacher acting as a facilitator) depends on the actor's willingness to perform the required activities. Although attributes are likely to be fixed to particular extra-diegetic elements, it is possible to change them by making informed decisions on the in- or exclusion of those particular elements. For example, a choice to use virtual reality (VR) headsets will result in different attributes (e.g., 'immersive', 'intuitive', or 'nausea-inducing') than creating a game for a setup using a screen, mouse, and keyboard.

Values, in turn, are aspects of the game that are determined by design decisions. Whether or not a game is 'user-friendly' or 'accessible' depends on a combination of mechanics, controls, rules, and user interface design. A game that uses keyboard controls needs to be designed differently to be accessible than a game for VR. As such, it may be challenging to attain specific values with certainty, but they can be set as design goals and evaluated.

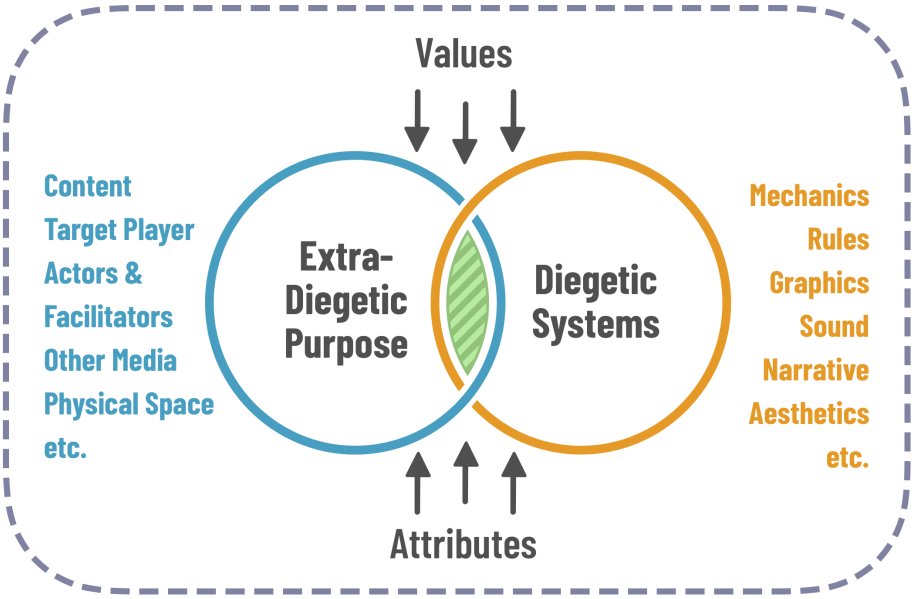


Figure 4.3: While the player predominantly interacts with the diegetic systems, the developer needs to take all aspects of the applied game into account. Both diegetic systems (orange) and extra-diegetic purpose (blue) consist of a combination of elements which vary from project to project. Green signifies where they overlap. Attributes can be considered to influence the applied game 'from the bottom up'; they are (largely) immovable aspects that will influence design. Values influence 'from the top', as they are qualities of the applied game that are actively designed for.

4.6 Engagement as Process

Section 4.3 posited that the overlap between diegetic systems and extra-diegetic purpose could vary between different game parts. For example, the overlap in a simulation-style training game will be different between a tutorial explaining keyboard controls to new players and the core gameplay loop. When developers design the various aspects of the game, this overlap should be kept in mind — the focus of that part determines how much overlap is desired. Designers should always consider that attention is limited and that focusing on one thing takes away attention from something else.

Interaction with an applied game will always include a moment that the player starts to focus their attention on the game (engaging) and a moment that they divert that attention away (disengaging). As engagement occurs, various elements, their attributes and values may influence engagement positively or negatively (O'Brien and Toms 2008). During play, the player's attention constantly shifts between different aspects of the game's systems (further discussed in Section 4.7) (Calleja 2011). In the case of applied game engagement, it is also necessary to include engagement with the extra-diegetic purpose.

When players engage with an applied game, their *locus of attention* shifts in varying amounts between the diegetic systems and the extra-diegetic purpose. A hypothetical example of this process is shown in Figure 4.4. How exactly the diagram looks depends on the applied game and which part of its design is illustrated. The horizontal axis represents the progression of time in playing a particular part of the game, while the vertical axis represents the player's full attention. Attention is focused on the game; thus, the player is engaged. Where exactly attention goes within the designed boundaries of the game varies. This situation supposes an ideal where the player does not experience any distractions and is entirely focused on interacting with the game. Naturally, this is not guaranteed to be the case in reality.

At times, the diegetic systems or the extra-diegetic purpose inevitably require more of the player's attention. Figure 4.4 shows an example of a tutorial explaining the game. While it is possible to integrate extra-diegetic purpose within a tutorial, it is likely that, at the time of learning how to control a game, a significant portion of attention is taken up by this learning process. Therefore, it is unreasonable to expect that players will be able to focus much of their attention on the extra-diegetic purpose. Similarly, a facili-

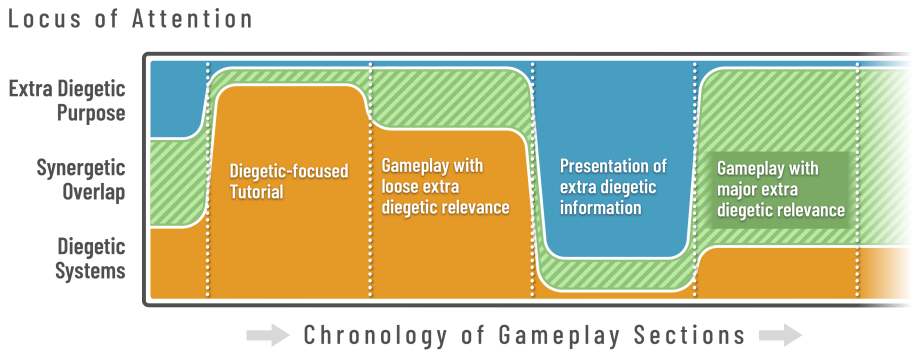


Figure 4.4: Locus of attention visualised across different gameplay sections in a hypothetical game. Orange indicates attention is focused on the diegetic systems. Blue indicates attention is focused on the extra-diegetic purpose. Green indicates where focus is divided between the two, or overlap takes place.

tator may be required to perform specific actions with the player during the gameplay session (e.g., a teacher initiating discussion, like in *CURIO*). Neither situation should be considered problematic or undesirable but instead identified as natural aspects of the applied game experience that designers should consider. Explicitly illustrating the locus of attention can show whether enough time with a game fulfils its extra-diegetic purpose. A lengthy control tutorial for a short game makes little sense when the tutorial itself is wholly unrelated to that purpose. In this case, designing more straightforward controls might be preferable.

This chapter has hinted at the potential benefit of directing attention from the diegetic systems and towards the extra-diegetic purpose by design. While this may seem counter-intuitive, it is an established method of inspiring reflection. When engaging with a narrative, for example, readers will form mental models (Graesser, Olde, and Klettke 2002). These models are continuously updated as a reader receives new information. If new information fits within the existing mental model, the reader incorporates it without question and maintains suspension of disbelief. However, if new information is ill-conceived (e.g., actions taken by a character are inconsistent with the reader's image of them), the reading experience can be disrupted. Generally, authors will aim to write so that readers can enter an 'effortless' state (Busselle and

Bilandzic 2009) in which suspension of disbelief is maintained, and they become absorbed in the text. In other cases, however, authors can also purposefully encourage readers to assume an *extra-textual perspective* on the text by disrupting this state. In this case, the text challenges 'engaged' readers through contradictory elements (Douglas and Hargadon 2001) that clash with their mental model. Engagement is not solely about becoming absorbed in the story but refers to mental involvement in reflecting on and processing the text.

Such purposeful attention redirection can also be helpful in applied game engagement. In extreme cases, the player's attention can be redirected entirely away from the diegetic system to engage more fully with the extra-diegetic purpose and its elements, such as in the example of *CURIO*. Since attention is limited, it should be spent on something other than game mechanics or other diegetic elements in such moments. In less extreme cases, the player's attention may be directed to elements that are still part of the diegetic systems but are shaped by the extra-diegetic purpose (e.g., information screens or integrated videos). Depending on the use case, this may be more beneficial than trying to remain 'in the game' fully. The conceptualisation of applied game engagement provides the flexibility to integrate other types of materials and interactions where appropriate as extra-diegetic elements.

4.7 Areas of Attention

Section 4.6 described how players' attention shifts over time as they interact with the game. So far, this chapter has established that attention can shift between diegetic systems and extra-diegetic purposes in varying amounts. However, this description majorly simplifies the applied game and its design. Whether or not the extra-diegetic purpose is integrated with diegetic systems, what that game looks like from moment to moment can vary enormously. In addition to mapping overlap, it is necessary to extend the conceptualisation of applied game engagement to understand the design of the diegetic systems as well.

The Player Involvement Model (Calleja 2011) provides a conceptual framework for understanding player experience as it relates to game design. Although the model has limited empirical validation, it provides one of the more comprehensive theories on

how games engage players. It focuses on player engagement and, similar to the conceptualisation of applied game engagement presented here, has its basis in attention. For any other constructs to arise, players must first direct their attention toward and become involved with the game. According to the Player Involvement Model, games offer six 'areas' of attention through their design: spatial, kinaesthetic, shared, narrative, affective, and ludic involvement.

Spatial involvement refers to a player's engagement with the spatial qualities of a virtual environment. This type of involvement relates to spatial control, navigation, and exploration. These factors are necessary for a player to internalise the virtual space, giving them a sense of inhabiting said space instead of merely being an observer.

Kinaesthetic involvement describes engagement with controlling avatar(s) or game pieces in the virtual environment. This type of involvement can range from the learning of controls to the fluency of movement. It is highly affected by the freedom of action and the ease of mastering controls.

Shared involvement relates to engagement derived from awareness of and interaction with other agents (human- or computer-controlled) in the game environment. Interactions include cohabitation, cooperation, and competition. This area thus encompasses aspects of other entities in a shared social environment.

Narrative involvement means to engage with story elements. These can either be part of the game's written story or emerge from players' interaction with the game (e.g., emergent results from simulation games).

Affective involvement encompasses various forms of emotional engagement. It is a catch-all category relating to the emotions that arise from interaction with the game. These can be wide-ranging, from high-intensity adrenaline rushes in battle sequences to calm relaxation in seeing a beautiful vista. This area of involvement does not focus primarily on positive emotions but suggests a wide range of emotional experiences.

Ludic involvement relates to a player's engagement with the choices they make in the game and the consequences of said choices. It relates to understanding the rules that define the system and the actions the player can take within those boundaries.

Games combine these areas, and attention shifts between them from moment to moment. Kinaesthetic involvement (i.e., involvement from controlling an avatar) may be

dominant during a challenging platforming section to reach a high point but shift to affective involvement once reaching the top and appreciating the view. Deciding when to heal during a combat encounter or reading enemy attack patterns are examples of ludic involvement. At the same time that such gameplay takes place, the player may still be concerned with dodging incoming attacks (kinaesthetic). In moments like these, where multiple areas are being utilised, the player's attention is more likely to become 'saturated'. For example, when a player is engaged in an intense combat sequence, they are unlikely to admire the scenery.

When and how to shift the player's attention is essential in structuring the game experience. Firstly, too much information or information from too many different attention areas can easily overload the player. Secondly, while too much stimulation can overload the player, spending longer in a single attention area may dull them to stimuli that are too similar for too long. For example, developers at CDProjekt Red devised a '40-second rule' when developing *The Witcher 3: Wild Hunt* (CDProjekt Red 2015), determining through playtests that players should see something of interest (e.g., a pack of deer, opponents, an NPC) every 40 seconds of exploring the game world in order to stay engaged (Strickland 2017).

Finally, different areas of attention are considered more or less effective than others in drawing and maintaining attention (Lemarchand 2012). Mechanics, controls, and spatial design pose an entry barrier that requires time and energy investment to understand and master. However, deep enough mechanics can maintain attention for a long time. Narratives and characters neither capture nor hold attention very well; while people are drawn to them, it is challenging to write them in a way that is both quickly understood and remains interesting (Bateman 2021). Finally, elements aiming at affective involvement capture attention well (e.g., through art style, music, and sound design) but are less likely to hold attention unless the game offers other elements of substance.

Depending on the game, the balance between the areas of involvement varies. A platforming game may involve few narrative or social aspects, while a game focused on creating an emotional experience through sound and visuals may have simple mechanics. However, it is reasonable to say that a balance is usually required in creating a unified experience (Schell 2008).

In order to understand applied game engagement using this theory, a diagram can be drawn to represent the balance of areas of a given game. Once again, these can be drawn for the game in its entirety or from moment to moment.

Figure 4.5 shows an example of such a breakdown using the opening moments of *The Legend of Zelda: Breath of the Wild* (Nintendo EPD 2017). The game begins with a cinematic scene (a) in which a disembodied voice tells the player character (Link) to wake up. The player is curious about the voice and to whom it belongs. They may also wonder why Link wakes up in a water tank, isolated in a cave. The player likely feels curious, excited, and mildly uneasy.

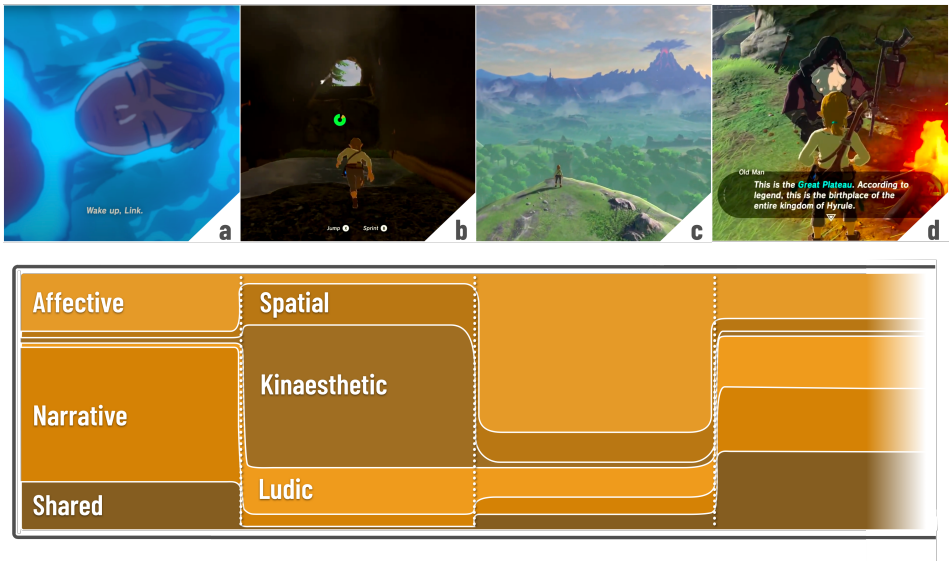


Figure 4.5: Screenshots from the opening minutes of LoZ:BotW and a breakdown of attention areas.

The cinematic is followed by a short, interactive section where the player learns the control as they follow a linear path to the outside (b). Here, they are primarily invested in trying out the controls (which are explained through prompts in the middle of the screen when applicable. The cave's design, with literal light at the end of the tunnel, guides them outside to begin the game in earnest.

Once outside, the game takes control away from the player and shows a zoomed-out view of the world (c), where the music swells and the title screen shows. In addition to creating an emotional moment for the player of awe and excitement (i.e., "this is yours to explore"), it also sets them up for some of the game's goals (i.e., "you need to go to these points"). The sequence ends by drawing the player's attention to an old man character some distance away. Considering he is the only other person around after Link just woke up alone, he stands out as a notable character who may not only have relevance to the story but the ludic goals of the game too (i.e., a 'quest' giver).

After talking to him (d), he gives Link some world history and points him to his next goal. He may also suggest to the player that they cook some apples on the campfire (setting up the cooking mechanic, which allows the player to craft valuable items) or provide commentary should the player see what happens when they remove all their clothes. This last option has no particular benefit to ludic goals but exists to entertain the player (affective involvement) and give the character more personality (shared).

This example shows that attention can shift considerably from moment to moment, even in a short sequence. This shift is carefully crafted through design decisions (e.g., when to give control or take it away, camera angle, tutorial message, cinematic sequences, dialogue with characters, etcetera). Most applied games will have a much simpler structure than large-scale entertainment games. As such, it is possible to divide the applied game into several distinct 'sections' for which a diagram of attention areas can be drawn.

4.8 Conclusion

This chapter presented a step-by-step conceptualisation of applied game engagement, addressing the six requirements identified in Chapters 2 and 3. To recall, these are:

1. A conceptualisation of applied game engagement should clearly distinguish between the related concepts and provide uniform terminology.
2. A conceptualisation of applied game engagement should posit the player's emotional experience as a potential design goal rather than the primary measure of success.

3. A conceptualisation of applied game engagement should include incorporating the game's purpose and how it is integrated into the various elements that make up the game.
4. A conceptualisation of applied game engagement should include the contextual factors influencing engagement with the game.
5. A conceptualisation of applied game engagement should focus on the process of being engaged.
6. A conceptualisation of applied game engagement should include a means to discuss the game's design.

The chapter addressed these requirements in the following manner:

Requirement 1: The chapter distinguished the related concepts of game engagement. It provided uniform terminology for further discussion in defining attention, game engagement, game experience, (applied) game, purpose engagement, extra-diegetic purpose, diegetic systems, elements, and attributes.

Requirement 2: Next, it brought the concept of engagement back to the root construct of attention and how it is purposefully focused on an activity (i.e., a game). It posits attention as a limited resource that can be actively directed through game design decisions. This perspective changes the focus of engagement to its foundation in attention, removing the previous emphasis on other constructs (e.g., flow) unless they are required by design.

Requirements 3 & 4: Two forms of engagement were established: game engagement with the diegetic systems of the applied game and purpose engagement with the extra-diegetic purpose of the game. These forms of engagement can overlap in various amounts, as does the integration of extra-diegetic purpose and diegetic systems. For developers of applied games, diegetic systems and extra-diegetic purposes must be considered. Attributes and values further define these elements.

Requirement 5: Engagement is considered a process during which the locus of attention shifts between different aspects of the game (i.e., the extra-diegetic purpose, the diegetic systems, or both in case of overlap). Depending on the project, the occasional redirecting of attention to encourage reflection on the extra-diegetic purpose may be desirable.

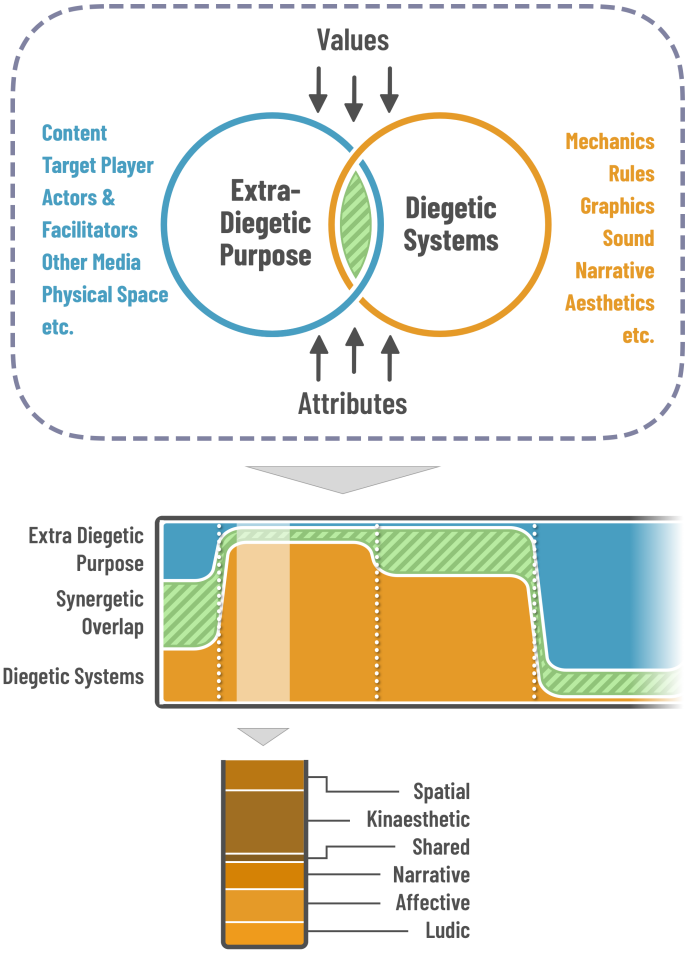


Figure 4.6: The combined aspects of the Applied Game Engagement Model. An applied game consists of diegetic systems (orange) and an extra-diegetic purpose (blue). These have varying amounts of overlap (green). Attention can be focused on diegetic systems, extra-diegetic purpose, or be divided between the two. The locus of attention can be mapped over time and gameplay sections according to areas of attention.

Requirement 6: Finally, game engagement was broken down into six areas of attention. This addition allows for a more detailed discussion on the design of any applied game. It provides a vocabulary for understanding where attention goes during various game parts.

Together, the theory presented in this chapter forms the Applied Games Engagement Model (AGEM) for analysing applied games, summarised in Figure 4.6. It is based on the root of engagement, i.e., attention, which is purposely focused on the applied game. Focusing attention can be either on the diegetic systems or the extra-diegetic purpose. These overlap in varying degrees from game to game and from moment to moment within a game. Each is comprised of various elements that vary from game to game.

Attributes and values further define the elements. Attributes describe characteristics of the extra-diegetic elements that influence engagement with the applied game. They are often static or can be influenced only within limits by the designer. Values describe the applied game's intentional characteristics that result from design decisions. Values may result from choices regarding extra-diegetic elements and their attributes.

The overlap between extra-diegetic and diegetic varies per game, both in its entirety and from moment to moment. The overlap in moments forms the basis for mapping the process of engagement. This mapping describes the locus of the player's attention and where it is focused during gameplay.

The engagement process can be specified when considering the areas of attention. As such, further insight can be gained into which aspects of the game demand the player's attention and whether they are used for the best result.

5 Applied Game Engagement in Analysis

The previous chapter presented relevant theories to conceptualise game engagement for analysing and designing applied games. This approach resulted in the Applied Games Engagement Model. In order to assess the value of this model and whether it allows for an analysis of applied games that the previous understanding of game engagement did not, this chapter re-examines the games presented in Chapter 2 using the extended conceptualisation of applied game engagement.

Parts of this chapter are based on the following publication:

- *"Re-framing engagement for applied games: A conceptual framework."* (2022)

5.1 Introduction

This thesis previously presented three applied gaming projects and discussed how they were validated using different measures. These measures were applicable and suitable to each project and consistent with commonly accepted approaches to assessing engagement in applied games (Hookham and Nesbitt 2019). In this chapter, the games presented in Chapter 2 are re-examined using the Applied Games Engagement Model (AGEM). For each of the projects, the following is determined:

- What is the game's purpose?
- What elements (diegetic and extra-diegetic) are involved?
- What attributes can be identified?
- What values directed the design process?
- What is the overlap between diegetic systems and the extra-diegetic purpose?

- What sections of gameplay can be identified, and what is the overlap in each section?
- Which areas of attention are utilised?

By answering these questions, the projects illustrate how the AGEM can be used for analysis. A meta-analysis of this process is then conducted to reflect on the use of the AGEM. As such, this chapter answers RQ3:

> **Research Sub-Question 3**
> How can the conceptualisation of applied game engagement be used to analyse applied games?

5.2 NESTORE

NESTORE Pocket Odyssey (*NPO*) is an intervention game that assists older adults in maintaining their mental and physical well-being by motivating healthy behaviour. It is part of a more extensive system that combines hardware and software to help older adults maintain healthy behaviour in four domains: physical, mental, social, and nutrition. The game fulfils its purpose through gamified physical exercises and game-based cognitive training, which should be performed regularly (multiple times a week) for anywhere between 10 and 30 minutes. Motivational and social game mechanics reward repeated and continued use of the game.

For a detailed game description, see Section 2.3.

5.2.1 Extra-Diegetic Elements and Attributes

The intervention game is situated within a more extensive technological system aimed at helping older adults maintain their well-being. Player performance is recorded and analysed by the system in order to provide tailored advice to the user. At the same time, the system will recommend using the intervention at regular intervals to motivate healthy behaviour. To this end, the intervention integrates with other technology to form a unified experience. The relevant technology includes the wearable fitness tracker, the tangible coach, the coaching application, and the backend servers.

The diegetic systems consist of the application installed on a user's phone. This application can be divided into four sub-systems: the submarine mini-game, the gym mini-game, the reward system (i.e., the Ship), and the leaderboard. Controls are based on touch through simple tapping interactions or using the phone's gyroscope to register movement. The visual style of *NPO* is colourful, reminiscent of the type of casual games that the target audience is most likely to have been exposed to or be familiar with (Nap, De Kort, and IJsselsteijn 2009). The character of Nestor reflects the target audience and signals that the game was made for them.

NPO was developed with the target player — an older person who is not necessarily technologically literate or familiar with (digital) games — in mind. The game should fit with the preferences and needs of this target audience (Gerling et al. 2012). Thus, the intervention must be accessible and fit into existing routines. Early co-design sessions with the target audience (Kniestedt, Lukosch, and Brazier 2018) showed that, while target users were appreciative of technology allowing for contact with people further away, they were also concerned about how digital technology was changing patterns of communication. Similarly, digital games were considered with some apprehension (mainly related to violence and the effects of excessive use of digital technology on children). However, board games were universally seen as a positive activity due to the social aspects and associated entertainment. Overall, a social connection was valued highly, primarily face-to-face contact.

This definition of the target player results in several attributes, including age, experience with games and technology, interests and preferences. Together with the applied purpose formulated by domain experts, these formed the foundation for the entire system. They, in turn, can be translated into values for design efforts.

5.2.2 Values and Diegetic Elements

Essential in addressing the attributes related to age, limited gaming and technological experience are the values of *usability*, *accessibility*, *reliability*, and *flexibility*.

Usability is addressed primarily through the design of tutorials, instructions, and easy-to-use control schemes. *Accessibility* refers to the ability of people with different skill levels and potential disabilities to use the game. Within the game industry, such considerations are addressed in various manners, for example, through different visual

modes or elements (e.g., for people with colour blindness or auditory impairment), adjustable difficulty, or the possibility to re-map or use alternate controllers. In the case of *NPO*, a choice for a simple interface with large text and buttons, tapping interactions, and gyroscope-based controls (Kniestedt, Camilleri, and Gómez-Maureira 2017) aimed to impact these attributes positively.

Reliability, instead, relates to the technical stability of the NESTORE system, which can be achieved through thorough testing. *Flexibility* is both a factor of design, addressed by making play sessions short and interruptible, and the choice in technology (i.e., a mobile phone that the target audience already uses).

The level of integration the game had with the rest of the NESTORE systems impacted the above values. It describes the relationship between the different NESTORE system components. Except for a sending back and forth of data and the occasional reminder by the coaching application to play NPO, there is no integration between the game and the other systems.

Another value is that of *novelty* or *replay-ability*; since the game is meant to be played frequently over multiple weeks or longer, it should either provide enough new content for the expected duration or an incentive for replaying the same content. The game was developed with a fixed amount of exercise routines designed by domain experts and a maximum number of fixed levels for the submarine game. The Ship also had a maximum progression level where content ended. This amount was deemed enough content for the duration of the validation study but would require expansion for future uses.

Both repetitive physical exercises, and bare-bones cognitive training tasks, are typically not considered particularly enjoyable to perform. The dull nature of these tasks is one reason why a game-based intervention was considered for motivational purposes. As such, *enjoyment* is of particular importance in the success of the intervention. Enjoyment was addressed through general game design but required a more detailed analysis to determine whether and how it was achieved. For example, the nautical theme of a ship and the inclusion of a character that could be relatable for the target audience both aim to address the thematic preferences of the user, and, in turn, this should relate to enjoyment.

The nature of the extra-diegetic purpose further calls for the inclusion of additional values, namely those of *physical* and *mental challenge*. While the game aims to improve or maintain physical and mental health, it may affect engagement if the challenge is too high or too low. While the submarine game had increasing difficulty in levels, the difficulty eventually evened out. The gym exercises had a single difficulty but could be varied by the player using weights or slowing the exercise down.

The game should furthermore be *social*, as this was a factor highly valued by the target audience and addresses one aspect of the game's purpose as well. This value was attempted through the inclusion of leaderboards and the ability to visit another player's Ship.

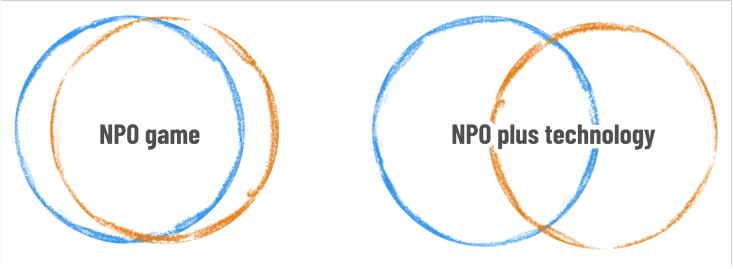


Figure 5.1: The general overlap between purpose and systems for NPO as a standalone application, and as part of the NESTORE system.

5.2.3 Mapping the Overlap

NPO can be mapped from two perspectives: the game alone and as part of the NESTORE system (see Figure 5.1). The overlap between diegetic systems and extra-diegetic purpose is considerable when considered alone. The primary aims of the game (i.e., providing physical and cognitive training, as well as a social connection) are accomplished through the diegetic systems, with little diversion of attention to extra-diegetic elements.

However, based on the understanding of applied game engagement, this mapping does not provide a complete assessment of the applied game. Beyond sending data to the backend to be interpreted by the coaching application, and that application suggesting using *NPO*, there is no interaction between the system's components.

For mapping the moment-to-moment shifting of attention, a focus on the game as a standalone application is valid; in its current state, the supporting technology does not actively impact attention while interacting with the game. In the game, both the Gym and the Submarine sections strongly overlap when engagement with the diegetic systems directly serves engagement with the extra-diegetic purpose (Figure 5.2).

Due to the physical nature of the exercises in the Gym game, the player's attention is split between the diegetic systems and their own physical body performing the exercises. Therefore, interaction with the diegetic systems is purposefully limited to compensate for the level of attention required in performing the exercises. While the Submarine game utilises physical controls (i.e., tilting to steer the submarine), this movement is more integrated into the gameplay and less likely to divert attention away from interaction with the game.

Visiting the leaderboard and the ships of friends shows notable overlap as well. The Ship portion of the game shifts attention primarily to the diegetic systems, where the focus is on the reward gained from interacting with the other parts of the game.

5.2.4 Areas of Attention

It can be determined that the game utilises the areas of ludic, kinaesthetic, affective, and shared involvement.

Ludic involvement, where the player is concerned with the goals of the game and the rewards they get as a result, is present in most aspects of the game — most prominently in the Ship, but to varying degrees in the Gym and Submarine game as well.

Kinaesthetic involvement is present in the Gym and Submarine game due to the inclusion of physical exercises and controls. While the Submarine game directly connects physical controls and steering the submarine, the physical exercise in the Gym game is disconnected from the on-screen action. Thus, the engagement is kinaesthetic in nature, but it is more related to the player's physical form than the diegetic systems.

Affective involvement, related to the player's emotional experience, is (to an extent) present in all sections. The Ship leverages this attention area the most, as decorating the Ship is designed to be a purely aesthetically pleasing experience to reward the player for their progress.

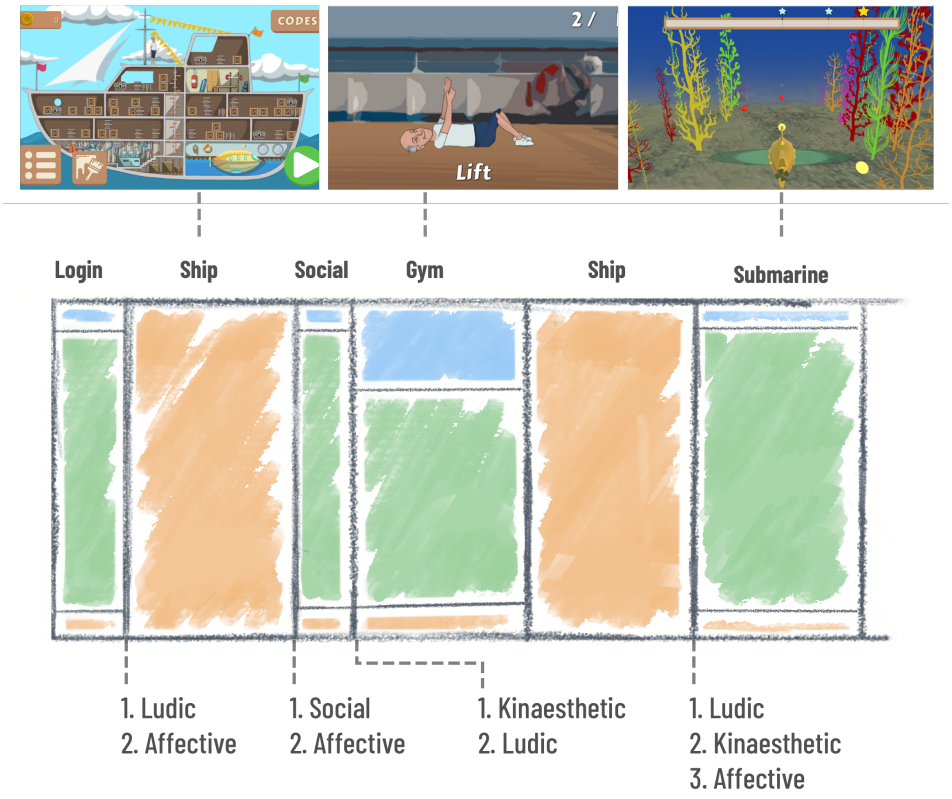


Figure 5.2: A section by section mapping of the attention overlap in NPO, including reference images to the important game scenes, and a listing of the dominant areas of attention ordered by importance.

Shared involvement is present in the leaderboard and visiting other ships. The presence of these features aims to entice players to add other users of the NESTORE system to their friend list, encouraging social interaction between them (e.g., through the social features integrated into the coaching application). Additionally, engagement with the leaderboards and visiting the ships of friends should incentivise players to catch up to other players.

The Gym game is an example of attention being directed away from the diegetic systems, namely when on-screen messages prompt them to focus on their movements or breathing. Affective engagement is also triggered through music accompanying different gameplay types (and intensities).

5.2.5 Analysis

When analysing *NPO* using the AGEM, a first observation lies in the overlap mapping. This mapping shows a notable overlap between extra-diegetic purpose and diegetic systems when mapping the applied game independently. When mapping it as part of the NESTORE system, it becomes clear that essential aspects of the extra-diegetic purpose must be integrated. While a game like *NPO* could exist on its own as a physical and cognitive exercise game, it was intended to be a part of this system. A decision was made to accept this lack of integration due to the parallel nature of the NESTORE technology being developed across various countries and, thus, an inability to design and develop games that could meaningfully build upon the created technology within the time constraints of the project.

While no attention is diverted from the game to these other aspects of the NESTORE system, it also means that the other components cannot support the game in its purpose (as well as the other way around). For example, the wearable could have provided alternative interaction methods for the game. This integration could potentially result in increased usability and accessibility, as well as more detailed logging of results that could be communicated back to the system for tailored feedback and suggestions. Similarly, the tangible coach could have been used as an interactive device to facilitate gameplay while adding a potential social component through a digital companion.

The separation of technologies (e.g., the existence of two applications, the game and the virtual coach) negatively impacted the system's usability. While the different tech-

nologies did not serve to support each other, they did work to each other's detriment. Test results (presented in Section 2.3.2) showed that one component's poor reliability impacted the entire system's perception. At the same time, dealing with multiple, seemingly disparate technologies likely increased the demand on the player's attention, impacting a willingness to engage with any of them or causing them to choose which ones were worth their energy selectively.

Another important observation can be made in the use of shared engagement. Even though social interaction was considered necessary by the target audience (described in Section 2.3.3, with similar findings in previous research, e.g., (de Schutter 2017)), only one aspect of the diegetic systems utilises this. While based on existing social features in casual games, the leaderboard and visiting friends' ships need to do more to facilitate interaction between players. Face-to-face contact is not incorporated at all.

Although exceptions exist, mobile phone games are not necessarily known for facilitating direct contact between people — interaction with one's phone is generally a solitary affair. It may also be challenging to make that experience more social, e.g., due to the need for more screen space. Displaying a game on a large screen is better for creating a social activity in which players can share the same game experience. Games like *WiiSports* (Nintendo EPD 2006b), where players take turns using motion controls to participate in different virtual sports, would be less effective when played on a small device. Therefore, while the choice of a mobile device positively impacted the values of accessibility, usability, and flexibility, it negatively impacted sociability. While this was considered during the design process (as described in Section 2.3.3), other considerations (e.g., the inclusion of specific physical exercises and cognitive training tasks) were given higher priority.

Although it lacks the social aspects considered important by the target audience, *NPO* functions as a standalone intervention for physical and cognitive training. Both aspects were given more importance throughout the project. The validation measures showed it would still need improvements to its usability and accessibility (e.g., by allowing users to compose their physical routines) and replay-ability (e.g., through randomly generated routes in the Submarine game and additional Ship content). Further study would also be required to assess whether issues with, for example, controlling the Submarine game were related to a decrease in usability (i.e., the controls

were not correctly understood) or in reliability (i.e., the controls were not working consistently).

Thus, *NPO* can be considered successful, at least in attention distribution and engagement, if assessed as a standalone intervention for physical and cognitive training. As a part of the more extensive NESTORE system, however, the game would need substantial changes to be considered a success.

5.3 CURIO

The purpose of *CURIO* is to foster curiosity in its target audience of elementary school children for STEM-related topics by pursuing activation and participation rather than through conveying and testing knowledge. It prompts players to ask questions about such topics as part of a fictional narrative. To improve the game's perceived usefulness, the lack of which forms a barrier to teachers adopting games in their practice (Takeuchi and Vaala 2014), the game involves the teacher in the game experience. The game allows them to control the game progression and customise the topics covered in *CURIO* to fit their curriculum.

For a detailed game description, see Section 2.4.

5.3.1 Extra-Diegetic Elements and Attributes

CURIO activates students to think about a new topic playfully. Rather than focus on a single topic with pre-defined information, it can cover multiple topics, thus requiring a degree of customizability. The game use takes place during school hours in the classroom, meaning the available technology is dictated by what is available. The dynamics between a class of students and their teacher may impact the game experience.

The target audience for the game is elementary school students between the ages of 9 and 11. As such, the game should be designed with this group in mind (Valenza, Gasparini, and Da Silva Hounsell 2019). For example, any text should be appropriate in wording and length for the expected level of literacy, and sessions should respect the ability of children to stay focused for a particular duration of time. In order to accommodate differences between students, the game should allow the teacher a degree of

freedom in adjusting and customising the game session. Students in *CURIO* are players and actors that could distract others from interacting with the game.

The teacher acts as a facilitator and actively participates in the game. Teachers prepare the educational content for a game session and guide interaction with it. They can also access the data from a session once it has concluded. Barriers may exist to adopting emerging technologies in education (Rogers 2000), e.g., varying technical literacy or willingness to adopt new (technology-based) methods among teachers.

Also of importance is the classroom environment, where *CURIO* is played in a group setting. While the environment itself is not necessarily a distractor (i.e., classrooms are generally set up to be calm spaces that promote the ability to concentrate and learn), the activity needs to be captivating enough for students not to get distracted. That being said, it is also not realistic to expect students to not interact with each other or for them to have their full attention on the game at all times.

To manage the session and the students, the teacher must have a degree of control over how the game unfolds. It can vary between countries, schools, and even individual classes what technology is available. While some classes may have an iPad for every student, another may only have a few computers available in the school library or computer room. The number of students is also different in every class, and the setup of tables and other equipment is different.

Finally, the extra-diegetic elements of *CURIO* would only be complete considering the scenarios the teacher creates to structure the game session. While they are not inherent to the applied game design, they are essential in making the game function as intended. The scenario content should align with the teacher's curriculum, which could be included as an extra-diegetic element. A scenario also needs to be appropriately phrased for the age and educational level of the students, making the content relevant and understandable for them.

5.3.2 Values and Diegetic Elements

The game's purpose primarily revolves around students' experience and, thus, that framing is dominant in this analysis. As such, the attributes of *accessibility* and *usability*, as well as *enjoyment* are considered necessary, although how they should be ad-

dressed differs from their use in NESTORE (i.e., by considering different user needs and preferences).

Furthermore, important aspects are the level of *customisability* and *control* given to the teacher in shaping the game experience. While there is no direct relation to the student's attention, the game experience is shaped by the teacher's input and, thus, influences engagement. *Relevance* is thus a value that may impact engagement, as the activity may be considered more or less meaningful by the players depending on how content scenarios are formed.

Additionally, accessibility and usability are also essential from the teacher's perspective. Even if the teacher's engagement is not the focus of this assessment, their experience with the game and ability to control it as a mediator may indirectly affect the students. The game should also function in schools with differing equipment and rooms. Thus, a need for *flexibility* in terms of technology and deployment was also established.

Accessibility and *usability* for students are achieved through a simple interface with large buttons and consistent use of colour. Information in the game is expressed through visuals and limiting text as much as possible. For example, the opening sequence with the Haze is presented without text and timers are shown as an analogue stopwatch. Possible actions are limited and focused on the extra-diegetic task. Game phases are also kept short, with an entire session scheduled to take between twenty minutes to an hour to limit the attention demand on students. At the same time, the game design is kept so simple that, even if students are not entirely focused on the task at all times, they can get back into it without having missed crucial information. The game's social nature also helps with this since the activity is collaborative and not dependent on the full participation of a single student.

The teacher side is similarly designed to be *usable* and *accessible*, assuming an end-user with limited technical capability. Launching the software is done by opening a single, standard application, which will automatically set up the necessary back-end to allow communication between teacher and student devices. Class and content files can be created in the application without an external program. During play, the teacher is only shown options relevant to the current game phase, and they can always pause the flow of the game or skip a phase as needed. This approach keeps the interface as

simple as possible and gives them the required control to maintain order in the class and tailor the game to their needs.

The last value of *flexibility* is addressed by enabling the game to run from one computer, which acts as the game's 'server'. Students connect to this server and play the game via a web browser, meaning many different devices can be used to play the game. Thus, the game is not affected by how a school network is arranged or reliant on the internet. It can also accommodate any number of students because they are sorted into teams, meaning only some students need their own devices to participate.

Most of these decisions make the game more readily usable for more teachers in a wide range of settings, which may impact students' engagement in turn. More important, however, is to consider how this flexibility to accommodate different environments also means that that environment cannot be designed for specifically. This fluidity increases the chance that the game is used in less than 'optimal' or assumed conditions. While classrooms are not necessarily a distractor, a library or computer lab may offer more distractions (e.g., different games or applications on the computer).

Additionally, sharing devices among students may also impact engagement, e.g., due to more dominant students hogging the game, as was observed during validation (Gómez-Maureira et al. 2020). Flexibility also opens up the possibility space for how the game is played and potentially introduces new or alters existing extra-diegetic elements. As such, while this may not seem like an attribute that influences the engagement of students directly, the decisions made to address it and the circumstances those create do so.

5.3.3 Mapping the Overlap

This assessment focuses on the player's experience (i.e., a student) as the primary target audience for the applied game. Decisions made in the teacher application will influence the game experience, but the player does not interact with it directly. The teacher application needs to be considered as it can indirectly affect the player's engagement but is not part of mapping the overlap from section to section.

The overlap between extra-diegetic purpose and diegetic systems in *CURIO* varies considerably between game phases. Some sections are entirely separate from the diegetic purpose and the other way around. A mapping of the game may frame overlap as be-

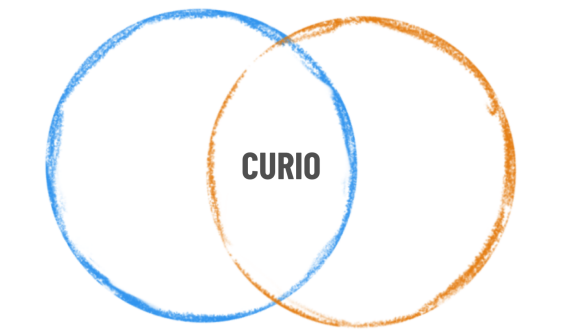


Figure 5.3: General overlap of purpose and systems for CURIO, where a clear separation is maintained between the two, depending on the game section.

ing somewhere in the middle, signifying the general balance between purpose and systems (Figure 5.3). More relevant, in this case, is mapping the locus of attention on a moment-to-moment basis.

The locus of attention is initially on the diegetic systems as the player joins the game session, is sorted into a team, and is presented with the game's premise. Overlap is substantial throughout the process of choosing a topic and asking questions. If the teacher pauses the game to facilitate discussion, attention is shifted away from the game to the teacher. The endgame shows more overlap as cinematic sequences are combined with answering multiple-choice questions, while the ship decorating has little to no relation to the extra-diegetic purpose (Figure 5.4).

5.3.4 Areas of Attention

CURIO primarily utilises the areas of ludic, shared and affective engagement. Narrative engagement is involved to some extent, but not meaningfully. Although the game has a narrative, it is elementary and primarily acts as a contextual wrapping for the game's ludic goals and to enrich the game's affective experience. The purpose of the Haze and the addition of colourful characters is to incentivise participation and communicate success, therefore serving both ludic and affective engagement.

Ludic engagement is present in sections where players take action (e.g., choosing planets and asking questions), while affective engagement is more apparent in the less interactive sequences (e.g., the intro, attacking the Haze, and decorating the spaceship).

Even though students primarily play alone, there are phases in which the activity is more shared between all classroom members. The teacher facilitates a group discussion involving all students in the class. Furthermore, they can see each other's input when they decorate the ship together at the end of the game. In a setting with insufficient devices for each student, the game could utilise shared engagement even more (e.g., when students play in groups). Of course, this could distract players from the game more.

The most significant directing of attention happens through the teacher, who controls the game flow through their application. *CURIO* provides teachers with suggestions on managing this transition and the session in general (Gómez-Maureira et al. 2020). One key aspect of *CURIO* is that it requires constant moderation rather than being a product that functions independently through interaction with the player alone. Thus, it externalises responsibility for engagement, and its success depends on the teacher acting as a facilitator.

5.3.5 Analysis

Analysing *CURIO* through the AGEM makes it possible to examine the game from moment to moment, including moments outside the diegetic systems. In doing so, the game functions as intended, with apparent shifts of attention accommodated by design. It also shows that engagement (even when understood as separate from other constructs) is still complex in its own right, with aspects that may influence it in unexpected ways.

The flexibility of technology, while not directly affecting the player's engagement, can have unintended consequences on the extra-diegetic elements and, thus, engagement. A similar observation can be made for customisability. Customisability (i.e., creating and adjusting content scenarios for a game session) may help the teacher adapt the lesson to their curriculum. This control, in turn, may result in more age-appropriate content for the students (aiding accessibility) that is relevant to their studies.

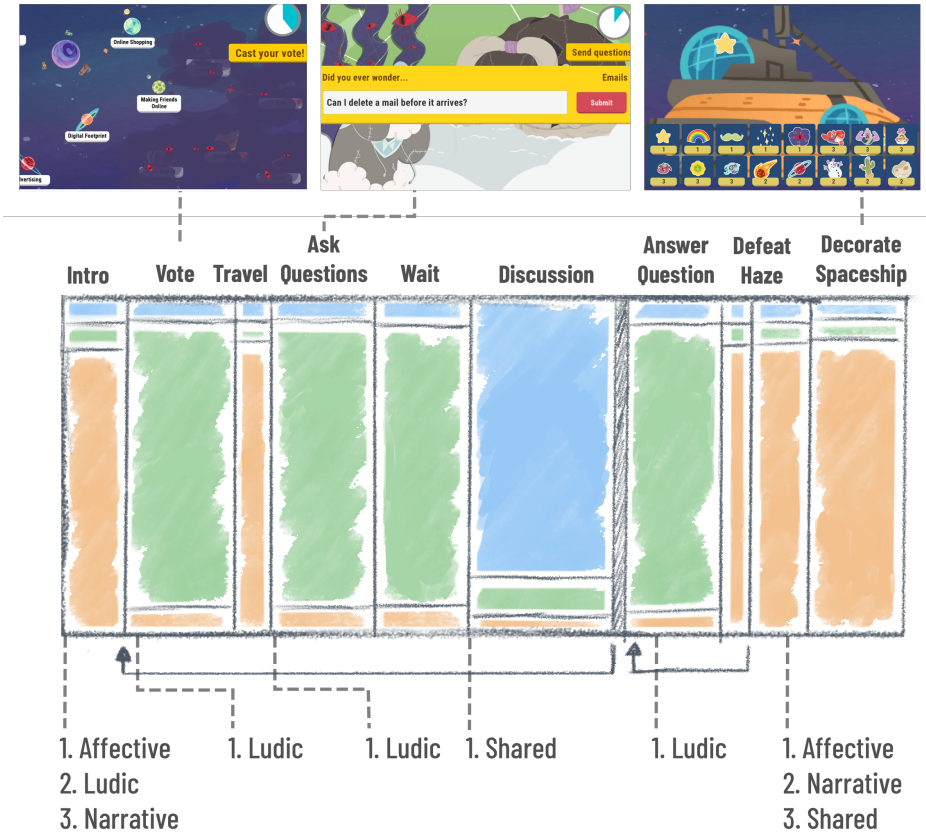


Figure 5.4: A section by section mapping of the attention overlap in CURIO, including reference images to the important game scenes, and a listing of the dominant areas of attention ordered by importance.

Customisability, however, rarely increases accessibility. Games that include the ability to customise a character may provide endless options for a player to create their perfect avatar. However, such customisation is (at least partially) optional. Since only some people want to figure out menus or spend time adjusting settings, games are likely to offer several pre-determined options. These can represent many players as they are or form the basis for simple modifications.

Similarly, it would benefit *CURIO* to offer some 'standard' scenarios on various topics for teachers who do not want to create their own or feel uncomfortable doing so. Even if these do not match the precise curriculum (impacting relevance), they can help a teacher become comfortable with using the game and, eventually, create or modify their own scenarios.

Another observation can be made in the waiting phase of the game. Although the area shows an overlap between extra-diegetic purpose and diegetic elements, there is nothing for the player to do during this time besides read already submitted questions. In testing, this resulted in students being distracted and becoming disruptive. This observation shows that more than simply having an overlap between the elements is needed to guarantee that the game's design successfully achieves its goals.

5.4 Shinobi Valley

The purpose of *Shinobi Valley* is to elicit spatial exploration in players and measure their behaviour. It presents players with a virtual environment to be explored in which specific design patterns are integrated. The game was created for academic research and provides quantitative data on player behaviour and game experience. In this manner, it is quite different from the previous two cases, as it accomplishes this by presenting itself as an entertainment game as much as possible.

For a detailed game description, see Section 2.5.

5.4.1 Extra-Diegetic Elements and Attributes

The purpose of *Shinobi Valley* relates to the generation and testing of game design knowledge. As such, this purpose is primarily integrated through the design of diegetic systems. The purpose can be considered two-fold. First, the game elicits spatial explo-

ration in players, functioning in the same manner as an entertainment game would. Second, it allows for that behaviour to be observed and recorded. Because of this second aspect of the game's purpose, several elements of the extra-diegetic purpose need to be considered.

The game's general presentation as part of a study may influence engagement. The presence of a researcher could influence how players view the game, as could the fact that applied games are often considered to be lacking in quality compared to entertainment games (Michael and Chen 2005). In the case of *Shinobi Valley*, this impact is minimised by conducting the experiment online. Doing so limits the potential influence of the research circumstances on player engagement. Also, it makes it easier for players to participate (i.e., they do not need to travel to a specific location).

One consequence of this decision is that the physical location in which the game is played can vary from player to player, in contrast to a laboratory setting in which the conditions and circumstances around the game can be controlled. While such a setting could also influence engagement (e.g., making the player less comfortable than they would be in their home environment), it can be considered consistent across participants. The influence of the environment on the player and results could be mitigated through presentation and provided instructions.

A second element is the inclusion of data collection methods. Much of the data collection in *Shinobi Valley* happens behind the scenes in a way that players are unlikely to be aware of (e.g., the logging of their position in the virtual environment). However, additional measures during and after playing are included to assess the player's game experience. The length, frequency, and extensiveness of these measures may potentially overwhelm participants and affect engagement.

The target audience for *Shinobi Valley* are players of games who can be expected to have basic gaming and technology literacy and experience in directing a virtual avatar through a virtual, 3D environment. For the study, it can be assumed that interaction with games similar to *Shinobi Valley* is something that participants have experienced.

It should be considered, however, that playing for one's enjoyment and research participation is not the same. In the experimental study, whether or not a player received monetary compensation for participating impacted how they explored (Gómez-Maureira et

al. 2021). This finding suggests that a player's motivation could affect their willingness to invest time and focus on the game.

Demographic factors, such as previous gaming experience, could also be attributes that influence engagement. While they should be recorded for data processing purposes, they were not included in this assessment. The game's purpose is to investigate player behaviour resulting from design patterns. As such, the conditions in which players encounter those patterns need to be controlled and consistent. While player attributes, such as experience, could be designed for (e.g., by including challenges or changing difficulty), such changes undermine the applied purpose.

5.4.2 Values and Diegetic Elements

Complexity and *duration* can be identified as values concerning the design of the experiment and the inclusion of data collection methods. Additionally, *consistency* in the physical environment is required to minimise distractions and provide even testing conditions. Furthermore, *accessibility*, *usability* and the related attribute of *flexibility* regarding the used technology (web) are also relevant, even if their requirements are not as specific as they were in the previous two cases.

Shinobi Valley enables and incentivises spatial exploration in the virtual environment by providing players control over a virtual avatar that can walk, run, and jump. Two different control schemes (mouse and keyboard) are offered to tailor to different player preferences and technical setups (e.g., laptop or desktop computer). The controls are explained through a tutorial and can be customised via a menu, increasing accessibility and usability.

Another aspect of the game is the inclusion of the ninja master (i.e., the goal for the player to reach). A timer starts to run upon finding the ninja master for the first time. Once the timer runs out, the player can finish the game by revisiting him. This period serves the game's purpose, incentivising further exploration during the waiting period. However, the length of the time is also adjusted depending on the time the player has already spent exploring. This dynamic adjustment limits experiment length and the chance of overburdening the player or affecting their game experience (e.g., a player that has already explored a lot before reaching the master getting bored by having to wait for a long time).

In addition to quantitative measurements taken after the game, an in-game survey appears intermittently during gameplay to assess the player's experience. Since this survey disrupts the player's exploration, care was taken to make it short and not appear too frequently (addressing *complexity* and *duration*). It appears in the centre of the screen, and control is taken away from the player until it is completed, making it impossible to miss.

Finally, while it is impossible to fully control the player's physical environment through the game's design, information screens at the beginning of the game inform the player how the game should be played (e.g., in one go, using headphones, and with minimal distractions). Although this does not guarantee consistent conditions across participants, it may limit the influence of the physical environment on the gathered data. It is important to note that while these screens were part of the game, elements of extradiegetic purpose (e.g., informed consent or instruction forms) could similarly be designed to affect these attributes.

Figure 5.5: General overlap between purpose and systems in Shinobi Valley. With only minimal disruption from the diegetic systems and high overlap, the overlap is close to complete.

5.4.3 Mapping the Overlap

Shinobi Valley functions, to a large extent, as an entertainment game. During interaction with the game, purpose engagement and game engagement overlap almost perfectly (Figure 5.5).

Should a broader perspective be taken, including additional research components (i.e., surveys and informed consent forms) would reduce that overlap. This difference is significant to note as, from the view of applied game engagement, the entire experience should be considered, especially concerning the attributes of complexity and duration discussed in the previous section.

Mapping moment-to-moment interaction with *Shinobi Valley* is primarily interesting for the part of the experiment in which the player interacts with the diegetic systems, as there are apparent moments within the experiment in which interaction begins and ends. Outside of these times, no overlap exists. During play, however, the overlap is nearly complete. The only exception to this is the time when the in-game survey pops up. While this interaction still occurs within the diegetic systems, it temporarily directs the player's attention away from spatial exploration and to the more explicit extra-diegetic purpose of conducting research and collecting data (Figure 5.6).

5.4.4 Areas of Attention

Although attention in *Shinobi Valley* is primarily directed using spatial and kinaesthetic involvement, all forms of involvement are utilised to some extent. Most of the game revolves around exploring the virtual environment presented to the player (i.e., spatial involvement). Kinaesthetic involvement is likely to be prevalent at the beginning of the game, as the player learns the controls, as well as at later times, e.g., when the player decides to climb a mountain requiring some navigation precision.

Affective involvement is present throughout, primarily through the visuals and soundscape used in the game to provide a calm atmosphere and a hint of comedy in the interaction with the ninja master at the end of the game.

On the other hand, Ludic involvement may vary depending on the experiment condition. In addition to the presence or absence of design patterns, players may or may not receive the goal of reaching the ninja master. Players who are presented with this goal

may be more focused on achieving it, while players who are not may wonder about the point of the game or focus on spatial exploration instead.

Narrative and shared involvement are both present, albeit minimally. This involvement is also partially dependent on whether or not the ludic goal of reaching the ninja master is included — for a player without a ludic goal, neither narrative nor shared involvement will be considered before players happen upon the master in their exploration.

Shinobi Valley is designed to be less 'segmented' than either *NPO* or *CURIO*. This difference means that the assessment of areas of attention is based more on specific areas of the game that are, in turn, shaped by design patterns. Data showed that while participants did not necessarily explore less without design patterns in the environment, their exploration was more focused on the instances of those design patterns. This difference shows how their attention was drawn to and directed by the patterns and influenced their game experience. While these can be tied to the different areas of attention, it would require a more granular mapping of the moment-to-moment gameplay than the AGEM proposes.

5.4.5 Analysis

Using the AGEM in the context of *Shinobi Valley* helps understand external influences (e.g., from extra-diegetic elements) that may impact engagement. Discussing *Shinobi Valley* through the model helps to illuminate aspects of games used in research projects that may go overlooked. Even when the eventual intention is to create a product for general use, it is common for applied games to start from within a research context (Gómez-Maureira et al. 2022), as was the case for the two other cases discussed in this chapter. This context invites elements with attributes that may influence engagement with the game. Thus, they should be accounted for when discussing the assessment of games in such a context. For example, in *Shinobi Valley*, these elements were the physical environment and the out-of-game and in-game surveys.

Another point of interest is how engagement is influenced by the changes in the game depending on experimental conditions. In Shinobi Valley, players could be presented with or without a goal (i.e., be shown the master), experience a different game aesthetic (nature or alien), or experience the world with or without design patterns. When A-B

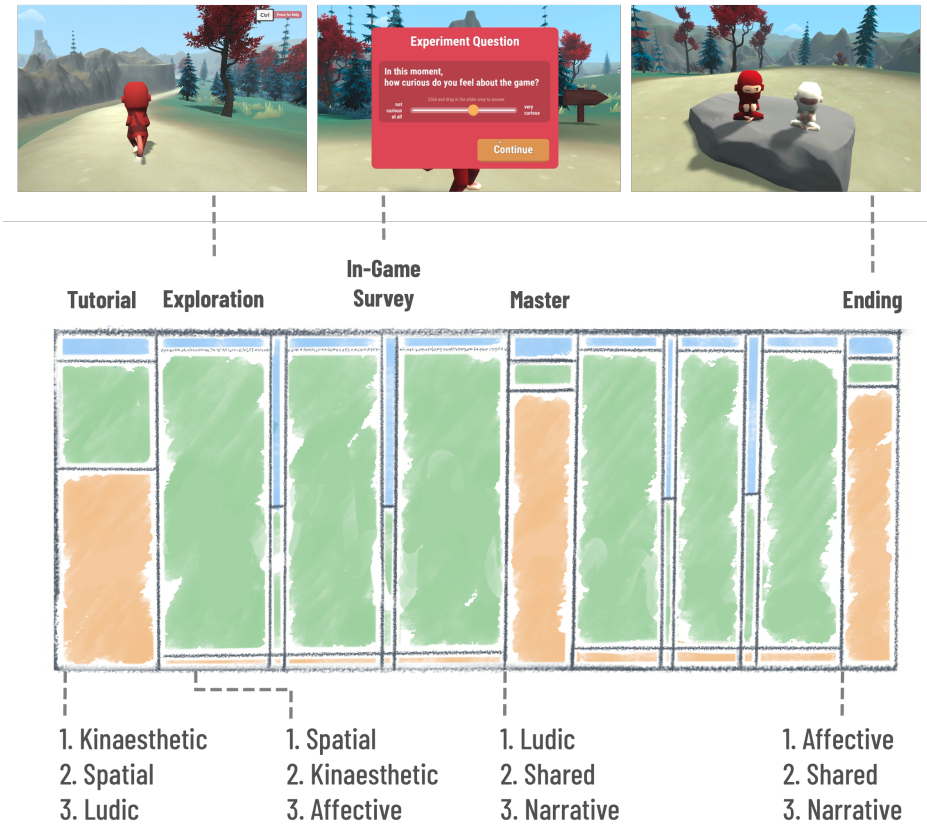


Figure 5.6: A section by section mapping of the attention overlap in Shinobi Valley, including reference images to the important game scenes, and a listing of the dominant areas of attention ordered by importance. Attention areas could be identified for each of the pattern instances. However, the overlap would not differ, potentially making a mapping with such granularity less useful.

testing different versions of the same game, mapping the impact of changes on engagement may help to explain statistical differences (or lack thereof) between conditions.

A final observation can be made in the inclusion of values. Although similar values were relevant to *Shinobi Valley* as they were to *NPO* and *CURIO*, they need to be considered in the context of each project. For example, accessibility and usability had different levels of importance and required unique design decisions in each case. Additionally, while formulating more attributes and values may always be possible, they should also be evaluated based on their impact on the game and extra-diegetic purpose to see whether they are worth including in the analysis.

5.5 Meta-Analysis

Applying the AGEM to these three cases reveals several factors regarding its use. The first is that even when removing game experience from the discussion of game engagement, the way engagement functions continues to be nuanced and complex. By focusing on attention and the process of engagement, however, it is possible to discuss the reasons behind those nuances.

The inclusion of extra-diegetic elements allowed for the analysis of such elements and their impact on engagement. It enabled discussion of interaction external to the diegetic systems, thus not framing this as separate from the applied game or detrimental to engagement. The analyses above illustrate that this is essential in adequately describing how applied games function, succeed, and fail.

The applied games included and discussed in this chapter are all considerably different, both in applied purpose and game design. Traditionally, this would make it difficult to discuss them alongside each other. This thesis aims to form a conceptualisation of applied game engagement that could allow for this. It was possible to compare the games' synergetic overlap, assess whether this overlap was intentional, and the effect this had on values and engagement.

Differing approaches can be identified in whether the responsibility for engagement was externalised to the extra-diegetic purpose elements, or whether it was considered inherent to the diegetic systems. The *CURIO* project made student engagement highly

reliant on the effort and willingness of the facilitator (teacher). In contrast, *Shinobi Valley* and *NPO* (external technology aside) were 'self-standing' pieces of software that primarily shaped engagement through the design of their diegetic systems. While *NPO* was negatively impacted by this decision, it did make it possible to adapt the game to a self-standing intervention (i.e., for the study presented in Chapter 3). Dependency on extra-diegetic elements is a notable consideration in examining how well an applied game may function and discussing its long-term plans for support and implementation (e.g., beyond the initial research project).

5.5.1 Observations on Attributes and Values

Attributes and values were critical in understanding how the extra-diegetic purpose and the diegetic systems could influence engagement. They formed the 'glue' between the two aspects of the applied game and engagement.

Many aspects of the applied game (both related to extra-diegetic elements and diegetic systems) can influence values, potentially turning them into a positive or negative influence on engagement. Whether or not attributes and values should be included in the analysis depends on their importance to the game's extra-diegetic purpose. While *NPO* required challenging players, this was not particularly important in *CURIO* or *Shinobi Valley*. Although both games had to be usable and accessible, neither was concerned with providing a specific level of challenge to the player, with *CURIO* favouring the elicitation of questions and discussion and *Shinobi Valley* carefree exploration.

Some values were more specific than others. Usability, accessibility, and enjoyment are generic and can be influenced in several ways. It will also be helpful to specify values like 'enjoyment' further through the use of intended aesthetics (Bateman 2016). Whether and how to specify values depends on the project's needs and the level of detail that can benefit it.

Thus, attributes and values, and how they are relevant, change depending on the project. The examples in this chapter should not be taken as specific definitions. Instead, it is primarily important that all project stakeholders understand what they mean and how they relate to the extra-diegetic purpose, diegetic systems, and the design decisions that define them. Some attributes and values appeared in various forms across the case studies and are backed by previous research (e.g., O'Brien and Toms

2008). Values such as accessibility, usability, and relevance are likely to be important in all applied games, even if they need to be considered in context.

The relevance value is notable, as it directly relates to the applied game's purpose. As discussed in Chapters 3 and 4, engagement is partly influenced by the meaning that a person attaches to the activity. In the case of *CURIO*, the notion of meaningfulness came up regarding content relevance in the scenario. Furthermore, while the other surrounding technology negatively impacted *NPO*, the existence of that technology does clearly emphasise the system's potential benefit to the player. In the case of a standalone applied game, the risk exists of meaning being taken as a given simply due to the underlying intentions of the game designer. As hypothesised in Chapter 3, it may be especially beneficial for such applied games to emphasise their purpose further, strengthening values like relevance and fostering engagement.

AGEM can help designers to be aware of such considerations. Meaning, however, may come from various places. Playing games, even those 'just' for entertainment, is meaningful for many people. It is this meaning that a game like *Shinobi Valley* leverages rather than communicating the importance of its extra-diegetic purpose.

5.5.2 Using the Model

While the analyses above are presented in a structured, linear fashion, performing them requires some iteration. Even when the purpose of the game and its design were clearly defined, it still took time before all elements were mapped out. The addition of attributes and values was similarly done by reconsidering the elements and their potential effects on attention and engagement.

It furthermore depends on the game to what level of detail it is helpful to break it down. While of varying complexity, the games discussed here are relatively simple in design. The straightforward designs mean that their breakdown in terms of engagement can also go into a manageable amount of detail, as the way elements interact is likely to be limited. While breaking down areas of attention, a specific mapping of each would not have resulted in a much greater understanding. More important was to understand which areas were dominant per section, and whether that was intentional or optimal.

However, the need for a more detailed view was also apparent. An analysis of *Shinobi Valley* may benefit in mapping how the design patterns affected player attention. Similarly, there was a moment in *CURIO* where, although overlap existed, students became distracted. Additional tools may be required to address such moments with more detail. This addition will be addressed in the following chapter.

Nevertheless, it is important to determine which aspects of the model are helpful in the applied game project and how granular that application should be. The model does not describe a particular way of approaching this. However, it is recommended that the steps are followed, even if they may seem of little importance initially. Considering the applied game from the different angles the model provides may lead to insights missed on a previous step or re-contextualise previous assumptions. For example, the notion of relevance in *CURIO*'s content scenarios was initially overlooked in analysing the game elements and overlap.

Performing these analyses can be especially useful in combination with formal validation studies. Existing methods aimed at measuring game experience or engagement (exemplified in Chapters 2 and 3) are often quantitative in the form of surveys and logged data (Hookham and Nesbitt 2019). At some point in the analysis, such data needs to be interpreted and contextualised. The AGEM provides a possible framing that can aid in this interpretation.

Results from mapping applied game engagement may vary at different development or testing stages. It is possible, for example, for attributes and values to emerge that were not initially considered or to disappear as designs and priorities change. Earlier versions of *CURIO* included a more significant component of competition (Gómez-Maureira 2018), which has been suggested as being able to affect engagement positively (Siu, Zook, and Riedl 2014). During the pilot test, however, this competition was only experienced as positive by students on the winning team. Since this could negatively impact the remaining students' engagement, this aspect of the game was changed. As such, the value would have been dropped from analysis at this stage.

A similar change can be seen between the *NPO* prototype (described in Section 2.3.3) and the final product. The decision to develop the game as a standalone intervention was calculated based on the development circumstances. However, this was not the case for the decreased importance of sociability. While the prototype prioritised shared

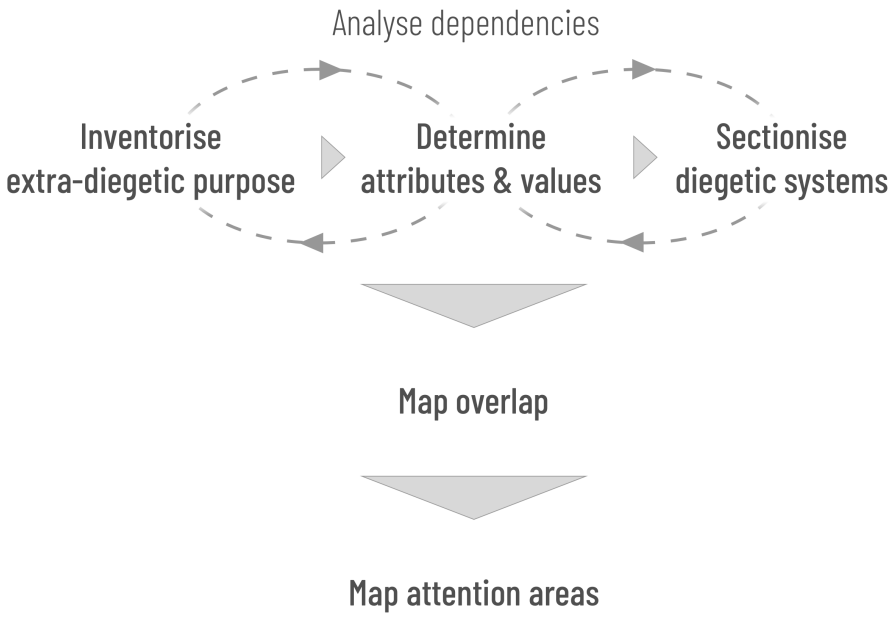


Figure 5.7: Visualisation of the process of applying AGEM to analyse applied games. A level of iteration is expected in determining the purpose and the systems, as well as the attributes that connect them. Once these aspects become clear, more detailed mapping may occur depending on the project.

involvement in many of the intended gameplay sections, this importance was strongly diminished in the final product. This change becomes apparent by mapping the applied game engagement and areas of attention. While this does not mean that the prototype would have been more successful than the final result, it might have allowed for discussion during development on whether this change was desirable or acceptable.

Finally, the model should be approached as something other than an exact science. The resulting graphs do not require complete accuracy, nor is that something that should be considered a goal in creating them (or even practically feasible). Another person analysing the three cases discussed in this chapter may differ in result, particularly concerning extra-diegetic elements, attributes, values, and importance. It is possible (and expected) for differences between various stakeholders performing the same analysis, in which they assess the game based on their own area of expertise and priorities. This variability is an expected outcome of the model and should even be considered desirable, as it can raise questions and foster discussion. Rather than expecting a single 'true' result, the model should provide a manner in which applied game engagement can be externalised, understood, discussed, clarified, and modified where needed.

5.6 Conclusion

This chapter showed how the model proposed in Chapter 4 can be used in analysing engagement with three different applied games.

Through this process, it was possible to identify and describe the various elements of extra-diegetic purpose and diegetic systems, as well as the attributes and values that linked them and express the design decisions that caused them to affect engagement. The games were furthermore mapped in terms of synergetic overlap, both on a global level and on a moment-to-moment basis, potentially highlighting inconsistencies in the designs.

The result of the chapter is a generalisable process for using the AGEM in analysing different types of applied games. It should be taken as inherent to the model that debate may occur over the exact representation of extra-diegetic purpose elements, diegetic systems, attributes and values, or any of the mappings concerning engagement. The model's intention is not to create a single 'true' representation of the game. Instead,

it provides the insight and vocabulary to facilitate debate in which differences of interpretation, opinion, and priority may exist, for instance, between stakeholders within an applied gaming project.

6 Incorporating Analysis into Design

This chapter presents the exploratory study of how the analysis of applied game engagement can be incorporated into applied game development practice. It incorporates the theory in small-scale game development projects and uses it to guide design discussions in two applied gaming projects. These studies refine the Applied Games Engagement Model and the analysis process from the previous chapter, leading to a practical design 'lens' for applied games.

Parts of this chapter are based on the following publication:

- *"Incorporating the Theory of Attention in Applied Game Design."* (2022)

6.1 Introduction

Chapter 4 brought together theories from different fields to conceptualise applied game engagement. Since the first goal of this thesis was to analyse applied games, it incorporated limited game design knowledge. The concept of areas of attention (Section 4.7) is most closely related to game design (although not applied in design practice) and will be of particular importance in this chapter. However, as illustrated through the case studies presented in Chapter 5, the areas of attention are only practical when dissecting the game to a certain level of detail. For example, the design patterns in *Shinobi Valley* would require a more precise method to capture and measure interaction with them. Thus, this chapter adds relevant game design knowledge related to attention to make the AGEM applicable to guiding design discussions.

This chapter first establishes the premise on which AGEM can be incorporated into design practice. Namely, that game development is an iterative practice that involves mul-

tiple moments of reflection (Section 6.1.1) and that game design is a complex practice that cannot fully be captured by prescriptive design methods (Section 6.1.2).

Second, the chapter introduces relevant theory from game design to supplement the AGEM model with practical design knowledge (Section 6.2) that allows for a more granular discussion of design decisions.

Next, it explores the implementation of the Applied Games Engagement Model in various (applied) game development situations. The first is a pilot study (Section 6.3), in which the theory was implemented in a university course on introductory game development to assess the ease of use of the model's various aspects in small-scale game development.

The model was then used to guide design discussions in two applied gaming projects (Section 6.4). This study focused on putting the process established in Chapter 5 into practice on games-in-progress and recording further questions that should be incorporated in such discussions.

Through this work, the model is refined into a design 'lens' (Schell 2008) through which applied game design can be viewed at various stages of development (Section 6.5), answering RQ4:

> **Research Sub-Question 4**
> How can analysis of applied game engagement be incorporated into applied game design?

6.1.1 Game Development Practice

Game development is a multidisciplinary practice in which people from many different backgrounds — e.g., art, technology, sound, and writing — come together to craft a single product (Schell 2008). There are different approaches to this process, but the most common is iterative development using agile software development methods (Osborne O'Hagan, Coleman, and O'Connor 2014). Agile development describes an iterative process in which ideas are conceptualised, developed into a working prototype, tested, and evaluated (Dingsøyr et al. 2012). The result of this evaluation is then used to re-examine and adjust the original ideas, entering the next development iteration.

This cycle continues until the game is finished or, more realistically, time and budget have run out.

In games, where elements can interact with one another in unexpected ways (Hunicke et al. 2004), designers aim to elicit a specific intended user experience (Schell 2008). For this reason, an iterative development cycle is desirable, as it quickly allows for an assessment of whether the intended experience is being achieved, as well as the diagnosis of potential problems and unexpected results. In a linear development approach, such issues would only become apparent at the very end of the project when it is too late to change them.

Applied games are developed by different people in varying circumstances, e.g., by dedicated applied game development companies, by small or individual developers in collaboration with domain experts (e.g., researchers or educators), or by teams of 'amateur' creators, e.g., within academic settings (Järvelä et al. 2015). They are often made possible by public funding through a grant proposal that lays out the project's goals, planning, structure, and anticipated outcomes. Such a structure, further influenced by factors such as project complexity and team composition, only sometimes lends itself to the flexibility desirable in game development. For example, although the *CURIO* and NESTORE projects were both funded and structured similarly, the smaller team in *CURIO* could adopt an iterative development method that allowed for considerable changes to the original concept while maintaining the 'spirit' of the initial project proposal (Gómez-Maureira et al. 2020). The larger, more complex NESTORE project could not adapt as well, with the evaluation of technology primarily happening at the end of the project when it was initially scheduled. Even within such a project, however, smaller iterations on individual aspects shaped the final results.

6.1.2 (Applied) Game Design Methods

Frameworks for applied game design focus on defining conceptual factors that play a role in the design process (Tsita and Satratzemi 2019; Marne et al. 2012). Some factors are well covered, such as the importance of defining the learning content (i.e., the intended skills or knowledge to be gained) (Bellotti et al. 2011; Kiili et al. 2012; De Freitas and Neumann 2009) or defining the intended player's needs, interests, experience, and skills (De Freitas and Jarvis 2006). Connections have also been made between these aspects and the intended design of the applied game. It has, for example, been suggested

that a game genre (e.g., 'strategy' or 'action adventure') should be chosen following previously established preferences (Yusoff et al. 2009; Bellotti et al. 2011; Malliarakis, Satratzemi, and Xinogalos 2014). This choice, in turn, should then lead to the inclusion of genre-appropriate rules and game mechanics (Tsita and Satratzemi 2019).

Games offer players agency through actions – it is one of the primary factors that sets them apart from other forms of media (Karth 2014). As such, it is not surprising that applied game design efforts tend to focus on mechanics (i.e., actions that can be taken to interact with the game world) and their corresponding systems (e.g., feedback mechanisms) (Sicart 2008). This type of approach has resulted in work focused on establishing the value of specific mechanics and their effect within an applied game or for a specific audience (e.g., Quiroga and Gómez-Martın 2019; Grund 2015; Parnandi and Gutierrez-Osuna 2015; Hew et al. 2016), to create an easy to use 'catalogue' of mechanics that can be applied to any purpose.

Such approaches are not unlike gamification efforts, however, where the same game elements are applied to any context (Hamari, Koivisto, and Sarsa 2014). Gamification has been criticised for oversimplifying game design (Hung 2017), mistaking incidental properties of games (e.g., leaderboards, points) for primary features (i.e., complex, meaningful interaction) (Bogost 2015). Applied game design approaches singularly focused on mechanics risk making that same mistake. Indeed, it has long been considered a failing of game studies to define games solely by their interactivity, as they are made up of many non-interactive aspects (e.g., narrative and cinematic sequences) that contribute to the overall experience as well (Newman 2002). The result of approaches focused solely on mechanics are games that similarly ignore essential aspects of game design practice.

To understand game design is to understand a complex web of creativity, psychology, art, and technology (Schell 2008). To further complicate this, in addition to presenting extra challenges, applied games are not always created by professional game designers (Levy et al. 2018). Nevertheless, to understand them, a certain understanding of the nuances of game design is required. It is here that attention can play a role once again. It factors into game design in many ways and at various 'stages', ranging from overarching design decisions (e.g., related to choosing a particular genre) to granular decisions that shape the player's experience from moment to moment.

6.2 Designing with Attention

Chapter 4 established that attention shifts over time as the player interacts with a game. This premise is essential for several reasons. First, that attention is limited, and thus, awareness of where it is focused is essential in understanding how the game functions. Second, how that attention shifts can be actively designed. While this has been established for entertainment games, it has seen limited application within applied games.

This section describes two uses of attention in game design practice for understanding applied game engagement: creating balance in rhythm, and guiding through feedback. Since this theory has only been sparingly used in applied games (in part, due to them generally being less complex than their entertainment counterparts), the following section uses examples from the entertainment industry to illustrate the concepts.

6.2.1 Balance and Rhythm

Attention factors into game design in two considerable ways. Namely, in repeatedly capturing a player's attention from moment to moment (reflexive) and maintaining that attention by offering depth within and variety between game areas (selective). It is furthermore necessary to be aware of overloading the player cognitively through too much information (vigilance) or under-stimulating them by staying within one area for too long. Designing with this knowledge in mind leads to creating rhythm or the 'emotional beat' in a game (Schell 2008; Lemarchand 2021).

Flow theory states that a pleasant state of enjoyment is reached when a person's skill and the challenges a task provides are balanced. This theory is often used concerning games (Sweetser and Wyeth 2005). However, it would be incorrect to assume that games merely provide a stream of challenges that continuously and exactly matches the player's skill level. Modern games provide various experiences, including moments of (extreme) challenge. These moments can be highly entertaining, memorable, and engaging.

The popularity (Orland 2012) of a game like *Elden Ring* (FromSoftware 2022) — developed by FromSoftware, a studio known for creating challenging games — provides an excellent example of this. In games like this, moments of high intensity (e.g., an encounter with a seemingly insurmountable enemy) are balanced with respite (e.g., ex-

ploring, crafting, and interacting with characters). This cadence can be found within the overarching game structure (in which significant enemy encounters are balanced with longer sections of exploration, affective experiences, and other lower-intensity gameplay) and on a more granular level, such as in the design of specific areas. Together, these moments form the 'rhythm' of the game, offering memorable highs and lows in the player's experience.

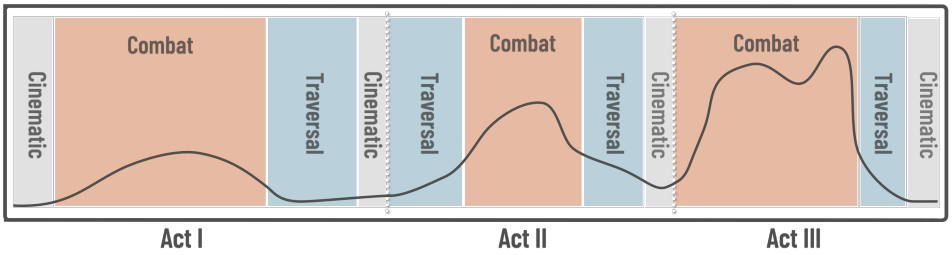


Figure 6.1: A hypothetical attention intensity curve, as used in games like the Uncharted series, where missions follow a three-act structure of rising and falling intensity.

There is no universal standard for this rhythm, which will vary depending on the game. Missions in *Uncharted 3* (Naughty Dog 2011), for example, follow a three-act structure similar to movies (Lemarchand 2012, 2021) (see Figure 6.1). Naturally, some games aim for a pleasant 'middle' experience, in which players never feel they cannot overcome the obstacles presented to them. Examples of these are zen-like games (e.g., *Flow* (Thatgamecompany 2006) or *Flower* (Thatgamecompany 2009)), puzzle games (e.g., *Monument Valley* (Ustwo Games 2014)), or simulation games (e.g., *Animal Crossing* (Nintendo EPD 2020) or *Stardew Valley* (ConcernedApe 2016)).

It is important to note that, even in lower-intensity experiences, there are still variations in attention demand and switching of attention between different areas (e.g., talking to characters, admiring visuals or music, movement, or (light) combat mechanics). Higher-intensity gameplay (e.g., fast-paced, reflex-based combat section) is more likely to saturate a player's attention quicker, requiring a careful balance with lower-intensity portions or shortening gameplay sections. Similarly, lower-intensity gameplay may sooner become dull.

However, the intensity of a game experience is not a defining factor in engagement or achieving other emotional or behavioural states. 'Flow' can be achieved in high-intensity shooting games, just as much as in a farming simulator (taking into account that player attributes, such as previous gaming experience and genre preference, also play a role). Both high and low-intensity gameplay can be considered equally effective in applied game engagement, depending on how they are used.

The examples above show how game design can manipulate attention to shape a player's experience. Game designers use everything at their disposal, including mechanics, environments, motion, stories, characters, lighting, visuals, and sound to grab and hold a player's attention, offer depth and variation, and structure and balance the player experience. This manipulation happens on different levels, both in the overall game structure and from moment to moment. In doing so, designers take care not to saturate players with different types of information but instead use the various aspects of design to enforce a defined and coherent player experience.

Figure 6.2: Intensity can vary considerably based on genre. Cuphead (a) presents hectic, high-intensity combat encounters coupled with low-intensity traversal. Uncharted games (b) vary from moment to moment, aiming for a rising intensity in every mission. Animal Crossing: New Horizons (c) is at a consistently low intensity with only slight variations (e.g., when trying to catch a fish).

Thus, in addition to mapping the areas of attention, it can be beneficial to map an applied game's intended rhythm in understanding how engagement occurs. Such mappings can aid analysis to see where a certain level of intensity is intended and whether it is being reached.

In the example of *CURIO*, the time students wait for the teacher to finish reviewing questions caused them to get distracted and disruptive. The low-intensity gameplay in

which they had nothing to occupy them was not enough to hold their attention. Thus, this moment where the teacher is distracted would lend itself to some higher-intensity gameplay (e.g., through a short mini-game) to hold the students' attention.

Some applied gaming projects may benefit from this approach more than others. Games that require putting a player under a certain amount of stress (e.g., Schoneveld et al. 2016; Mavromoustakos-Blom, Bakkes, and Spronck 2020), for example, could benefit from this mapping in particular. Naturally, a mapping of areas of attention will inform a mapping of intensity as well — certain areas of attention lend themselves more or less to a certain level of intensity.

6.2.2 Feedback and Guidance

Other ways in which attention can be 'used' to a designer's advantage is through feedback and guidance, particularly how information is presented to the player (Schell 2008; Bateman and Boon 2005). One way this is done is through user interface (UI) design. The general rule regarding interface design is that essential information is shown within the player's direct view, in the centre of the screen. Critical messages will often be accompanied by additional elements, such as visuals, sound, and animation, to create a stimulus that the player is unlikely to miss or ignore. Information that is less critical or only needed on demand (e.g., status indicators or menu buttons) tends to be distributed towards the edges of the screen, where the player will need to look for them actively (selective attention) to get the information.

To all general rules, however, there are also exceptions. An ongoing trend in UI design is the idea of an 'immersive' interface, where the goal is less to rely on prominent menu buttons that overlay the game but instead provide an interface that is somehow integrated with the game world. *Horizon: Zero Dawn* (Guerilla Games 2017), for example, presents its interface as a projection cast into the environment by a device worn by the main character, Aloy (see Figure 6.3).

While this means that information is less likely to distract the player from the gameplay, it can be challenging to keep such information readable. For example, when Aloy is about to be attacked by an off-screen enemy, a visual indicator will appear on the corresponding side of the screen to warn the player of this threat. While the indicator's position informs the player of the danger's direction, it is also more likely to be over-

Figure 6.3: Screenshots of Horizon: Zero Dawn (a) and Civilization 5 (b). Although each have different styles, they both show how information is hierarchically presented, with critical information (game action) given the focus in the middle of the screen and less critical information ordered along the sides in varying amounts. Information requiring attention is presented in bold colours, often using a combination of sound and animation as well.

looked by being on the edge of the screen. The designers compensate for this by using a contrasting colour, making the icon flash, and accompanying it with a sound effect.

This manner of design requires careful balancing between different considerations, always considering where to draw or direct a player's attention in critical moments and which importance to give information. Overloading the player with messages, sounds, and visuals would make it so that no information ever stands out. Not providing clear indicators of critical information, especially that which would negatively impact the player, would negatively impact the game experience. It could, for example, feel unfair to be knocked out by an off-screen enemy when the player was not given a clear indication of their presence.

While UI design provides clear examples of how a player's attention is directed across the screen, this is by no means the only way in which feedback and guidance are utilised in game design. Additionally, attention plays a large part in guiding the player through the game world itself. Multiple strategies (i.e., design patterns (Bjork and Holopainen 2005)) are utilised in designing virtual environments to direct the player towards points of interest, essential characters, quest locations, secrets and collectables. Completing collections or gathering currency can motivate the player to continue to play. They also indirectly direct the player through the environment and show them the potential for further gameplay.

For example, coins in *Mario* games have a functional purpose (e.g., gaining lives). However, they also show the player where opportunities in the environment may otherwise go unnoticed (e.g., the presence of a hidden path). This strategy is used in any game where players navigate a virtual environment, regardless of camera perspective, art style, or graphical fidelity. In addition to the placement of objects, designers may also use other design aspects of the environment, such as geometry, colours, and lighting (see Figure 6.4).

Analysing attention on this level requires granular breakdowns of a game's design, e.g., through detailed design documentation. For analysing and comparing applied games, it may only sometimes be worthwhile to break down the game's design to that degree. However, discussing how attention is manipulated in describing the game's design can provide helpful insight into engagement with that game. Awareness of how attention can be influenced on this level is required to achieve desired values, such as usability, accessibility, and clarity. The tactics can also direct the player between different areas (Section 4.7) of attention.

Figure 6.4: Screenshots showing different ways in which games guide attention within the environment. Journey (a) uses level design and camera angles to guide the player towards their goal. Glowing points of grace in Elden Ring (b) not only provide a point of interest from a distance, but faint trails hint at the next suggested location. High points in the environment furthermore act as landmarks. In Mario 64 (c), coins are not just used as a collectible, but also point out areas of interest in the environment, like a secret passageway.

6.3 Pilot: Game Development with Attention

The use of the Applied Games Engagement Model for analysing applied games was shown by retroactively applying it to three cases (Chapter 5). Although these analyses

were helpful for academic purposes, this does not guarantee they would be in development practice. They were, for example, time intensive to perform. They were only performed once the project had been completed and, thus, do not indicate how useful they would be in a work-in-progress. These limitations raise the question of how practical the model is when applied in game development.

To examine this, the AGEM was incorporated into an introductory university course on game development. The course was given over one semester as an elective course for third-year bachelor's and first-year master's students. Students joined the course from different academic backgrounds, e.g., Computer Science, Japan Studies, Archeology, Civil Engineering, and Psychology. Eighty-eight students actively participated in and completed the course with passing grades. While about half of the students had experience in programming, most had yet to make games before the course.

Together, student teams made a total of twelve games. Although the students were given the option to make an applied game, none of the teams chose to do so. The games are summarised in Table 6.1, and a screenshot for each game is included in Figures 6.5 and 6.6.

6.3.1 The Course

The course was given over fourteen weeks of active teaching, excluding an additional three weeks of development time before final submission. It was structured into weekly lectures that provided a broad overview of the various aspects of game development (e.g., game technology, game and level design, interfaces and input methods, user testing and bug fixing). Additionally, each week consisted of a workshop in which students could work on their assignments.

Aspects of the AGEM were gradually introduced to the students at appropriate moments. For example, a general game design lecture discussed areas of attention. In contrast, attention intensity and directing attention through game design were featured in several lectures (i.e., level design, UI design, and providing feedback). The notion of overlap and the integration of an applied purpose were topics reserved for a lecture that introduced the course's main project: creating an original game using Unity3D. The project commenced in week 7 of the course after the stu-

Title	Genres	Summary
Memory Game	Puzzle, Exploration	An atmospheric 3D first-person game in which the player solves puzzles to recover their memory.
Witchcraft	Puzzle, Life Simulation	A 2D simulation game where the player explore a city, gathers ingredients, and brews potions for clients.
Snow Boi	Puzzle, Exploration	A 2D game in which the player explores snowy woods, solves puzzles, and recovers presents to save Christmas.
Gravity Flip	Puzzle, Exploration	A 2D side-scrolling game, where the player navigates a spaceship by flipping gravity to solve puzzles.
Zombies on Ice	Puzzle, Reflex	A 3D top-down game, where the player outmanoeuvres zombies on an ice-skating rink for as long as they can.
Agrizio	Reflex, Exploration	A 3D first-person game where the player explores a medieval village through parkour platforming.
Explorer Karen	Puzzle, Exploration	A 3D adventure game where the player explores a jungle temple with puzzle-solving and platforming challenges.
Good Wizard, Bad Wizard	Puzzle, Reflex	A 3D first-person game in which the player is a wizard solving physics-based puzzles to escape a castle.
Attack of Greg	Strategy, Reflex	A tower defence game with a shooting mechanic where the player defends themself against waves of enemies.
Orpheus	Puzzle, Exploration	2D game where the player explores rooms and solves puzzles to escape the underworld while avoiding their wife.
Shadow on the Wall	Puzzle, Exploration	A 3D horror game in which the player explores an old house, recovering video tapes to reveal the story.
Danger Island	Strategy, Exploration	A 3D first-person survival game where the player gathers resources to craft traps.

Table 6.1: A list of all game titles created by the students as part of the course, including their chosen genres and summary.

dents had become familiar with the engine through individual exercises and smaller assignments.

Students were divided into teams of five or six members. Teams were formed in a way that they were comprised of students from different backgrounds and with varying skill levels (e.g., technical, artistic, design-based, and organisational). There were fifteen teams, out of which twelve decided to participate in this study. To be included, all team members had to give individual consent.

Teams were given freedom in choosing the type of game they wanted to make as long as the following requirements were met:

- The game had to have an applied purpose or with two genres (discussed further below).
- The game had to offer engaging gameplay for around 5-10 minutes. Students were encouraged to focus on making their game interesting for this duration rather than padding it with content (e.g., with extra levels). They could ignore replay value and only had to focus on making the game engaging for the first few play sessions. The game also had to be enjoyable for a casual audience, not including overly harsh or punishing gameplay. It should furthermore be self-explanatory — everything needed to understand the game and its mechanics was to be included in the game itself. With these requirements, students were guided into thinking carefully about their design and considering values such as accessibility, usability, and challenge.
- A maximum of 500 words of text was allowed throughout the entire game (including UI and credits). This limit prevented students from creating visual novels or games that were otherwise very text-heavy, forcing them to think of other ways to convey information or story and to build games with interesting mechanics or aesthetics.
- The submission had to be in a 'playable prototype stage'. No polished artwork or sounds were necessary, but the intended gameplay had to be clear. For example, feedback sounds should be used where needed, and visuals should help communicate game information. The game could not have any 'show-stopping' bugs and had to be playable from start to finish.

- Purchasing assets or 'build-a-game' packages (e.g., a pre-made platforming game that the students could modify) was not allowed. All used assets had to be self-made or freely available, and credits needed to be included for external content.
- The game had to run in browsers using WebGL, using a fixed resolution of 1280x720.

At the start of the project, students were given a choice to create an applied game following an external client brief or make a game incorporating two genres. The external client brief was of a virtual reality (VR) game to train healthcare workers in patient-centred care (discussed later in this chapter). However, none of the groups chose to do this for their assignment, with the primary reason being the desire to realise their own game ideas. The alternative was to choose two of five genres (Gómez-Maureira and Kniestedt 2018) to be incorporated into the game. The choices were:

- Exploration: The game design encourages the player to explore, whether spatial or conceptual. For this purpose, it was not sufficient to simply create a large environment. Instead, students had to think of game elements that work together to invoke a sense of curiosity and discovery.
- Life Simulation (Sim): The game design involved people's lives, e.g., by telling (or playing) their stories or including interactions of 'everyday' activities. Students were encouraged to find inspiration in the mundane and experiment with storytelling methods that do not rely on text.
- Puzzle: The game should present challenges requiring multi-step problem-solving skills.
- Strategy: A genre that requires players to plan their actions, often having to consider available resources (e.g., a form of currency, consumables, time, or space).
- Reflex: With this genre, succeeding in the game relies heavily on a player's reflexes or dexterous use of controls.

Instead of creating a game for an applied purpose, including two genres required students to make thoughtful decisions regarding player attention and incorporate different gameplay aspects to include those chosen genres best. The AGEM was only partially applicable to such projects (e.g., no extra-diegetic purpose was to be included). How-

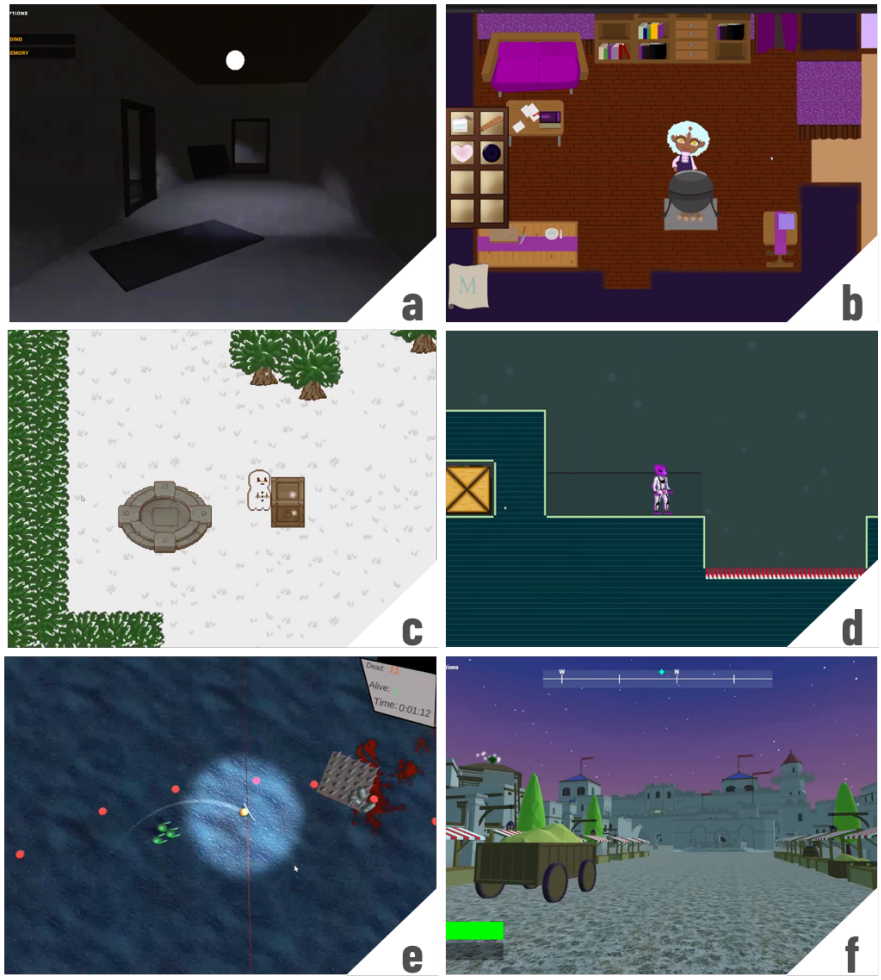


Figure 6.5: The first six student games: Memory Game (a), Witchcraft (b), Snow Boi (c), Gravity Flip (d), Zombies on Ice (e), and Agrizio (f).

Figure 6.6: The second six student games: Explorer Karen (a), Good Wizard, Bad Wizard (b), Attack of Greg (c), Orpheus (d), Shadow on the Wall (e), and Danger Island (f).

ever, it still required students to consider attributes (e.g., related to the intended player) and values to make design decisions based on attention.

Throughout the project, teams were regularly supervised by one of the teaching assistants in weekly meetings. Additionally, they could ask the lecturing team for feedback during workshops. At two weeks, each team gave a pitch presentation of their game idea, which served as a first moment of reflection. A 'work-in-progress' presentation was furthermore given at the seven-week mark. In addition to their final game submission, students had to prepare a video presentation in which they elaborated on their design. A required part of the video was visualising the game's 'rhythm', illustrating high and low intensity and attention demand. Teams also had to elaborate on three critical design decisions and how those decisions aimed at directing the player's attention.

6.3.2 Pitch Presentations

Out of twelve teams, eight chose the 'puzzle' genre. Out of these, six chose 'exploration' as the second genre. The remaining four chose 'reflex' as their first genre, with three choosing 'strategy' as the second. None of the teams opted for creating an applied game based on the external client brief.

Although the students only sometimes used the terminology proposed by the AGEM, they used various attention areas to communicate their vision during the pitch presentations. Some teams began their conceptualisation from specific ludic experiences focused on goals and mechanics (e.g., combining a tower-defence game with strategic and real-time elements). Others focused on an intended narrative (e.g., adapting a Greek myth) or on the affective experience (e.g., creating a Playstation 1-era horror game to elicit fear and discomfort).

Some areas of attention were mentioned, but rather in service of others instead of being the primary focus. For example, characters (shared involvement) were generally mentioned as part of the narrative, while kinaesthetic involvement was considered part of the ludic or affective experience. One team, for example, suggested a free-running parkour game (*Agrizio*) where the aesthetic experience revolved around a sense of speed. Similarly, the team that pitched *Zombies on Ice* discussed how ice-skating to escape zombies should feel graceful and satisfying and that the zombie horde chasing the player should 'move like a snake'.

Figure 6.7: Presentation slide for the game Danger Island, showing an intended intensity 'curve'.

Teams that chose the 'puzzle' genre did not discuss structuring the game experience or directing the player's attention. Instead, puzzles were presented as an undefined element of the game. Enjoyment from solving those puzzles was presented as a given and a design aspect to be figured out later. This lack of specificity was in contrast to teams that chose other genres. Although only one team had visualised their intentions for the player's attention demand using an intensity curve at this stage, three teams discussed how the intended play session would be structured. They presented different game phases (utilising different areas of attention) that would alternate or be presented in a sequence (see Figure 6.7). While they were all different, each team had clear plans for the mechanics involved and the intended gameplay experience for the requested play duration.

The game ideas sometimes showed a 'mismatch' in attention areas. For example, the character of Ghost Boi (a ghost) would solve puzzles by moving boxes, despite the general understanding that ghosts are incorporeal and do not normally interact with physical objects. In *Witchcraft* (see Figure 6.8), the player would solve trial-and-error logic puzzles to brew potions. These were intended to function in the style of the board game *Mastermind*, where the player needs to deduce a sequence of symbols by trying differ-

ent combinations and being informed whether their guesses are incorrect, correct but in the wrong location, or correct. The narrative of the game described a witch running a potion shop, resulting in a disconnect between narrative and ludic goals, which implied that the witch had to deduce her own recipes through trial and error rather than discovering potential recipes through free experimentation.

A similar issue was in *Orpheus*, following the Greek myth about a man who tried to rescue his wife from the underworld. While she was allowed to leave the underworld, she had to walk behind Orpheus as she did, and he was not allowed to look back. When he did so, he doomed her to stay in the underworld forever. While the team aimed for a dramatic retelling of the tragedy, the proposed mechanics required the player to actively dodge the wife as she purposefully tried to get in his way while solving puzzles. This premise suggested a more comedic take on the story. While discrepancies like these were pointed out as feedback, teams were not told whether or how to address them.

Based on the intended experience and target player, teams also began formulating their first values. As explained previously, values such as accessibility and usability were imposed upon the teams through the project brief. Students also added their own values, e.g., agency, game feel, creativity, challenge, and curiosity. However, formulation of values was rare, and they often blended with descriptions of the intended player experience. In addition to communicating the game's basic concept, teams were primarily concerned about potential development challenges and how to manage them should they arise — as expected from an introductory course. Overall, two weeks into a ten-week project, there was a limit to how much the theory could be fully applied.

6.3.3 Final Submission and Video

For the final submission, teams were graded on their concept (originality and complexity), gameplay (flow/game feel, challenge/progression, integration of genres/purpose), implementation (aesthetics, sound/music, self-explanatory/tutorial, feedback), and stability (performance and polish).

All teams received a passing grade for their final submission. Pitch presentations gave a general indication of final performance — while the visual quality of presentations, as well as the polish in terms of stability and implementation, varied, those who man-

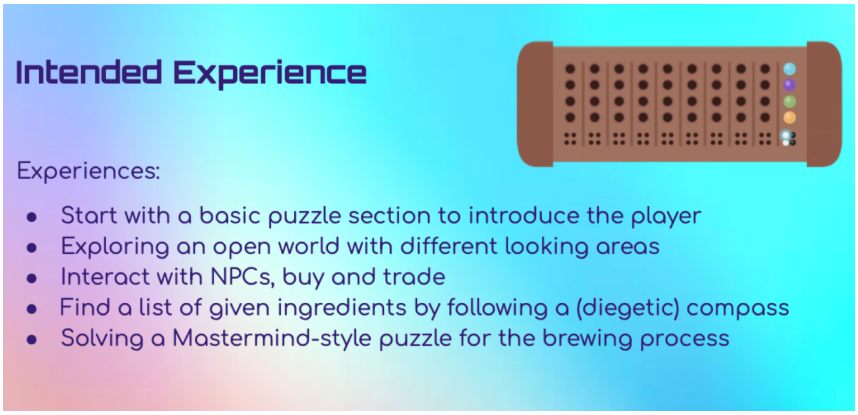


Figure 6.8: Presentation slide for Witchcraft, where the team identified distinct sections of gameplay to create rhythm.

aged to articulate a clear vision in the pitch presentations also achieved above-average scores for concept and gameplay. These projects — *Danger Island*, *Zombies on Ice*, and *Attack of Greg* — had stayed much the same in design from their original concept as it was pitched five weeks prior. All of them were reflex/strategy games focused on ludic involvement.

Others could implement the feedback given during pitch presentations to improve their concepts. Ghost Boi became Snow Boi in a Christmas-themed adventure, and the *Witchcraft* team exchanged the 'puzzle' for the 'life sim' genre, changing the brewing of potions to a combination of short interactions similar to cooking games like *Cooking Mama* (Office Create 2006). The *Orpheus* team decided to keep their chosen genres the same and instead leaned into the comedic aspect of their concept through visuals and dialogue lines.

Despite these differences, there was no clear correlation between the clarity of early designs and the final score. While some puzzle games that started with less defined concepts ended up being highly graded, other games with more robust initial concepts needed polish regarding implementation and stability.

All teams reflected, in varying degrees, on how the areas of attention were used to enforce the game's intended experience. Similarly, they pointed out instances in which

the player's attention was directed more precisely, e.g., through interface elements. While most teams included a visualisation of attention intensity in their videos, sometimes reflection on it was limited. In these cases, while the curve was present and accurately reflected the game's structure, the team did not use it to discuss their design in more detail — for example, the presentation would be limited to stating, "this is the attention curve for our game", before continuing. Four teams that provided more in-depth reflections are discussed below.

Figure 6.9: Final submission of Witchcraft, with a clear intended attention curve and distinct sections of gameplay (exploration and potion cooking).

Witchcraft: In their video, the team discussed how the variation of mechanics (exploration, fulfilling requests from characters and collecting ingredients, and mixing potions) was structured to switch between different areas of attention and prevent boredom in the player (Figure 6.9).

They also discussed how the background music, which starts calmly, increases in speed over time to signal the time-based aspect of crafting the intended potion before the potion shop needs to close. They also discuss a design challenge in directing the player's attention during exploration without taking away their freedom or sense of curiosity. Their solution was implementing a 'scrying' mechanic on the world map, where a flame can reveal the approximate location of ingredients. Similarly, the locations where ingredients can be found are highlighted with sparkles once the player is close enough.

The team discusses how the inclusion of the puzzle genre did not fit their intended affective involvement of putting the player in the role of a modern witch and the decision to instead focus on the tactile game feel of cutting up and cooking ingredients.

Figure 6.10: Final submission of Gravity flip, with a rising intensity curve as difficulty of puzzles increases and the narrative turns more serious towards its conclusion.

Gravity Flip: In this game, the player explores a space station and solves puzzles by flipping the gravity up and down (Figure 6.10). The team combined the puzzle and exploration genres; puzzle rooms are alternated with 'traversal' and 'narrative' rooms.

Attention shifts from section to section, with an increase in difficulty resulting in higher attention demand as the game progresses. These sections are distinct through visual cues. Stark, empty areas during puzzles allow the player to focus on the presented challenge, and more detailed art can be admired in narrative sections.

The team also reflects on how they wanted to include a jumping option for more possibilities in puzzle design but disincentivised the player from using it by making it intentionally short and awkward to use. While such a decision could impact engagement (e.g., through the attribute of 'game-feel'), it was offset by making the main mechanic, the gravity flip, satisfying to use and, thus, the preferred method of traversal.

Finally, they discuss the design of the levels and how the player is guided through the maze-like environment through doors that unlock in sequence and other landmarks to prevent them from getting lost.

Attack of Greg: This game combines strategy and reflex genres in an action-based, 'tower-defence' game (similar to, e.g., *Plants vs Zombies* (PopCap Games 2009)). Players defend their kingdom on the right side of the screen while the enemy army attacks along three lanes from the left (Figure 6.11). The player purchases units with specific strengths and weaknesses in anticipation of the incoming attack and then deploys

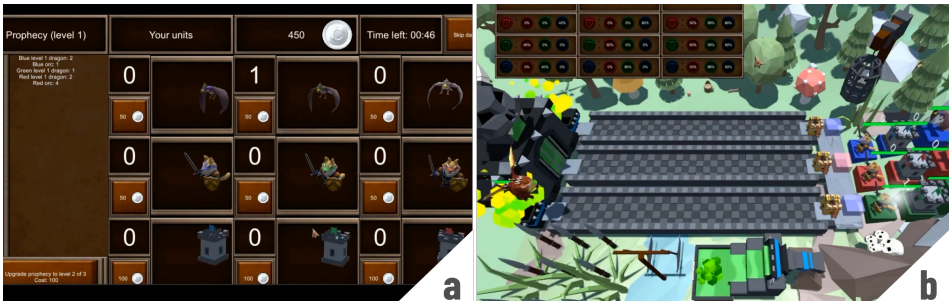


Figure 6.11: Final submission of Attack of Greg. While the team forgot to include an attention curve visualisation, they used the theory to reflect on design decisions and how rhythm was created in the game through distinct game phases.

those units as the attack unfolds. In doing so, the game requires both advanced planning and in-the-moment action while defending the kingdom.

The game is structured in planning ('day') and action phases ('night'). Attention demand rises through the layering of mechanics (i.e., strategic use of units, placing units, and real-time shooting) and the complexity and scale of enemy attacks. The intensity of these sections rises over time as enemy attacks rise in danger and are alternated with calmer 'day' sections of purchasing units.

Danger Island: A similar structure to *Attack of Greg* was used in *Danger Island* (Figure 6.12), which also used a day/night cycle (using audio and visual cues) to signal times of higher intensity and lower intensity on attention demand to the player.

The player is stranded on an island, and their goal is to leave. During the day, they collect resources and use them to craft traps, while at night, they defend themselves from attackers coming out of the water. At night, the temperature goes down, causing the player to freeze if they are not close to the fire on the beach. This mechanic forces the player to return to the area where they will not die of hypothermia but will be attacked by enemies.

The fire, in itself, helps to direct the player back to the beach area and not get lost. Similar to *Attack of Greg*, *Danger Island* uses a combination of real-time mechanics (i.e., hitting enemies) with strategic elements (i.e., placing traps), increasing attention demand in those sections of the game.

Attention is further directed on a lower level by highlighting possible trap positions and resource locations through visual cues.

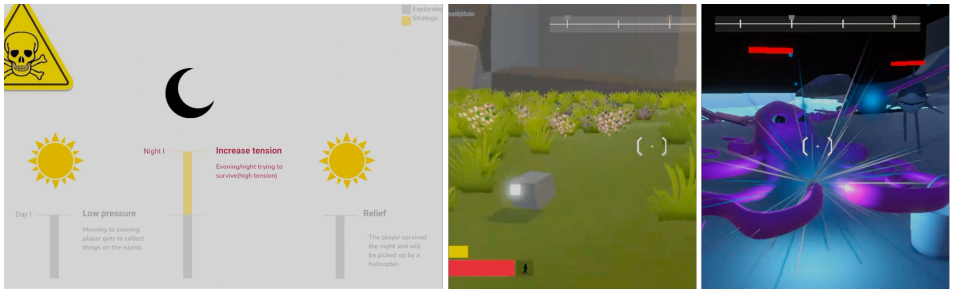


Figure 6.12: Final submission of Danger Island, with a clear separate between day and night. Due to limited time, the team focused on a single day cycle, with the intention of adding more days with increasing intensity as described in the pitch.

6.3.4 Meta-Analysis

None of the teams chose to develop an applied game based on the external client brief. Reasons for this included that students expected it to be too tricky, negative perceptions of applied games in general, and students simply wanting to create 'their own' ideas for entertainment games. As such, the observations made during this pilot study could not fully inform how the AGEM may be used in game development. However, other parts (i.e., areas of attention, attention intensity, and using attention for feedback and guidance) of the theory were used and tested.

From observing the teams, it is possible to see how some aspects of the theory were successfully applied while others proved more difficult to comprehend or simply less practical. Few of the students involved in these projects had prior experience creating games. As such, they had to quickly familiarise themselves with the many complex tasks of game development, e.g., design, programming, creating art, and user and bug testing.

Twelve playable (and even entertaining) games were delivered, which should be considered a success. The addition of the AGEM was intended to help the students rather than burden them. As such, use of it was not enforced beyond its being integrated into the curriculum. This pilot can, therefore, primarily serve as an exploratory study that

illustrates which parts of the theory were more and less valuable and at what point in development.

Areas of attention: Teams did not utilise all areas of attention equally. Each started their design process from a particular angle: how the game played, what the story was, or what the emotional experience was meant to be. The more specific areas of attention were used to define each of these more general categories further. For example, characters were usually presented as part of the narrative. Attention focused on movement could be considered a natural extension of the mechanics, while enjoyment derived from the movement was also mentioned as part of the affective experience.

These general categories align with existing game design approaches, separating game design into gameplay, social, and affective aspects (Lemarchand 2012). No approach necessarily led to a better result; thus, each could be considered equally valid. By assessing how their design decisions related to the different (simplified) areas of attention, teams could pinpoint issues in their design and adjust their plans during development.

Balance and rhythm: Each game had a different balance of the various areas (e.g., using gameplay in service of affective involvement or the other way around). Few games were heavy on narrative (partly due to the limitation on word count), using characters and narrative in support of the other two areas. Teams were reflective of these decisions in their video submissions. They also used the video submission to describe how various design aspects worked to guide the player's experience.

Most common were awareness of attention overload, for example, in tutorials and the presentation of important information. The teams that included visualisations also discussed alternating moments of calm with moments of (relative) intensity (relative). Some teams did not discuss these visualisations in detail, suggesting they included them for the sake of the assignment rather than that it was of inherent value to them during the design. This omission occurred primarily for games that aimed for a less intense experience (e.g., casual puzzle games).

Despite this, teams still used the visualisation to reflect on the balance between different game sections (e.g., having a room with narrative elements between puzzles). Teams with more intense intended affective experiences (e.g., fear or stress) were more

reflective using their visualisation. Balance and rhythm were considered helpful during development in varying amounts, depending on the team and their design.

Feedback and guidance: Teams generally followed rules of visual attention, for example, placing user interface elements on the edges of the screen and essential information in the centre. Multiple feedback methods were used to communicate information (e.g., sound, visual, motion). While many games could have been more polished, most were self-explanatory and communicated their functionality well. Given more time, further iterations of testing and adjusting could generally lead to improvements. As such, this aspect of attention is generally more important in the later stages of development.

In summary, different ways in which attention factors into game design were used, depending on the game design and the stage of development. Areas of attention as proposed in literature did not appear completely practical in development, yet knowledge of the areas helped reflect on design decisions. Structuring the game experience is either related to balancing areas of attention, levels of intensity, or attention demand. It depended on the game how helpful the latter was, in particular. Considering how to direct the player's attention on the screen was always beneficial, but only in the later stages of the projects.

Finally, one key observation is that none of the theory, in itself, helped in generating game ideas. Teams would start from one area of attention in particular, further defining other areas throughout the development. Fairly soon, it was possible to reflect on ideas using the theory. However, it seems essential that some design work has already taken place before the theory can be meaningfully used.

6.4 Study: AGEM in Applied Game Development

The aspects of designing for attention tested by the students in the pilot are of particular importance in designing the diegetic systems of an applied game. The following section assesses the complete AGEM, using the same design theory but with the addition of an applied purpose and, thus, the notion of overlap between purpose and game engagement.

Stakeholders from two applied game projects participated in guided design discussions. Both projects were ongoing at different institutions, each having undergone a design and development cycle resulting in a functional prototype. However, both projects were discontinued at this stage due to different circumstances. The projects were then continued by people other than the original developers, who identified several issues with the existing design. At this stage, they met with the author of this thesis. It was an opportune moment for the AGEM to be applied and assist them in taking the projects further, evaluating the AGEM itself in the process.

6.4.1 Case 1: Person-Centred Care (PCC)

The first case study was developed by the Trimbos-institute (a research institute focused on addiction and mental health) with the aid of an applied game developer. It was offered as a potential project for the students in the pilot study, as the stakeholder was looking for ideas to improve the existing game design. As previously discussed, the students did not opt to make an applied game. However, the stakeholder agreed to participate in this case study to improve their game and evaluate and refine the AGEM separately from the course.

The applied game is a virtual reality (VR) based training software aimed at training health workers caring for people with dementia. The game's purpose is to train players in person-centred care (Fazio et al. 2018) by placing them in the role of a carer working in a nursing home. The cornerstones of person-centred dementia care focus on making the patient feel comfortable and included, respecting their personality and identity (e.g., adjusting care based on their background), and fostering a sense of connectedness and belonging. The indirect consequences of this approach are improved quality of life for the patient, e.g., by lessening agitation and improving self-esteem. Additionally, this way of working has also been shown to improve the well-being of health professionals themselves, lowering stress levels and increasing work satisfaction (Barbosa et al. 2015; Edvardsson, Sandman, and Borell 2014; Fazio et al. 2018).

The game consists of short narrative scenarios that the player must resolve by choosing one of several options (see Figure 6.13). The presentation of these scenarios happens through a combination of visuals, text, and sound. For example, a scenario may present the player with the situation that they encounter a patient in distress while on their way to wake another of the nursing home residents. The player sees the woman crying

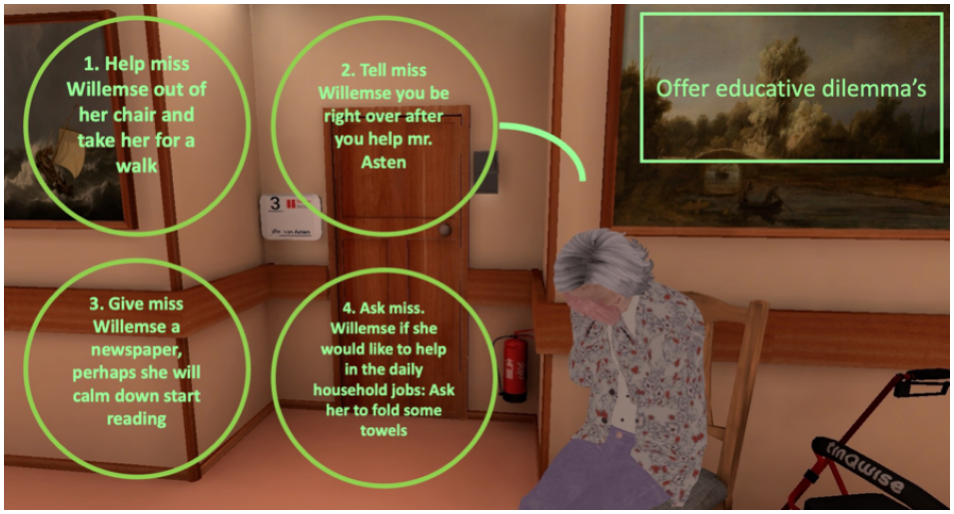


Figure 6.13: A prototyping image of PCC, showing the visual style of a character and the environment, and a potential dilemma that a player may be faced with. i.e., 'How to comfort miss Willemse'.

(emphasised by animation and sound) and is told the scenario premise in text and by the voice of an omnipresent narrator. They may also hear an 'inner monologue' of the player character, wondering what to do. The player must then choose whether to help the woman or continue with their task of waking the other resident.

Only one option is considered the correct answer based on the principles of person-centred care. In the case of the example in Figure 6.13, the correct answer would be to check on the crying woman. After choosing correctly, the scenario continues with another choice-based situation on how to deal with the crying patient. In case of a wrong answer, the player is informed of their mistake and educated on the correct choice. The scenario then continues as usual. Once the situation with the woman is resolved, the player will continue to wake the other resident, resulting in another short scenario.

Players are informed of their success through a score at the end of the scenario, and they receive further relevant information on person-centred care. The entire game consists of multiple of these scenarios. It incorporates a realistic 3D art style, using sound and simple animations to emphasise the characters' actions.

The project was inactive for some time until a new stakeholder picked it up. As identified by the new stakeholder, issues with the original design were primarily related to the game being ‘’not very much like a game’’. Especially the allocation of arbitrary points and the restrictive nature of the scenarios were considered inadequate for the subject matter of person-centred dementia care. At the time of the design discussion, the new stakeholder was intent on developing the game further but had few specific ideas on how to approach this.

6.4.2 Case 2: When Life Gives You Lemons (WLGYL)

The second case study was developed as part of an MSc graduation project (Libbi 2021). WLGYL is a 2D role-playing game (RPG) aimed at teaching girls with autism about emotions and social skills. Through multiple co-design sessions, the game prototype was designed with input from domain experts and the target audience.

In the game, the player takes the role of a young girl going to summer camp on an island. Her goal is to make good memories while she is there (see Figure 6.14). She is given this task by a magical cat, with the ultimate goal of unlocking the island’s secrets. Memories are made by exploring the island and talking to other characters. Talking to characters presents the player with narrative scenarios in which they must make a series of choices based on different emotional responses. The player can acquire experience in specific emotions and social strategies (e.g., confrontation, avoidance), which will influence some choices.

The scenarios encourage the player to explore the effects of choices and learn about different social interactions. Through interactions, the player unlocks ‘memory cards’, which provide further information on emotions or social strategies. The original concept intended for the player to be able to travel back in time and repeat social interactions to try different options. However, this was not implemented in the prototype.

Another group of MSc students subsequently continued development and set out to evaluate the game. In order to do this, the existing prototype required additional functionality and content. The new group was advised by the previous developer, their supervisors, and a research group of domain experts. They determined that the initial game’s design was too complex by attempting to combine multiple applied purposes, i.e., teaching about and training emotion regulation and social skills. In order to focus

development, they decided to limit the game's scope to anger coping mechanisms. At the point of design discussions, they faced difficulties managing the input from several stakeholders and needed help to evaluate the impact of their design decisions.

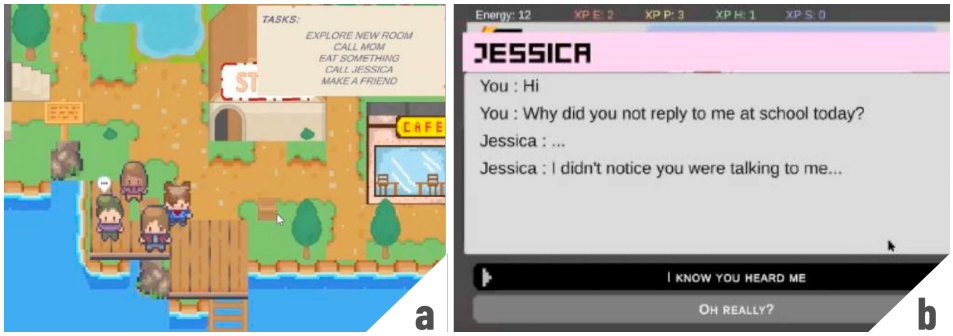


Figure 6.14: Screenshots of the When Life Gives You Lemons prototype, showing island exploration (a) and dialogue sections (b).

6.4.3 Design Discussions

Design discussions were held to answer the same questions as those proposed at the start of Chapter 5. This process was meant to map the existing design and bring to light inconsistencies between the applied purpose and the existing diegetic systems, and highlight potential areas for improvement. While the existing questions were used to structure the discussions, they were kept open enough for stakeholders to add their own. Any other questions or topics that arose naturally throughout the discussion were catalogued to extend the analytical process proposed in the previous chapter.

Thus, the discussions followed the following general structure: The applied purpose of each project was discussed without specific regard for the existing design to clarify the project's exact goals and how the applied game was meant to serve them. Elements of the extra-diegetic purpose and related attributes and values were formulated. The existing diegetic systems from the prototype were analysed regarding overlap and their impact on these elements and values. Improvements in the diegetic systems were discussed regarding attention, rhythm, feedback and guidance.

Design discussions took place after the pilot had concluded. Based on the observations made during the pilot, the simplified areas of attention (gameplay, social, and affective)

were used during discussions in addition to the original six. This inclusion was intended to assess whether the additional areas would help to facilitate discussion or whether stakeholders would similarly prefer the simplified ones.

Discussions were hosted by the author of this thesis, a researcher and applied game developer. Multiple stakeholders were involved in the case of WLGYL, who primarily discussed the game amongst themselves using AGEM with less involvement from the researcher. PCC involved a single stakeholder, causing the researcher to take on a more prominent role. However, all discussions were collaborative. The researcher answered questions if aspects of AGEM were unclear or prompted the stakeholders with questions to consider specific topics and trigger reflection.

Visual aids were used in the form of a (physical or digital) whiteboard to which both the researcher and stakeholder(s) could add information (Figure 6.15). The discussion was kept open for stakeholders to ask questions, amend the theory to suit their needs or add thoughts and ideas that had yet to be disussed. Similarly, the researcher could add or adjust questions and topics of discussion when the situation called for it. Although all stakeholders had some familiarity with (applied) games and design, none had extensive experience with either designing or studying them.

Defining the Purpose and Extra-Diegetic Elements

Discussions began with defining the intended applied purpose, which, in turn, resulted in determining the games' goals and target audience. This process was a challenging exercise for the stakeholders. In order to help along the discussion, additional questions arose to help them consider various aspects of the applied purpose. Examples include asking them what goals the game was meant to address through direct interaction with the diegetic systems and indirect goals that should be achieved as an extension of playing the game.

In the case of PCC, for example, the immediate goals related to educating on and experimenting with aspects of patient-centred care, while indirect goals related to the internalisation of this knowledge and participants using it in practice. In order to make the applied purpose more specific, metrics of success were also considered (i.e., how to measure and know that the game was fulfilling its purpose).

Despite both projects previously having gone through a significant design and development phase, discussion of these topics unearthed multiple points of confusion or disagreement. While the target audience was relatively defined in both cases, the question of extra-diegetic purpose elements (e.g., play conditions, physical environment, and facilitators) had also not been considered.

Both applied games were assumed to be standalone products used by their target audience, seemingly, 'just because'. In PCC, this raised the question of whether healthcare workers would autonomously decide to put on a VR headset (either at home or in the workplace) to learn about person-centred care or what would keep them from doing so. A similar discussion took place in WLGYL on whether the game should be used with a therapist. In both these discussions, the notions of time and frequency arose, i.e., how often and how long the game should be played.

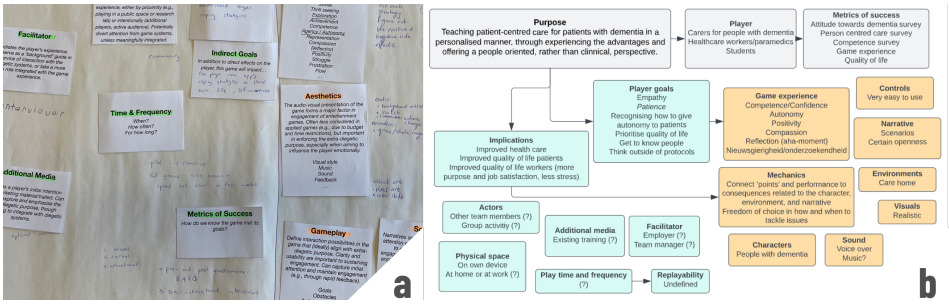


Figure 6.15: Visual aids used during design discussions of WLGYL (a) and PCC (b).

These factors had yet to be a point of consideration in either project. However, they led to extensive discussion on the design implications of various decisions and how the context could be more meaningfully integrated into the game's design. For example, the option of integrating the PCC game into existing (non-game) training programs teaching person-centred care was discussed. This group setting would make VR only valid if the functionality to project the player's view onto a screen for a group to follow along were added.

In both case studies, the act of reflecting on the applied content the player was being presented with was also an essential element. This consideration brought up discussions on whether the games would benefit from being played over multiple sessions,

allowing players to let the information sink in, put what they had learned into action, and see the consequences of their actions. In WLGYL, new additions to the diegetic systems were furthermore considered to inspire reflection, e.g., the inclusion of a character that could help the player reflect on their past week (in the case of weekly play sessions).

Mapping the Overlap and Areas of Attention

By mapping the original design, the aim was to establish where there was an overlap between applied purpose and diegetic systems in the current prototype. The goal was to lay out the design transparently and assess where the perceived issues originated.

Both prototypes heavily relied on narrative/shared (i.e., 'social') involvement to serve their purposes. The clearest overlap between purpose and systems lay within the narrative scenarios, where players were exposed to the educational content through the story and characters and made choices to learn more about it. However, the overlap was limited in the remainder of the design. This observation is illustrated through the mapping as it was performed for PCC, seen in Figure 6.16.

The WLGYL prototype did alternate narrative sections with moments of exploration. Although this had little overlap with the purpose, it did introduce rhythm into the game structure by switching attention to a different type of gameplay and allowing for moments of 'downtime'.

Additions similar to this were discussed in the context of PCC. Changes aimed to bring variety to the experience and provide players with the agency to learn about the characters and make informed choices. Rather than throwing the player into one narrative scenario after another, the possibility of a 'hub' environment (e.g., a staff room) was discussed. Another idea was to allow players to freely traverse the nursing home environment to fulfil a list of tasks (i.e., scenarios) that could be tackled in different orders. This change could break up the gameplay, and it also opened up the design to include other elements.

For example, one of the issues identified by the stakeholder was that players were given limited or no information before starting a scenario that would help them make informed decisions based on the principles of person-centred care. Such an issue could be addressed by adding helpful characters (e.g., 'colleagues') that provide information

on the theory of person-centred care. Additionally, other ways of getting information about the fictional nursing home residents (e.g., through non-scenario conversations or finding 'clipboards' with notes) could be added. Adding sections in which the player can explore and encounter such interactions would create more rhythm in the gameplay and potentially increase the relevance of the game experience.

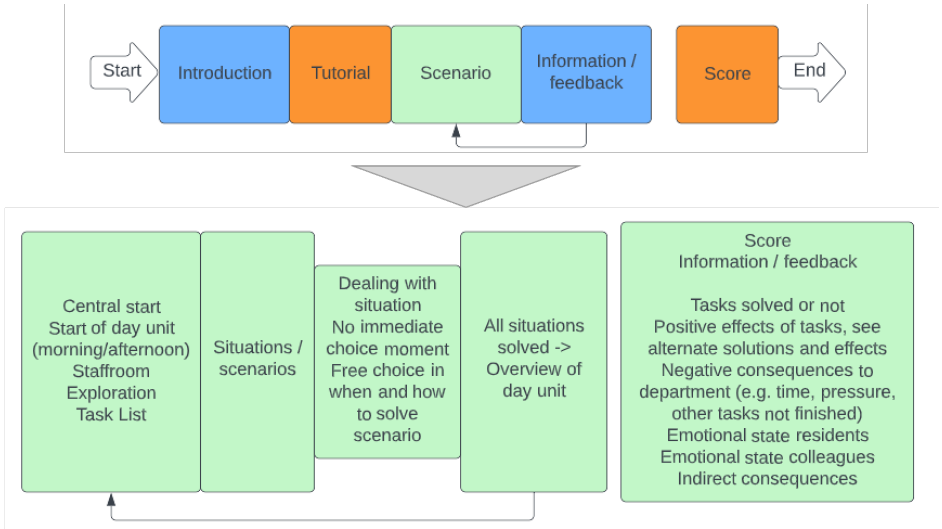


Figure 6.16: The original mapping of areas of involvement per game section in PCC (top), versus the new mapping based on proposed design changes (bottom) Orange signifies primarily game engagement, blue signifies primarily purpose engagement, green shows synergetic overlap.

While both games used gameplay and social involvement to some extent, affective involvement still needed to be addressed. Art styles were chosen either for realism (PCC) or to be reminiscent of other styles considered appealing to the target demographic (WLGYL) rather than invoking a defined emotional experience.

The WLGYL team had some ideas on the emotions they wanted players to feel (e.g., anger and relief) but still needed to consider how to elicit such emotions through their design. The stakeholder in PCC still needed to consider the player's emotions before the design discussion, even though the target audience experiences deep and varied emo-

tions when dealing with their clients. In both cases, discussions on affective involvement led to amendments to the original design.

The WLGYL team considered how the game's aesthetics could enforce the emotional experience by emphasising what characters (including the player) were meant to emote. For example, in addition to informing the player through text, they also considered shrinking the character portrait when they felt uncertain or insecure or enlarging them using animations and changes in colour to convey anger. While such additions could be made even more impactful through custom portraits with different expressions and musical cues, the team had to balance increasing their affective experience with their available time and resources.

Both games also used some form of points as feedback for the player. PCC gave players stars based on their performance in a scenario. In WLGYL, in addition to points, the player could collect 'emotion cards' that gave information on specific emotions. Although these had some extra-diegetic relevance, they had no other function in the game.

In many applied games, points serve as both an indicator of success and a motivator for improvement. In both case studies, however, the stakeholders wanted to change the original design's utilitarian approach to points and collectables. Through discussion, it became clear that this was partly due to the sensitive or emotional topics the games aimed to address. In the context of person-centred care and emotion regulation in children, the feeling was that judging a player's performance through a simple point-based mechanic was detrimental to the critical topics the games aimed to serve.

Through the AGEM, this dissatisfaction was explained through the value of *relevance*, which the stakeholders deemed negatively impacted by the 'trivial' use of points as part of the diegetic systems. The stakeholders also questioned whether players would experience the intended reflection on their behaviour based on points as a primary feedback mechanism. In PCC, it was considered likely that, rather than reflecting on the scenarios and applied content, players would be motivated to find the 'correct' answer to gain a good score (Hung 2017).

In order to address this perceived issue with relevance, the stakeholders considered ways in which the evaluation of players could become more meaningful. Discussions

focused on shifting the area of attention from ludic involvement (points) to affective involvement by contextualising the feedback given to the player. In WLGYL, stakeholders decided to use the emotion cards as a gameplay mechanism by allowing the player to use previously collected cards and 'put them into practice' in subsequent conversations. This change elevated the cards from feedback to an active component in the game's mechanics, allowing for further integration of the purpose. They also considered changes to the game's progress screen, visualising the extended effects of the player's decisions on how skilled they became in coping strategies and the overall camp atmosphere.

A similar discussion took place for PCC. The consequences of person-centred care go well beyond the 'performance' of the practitioner. Rather than a simple score, decisions by the player could show the impact on the happiness of the nursing home residents and the player character's well-being. On the other hand, spending more time with a client could negatively impact other factors, such as being able to finish other tasks or increasing pressure on colleagues. Incorporating such elements in the feedback would make the benefits of practising person-centred care more tangible to the player, could inspire reflection beyond the educational information offered by the game, and spark discussion outside the game environment (e.g., about aspects of a department preventing practitioners from working more person-centred, like time and budget).

Ideas like these were partially fleshed out within the design discussions, as the researcher and stakeholders required additional information on the topic (e.g., circumstances in nursing homes). However, such topics were considered suitable to discuss in a co-design session with the target audience and other stakeholders using the AGEM.

6.4.4 Meta-Analysis

Both the case studies described in the previous section started by considering applied purpose being turned into suitable diegetic systems, which is in line with many applied game design frameworks. This approach could have resulted in better designs, as should be expected. After all, the first iteration of an idea is rarely the last. However, it also left stakeholders needing help with how to diagnose issues with their games and continue development. While different issues were diagnosed in both cases, us-

ing AGEM helped to identify a lack of connection between the different aspects that, together, shape engagement.

General Process and Application of the Model

To some, the retelling of the design discussion above may read as relatively unstructured, especially compared to the more rigidly framed analyses presented in Chapter 5. However, this 'messiness' accurately reflects the nature of the discussions as they took place.

Although the same questions were used as a guideline, conversations with the stakeholders often diverged in various directions before returning to the model's main structure. Ideas would also come and go throughout the session. Some were noted for future consideration, while others were dismissed. The stakeholders also ran into issues while discussing design that did not occur during previous analyses. For example, formulating the game's applied purpose posed more of a challenge, prompting the researcher to ask more questions to help the stakeholders consider relevant factors. While this interference makes the case studies a less 'clean' evaluation of the AGEM, it is also inherent to a research-through-design approach of continuously shaping theory through practice (Zimmerman, Forlizzi, and Evenson 2007) and helped to both further develop the applied games being studied and the method itself.

While this process partially unearthed factors that strengthen the model, it is also necessary to note that, to be relevant in design practice, the model requires a certain kind of flexibility. The discussion topics would move back and forth between aspects of the diegetic systems and those of the extra-diegetic purpose. In these conversations, attributes and values were used to contextualise decisions made on either end.

Neither of these sides was fixed at this stage, as it was in the finished games in Chapter 5. While the structure proposed in the previous chapter helped ensure all aspects of the game were discussed, it is more fruitful for stakeholders to have freedom in applying it as they are still shaping each element. During design, the AGEM should allow for free iterations of both purpose and systems, using the attributes and values to reflect on design decisions that affect them both. While this was already the case when using the AGEM for analysis to ensure no critical factors are missed, it is even more essential in the design context.

Similarly, it is optional for the graphs and other visualisations produced by the model to be fully rendered and organised. Visualisations generally helped make design decisions and the consequences of those decisions more tangible to the stakeholders. However, they also only had to be as 'good' as was required to allow for clear communication between all parties. Due to the changing nature of the discussion, it was better to make quick sketches that could be changed on the fly rather than spend time making them perfect.

Finally, while stakeholders tried to use the terminology of the model, they also frequently used more colloquial language during discussions. The extra-diegetic purpose was commonly referred to as 'applied purpose' or simply 'purpose', while diegetic systems were generally discussed as 'the game'. The terminology was proposed in Chapter 4 to avoid confusion with other terms, and for academic purposes, it would still be considered essential to use it consistently. For design, however, less academic language may be preferred.

The above observations are backed by those made in the pilot study. Students used different ways of visualising attention in their presentations, some more polished looking than others. Nevertheless, the teams managed to use them to communicate their design decisions. When applying the AGEM and its related theory in practice, the freedom to apply it and adjust it to the project's needs is vital.

Observations on Aspects of the Model

Extra-Diegetic Elements: To a large extent, the extra-diegetic elements proposed in Chapter 4 adequately covered those required in discussing the case studies. In the case of PCC, for example, the larger context in which the game was to be situated could be described using a combination of physical location, actors, facilitators and the potential involvement of additional materials, like a training course.

There were other potential aspects to the extra-diegetic purpose as well, such as work culture and a manager's influence in valuing training programs or a game-based intervention. Part of applying the model is to draw a line where a potential extra-diegetic purpose element is actively capable of influencing the player's attention and engagement or whether it relates more to the applied game being put to use in the first place.

For example, a manager or department head was not included as an extra-diegetic element in the visualisations in PCC. However, their potential relation to employees practising person-centred care was considered to contextualise feedback in the game. For example, they can represent an overarching presence that requires the player to perform specific tasks in time, which may conflict with some person-centred care principles that are more time-consuming.

Values: In discussions on extra-diegetic elements, the notions of intended *playing time* and *playing frequency* emerged as particularly important. With attention demand and instilling moments of reflection, these could be considered values influenced by design decisions of the extra-diegetic elements and can be added to the list of common values to be considered.

Mapping the Overlap: Mapping the game's intended elements or sections of gameplay helped to visualise where there needed to be more meaningful integration between purpose and game systems. This exercise particularly helped identify where perceived issues with the existing design originated. In the case studies, the lack of overlap was especially noticeable in the feedback systems. It also clarified whether and when a game could benefit from (out-of-game) reflection moments or whether the experience was potentially more monotonous than intended through the singular use of an attention area.

Attention Areas, Rhythm and Affective Involvement: The consideration of balancing the different areas of involvement flowed naturally from mapping the overlap. A varied experience is required to keep players engaged and willing to focus on the learning content. This variety can be achieved through gameplay and social involvement. However, affective involvement should also be utilised. It is recommended to search for aspects of a project's design in which that third area of attention, in particular, can be better utilised.

As hypothesised in Chapter 3, applied games could benefit from increasing players' perceptions of 'usefulness' by integrating the applied purpose into the diegetic systems in various ways. One way of doing this, as was considered in the design discussions, is to integrate the extended effects of the game's learning content into the feedback systems. Feedback mechanisms, in particular, proved to be underutilised in the case studies, despite their potential to increase reflection and affective involvement. Instead of

being merely a measure of 'success' and a motivator for further interaction, they could instead be used to inspire reflection and illustrate the learning content through interactions and the consequences afforded by the diegetic systems. By shifting attention from purely gameplay involvement to include affective involvement, feedback systems offer particular opportunities for strengthening relevance.

However, only some applied games need to provide a deep, emotional experience. Many entertainment games successfully aim for simple, singular mechanics (e.g., mobile games, such as *Candy Crush* (King 2011)). By extension, many applied games can benefit from similar designs, using simple mechanics, bright colours, and feedback points to motivate further play. However, applied games often tackle subjects that would benefit from using design decisions to increase emotional investment and, in turn, how relevant or meaningful the experience is for the player.

6.5 Lens of Applied Game Engagement

This chapter examined various aspects of the Applied Game Engagement Model in design practice. In these efforts, it performed successfully as a reflection tool that helped identify problems, facilitate discussion, and open the door to new design ideas.

It would be incorrect to conclude that the game concepts in the pilot study, or the proposed changes to the designs in the case studies, could not have been accomplished in another way or through another framing. The AGEM is one of many methods to facilitate such design discussions or inspire ideas. However, it is the first that combines these differing, relevant topics and frames them from an engagement perspective. It was used successfully by various people with limited previous knowledge or experience in making games. This result suggests that it can be sued as a discussion tool in diverse teams of stakeholders. The practical work presented in this chapter shows its promise in eliciting the right questions, relating relevant aspects of the game to one another, and making those topics tangible and possible to discuss.

For application in design practice, it is helpful to reshape the model into a design 'lens', which refers to a particular perspective that can be used to analyse and discuss a game's design. It is framed as a boxed 'set' of questions, which provides a unique way of seeing a game that aims to inspire and shape the creative process (Schell

2008). Framing the AGEM as a design lens — the Lens of Engagement for Applied Games — helps to communicate that it provides one perspective that may be used in conjunction with others (Figure 6.17).

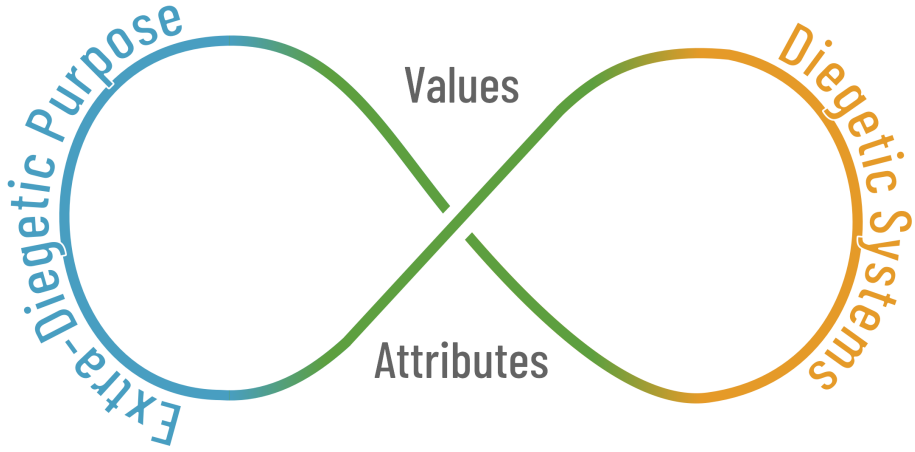


Figure 6.17: A visualisation for the Lens of Engagement. It frames the design process as a cyclical practice in which both extra-diegetic purpose (blue) and diegetic systems (orange) are repeatedly evaluated through the identified attributes and values and how they affect engagement. Green indicates that both are considered in tandem every cycle through attributes and values.

The lens should be used as described in Section 6.4.4, in the sense that it requires a constant evaluation of elements, both of the extra-diegetic purpose and the diegetic systems, in how these determine and influence attributes and values. These, in turn, directly influence attention and, thus, engagement. Neither purpose nor systems are fixed while applying the lens but instead shaped through this iterative evaluation process.

Common questions likely to feature in this process are formulated based on Chapters 4 and 5 and the case studies presented in this chapter. They are divided into three sets.

The first set of questions relates to defining the extra-diegetic purpose and its elements. These directly relate to the elements proposed in AGEM (see Chapter 4, Figure 4.3). They usually result from the project brief and stakeholder intentions. This information may

also directly prescribe elements of the diegetic systems (e.g., if a specific type of gameplay is expected). However, the extra-diegetic purpose tends to be leading in design.

The second set relates to defining the attributes and values that define the project. Attributes follow naturally from extra-diegetic purpose elements. The attributes, in turn, lead to corresponding values. Over time, these may still be adjusted as the design changes throughout the iterations.

The next step in the process lies in defining the diegetic systems and their elements. These directly relate to the elements proposed in AGEM (see Chapter 4, Figure 4.3). It was observed in the pilot study that the AGEM is not the most useful in initial idea generation. Thus, brainstorming game ideas should be a flexible process (Fullerton 2014). Once some ideas are decided, they can be refined through the third set of questions.

The third set of questions, thus, concerns the game's design, using the theories presented throughout the thesis. Depending on the project, the different elements that make up the diegetic systems can be evaluated per game section. Asking and answering these questions will lead to re-evaluating some previous decisions on extra-diegetic purpose elements, attributes, values, and diegetic system elements.

6.5.1 Design Questions

The first set of questions concerning the extra-diegetic purpose are as follows:

- **Content**

  What does the game aim to accomplish? How does interaction affect the player (immediate goals)? What are the extended effects of that interaction (indirect goals)? How can those effects be measured (metrics of success)?

- **Target Player**

  Who is the intended player? What motivates them to interact with the game? What do they get out of it? Is play self-initiated or motivated externally? How does the player relate to the other elements of the applied purpose?

- **Actors and Facilitators**

Who else is involved besides the player? Do they have an active role in the game — is play self-guided or mediated? Do they influence attention directly, or are they indirectly involved?

- **Other Media / Technology**

  Does the game stand on its own, or is it situated among other materials? Do those divert attention away from the game, or can they help focus it?

- **Physical Space**

  Where does playing the game take place? Are there any factors that draw or direct attention, intentionally or unintentionally? Can or should the environment be controlled?

Answering these questions leads to the first set of attributes through which the diegetic systems should be viewed. These, in turn, will lead to a set of corresponding values that will shape the design process.

The second set of questions concerning attributes and values is as follows:

- **Attributes**

  What external influences may influence the player's engagement with the game? Is that influence positive or negative?

  Think of: Demographics, Preferences, (Gaming) Experience, Motivation, Interests, Infrastructure, Technological characteristics, Performance, Complexity, Distraction, Private/Public, etcetera.

- **Values**

  What design goals are inferred from extra-diegetic purpose elements and attributes? How do these goals influence engagement? Is that influence positive or negative?

  Think of: Relevance, Accessibility, Usability, Playing time, Playing frequency, Enjoyment, Flow, Agency, Challenge, etcetera.

In the case of early development, the determination of attributes and values may guide some first decisions (e.g., choice of genre or type of mechanics). While the focus in ap-

plied game design often lies in the design of the diegetic systems, which are in service of the applied purpose, extra-diegetic elements may be shaped throughout the design process as well (e.g., the choice of physical location). While attributes are generally fixed based on the inclusion of extra-diegetic elements, it is possible to change elements and, thus, the attributes. For example, VR technology is a relatively solitary experience without specific design decisions. Other presentation modes may be better if external actors or social involvement are desired. Alternatively, it could be made suitable based on other decisions (e.g., projecting onto a screen or integrating multiplayer features). Choosing a different or altering the presentation mode will alter the attributes and impact the values. The design of the diegetic systems may then be altered accordingly.

Finally, the third set of questions concerning the diegetic systems is as follows:

- **Game sections and overlap** What elements does the game contain? What sections of gameplay follow from those elements? What is the overlap for each section? How do elements and sections affect the chosen values?
- **Areas of attention**

  What is the dominant area of attention in each of the sections (gameplay, social, aesthetic)? Do the areas support the extra-diegetic purpose and values? Do the areas support the game's intended experience? Can the area of affective involvement, particularly, be strengthened to support the values?
- **Rhythm**

  Do the sections, and areas of attention, allow for a change in intensity while playing the game? Is attention demand generally low or high? Do external (extra-diegetic) factors influence attention demand? Can sections be added or changed up to increase balance? Is the attention demand suitable for the chosen values?
- **Feedback**

  Does the game guide the player from moment to moment, using visuals and sound to alert them to important information? Can the game benefit from con-

textualising how it presents the consequences of interaction and the player's level of success? Can feedback be used to emphasise the intended values?

As noted during the applied game case studies, the sets of questions are not meant to be answered linearly. Likely, any design discussions bounce between categories and reconsider previously answered questions. Likewise, the same questions will need to be revisited once development has taken place and a new prototype can be evaluated. This discussion may then be paired with other evaluation efforts to determine how well the values are being reached. What is important to note is how each topic can be brought back to how it affects the chosen values and how that may lead to changes to either extra-diegetic purpose elements, attributes and diegetic system elements.

The above questions do not present all possible questions and discussion topics that can arise in a design session. Others may surface, and some may not be relevant in every situation. However, they reflect the topics of discussion that came up during the exploratory studies described in this and the previous chapter. They can help trigger critical thought processes during design discussions. Future efforts may expand on this list of questions and specific suggestions for standard features and elements.

6.6 Conclusion

This chapter described exploratory efforts in integrating the Applied Games Engagement Model in game design and development practice. This work aimed to refine and extend the process presented in Chapter 5 with additional game design knowledge and practical experience. By observing how the theory was applied and noting questions and topics that came up during that application, a design 'lens' could be formed as a practical tool for applied game design.

The chapter achieved these goals through a pilot study in which teams of students developed short games with limited time and resources. Additionally, two case studies of applied games where discussions were held with stakeholders were presented.

The student projects illustrated how the theory of attention can be used to make informed design decisions as they attempted to balance areas of attention and intensity of attention demand and guide the player through the game. They also show how

the theory can be applied by those with minimal experience developing and designing games.

The entire model could be applied during design discussions with stakeholders in applied gaming projects. This process uncovered how the AGEM sparked thoughts and questions that the stakeholders had yet to consider in designing their games. Considering these topics helped them to identify perceived issues with their designs and sharpen their ideas on the game's applied purpose. They also learned that many extra-diegetic elements and attributes that affect engagement could be easily overlooked. The sessions led to concrete ideas for future iterations of the applied games, which could be evaluated later using the model in further discussions.

The theory and practical work presented throughout this thesis formed the basis for the Lens of Applied Game Engagement, a practical tool for applied game design discussions. It presents a set of topics and questions that form a specific 'lens' through which to view a particular design. It is meant to be used iteratively and helps stakeholders to evaluate the extra-diegetic purpose and diegetic systems and how their decisions affect their intended values. It can be used in tandem with other design methods and lenses, offering a specific perspective on an applied game's design focused on how attention and, in turn, engagement are affected.

7 Conclusion

Games are often applied to purposes other than pure entertainment. One reason for this is that they are generally considered 'engaging' and, thus, can motivate a person to perform tasks or absorb content they would otherwise not be as likely to do. Nevertheless, while these applied games are designed for the particular reason that they are 'engaging', it is still being determined what that exactly means.

The commonly accepted understanding of game engagement revolved around 'state' (i.e., complex emotional and behavioural constructs that can arise from being engaged) and 'use' (i.e., measurable behaviour). Because of this focus on outcomes, understanding how engagement functions from moment to moment could be extended. The previous lack of clarity limited how the engagement process could be discussed, particularly concerning applied game design. Entertainment games are discussed in how they achieve a particular experience and precisely in how they achieve it through design. Such detail is needed in discussing applied games as well. Additionally, there was no previous framework for including the game's applied purpose in discussion and how it relates to engagement. Thus, this thesis's primary focus was to form a conceptualisation of game engagement that can guide the analysis and design of applied games.

7.1 Research Questions Revisited

This thesis's primary research question was: *How can game engagement be conceptualised to guide the analysis and design of applied games?* This question was addressed through a combination of research methods and design practice, structured along four sub-questions.

Research Question 1: Requirements

The first question related to the issues with the commonly accepted understanding of game engagement and what requirements a conceptualisation of applied game engagement should meet. The research question addressed was: *What are the requirements for conceptualising applied game engagement?*

Three applied game projects and an in-depth empirical examination comparing different designs of the same applied game were presented and discussed. These cases illustrated where the commonly accepted understanding of game engagement fell short in analysing applied games. These efforts resulted in formulating six requirements that should be incorporated into the conceptualisation of applied game engagement. These were:

1. A conceptualisation of applied game engagement should clearly distinguish between the related concepts and provide uniform terminology.
2. A conceptualisation of applied game engagement should posit the player's emotional experience as a potential design goal rather than the primary measure of success.
3. A conceptualisation of applied game engagement should include incorporating the game's purpose and how it is integrated into the various elements that make up the game.
4. A conceptualisation of applied game engagement should include the contextual factors influencing engagement with the game.
5. A conceptualisation of applied game engagement should focus on the process of being engaged.
6. A conceptualisation of applied game engagement should include a means to discuss the game's design.

Research Question 2: Conceptualisation

The second question continued from the previously identified requirements and regarded the conceptualisation of applied game engagement. The question addressed was: *How can applied game engagement be conceptualised?*

The six requirements formed the basis of a multidisciplinary literature review, from which an understanding of applied game engagement was constructed. The result was

the Applied Games Engagement Model (AGEM), which formed the basis for the remainder of the thesis.

The AGEM presented new definitions for each component, i.e., attention, game and purpose engagement, game experience, (applied) game, extra-diegetic purpose, diegetic systems and their elements, attributes and values. It brought the concept of engagement back to the root construct of attention and how it is purposefully focused on an activity (i.e., a game). It posits attention as a limited resource that can be actively directed through game design decisions. This perspective also changes the focus of discussing engagement to its foundation in attention, removing the previous emphasis on other constructs (e.g., flow) unless they are required by design.

Two forms of engagement were established: game engagement with the diegetic systems of the applied game and purpose engagement with the extra-diegetic purpose of the game. These forms of engagement can overlap in various amounts, as does the integration of extra-diegetic purpose and diegetic systems. The extra-diegetic purpose is defined by attributes that influence the applied game. The diegetic systems are, in turn, influenced by values set during the design process.

In this conceptualisation, engagement is considered a process during which a player's attention shifts between different aspects of the game, including possible elements of the extra-diegetic purpose. Engagement with games was divided into six areas of attention to further analyse how an individual game captures and holds a player's attention.

Research Question 3: Analysis

With a conceptualisation for applied game engagement (in the form of the Applied Games Engagement Model), its practical use had to be assessed in whether it could better facilitate the analysis of applied games. Thus, the following question was addressed: *How can the conceptualisation of applied game engagement be used to analyse applied games?*

The use of AGEM in the applied game analysis was shown through a discussion of the three applied games previously investigated for the formulation of requirements.

This process showed how the model could be used in analysing engagement with applied games of varying purposes and designs. It was possible to identify and de-

scribe the various elements of extra-diegetic purpose and diegetic systems that made up those games, as well as the attributes that linked them together and express the design decisions that caused them to affect engagement. This analysis served to highlight inconsistencies in the designs. Examining the games in this manner also allowed for externalising and describing engagement with the game at a more detailed level than the previous understanding of game engagement allowed.

The research question was answered with a generalisable process for using the AGEM in analysing different types of applied games. Inherent to this process is that debate may occur over the exact representation of extra-diegetic purpose elements, diegetic systems, attributes and values, or any of the mappings concerning engagement. As such, the model provides the insight and vocabulary to facilitate debate in which differences of interpretation, opinion, and priority may exist, for instance, between stakeholders within an applied gaming project.

Research Question 4: Design

The final consideration of the thesis lies in whether the understanding of applied game engagement could aid in applied game design. Since analysis and iterative decision-making are inherent in game design, incorporating the AGEM at moments of reflection could be a useful exercise. The final research question addressed by the thesis was thus: *How can analysis of applied game engagement be incorporated into applied game design?*

The notion of balance and rhythm and using attention for feedback and guidance were added to the theory. The practical use of the theory was then examined through a pilot study in which short games were created. Additionally, the AGEM was applied in two applied game case studies, where it was used to guide design discussions with stakeholders. These studies helped define and develop the AGEM, leading to the Lens of Engagement for Applied Games.

The Lens of Engagement provides a practical, workable version of the AGEM theory that allows for flexibility in its application. It does so by prompting questions regarding the various aspects of the applied game. These aim to help evaluate design decisions impacting extra-diegetic purpose elements and diegetic systems and how they affect attributes and values that influence attention and engagement.

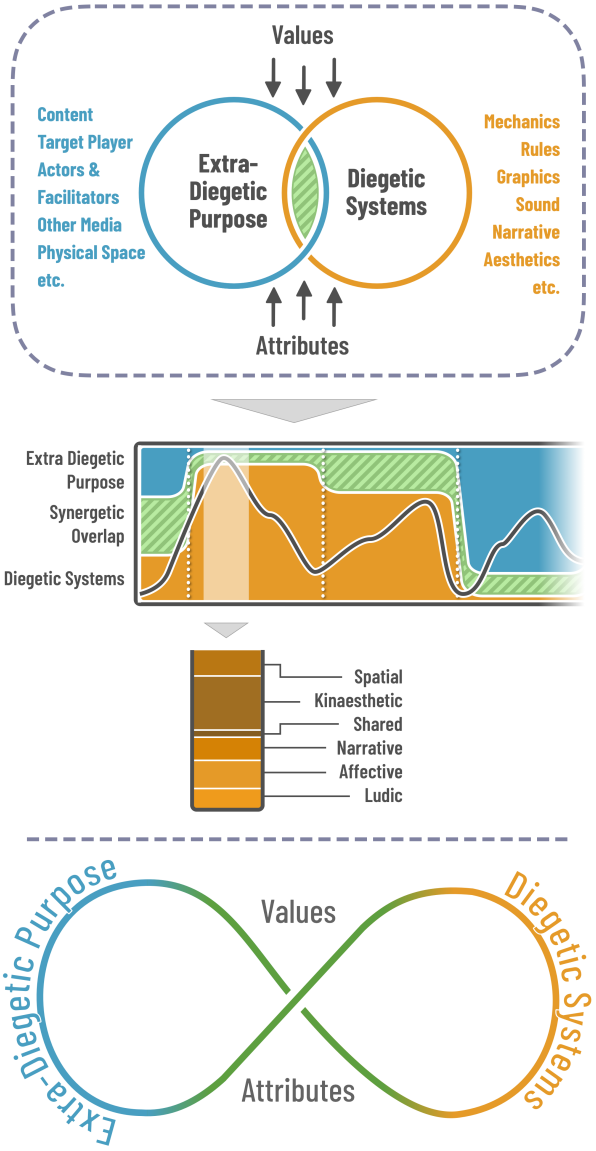


Figure 7.1: The Applied Game Engagement Model (Chapter 4), including an attention intensity curve (Chapter 6) as part of mapping the locus of attention, and the Lens of Applied Game Engagement (Chapter 6).

7.2 Contributions

This thesis extends the existing work on applied game engagement. As of recently, applied game engagement was considered a complex subject in which related concepts were often conflated or used interchangeably. The work presented here introduces an extended perspective on applied game engagement, refocusing it on the consideration of attention and its close connection to game design. The contributions of this work are visually summarised in Figure 7.1. This thesis thus fills a considerable gap in the existing literature by providing a comprehensive understanding of applied game engagement that offers a novel perspective.

This thesis can be of use to any who seeks to design, create, or do research with applied games. These may include game designers and developers, but more likely are those other stakeholders that are often the instigator of applied gaming projects. Government agencies, businesses, and educational or research institutions provide domain expertise in applied gaming projects. However, they cannot be expected to be well-versed in game design theory or development practices or understand how their expertise relates to the work of game designers. The field of game design is vast and offers many potential approaches to solving a particular problem. This thesis provides an approach that combines relevant theory into a comprehensive and workable model. Thus, it can help educate domain experts and support game developers collaborating with other stakeholders to discuss design considerations.

In summary, the four main contributions of this thesis are:

1. **Requirements for a conceptualisation of applied game engagement**

   In order to fully grasp the complexities and nuances of applied game engagement, an in-depth examination of an array of existing applied gaming projects was undertaken. The examination was focused on critically evaluating the validations of these projects, with the ultimate goal of gaining a more profound understanding of how the commonly accepted perception of game engagement could be expanded. The outcome of this examination was the identification of six requirements for a holistic conceptualisation of applied game engagement. These requirements provide a foundation for future studies and research endeavours that delve into applied game engagement's intricacies.

2. **Conceptualisation of applied game engagement**

   The thesis comprehensively conceptualises applied game engagement by integrating relevant theories from diverse fields. The model is carefully crafted to examine applied game engagement at various levels of granularity and detail, depending on the specific requirements of the project at hand. This structure allows for a more thorough and nuanced understanding of the complexities of applied game engagement. It also provides a flexible and adaptable approach to addressing the unique needs of different projects.

3. **Analysis process of applied game engagement**

   In addition to providing a comprehensive model for analysing applied games, a methodical process has been established to assist in applying the model. To further illustrate the practicality of this process, three specific examples have been provided to demonstrate its effectiveness. In order to make the model more accessible and valuable in various contexts, suggestions have been made regarding how the model can be tailored and adapted to suit the unique requirements of different situations.

4. **Design lens for applied game engagement**

   The thesis not only comprises a model that primarily emphasises academic analysis but also includes a practical design perspective for applied game engagement that can serve as a valuable aid during design discussions. This design lens differs from the model in that it promotes iterative conversations and encourages active participation from all stakeholders involved in an applied gaming project. The lens presents a series of thought-provoking questions that stakeholders can consider and helps those putting the theory into practice to begin implementing it and to develop it further.

These contributions were formed based on multiple research methods, combining more rigid evaluation practices with exploratory design case studies. The thesis provides additional contributions by discussing its practical work, which provides new insights into applied game engagement and inspires further study.

It should be noted that although the thesis focuses on applied games, in particular, its theory can also be applied to entertainment games. While some aspects of the model

are not as relevant in such an application, others are. Furthermore, while the work presented in this thesis was based on digital games only, the theory could also extend to analogue games, e.g., board, tabletop, or physical. The theory would need to be revised and adjusted for these purposes, especially in formulating extra-diegetic and diegetic elements and relevant attributes and values. Considering that attention is a universal construct that applies to any activity, such adaptations should be possible.

7.3 Future Research

This thesis contributes to the existing library of work discussing (applied) game engagement. It forms a comprehensive start for anyone looking into this topic, especially in understanding it concerning design decisions. It lays the groundwork for many potential areas of further investigation. These include:

1. **Further refinement of the model and lens**

   The work presented in this thesis shows the potential of the Applied Games and Engagement Model and the Lens of Applied Engagement. Although their application has been limited, it has been successfully used by many students and stakeholders in applied gaming projects. Their experience is encouraging since neither group had previous experience designing or analysing (applied) games. As such, the model and lens will likely be able to be applied by a wide-ranging group of stakeholders with varying experience levels in game design. However, both the AGEM and the lens should continue to be applied by others and in more situations to develop and refine them further. In particular, it would be beneficial to use them in projects that either share a general applied purpose (e.g., games for health interventions or skills training) or similarities in design so that more direct comparisons can be drawn between particular types of games. Systematic reviews of applied games for a purpose often show conflicting and inconclusive results. Using the AGEM to analyse them in-depth could reveal why this is the case and lead to additional elements, attributes and values of particular importance in that context.

2. **Re-examining experience measures in relation to the engagement process**

To better understand the relationship between attentional shifts and measures of game experience, it may be necessary to re-examine the methods used to assess game experience. Traditional measures such as self-report questionnaires may not capture the nuanced changes in emotional experience that occur on a moment-to-moment basis during gameplay. Instead, it may be useful to develop more dynamic measures that assess emotional experience in real-time, such as experience sampling methods or continuous monitoring of physiological responses. By collecting data on both attentional shifts and emotional experience simultaneously, researchers may be able to identify patterns and correlations that were previously undetectable. This could allow for a more sophisticated understanding of the relationship between attentional shifts and game experience, and could help inform the design of (applied) games.

3. **Expansion of attributes and elements**

   While the formulation of additional attributes and values should result from practical application, they could also be found in existing literature from different fields. However, more than merely expanding the model and lens is required. They should also be considered in their relation to extra-diegetic elements and diegetic systems and how these are potentially influenced (positively or negatively) by decisions related to those aspects. Design patterns can also form a basis for such an investigation, as they describe recurring design elements commonly used in games. Establishing an array of attributes and values, as well as how they influence engagement and how they are affected by design patterns, would ease the use of the model and lens and make their application more replicable and less dependent on individual interpretation.

4. **Application of the theory in related domains**

   The work underlying this thesis was primarily focused on digital, applied games. While the definition of applied games outlined at the start of the thesis allows for a wide range of products to be included in the discussion, this framing is inevitably limited. On the other hand, the theory that informed the presented model and design lens is more generally applicable than the framing might suggest. Many types of products benefit from ‘gameful’ or ‘playful’ design elements, and the concept of attention is relevant to any task or activity. While the model

presented here was created explicitly for applied games (providing field-specific terminology to, in part, clarify ongoing discussion on the topic), that does not mean that it can not be applied anywhere else. A first area of interest may be in analogue applied games or game-like activities. However, it may also find use in unexpected areas, especially those related to human-computer interaction, where consideration for an end-user's attention and the design of systems in a real-world environment is vital in deciding the difference between failure and success.

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Curriculum Vitae

Isabelle Kniestedt

Born in **Zoetermeer** on **14 December 1989**

PhD Research conducted at **Delft University of Technology** from 2017 until 2023

Education

2015 - 2017	M.Sc. in Digital Games	University of Malta
2013 - 2014	M.Des. in Animation	Avans University of Applied Sciences
2007 - 2013	B.Eng. in Game Architecture and Design	Breda University of Applied Sciences
2001 - 2007	VWO Atheneum, Natuur en Gezondheid	Maerlant College Brielle

Professional Practice Since M.Sc.

2022 - Present	Teacher	Grafisch Lyceum Utrecht
2008 - Present	Independent Game Developer, ZZP	Dandy Unicorns
2021 - 2023	Project Manager	University of Twente
2020 - 2022	Guest Lecturer	Leiden University

Publications Relevant to this Thesis:

- Kniestedt, Isabelle, Stephan Lukosch, Milan van der Kuil, Iulia Lefter, and Frances Brazier. 2022. “Incorporating the Theory of Attention in Applied Game Design.” In *International Conference on Entertainment Computing.*

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- Gómez-Maureira, Marcello & Isabelle Kniestedt. 2019. "Exploring Video Games That Invoke Curiosity." *Entertainment Computing Special Issue ICEC2018*.

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Games have been widely used for purposes other than entertainment due to their engaging nature. However, the concept of game engagement is still not well-defined, which limits its use in analysis and game design. The primary objective of this dissertation is to conceptualize game engagement to guide the analysis and design of applied games.

The dissertation first explores the requirements for conceptualizing applied game engagement, identified through an analysis of three applied gaming projects and an empirical study. It then uses these requirements to develop the Applied Games Engagement Model (AGEM). The AGEM posits that engagement is the process of focusing attention on a task and that attention can be purposefully directed through design.

The practical use of the AGEM is then explored by analyzing applied games. The theory is extended with relevant game design knowledge and applied to game design practice. This results in the Lens of Engagement for Applied Games, a unique way to view the design of an applied game.

Overall, this dissertation provides a comprehensive perspective on applied game engagement, emphasizing the role of attention and its relation to game design. It offers a practical and workable method of considering and discussing game engagement, which can be used by anyone creating or studying applied games.

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