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Abstract:
In recent years, user-centered design has gained tremendous focus. Companies are recognizing the importance of their end-users, where testing on real people through the development has become a stable in the industries. This can especially be seen in game companies, where TRUE instrumentations created by Microsoft is a tool used to evaluate the user experience of their games.

For this reason a framework to evaluate both the game and its players can be of high interest. Play and player motivation types has been highly researched in the field of video games.

This master thesis documents the development of the "Decision Dimensions" framework, measuring player choices on a per-decision level, investigating which factors have a significant impact on the choices that players make in video games. This is based on an interactive narrative created in Twine, which is used and applied through several iterations:

First iteration establishes the significant factors contributing to differences in decision making in games, which were found to be various demographic variables such as age, gender, and game experience.

Second iteration establishes what those difference mean through developing the initial four factors and five personas using explanatory sequential mixed methods based on the findings from the interview and questionnaire.

Finally, through principal component analysis, we derive the six Decision Dimensions that together contribute the most to player choice. Further, we are also able to not only rank players' decisions, but also rank choices in a video game, creating a framework to be used in the future evaluation of games.

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Decision Dimensions
The six factors to decision making in video games

Anders Schultz Christiansen Carol Srisong Lund

May 2020

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Preface

This study is a master thesis in Medialogy (Interaction Specialization) from Aalborg University Copenhagen, Denmark, written between February and May of 2020.

1.1 Reading Guide

This study is structured by its three iterations:

1. Significant factors in decision making in video games
2. Interview and personas
3. Developing the framework

1.2 External Links

Content which can not be included in the report of the study can be accessed by following the directions in the following sections.

Electronic appendix

Any material used in the study but not included in the report is compiled in the electronic appendix, available here:

`kortlink.dk/265pt`

The interactive narrative

The questionnaire and the interactive narrative can be found here:

`www.axy.dk`

Github repository

The git repository for all the code used in the project can be found here:

`https://github.com/RytmeAnders/master-thesis`

Project video

A video explaining the project can be found here:

`https://youtu.be/v2ndKiQRPV0`

Introduction

In recent years, user-centered design has become an intensely researched topic. More and more focus has been directed towards the user-centric experience and bringing users to the forefront of development. Companies have recognized the importance of their end-users, and the area of video games is no different. Big names such as Microsoft and Ubisoft have implemented user-centered methodologies, and testing on real people has become a staple in the industry using a plethora of techniques such as focus groups, video observations, telemetry analysis and machine learning.

Microsoft has developed the TRUE instrumentation [Schuh et al., 2008] which evaluates the user experience of their games by triangulating telemetry data (what happened?), contextual information (when did it happen?), attitudinal information (what did players feel?), and observations, to get a rich insight into the minds of their players. To an increasing degree, participants are invited to test the products of companies at an earlier and earlier state, because catching a bug or an unsatisfactory experience early is vital to potentially saving millions of dollars in development costs. User experience exists in the interplay between user and product, and no medium is more collaborative in nature than video games [Dovey and Kennedy, 2006, ch.7].

For this reason, frameworks that not only evaluate the product, but the player and the player experience is of great interest to the field of video games, not exclusively for academic purposes, but also from a business standpoint. A considerable portion of the body of literature on the topic is interested in categorizing either the player or the game. In the 1960's, Caillois described four distinct types of play, and later in the 1980's Bartle categorized four different types of player. These theories have been refined over the years, for instance by Yee [Yee, 2019], who recently increased Bartles four types to six motivational scales. The literature describes the motivations behind playing the games we play, but to a lesser degree the choices we make and why.

The goal of this study is to develop a framework for assessing which factors have a significant impact on the choices we make in video games. Yee criticized Bartle's rigid view on player types and recognized that they are of a dynamic nature as opposed to constant from person to person. We suggest an even finer granularity, and hypothesize that player choice motivation exists on a per-decision micro level. Through quantitative player data, in-depth interviews, and principal component analysis, we have developed six Decision Dimensions through which we can categorize choice. These Dimensions make up the significant factors that players consider their actions through while playing. This is evaluated through a self-made interactive narrative, where choices are discrete and therefore their outcome easier to measure.

Summing up, our research question is: *"How well can the decision making in video games be modelled and quantified by latent factors in player behavior?"*

This report begins with a literature review on the topic to introduce the reader to the subject of game evaluation. Then follow each of our iterations, beginning with the initial quantitative

evaluation of which demographic factors cause a significant change in in-game choices ("Significant Factors In Decision Making In Games"), followed by our in-depth player interviews and subsequent development of personas ("Interviews And Personas"). During this iteration and the following, the framework is applied and iterated using our own interactive narrative implemented in Twine as oppose to a pre-existed Twine narratives. Based on the interviews and personas, we created a 20-item initial questionnaire which was analysed through principal component analysis, outlined in the next section, "Developing The Framework". We then discuss our findings and end the report with a conclusion on their implications for the future.

Methodology

This chapter outlines the methodologies applied in this study to investigate our research question. A more detailed description of the practical testing and test procedures can be found in their relevant chapters under each iteration.

This study relies on multiphase mixed methods [Bjørner, 2015, p. 21], as we mix quantitative and qualitative data and that the first data gathering informs the next, and so on. We are building on top of previous player type theories such as Bartle's player types and Yee's motivation types, therefore this study is mainly an instrumental case study, seeking to refine this body of literature [Bjørner, 2015, p. 31].

The first iteration gathers quantitative data about demographic factors in players through a questionnaire and graph matching of paths taken in a narrative in a formative evaluation [Bjørner, 2015, p. 49]. The data was analysed through various inferential statistical methods, such as a Kruskal-Wallis test followed by post-hoc pair-wise Welch's T-tests, χ^2 and Mann-Whitney U-tests. This is detailed in chapter 5, Significant Factors In Decision Making In Games.

Then follows audience ethnography to determine 1) how to interpret the findings from the first test, and 2) the user experience of our narrative, participants' narrative comprehension and their engagement [Bjørner, 2015, p. 43]. For this, we used semi-structured respondent interviews [Bjørner, 2015, p. 87] and the engaging and fiction-based persona perspective [Nielsen, 2013]. This is described in chapter 6, Interviews And Personas. Furthermore, personas can be found in the *appendices*.

Lastly, we conduct a summative evaluation to determine the quality of our framework in a quantitative fashion [Bjørner, 2015, p. 49]. This is assessed through a principal component analysis, specifically an exploratory factor analysis, seen in chapter 7, Developing The Framework.

Throughout the study we have employed a non-probabilistic convenience and snowball sampling [Bjørner, 2015, p. 61-62]. This is in part due to the limitations imposed on us by the outbreak of the covid-19 pandemic, as this study was conducted in the spring of 2020.

The following chapter outlines the background literature.

Background

This chapter reviews the background literature in order to introduce the reader to the subject of video game evaluation and traditional structures in video game narratives. We begin with an introduction to the subject of interactive fiction, and why it can be a costly development. Then we describe the concept on storylets, and why these may be beneficial to interactive narratives. This is followed by a review of how to define player engagement and how to design for it, a review of previous work on playing styles, concluding with the current state-of-the-art within the field of interactive media.

4.1 Interactive Fiction

Interactive storytelling is by no means an emerging technology, but a stable within narrative design. Choose-your-own-adventure-books has since the 1970's used a branching narrative structure, and text-based computer games rose to popularity in the 1980's. Researchers and game developers alike have long investigated how to adapt not only narratives, but game content in general, to the individual user, creating a whole field on its own.

Autonomous, run-time adaptation of games has previously been shown to function well with biometric input such as heart rate or galvanic skin response, with self-report such as continuation desire measurements [Schoenau-Fog, 2012], and with rich player action and behavior feedback [Browne et al., 2014, Schuh et al., 2008], also known as telemetry, to name a few. More recently, adaptive games have entered the machine learning domain. Bontchev and Georgieva [Bontchev and Georgieva, 2017] adapted a learning game by training a network to predict player types (see section 4.4 on page 15), and Selvig and Schønau-Fog's image recognition network adapted from visual input of players' faces while playing [Selvig and Schoenau-Fog, 2019].

What type of content to adapt has also been extensively researched. A common approach is dynamic difficulty, but also includes procedurally generating new game levels, changing NPC behavior, mixing in-game music, or adapting the dramatic arc of a narrative. Choosing when and how to trigger dramatic beats within a story has the potential to change the emotional response and engagement of a user [Farrel and Ware, 2017, Farrel et al., 2019]. The following section investigates how interactive fiction can be designed to further afford this notion, as well as addressing common problems within the field.

4.1.1 Structures in branching narratives

This subsection firstly reviews the classic designs of branching narratives to provide an introduction to the field. Then follows a review of more recent digital techniques that utilize the affordances of a computer, where many branching narratives are played today.

A branching narrative refers to a non-linear narrative structure containing multiple possible paths to the ending, of which there might be several. It is beneficial to consider a graph,

where nodes are story beats or small, discrete bits of narrative, and edges are the user choices. Depending on the granularity of the story beats, a node might contain only a line of dialogue or up to an entire scene. Each node must contain at least one edge, but may have several. Such a graph can be designed in many different ways depending on the nature of the narrative and the scope of the production. Scope especially is important to consider, as these structures are subject high complexity downsides such as the nature of combinatorial explosions (see *section 4.1.2* on page 6). In the field of machine learning, these nodes and edges may also be refered to as the narrative's state space and action space respectively. Ashwell has reviewed the classical branching structures [Ashwell, 2015], a few of them described in detail below.

Time Cave: A binary tree with an initial state and a binary choice at each node. This offers a wide breadth of choices for the user. Each path down the tree is unique in that nodes have one and only one edge leading to it, so branches never merge or join. A Time Cave has many different endings and is usually very short, affording many replays. A good example of this is the 2011 game The Stanley Parable [Wreden and Pugh, 2020], which contains a short story that the player can repeat many times with different endings. The game features a narrator that speaks about which choice the player should do. The player may then either do as told or defy the narrator, providing an interesting commentary on the nature of free choice.

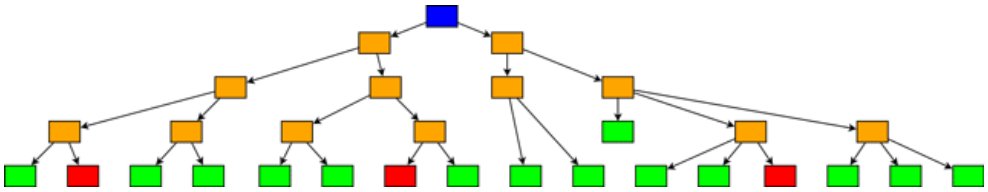


Figure 4.1: Time Cave-style graph

Gauntlet: Where a Time Cave is a wide graph, a Gauntlet is a deep one. Few diversions from the main path exist, and these typically either end in death or backtracking. This structure affords a longer story that is less costly to produce, but comes at the expense of player agency and story variability. Twine [Foundation, 2020], a tool for writing web-based interactive stories is a great example of this, as many of the stories published here share this structure.

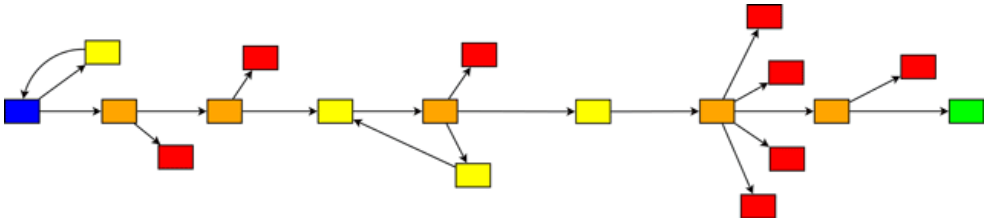


Figure 4.2: Gauntlet-style graph

Branch and Bottleneck: If a game does need a wide graph structure, one approach to limit its breadth is to heavily merge branches at specific points in the narrative down to a single or only a few nodes. A disadvantage with this is that branches never truly diverge, and if so only briefly, meaning that the effect of player choice is diminished unless the narrative relies heavily on state-tracking story variables [Rickerby, 2015]. To reintroduce meaningful choices to the player, this structure can benefit from delayed branching [Fabulich, 2011], in which choices in one cluster will affect states in later clusters.

Quest: A structure that organizes narratives in smaller, self-contained chunks. Organized by geography rather than time, they are often embedded in the environment of a larger world,

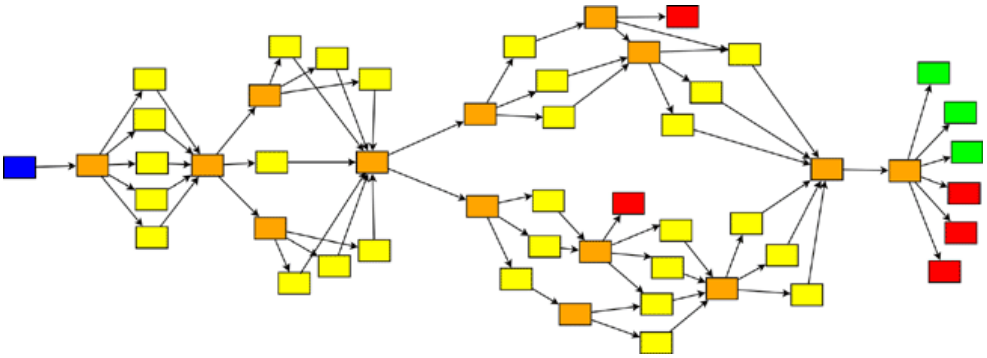


Figure 4.3: Branch and Bottleneck-style graph

and allow for a somewhat asynchronous playthrough. Relies heavily on state-tracking, so that each quest carries a consequence for the bigger narrative. This structure is much less costly to produce compared to the structures outlined above, as it is composed of many smaller narratives with limited breadth.

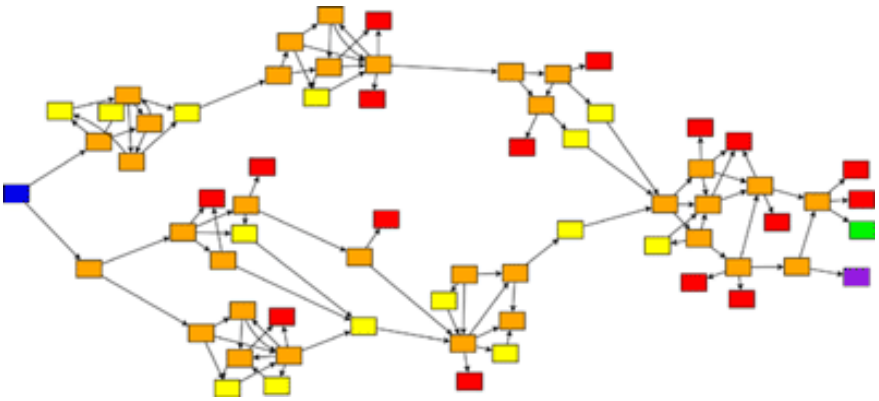


Figure 4.4: Quest-style graph

Here, the challenge lies not in producing a lot of content, but rather in organizing when a player encounters which quest, so that the bigger narrative tied together by them is still coherent. For instance, meeting a prisoner before entering the prison would break the logic of the story. In an academic sense, quests are also known as storylets [Short, 2016, Short, 2019]. There exist several methods for sorting or organizing storylets, some of them reviewed in *section 4.2*. Sorting is beneficial, because the structures mentioned in this section share the same problem of combinatorial explosions, which we will outline next.

4.1.2 Combinatorial Explosions

Combinatorial explosions is a great and well-known problem within the field of interactive fiction and branching narratives [Wang, 2014, Short, 2016, Fabulich, 2011, Rickerby, 2015]. A branching narrative can be viewed as a graph with nodes as texts (a storylet) and edges as choices, and given n choices at each node, such a graph grows exponentially at 2^n [Fabulich, 2011]. This means that even with a binary choice structure, a 7-page narrative requires 128 pages of text to fill out all the combinations of choices, and at "eight pages, the author has to deliver twice as much text, 256 pages" [Fabulich, 2011]. Within graph theory, several other approaches exist that can be applied to interactive narratives, such as choices-as-graphs or characters-as-supernodes [Rickerby, 2015], but they are beyond the scope of this study.

Producing an adaptive narrative is therefore extremely costly for writers, and often unfeasible

for games of a bigger scope or complexity, such as massively multiplayer online roleplaying games (MMORPG's) [Wang, 2014], relegating the medium to more simplistic genres such as children's stories.

Many approaches exist to mitigating this downside, such as treating quests in open-world games as miniature self-contained stories (as we reviewed in the quest-structure), allowing them to adhere to a classic narrative structure [Wang, 2014] or merging story branches aggressively at pre-defined times in the narrative, limiting the breadth of the graph significantly [Fabulich, 2011].

4.2 Storylets

Storylets refer to "discrete, reorderable narrative "chunks" or "modules"" [Kreminski and Wardrip-Fruin, 2018]. Rather than constructing a pre-defined graphed narrative, authors can write small bits of story and have them dynamically arranged, either before playing or at run-time. When designing storylet-based narratives, one needs to consider how to categorize them (what *precondition types* to assign to them), their internal structure (how they are written), and their selection (when to show which storylet to the player). In this section storylets and their design will be discussed in detail.

4.2.1 Precondition

A storylet is commonly tagged with specific conditions that have to be met for it to be available to the player at any given time, such as a location the player has to be in or an item that the player has to hold, also known as a storylet *quality* [Kreminski and Wardrip-Fruin, 2018,Short, 2016, Wang, 2014].

> *Qualities are numerical variables that can go up or down during play, and represent absolutely everything from inventory (how many bottles of laudanum are you carrying?) to skills (what is your Dangerous skill level?) to story progress (how far have you gotten in your relationship to your Aunt?).* [Short, 2016]

The qualities of storylets define subsets of all storylets that are currently legal and accessible to the player, which can be defined as $X_{legal} \subseteq X$, where X is the set of all storylets in a given game. Depending on the granularity of the storylets, a storylet can have many or few qualities, tying them to a location or a pre-defined moment in the narrative. In this fashion, storylets can either be location-based [Wang, 2014], time-based [Schoenau-fog, 2015], or otherwise parameterized, like in the game Starfreighter [Kreminski, 2017]. Qualities also allow progression in the story to be gated by certain conditions, such as not allowing entrance to a house without first holding the key to it [Short, 2019].

4.2.2 Internal structure

The narrative beat within the storylet can be designed in numerous ways. They can either be pre-written or dynamically created: "The simplest possible storylets contain fixed, static text. Other systems extend this mechanism by allowing for the substitution of variables from the game state into otherwise static text templates" [Kreminski and Wardrip-Fruin, 2018].

4.2.3 Selection

Some architecture needs to be in place to decide how to rank legal storylets and how to show which storylet to the player at any given time. These can be referred to as *content selection arhitectures* [Kreminski and Wardrip-Fruin, 2018], a *narrative planner* [Farrel et al., 2019], or a *drama management system*, such as the one proposed by Wang for MMORPG games [Wang, 2014]. For the purpose of this study, we refer to such architecture as the latter (DMS). Kreminski has reviewed the ones most commonly found in interactive fiction

today [Kreminski and Wardrip-Fruin, 2018]: The simplest option is to not rank them at all, but let the player decide from the entire subset X_{legal}. This increases player agency and enhances the feeling of a *sandbox game* where every action is possible at all times. Another option is to group and order storylets into smaller graphs, using pathfinding or search algorithms to get to a certain desired condition. As described by Schønau-Fog [Schoenau-fog, 2015], storylets can be ranked by space-time. Further, storylets can be assigned at random, either fully randomly or with a weighted probability, the latter increasing the chance of selecting a storylet the more qualities it has in common with the current state of the player (choosing storylets from the church more often if the player is currently inside the church).

4.2.4 Short's Definitions

Short has proposed three methods that deal specifically with the notion of storylets, "quality-based", "salience-based", and, on a beat-to-beat micro level, "waypoint narratives" [Short, 2016]:

Quality-based narratives make heavy use of state-tracking and uses qualities to create player-driven emerging narratives. One storylet (or group of storylets or quests) might end with the player receiving a knife. Then, in a subsequent storylet, the player is fishing and can then use the knife to hunt, from where an interesting narrative emerges by combining the player states with open-ended narrative situations. "[Players] accomplish the same goals [they] would otherwise be able to accomplish, but in a special way, with some unique text, or maybe even with a small extra inventory reward" [Short, 2016]. According to Short, this produces a narrative that affords agency to the player and gives them control of the beat-to-beat story, while still allowing the larger narrative to remain intact.

Waypoint narratives is a technique to create dynamic conversations between the player and a non-player character (NPC). It treats conversation as a graph with topics of discussion as nodes and lines of dialogue as edges, meaning it is mostly concerned with the transitions between topics. The NPC has a desired end state, a topic they want to end the conversation on, and uses pathfinding to find the optimal path through the graph to get to that. The player can then choose lines of dialogue themselves, shaping the dialogue dynamically by having them and the NPC take turns choosing where to go in the graph and thus the conversation.

Salience-based narratives refers to

"*... interactive narratives that pick a bit of content out of a large pool depending on which content element is judged to be most applicable at the moment, [...] salience narratives can be tied to pretty much any testable information in the world state* [Short, 2016]."

This is similar to the weighted random selection method described in *section 4.2.3* on page 7, only that the system always chooses the highest ranked storylet at any given time and not from a pool of storylets with weighted probabilities.

4.3 Player Engagement

Engagement is a term that has been widely researched. There exists many different perspectives within different fields, and the term is widely discussed.

One definition described by Kappelman [Kappelman, 1995] views the components of engagement as both behavioral and attitudinal, further defined as user activities and user involvement in relation to objects of engagement. Kappelman has taken into consideration the role of engagement inside an institution during the later phases of the implementation. Said [Said, 2004] identified five main factors; simulation- and construction interaction, immediacy, feedback and

goals. These interplay to create an engaging experience for children in digital games. Chapman [Chapman, 1997] mentions that engagement can *"manifest itself in the form of attention, intrinsic interest, curiosity, and motivation"* [Chapman, 1997]. Lastly Quesenbery [Quesenbery and Design, 2003] used engagement in developing a tool for measuring the usability of different interfaces using different platforms. They describe engagement as *"[...] the ways that the interface can draw someone into a site or a task. It also looks at the quality of the interaction, or how well the user can connect with the way the product is presented and organized."* [Quesenbery and Design, 2003] This definition uses engagement as one of the dimensions of measurement.

Brockmeyer et al. defines engagement as a sum of smaller components, namely immersion, presence, flow, psychological absorption and dissociation [Brockmyer et al., 2009]. These are used as scales in their game engagement questionnaire (GEQ).

Next, we look further into engagement in digital games.

4.3.1 Game engagement

> *What makes one game capture the imagination of players and another fall flat?* [Fullerton, 2018]

The answer to that question could potentially be engagement, even though engagement is a highly subjective topic [Fullerton, 2018]. Research has been conducted on engagement used in learning games or for gamification [Muntean, 2011, Hamari et al., 2016]. As mentioned in *section 4.3*, Said [Said, 2004] looks at five different factors which engage children in digital games. They used *The Sims* as the game in which the children played, as it fulfilled the defined requirements. Here she looked only at which factors would make the children engaged while playing, and how you could apply this to other games in order to make them as engaging. Since the study is performed on children ranging from 9-14 years of age [Said, 2004], some of the findings might not apply for younger or older persons.

By using a more user-centric, or, as described by Fullerton [Fullerton, 2018] *play-centric* approach, to developing games, the developers are involving the end-user in every part of the process, including focusing on the player experience of the target user and testing the gameplay with them. The final outcome should be a game which caters to one or more specific playertypes and should achieve a higher engagement within the target group [Fullerton, 2018].

4.3.2 Challenge

Fullerton mentions challenge as one of the factors in creating an engaging experience [Fullerton, 2018, p. 34]. Challenges creates conflicts that challenges the players to resolve them. The conflicts create tension as the players are working to resolve them, thereby increasing the level of challenge and tension simultaneously, but if the challenge is too hard it might cause frustration in the player [Fullerton, 2018, p. 34]. It has to be balanced, but this can be difficult to achieve, since challenge is very subjective and is determined by the individual's skill in the game [Fullerton, 2018, p. 86]. A younger player currently learning to calculate, might find an advanced mathematics game too challenging, while an adult who has already mastered that skill might find it too boring. Furthermore, challenge is also dynamic [Fullerton, 2018, p. 87]. As a player accomplishes a challenge in the beginning of the game, they will no longer find it challenging if returning to it. The game must be dynamic and should be able to uphold the interest of the player as the game proceeds.

When thinking about creating challenge for players, its components being both dynamic and individualized, it can be related to the concept of Csikszentmihalyi's challenge and level of challenge known as the theory of *flow*:

> *[...] a sense that one's skills are adequate to cope with the challenges at hand, in a goal-directed, rule-bound action system that provides clear clues as to how well*

one is performing. Concentration is so intense that there is no attention left over to think about anything irrelevant, or to worry about problems. Self-consciousness disappears, and the sense of time becomes distorted. An activity that produces such experiences is so gratifying that people are willing to do it for its own sake, with little concern for what they will get out of it, even when it is difficult, or dangerous. [Csikszentmihalyi, 2008, p. 71]

We will now discuss flow in detail.

Flow

During the research of identifying elements of enjoyment, Csikszentmihalyi made some discoveries. First one being that across very different activities, the respondents described their experience similarly when performing their activities especially well [Csikszentmihalyi, 2008, p. 48]. The second being that regardless of social class, culture, age, gender, and stage of modernization, the respondents would describe enjoyment in a very similar manner, but what they did to experience that enjoyment would vary enormously and this meant that the optimal experience is psychologically similar all across the world [Csikszentmihalyi, 2008, p. 49]. The eight major components of enjoyment is the following:

First, the experience usually occurs when we confront tasks we have a chance of completing. Second, we must be able to concentrate on what we are doing. Third and fourth, the concentration is usually possible because of the task undertaken has clear goals and provides immediate feedback. Fifth, one acts with a deep but effortless involvement that removes from awareness the worries and frustrations of everyday life. Sixth, enjoyable experiences allow people to exercise a sense of control over their actions. Seventh, concern for the self disappears, yet paradoxically the sense of self emerges stronger after the flow experience is over. Finally, the sense of the duration of time is altered; hours pass by in minutes, and minutes can stretch out to seem like hours. The combination of all these elements causes a sense of deep enjoyment that is so rewarding people feel that expending a great deal of energy is worthwhile simply to be able to feel it. [Csikszentmihalyi, 2008, p. 49]

When asked about how they felt during the experience, the respondents would mention at least one and often all of the above. Based on the findings of the study, Csikszentmihalyi created the theory of flow as seen in *figure 4.5*. Every flow activity whether it involves any of Caillois' [Caillois, 2001] forms of play, mentioned in *section 4.4*, would transport the player into a new reality, pushing the player into a higher level of performance and a complex form of consciousness. This growth is where the key to flow lies [Csikszentmihalyi, 2008, p. 73].

The dynamic nature of flow can be explained using *figure 4.5*, where the two axes represent *challenge* and *skill* [Csikszentmihalyi, 2008, p. 74]. A is a person performing a specific activity. A_1 is when the person first starts out, where challenge and skill is in balance and they are in a state of flow. Naturally, after some time the person either gets better at the current activity or is met with a new challenge, e.g. meeting a greater opponent. When their skill exceeds the current challenge, the person becomes bored as seen in A_2, or if the challenge is greater than the individuals current skill, the person will become frustrated or anxious as in A_3. Since these two states are not optimal, the person will naturally be motivated to move away from them. To move from A_2, the person simply needs to raise the challenge by e.g. facing a stronger opponent or by practicing a harder technique. In order to move from A_3, the person can lower the challenge, but this means that they might end back in state A_1, and people have a tendency to find it difficult to ignore challenges when they present themselves [Csikszentmihalyi, 2008, p. 75]. Another outcome could be the person simply quitting the activity because of boredom or anxiety, but the optimal outcome in this case would be reaching A_4, where the person once again is in the state of flow. This time the complexity is higher because of the greater challenge and skills involved during that state [Csikszentmihalyi, 2008].

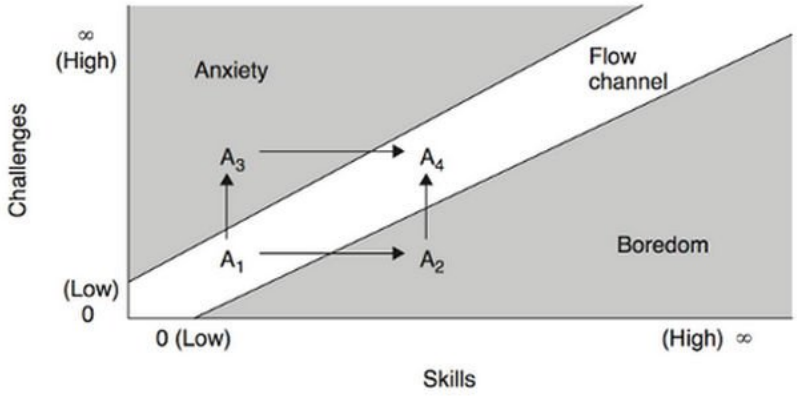


Figure 4.5: *State of flow as formed by two important dimensions; challenge and skills* [Csikszentmihalyi, 2008, p. 73]

This means that if the level of challenge remains the same, the player will become bored in time, therefore the level of challenge needs to remain at an appropriate level of the players ability in order to keep the player in a state of flow. Csikszentmihalyi [Csikszentmihalyi, 2008, p. 49-66] presents different elements to help achieve flow, drawing similarities to the eight components of enjoyment as mentioned before:

- **A challenging activity that requires skills:** Flow often occurs within activities which are goal-directed and bound by rules and can't be achieved without the proper skills. [Csikszentmihalyi, 2008, p. 49]. These skills can be both mental, physical etc., but if a player does not posses any of the necessary skills that the task requires, the player will end up frustrated. Whilst a player having the skills, but being unable to see the meaning or outcome of the challenge, might find it pointless.
- **The merging of action and awareness:** When the relevant skills are sufficient for the current challenge, the player's attention is completely absorbed by the activity, meaning that they become so involved in it that their actions become spontaneous and they stop being aware of themselves, unable to separate them from the actions performed [Csikszentmihalyi, 2008, p.53-54].
- **Clear goals and feedback:** During a flow experience, the player clearly knows what needs to be done and gets immediate feedback on how to achieve the goal [Csikszentmihalyi, 2008, p. 54-57].
- **Concentration on the task at hand:** Another elements of being in flow is that players forget all unpleasant aspects of their life. They need to have complete focus at the challenge at hand and therefore leaving no room in the mind for irrelevant things [Csikszentmihalyi, 2008, p. 58].
- **The paradox of control:** People enjoy the sense of control during a flow experience, however, it is not possible to experience the sense of control unless the outcome is undetermined, meaning that in reality the person is actually not in control [Csikszentmihalyi, 2008, p. 61]. This is a key element to the enjoyment of a game, as developers need to offer meaningful choices to players without actually giving the player complete control or an assured outcome [Fullerton, 2018, p. 89].
- **The loss of self-consciousness:** The player has no attention left for anything other than the task at hand. As mentioned by Csikszentmihalyi *"one item that disappears from awareness deserves special mention, because in normal life we spend so much time thinking about it: our own self."* [Csikszentmihalyi, 2008, p. 62]. There is no room for

self-scrutiny, since the flow activities have everything set up for the player, leaving no room for the person's self to be threatened. The person feels as though they are part of a system of action, and not as though they have lost or given up the control of their own body [Csikszentmihalyi, 2008, p. 64].

- **The transformation of time:** A common description of a flow experience is the concept of time being altered [Csikszentmihalyi, 2008, p. 65-66]. Often people will mention that time passes by fast, but occasionally the reverse happens, where seconds are experienced as minutes. Often digital games are associated with sucking their players in for hours and altering their perception of time [Fullerton, 2018, p. 90].

When most of these elements are present and occur, the experience becomes autotelic, meaning doing an activity for the enjoyment it provides, whereas most things in life are exotelic (doing something to achieve a goal, not for the enjoyment of the experience) [Fullerton, 2018, p. 90]. The elements mentioned above are concepts which can be used in the context of developing games, but should not be seen as a concrete guide [Fullerton, 2018]. Csikszentmihalyi places focus on the flow activities being goal-oriented and rule-driven with clear goals and immediate feedback [Csikszentmihalyi, 2008].

4.3.3 Narrative Engagement

This can be viewed as another form of engagement, but with more focus on the narrative and the story, with many of the traits seen in the theory of engagement, such as flow [Busselle and Bilandzic, 2009] (*section 4.3.2*). As explained by Buselle and Bilandzic [Busselle and Bilandzic, 2009], they are many theories surrounding the different aspects of engagement, with or without a narrative. They seek to create a greater clarity on the roles that the different theories play in narrative experiences, how they relate to one another, and how they facilitate the perception and construction of reality [Busselle and Bilandzic, 2009]. They outline six main topics, but only four will briefly be mentioned in this subsection.

- Mental models in narrative engagement
- Perspective taking
- Presence in a story world
- Flow related to narrative engagement

Mental models

Mental models are constructed by the individual audience member to comprehend a narrative and give meaning to the story presented [Busselle and Bilandzic, 2009]. The primary mental model in relation to story comprehension is the situation model [Busselle and Bilandzic, 2008], which can be seen as an index model of the events and actions performed by the characters. As new information is gathered, the current situation model is updated, this happening progressively as the narrative unfolds [Busselle and Bilandzic, 2008]. The inside of the model contains information in logically coherent clusters, from events and actions which has not yet happened, to questions and uncertainties providing suspense or requiring resolution [Busselle and Bilandzic, 2008]. These models are important as they give meaning to the narrative and enables the audience member to construct these models of meaning, representing the fictional characters, places, and problems, as well as updating these as the narrative progresses [Busselle and Bilandzic, 2009].

Perspective taking

During narrative comprehension the audience member should locate themselves within their constructed mental model of the story presented [Busselle and Bilandzic, 2009]. According to *deictic shift*, the audience members exchange their own time and location with the time and

location of the narrativ, finding themselves in the subjective world of the characters [Busselle and Bilandzic, 2009]. This step is necessary, as the reception of information makes sense only from the deictic center of the story [Busselle and Bilandzic, 2009]. The deictic shift is seen as a necessary cognitive process for understanding narrative plot and for the emotional processes used for perspective taking, such as *identification*, *empathy*, and *sympathy* [Busselle and Bilandzic, 2009].

Identification happens when the viewer or reader strongly identifies with a character, that the person ceases the be aware of their social role and temporarily adopts the perspective of the character [Busselle and Bilandzic, 2009]. Cohen's definition of identification is the sensation of experiencing the narrative with the character, rather than distanced judgement [Cohen, 2001]. Now follows the three elements of identification.

Firstly, seeing all the events and characters from within the narrative, making the viewer aware of the character's perspective and their interpretation of events and situations, as well as a character's motives in relation to a situation or an action [Busselle and Bilandzic, 2009]. This is called cognitive perspective taking and provides an understanding of events and situations whilst inside the narrative, different from an objective observer [Busselle and Bilandzic, 2009].

Secondly, *empathy*; adopting the character's perceptive, allowing the viewer to understand and relive the character's emotions, mirroring the emotional experience of the character simultaneously [Busselle and Bilandzic, 2009]. The viewer should also be able to understand the feeling of the character without having them share those emotions [Busselle and Bilandzic, 2009].

Third and final is *sympathy*, where the viewer may feel emotions towards the character such as embarrassment, concern etc. [Busselle and Bilandzic, 2009]. This differs from empathy as the audience member does not feel the same emotion as the character. An important aspect of sympathy in narratives often occurs e.g. in horror or thriller movies where the audience member knows something that the character does not and is therefore fearing for the character unaware of incoming danger.

Flow and presence in narrative engagement

Flow has been explained earlier in *section 4.3.2*, therefore we will not go further in-depth about the concept, only its relation to the mental model, which suggests that experiencing flow in a narrative does not differ from flow in activities with no narrative, meaning that the attention is focused on the activity [Busselle and Bilandzic, 2009]. On another level, experiencing flow in a narrative opens up alternative worlds, characters etc., making available to readers and viewers immersion in an alternative reality, whereas musicians and athletes may only be focused on other aspects of the activity [Busselle and Bilandzic, 2009]. The loss of self-awareness (as seen in flow) combined with a construction of an alternative world, provides the feeling of presence (being inside the narrative world) [Busselle and Bilandzic, 2009].

These sensations mentioned by Buselle and Bilandzic [Busselle and Bilandzic, 2009] throughout this section, may contribute to the loss of one's surroundings, but regardless of the cause, the engagement in a narrative should result in the opposite, the loss of one's self, which can be explained as a product of the identification and perspective taking with the characters. Combined with flow, the activity may result in the altering of the perspective of time, also known as narrative involvement [Busselle and Bilandzic, 2009].

4.3.4 Data gathering during player experiences

Different methods and tools exist for measuring engagement. These can be adjusted and used interchangeable to create the desired structure, taking into account external factors and the desired type of data.

Biometrics

Biometrics is a great way to collect objective autonomic data from players. The autonomic responses differ from the somatic ones in that they are automatic and self-regulated by the body. This section briefly mentions some of these methods.

- **Eye tracking:** can be used to study the player's eye movement and/or gaze behavior such as pupil dilation [Duchowski, 2007]. Recently eye trackers have become more advanced, providing an easier approach for using them, suggesting that they are not as distracting to participants as older models. Accuracy is an on-going problem because of issues such as calibration, ability to track different users and extraction and interpretation of the eye movements [Hansen and Ji, 2009].
- **Galvanic skin response (GSR) and heart rate:** Skin conductance levels and higher heart rate correlates with psychological arousal [Nacke, 2013]. These methods are easy and non-intrusive in the current state-of-the-art. Mionix Naos QG gaming mouses [Mionix, 2020] has build-in heart rate and GSR sensors making it non-intrusive to use when doing screen-based testing where the participants need to use a mouse. Other tests involving participants standing or moving could make use of wristbands featuring these sensors, such as the Empatica E4 wristband [Empatica, 2020].

TRUE Instrumentation

The TRUE (Tracking Real-Time User Experience) method is a tool, which can be applied to digital games in order to collect extended gameplay feedback from the player [Schuh et al., 2008]. The three forms of data gathered is as stated:

1. Attitudinal feedback using in-game surveys.
2. Contextual data in the form of telemetry.
3. Utilization of video or other methods for better understanding of the data.

These forms of data can be triangulated to create a better impression of the player experience, as using different measures in collaboration constructs a more coherent justification of the hypothesis [Bjørner, 2015, p. 109].

Surveys: Capturing the behavior of the player only shows part of the whole picture. Knowing that a player died multiple times against an enemy is an interesting point, but is hard to interpret. Is the player frustrated or enjoying the challenge? Without attitudinal data, it can be very hard to know if the repeated deaths are a problem or a key component to the enjoyment [Schuh et al., 2008]. To address this issue, a brief in-game survey can be used. At determined points during the game, the game could pause and display a brief question which the player should be able to answer quickly. The TRUE documentation highlights three categories of in-game surveys suitable for different purposes [Schuh et al., 2008].

- **Event-based surveys:** Surveys which are displayed when certain events occur and when they are completed. These types of surveys are useful for feedback about the experience leading up to the current event.
- **On-demand surveys:** Surveys that the player is able to open at all times. This allows for the player to freely provide feedback during the experience, when they feel in a particular way or if they want to highlight something throughout the experience.
- **Time-based surveys:** Surveys which will be displayed after a set amount of time. These surveys are useful for assessing engagement or enjoyment in the experience over time. A danger of using this type of survey is that it can potentially impact the player negatively. If the player is interrupted constantly every minute, they will eventually become frustrated. To avoid this, space out the survey as infrequently as possible while still being able to gather the information needed. Also, make sure that the survey is

displayed during a natural break during the game, making sure it does not display in the middle of a fight or a similar situation.

Contextual Data: An important factor to all data gathered, is providing the relevant contextual information needed in order to interpret the result [Schuh et al., 2008]. You need to understand the context in which the information was collected. The specific contextual data will vary between games, genres etc., but with every data point, some of the information about where it occurred should be gathered (both in surveys and behavioral responses), such as the following [Schuh et al., 2008]:

- **Build number:** When iterating on the game several times, you will need to indicate which build a particular data set is related to.
- **Test name:** There might be several tests performed on the same build, and by naming the individual test with a title and assigning that to every data point you are able to separate or combine the data from the different groups.
- **Participant ID:** Identifying which participant the data is from.
- **Timestamp:** Knowing when the data was collected.
- **Difficulty setting:** You want to be able to distinguish when a certain problem you identified in the data is common for all participants or just some playing a certain level of difficulty.
- **Chapter/mission/quest/level/map name:** Depending on the games being tested, there should be some identification of what portion of the game the data is collected from.
- **Position coordinates:** Recording the $[x, y, z]$ coordinates of every data point allows for the information to be plotted onto a map, which is a powerful way of identifying and displaying problems.

Video: Video recordings can also be used to investigate actions of interest in-depth. What was done by Schuh et al [Schuh et al., 2008] was having the players' on-screen activity recorded and synced with all the instrumentation data using the always-present timestamp information. All the combined data was included in an SQL database and the resulting outcome was different reports allowing the researches to skip hours of reviewing videos. Instead, it could jump directly to an action of interest, ranging from survey answers to an event etc.

Next, we review the literature on identifying or discretizing playing styles.

4.4 Playing styles

Throughout the decades, various player models have been proposed. The origin of playing style models can be found in the origin of play as proposed by Caillois [Caillois, 2001], which includes four different forms of playing behavior. *Agôn* as competitive games, *alea* as games of chance, *mimicry* as role-playing games and *ilinx* as games involving vertigo or otherwise altering perception. Caillois further modifies these by categorising them into *ludus* being rule-based play and *paida* being free-form improvisational play [Caillois, 2001]. This classification allows for quick categorizing of different games and their key pleasure.

Malone defines a framework for a theory of intrinsic motivation instructions including three areas of issues when developing fun digital games [Malone, 1981]. *Challenge*, involving goals which are important to intrinsically motivating environments. For instance, in a learning game, the goal of the game is to teach the player a certain skill, such as reading, but the immediate goal of the player is to complete the apparent task, like navigating through a maze. Further, if the player is able to relate to the character of the game, they may relate to the goal. The

difficulty level also takes inspiration in Csikszentmihalyi's [Csikszentmihalyi, 1978] description of motivating activities. This all involves ways of making the activity challenging for the person with both intrinsic and extrinsic *fantasy* and cognitive *curiosity*.

In this section, we will look into different models for categorising player style.

4.4.1 Continuation desire

Engagement in video games can be related to many different concepts. Among others flow, as described in *section 4.3.2*. In a study by Schønau-Fog and Bjørner [Schønau-Fog and Bjørner, 2012], engagement is described as the desire to continue playing, using continuation desire as a tool to measure engagement in digital games. They have categorised the causes of engagement into six different types:

Intellectual Engagement: This type of engagement is concerned with intellectual challenges and activities. This could be the result of the players' desire to continue in order to face the challenges demanding the use of intellect [Schønau-Fog and Bjørner, 2012]. Some of the causes describing the desire to continue through intellectual engagement is as follows: Problem solving, puzzles, strategic thinking, acquiring knowledge etc.

Physical Engagement: This type of engagement is due to the physical interaction performed during the game [Schønau-Fog and Bjørner, 2012]. The desire to continue is caused by the moving of the players' body in relation to the type of input interfaces that the game offers. The cause of physical engagement can occur when game mechanics demand a larger amount of physical action and challenges which require precise and fast timed movement from the player [Schønau-Fog and Bjørner, 2012]. The physical action depends on the physical input type of the game, but could range from finger tapping to larger movement, such as whole body movement.

Sensory Engagement: This type of engagement is caused by stimulation the senses during gameplay and is experienced when the player wants to continue playing in order to experience these sensations and sensory elements occurring in the game [Schønau-Fog and Bjørner, 2012]. This could be both audiovisual or haptic elements.

Social Engagement: Social engagement is caused by interacting with other players, both during gameplay as characters, but also with people in real life [Schønau-Fog and Bjørner, 2012]. This engagement occurs when the player desires to continue playing due to feeling connected with friends and other players during gameplay or real life. Competition and cooperation also strengthens social engagement and may keep players engaged during gameplay [Schønau-Fog and Bjørner, 2012]. Some situations, which could cause social engagement, are quests, challenges, puzzles, and other activities which require involvement of multiple players in order to be solved. Being accepted, well-known by others, the feeling of belonging, bragging, competing and other action involving interpersonal relations can also be further cause for social engagement [Schønau-Fog and Bjørner, 2012].

Narrative Engagement: This engagement can be caused by the player experiencing the narrative during the game. The desire could be caused by curiosity, excitement and suspense to know how the narrative is going to unfold throughout the game [Schønau-Fog and Bjørner, 2012]. Characters involved in the game might acts as support to the narrative, and as the player involves themselves with the characters, they experience how the characters are developing throughout the narrative. This could contribute to the desire of continue playing. How the players act and behave in certain situations and events in order to discover how the narrative unfolds, could also be due to the narrative engagement [Schønau-Fog and Bjørner, 2012]. To achieve narrative engagement in players, a range of narrative tools can be used, such as cues, exciting character builds, interesting events, and developing a good story-arc.

Emotional Engagement: This type of engagement affects the players' emotion during gameplay. The desire to continue playing is caused by the feeling towards other players or empathy towards the characters in the game world [Schønau-Fog and Bjørner, 2012]. These emotions can be caused by an event, action by other players, or by attributes of game assets. The emotions have a wide range with everything from revenge to relief and affection [Schønau-Fog and Bjørner, 2012]. Narrative engagement *(section 4.4.1)* can also cause emotional engagement by building a strong relationship between the player, characters, and story of the game [Schønau-Fog and Bjørner, 2012].

4.4.2 Bartle

Bartle is the co-creator of the first MUD, originally known as *multi-use dungeon*, but later variants as *multi-user dimension* and *multi-user domain* combining various game genres into one space. He analyzed the replies of senior players of MUD2's debate about "what do people want out of MUD?" [Bartle, 2004, p. 130]. What he concluded was a summary of their ideas of what contributed to *fun* for the players, which would fall into one of four categories:

- **Achievers:** These players like achieving defined goals within the built-in ranking system of the game and thereby progressing their character.
- **Socializers:** These players' biggest reward is interacting with other players through the medium of the game's virtual world. Some of these players will behave as themselves, while others might roleplay.
- **Explorers:** These players like to explore and seek out new things and items. They take pleasure in increasing their knowledge of understanding how the virtual world works, and their joy lies in discovery.
- **Killers:** These are players which seek to dominate others. The classic method is through attacking or perhaps making life more difficult for other players. Other methods can also manifest in less apparent fashion such as rumor-mongering and guilt-tripping other players.

To formalize these player types, they are placed in a two dimensional graph, where the player types are placed in the four quadrants. The axes are based on the preferences of the player types [Bartle, 2004, p. 130]. Achievers and explorers are more interested in the game and virtual world, while socializers and killers are more focused on the players than the game aspects. This would provide one axis, while the other would take into account the way the player types act and interact with the virtual world and its players [Bartle, 2004, p. 130-131]. The graph can be seen in *figure 4.6*.

The graph is a tool to inform designers when developing their game. The strength of it lies in the categorisation of players into four categories, taking into consideration that it is based on what the player types find fun inside the virtual world and is therefore attuned to situation impacting fun [Bartle, 2004, p. 139]. This could be when you are creating the virtual world and do not yet have a user base and utilizing the model can give you an idea of how the players might react to a certain feature.

There is a limitation in what this model can be used for and what to be aware of.

- It does not address the change of player style over time.
- It does not take into account players that appear to play one style, while actually playing another. An example could be if achievers regard killing as an achievement.
- If the scale of the world is large enough to have several sub-worlds, the model can not be applied to the world as a whole, but to the individual.
- It can be misinterpreted, since players are not good at judging their own playing style.

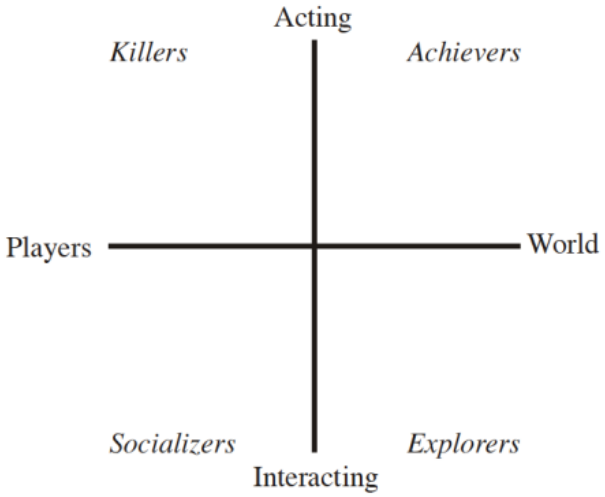


Figure 4.6: Bartle's player interest graph [Bartle, 2004, p. 131-132]

The points mentioned are just a few of the main issues with this theory [Bartle, 2004, p. 140]. It should also be taken into account that the model have little to no use, when applying it to games which players play for other reasons than having fun, for instance learning games [Bartle, 2004, p. 140].

The Bartle Test

The Bartle test is based on the player types mentioned above. The test is an online binary-choice questionnaire [Barr, 2017, Andreasen and Downey, 1996]. This may be useful for designers in order to gather a loose overview of the different types of players playing their game. The outcome of the test is expressed as four letters, each of them being an abbreviation for the persons player type, the first letter being the primary, dominant playing style, the second letter the second playing style etc. [Barr, 2017]. The test has some intrinsic biases, both in terms of participants being self-selected and the nature of the questions, since which player type the answers refer to can be easily distinguished by the wording of the questions. This means that some people might give the answer they believe will lead to a certain outcome. Therefore this test might not be useful for certain scenarios and if using this questionnaire anyway, the biases should be taken into consideration and results should be taken with healthy skepticism. This does not mean that the test is deemed useless, but could provide knowledge for players when seeking virtual worlds matching their player type [Bartle, 2004, p. 146].

4.4.3 ADOPTA

The ADOPTA (ADaptive technOlogy-enhanced Platform for eduTAinment) model is used as a tool to facilitate the players' motivation, creativity, and learning by drawing a parallel between learning styles as presented by Honey and Mumford [Honey and Mumford, 1992] and playing styles in video games. To establish the ADOPTA model, existing game player models and playing styles have been used [Bontchev et al., 2018]. Among them is the one presented by Stewart [Stewart, 2011], were he describes player types as the human personality when playing in a game context and how this should be considered in models including game design and *Behavlets* developed by Cowley and Darryl [Cowley and Charles, 2016], described as *"[...] a way to model players based on variation of their dynamic gameplay behaviour."* [Cowley and Charles, 2016]. Their characteristics are compared and used for the development of the ADOPTA model, further defined on top of Kolb's theory of experiential learning [Kolb, 2014, Bontchev et al., 2018].

The ADOPTA playing styles are defined through four playing styles focusing on individual gameplay preferences [Bontchev et al., 2018] with ten questions in each category being typical for that particular style.

Competitor: Players who enjoy action and shooting, this style focuses on the competition itself. It supports good hand-eye coordination, as well as taking great risks unusually not seen as reasonable by others. Further, it supports quick thinking during planning and choosing tactics. Competitors are very expressive, meaning that rely mostly on intuition rather than theories and are prone to spontaneous actions, deeming strong competition to be the best option for discovering new things and improving themselves. They are also seen as open-minded and intuitive.

Dreamer: Players who enjoys roleplaying and fantasy worlds filled with avatars, where they often prefer to observe the game rather than controlling it. They like guided gameplay and would like to have mastered a given game level before moving on. Dreamers gather different perspectives and consider things carefully before deciding on missions and playing actively. They also demonstrate good communication and collaborative skills, while being open-hearted about their feelings. Dreamers prefer to listen to arguments and observe before making bigger decisions and communicating them. They like complex gameplay and situations, and are fond of social interaction, diplomacy, and negotiations.

Logician: These players enjoy logic and analyses. They are fond of pattern-based approaches when executing tasks and posses good spatial awareness, contextual thinking and verbal skills, as well as numeracy and spelling skills. They often approach games by learning the intricacies of each and applying them to different moves in a rational and perfect manner. When exploring the game space, they like to split the gameplay into steps of precise details. When playing, they like to be recognized by other players as being rational, methodical, and objective.

Strategist: These players are very pragmatic and like resolving complex problems in the most effective way, disliking acting without a reasonable outcome of good results and benefits in the game. They explore new ways of thinking and try practical ways to succeed the game tasks on time. They demonstrate long-term thinking when contemplating strategies, testing hypotheses, and watching the outcome of their actions. Strategists like decision-making and like anything which works.

4.4.4 Yee

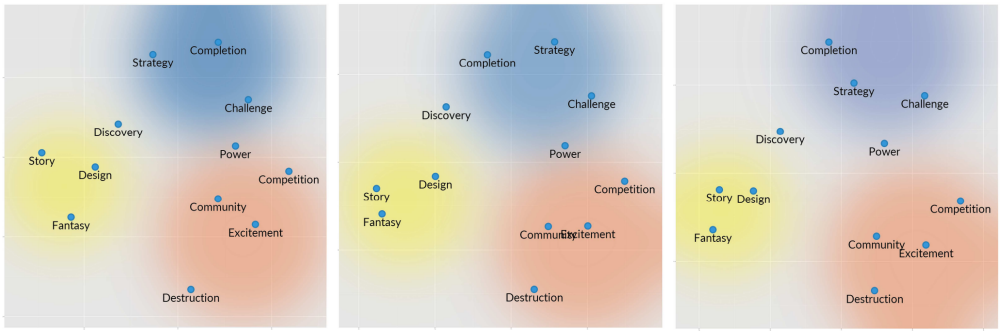
Yee [Yee, 2016, Yee, 2019], together with his company Quantic Foundry, developed a gamer motivation model from survey data from more than 400,000 gamers. Using factor analysis on the data he identified six scales (Action, Social, Mastery, Achievement, Immersion and Creativity). Through research in similar fields of player motivation/engagement/enjoyment, they created a matrix with an overview of different player categories others had previously developed and how they related to one and another [Yee, 2016]. This matrix can be seen in *figure 4.7*.

A bootstrap method, using multiple questions regarding different areas of interest, was formed based on an initial panel of 600 gamers [Yee, 2016]. A revised model was developed using 13,000 gamers, where poorly performing questions were changed or completely removed. At the time of writing, over 400,000 gamers have taken the test [Yee, 2019]. 12 motivation types were derived, grouped into 6 scales in which they intra-correlate highly, seen in *figure 4.9* (Column wise).

Looking at the relationship between motivation types across columns, a multi-dimensional scaling was used on all of their data, producing three clusters, as seen in *figure 4.8*. The shorter their euclidean distance in the map, the higher their correlation [Yee, 2016]. The

	Story	Excitement	Social	Compete	Escapism	Challenge	Creation	Achieve	Curiosity	Fantasy
Hilgard et al. (2013)	☑	☑	☑		☑	☑	☑	☑	☑	
Rigby et al. (2006)			☑			☑		☑	☑	
Bartle (1996)			☑	☑				☑	☑	
Sherry et al. (2006)		☑	☑	☑		☑				☑
LeBlanc (2004)	☑	☑	☑			☑	☑		☑	☑
Steinkuehler (2005)			☑	☑		☑		☑	☑	
Yee (2006)	☑		☑	☑	☑		☑	☑	☑	
Caillois (1961)	☑	☑		☑						
Griffiths (1991, 1993)		☑	☑		☑	☑				
Myers (1990)			☑			☑			☑	☑
Jansz & Tanis (2007)		☑	☑	☑		☑				☑
Lee at al. (2012)			☑		☑	☑				☑
Lazarro (2004)		☑	☑			☑			☑	
Malone et al. (1987)			☑	☑		☑			☑	☑

Figure 4.7: Literature review by Yee [Yee, 2016]



(a) Eastern Europe (b) Australia and New Zealand (c) North America

Figure 4.8: Motivation map over different regions of the world [Yee, 2016]. Yellow: Immersion -Creativity, Blue: Mastery-Achievement, Red: Action-Social

mapping shows three clusters, consisting of Action-Social, Mastery-Achievement, Immersion-Creativity with Discovery being a bridge between Action-Social and Mastery-Achievement and Power as a bridge between Action-Social and Immersion-creativity.

The interesting discovery was that the motivation maps were stable across different regions of the world, as seen in *figure 4.8*.

The 12 motivation types

Yee expressed 12 motivation types across six scales [Yee, 2016]. These are displayed in *figure 4.9*, but in this section we will dive further into each of them.

The 12 motivation types are categories into six scales with two motivation types in each (*figure 4.9*). Initially, the motivation type were somewhat rigid, but after further data analysis, the model has expanded by using the negative space of each motivation type [Yee, 2019]. This solves the issue of placing where to place a gamer which is a non-achiever, which has been a reoccurring problem in models like such as Bartle's player types [Bartle, 2004, Yee, 2019]. The different motivation spectra are based on the top and bottom 20 gamers with that motivation type and their answers to their top three favorite games to play [Yee, 2019]. The spectra (*figure 4.10,4.12,4.11*) are based on the core audience of the mentioned games, meaning their typical/average player, but still it is possible to play the games with different motivations [Yee, 2019].

Figure 4.9: The gamer motivation model [Yee, 2016, Yee, 2019]

Completion is the part of the Achievement scale (see *figure 4.9*). It revolves around quantifying the game experience, in the sense that the game and its progress is visually quantified [Yee, 2019]. The player will always be able to see the progress made and how much is needed for it to be complete. There are also clear goals given to the player together with clear instructions on how to achieve these goals [Yee, 2019]. As seen in *figure 4.10*, the spectrum dimension is *source of goals*, where the opposite ends of the scale are *task-oriented* and *self-driven*. The players on the high end would usually prefer games that have tasks/quests to complete and trophies to collect. On the low end, the player prefers games that are more in the style of open gameplay/sandbox, with the possibility for them to set their own goals and agendas.

Strategy is part of the Mastery scale (see *figure 4.9*). It revolves around long-term motivation, meaning items which take planning and time to accomplish [Yee, 2019]. Its core is about the decision complexity and the amount of information needed for the player to process in order for them to make their next decision and plan for possible outcomes in the future [Yee, 2019]. There is therefore a difference in time horizon, one step ahead or 50 steps ahead, depending on which side of the spectrum the player is on. As seen in *figure 4.10*, the spectrum dimension is *decision complexity* where the opposite ends of the scale are *contemplative* and *spontaneous*. The players on the high end usually prefer games with complex decision making, long-term strategies etc.. Players on the low-end prefer games with a short time horizon and a lower cognitive load.

Challenge is part of the Mastery scale (see *figure 4.9*). It revolves around long-term oriented gameplay, where the player is getting better at something or overcoming something difficult [Yee, 2019]. As seen in *figure 4.10*, the spectrum dimension is *skill improvement*, where the opposite ends of the scale are *skill-based* and *easy fun*. The players on the high end usually prefer games with a steep learning curve, complex moves and difficult missions for them to overcome, whereas players on the low end prefer games which are quick to learn, straightforward and do not really require fine tuning of any skill.

Power is part of the Achievement scale (see *figure 4.9*). Usually, you would relate power to players only focusing on being stronger than everyone, but it is actually focused on constant growth over time. Being able to see your character getting bigger and stronger in absolute numbers [Yee, 2019]. As seen in *figure 4.10* the spectrum dimension is *growth*, where the opposite ends of the scale are *progression-based* and *flat-progression*. The players on the high-end usually prefer games with characters that can be leveled up over time, being able to constantly develop the character in order to grow stronger. On the low end, players prefer

Preferences	Games Examples	Motivation	Game Examples	Preferences
Self-Driven Decide what to do myself. Sandbox/open gameplay. Self-directed goals.	RimWorld, Victoria II, Kerbal Space Program, Cities: Skylines	**Completion** *Source of Goals*	Dragon Nest, Aura Kingdom, Lego Dimensions, Final Fantasy	**Task-Oriented** Complete tasks/quests. Collect stars/trophies and collectibles.
Flat Progression Fully-developed characters from the start. Static. Level playing field.	Night in the Woods, The Longest Journey, Ico, 80 Days, Her Story	**Power** *Growth*	World of Warcraft, League of Legends, Diablo III, Summoners War	**Progression-Based** Start weak and grind. Level up character/stats. Upgrade weapons/spells.
Spontaneous Reactive gameplay. Low cognitive load. Short time horizons.	The Sims, Disney Emoji Blitz, Mario Kart Wii, Covet Fashion	**Strategy** *Decision Complexity*	StarCraft II, Crusader Kings II, Europa Universalis IV, Stellaris, Eve Online	**Contemplative** Think. Plan. Complex decisions. Long-term strategies. Consider consequences.
Easy Fun Quick to learn. Low skill barrier. Straightforward mechanics. No skill-based gates.	Oxenfree, Stardew Valley, The Longest Journey, Animal Crossing	**Challenge** *Skill Improvement*	Super Smash Bros. Melee, DotA, osu!, Street Fighter V	**Skill-Based** Steep learning curve. Complex moves/rules. Difficult missions, bosses.

Figure 4.10: Achievement-Mastery Spectrum [Yee, 2019]

games where the characters are possibly already fully developed from start with very static gameplay or otherwise level playing field.

Design is part of the Creativity scale (see *figure 4.9*). It revolves around the players' expression of themselves when playing, how are they able to express their personality in the game and leaving a mark. Also, to what degree the game is able to provide the necessary tools for the players to truly design their avatar, spaceship, or other artifacts [Yee, 2019]. As seen in *figure 4.11* the spectrum dimension is *expressing individuality*, where the opposite ends of the scale are *customizable* and *curated*. The players on the high end prefer games which provide lots of accessories and items for the player to customize their avatar/house etc. with, where players on the opposite end prefer games which have fixed characters and few to none customization options.

Fantasy is part of the Immersion scale (see *figure 4.9*). It revolves around the players' willingness to set aside reality in order to transport themselves to a different world and become someone else [Yee, 2019]. As seen in *figure 4.11* the spectrum dimension is *suspending disbelief*, where the opposite ends of the scale are *deep lore* and *generic/abstract*. Player situated on the high end prefer games which have a rich story world which is visually immersive and compelling. Players on the low end prefer games which are either visually generic or in an abstract, but simple environment. Also, the games often contain minimal history and world-building.

Discovery is part of the Creativity scale (see *figure 4.9*). It revolves around the broader game, exploring the unknown and poking at the boundaries of possibility inside the game world [Yee, 2019]. As seen in *figure 4.11* the spectrum dimension is *the unknown*, where the opposite ends of the scale are *curious* and *practical*. Players on the high end often prefer games where they are able to explore the game world, find hidden artifacts, uncover secrets and experiment with objects. On the low end, the players prefer games where the rule sets are already exposed and where there are minimal to no unknown variables and a known set of possible interactions.

Story is part of the Immersion scale (see *figure 4.9*). It revolves around the possibilities of interaction with characters and other game elements, involving yourself with the narrative [Yee, 2019]. As seen in *figure 4.11* the spectrum dimension is *web of human drama*, where the opposite ends of the scale are *scripted drama* and *open-ended*. The players on the high end often prefer

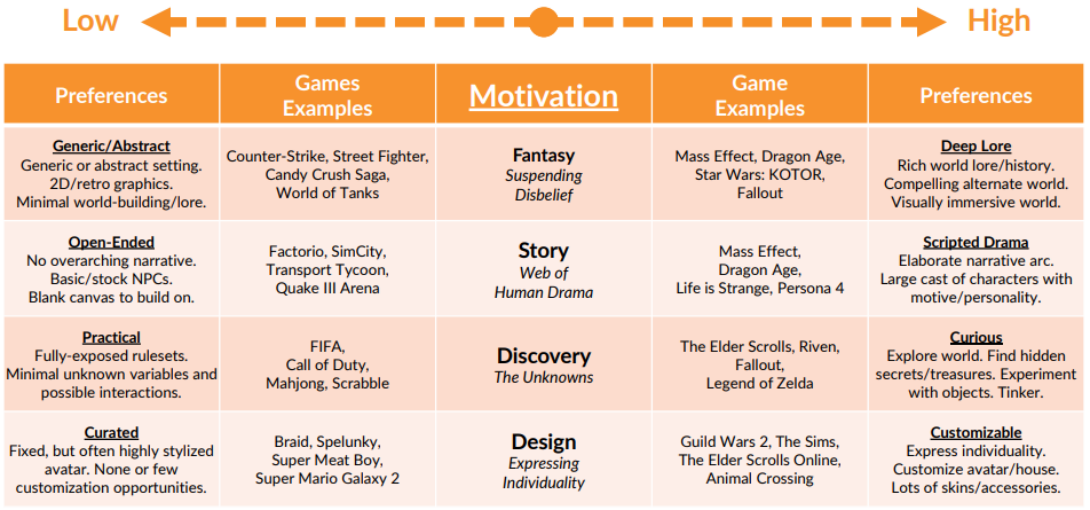


Figure 4.11: Creativity-Immersion Spectrum [Yee, 2019]

games with elaborated narrative arcs, large casts of multiple characters with fully developed motives and personalities. On the opposite end, the players prefer games with no narrative arch, more basic or simple NPCs and more of a blank canvas to build upon.

Excitement is part of the Action scale (see *figure 4.9*). It is action-based and fast-paced with many surprises acting as unexpected stimuli, meaning at its core it is about new stimuli over time [Yee, 2019]. As seen in *figure 4.12* the spectrum dimension is *novelty* where the opposite ends of the scale are *thrilling* and *calm*. The players on the high end prefer fast-paced games which provide adrenaline rushes using many actions, where players on the low end often prefer games which are turn-based and able to be paused. The games are often relaxing and predictable.

Community is part of the Social scale (see *figure 4.9*). It revolves around having shared experiences with other players. It strikes the balance between having full control and being dependent on other players [Yee, 2019]. As seen in *figure 4.12* the spectrum dimension is *shared experience*, where the opposite ends of the scale are *teamwork* and *independence*. The players on the high end prefer games which allow for multiple players and teamwork, with possibilities for the players to socialize and collaborate during play. On the low end, the players prefer single-player games with solo quests where they are in full control themselves.

Competition is part of the Social cluster (see *figure 4.9*). When players or real people competes it triggers the acute stress cascade also known as fight or flight response [Yee, 2019]. The anxiety triggers these responses even if the situation you are situated in is digital or not, therefore many people will get excited with higher heart rate and start to shake, because of the releasing of cortisol and adrenaline [Yee, 2019]. The players like this feeling of going against other players, since this can be seen as a way to hack the body into this mode [Yee, 2019](the same as when people watch horror movies or due extreme sports). As seen in *figure 4.12* the spectrum dimension is *social comparison*, where the opposite ends is *high conflict* and *non-adversarial*. Players on the high-end prefer games which are adversarial involving arenas, duels/matches, leaderboards and more to support the conflicts, where player on the low-end prefer games that is non-competitive with no rankings or conflicts against other human players.

Destruction is part of the Action scale (see *figure 4.9*). It revolves around the attraction to chaos and mayhem [Yee, 2019]. As seen in *figure 4.12* the spectrum dimension is *entropy*,

Figure 4.12: Social-Action Spectrum [Yee, 2019]

where the opposite ends of the scale are *chaotic* and *enduring*. The players on the high end prefer games which involve guns, explosions, gore etc., and being in a destructible environment. The players on the low end prefer games which offer a sense of reliability and calmness. They are idyllic and serene with no weapons or gore.

Next, we move on to reviewing the current state-of-the-art within interactive media.

4.5 State Of The Art

This section will investigate different digital games and movies, which deals with interactivity in a different manner, setting them slightly apart from the common product.

4.5.1 Graphic adventure games

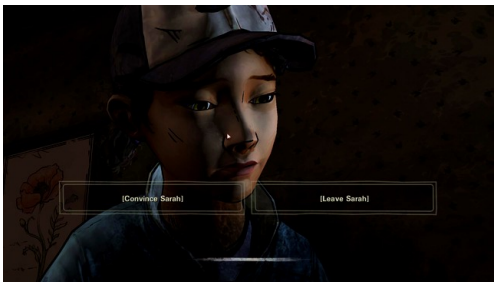
Games might be structured in different ways according to how the designer wants the target user to play their games. Some of the branching structures can be seen in *section 4.1.1*. Games make use of these structures to provide the player with a sense of agency without giving them full control. In this section we will look into graphic adventure games and how they use different branching structures in the narrative to provide agency for their players, and how these might impact gameplay.

The Walking Dead: The Telltale Series is a video game series developed by Telltale Games in association with Skybound Entertainment. The series consists of five seasons with a total of 23 playable episodes distributed throughout the seasons. The first season came out in 2012 and the last one in 2019 [Fandom, 2019].

The game is developed as a graphic horror adventure, where it uses point-and-click to navigate and has more focus on narrative and character development rather than combat, and unlike other games within the same genre, it does not emphasize problem-solving as much [Fandom, 2019]. The game takes place within the world of The Walking Dead comics series' universe, shortly after the onset of the zombie apocalypse [Fandom, 2019, Skybound, 2019].

The game is centered around a young girl, Clementine, growing from a scared little girl to a capable survivor, as you follow her around, helping her decide, survive and much more [Fandom, 2019,Skybound, 2019]. The narrative is affected by the dialogue choices of the player character

(a) Screen capture during gameplay



(b) Screen capture of player choices i relation to other [Gameinformer, 2020]

Figure 4.13: Screen captures of choice option during gameplay (a) and player choices in relation to other players (b) [Gameinformer, 2020]

and their actions during timed events which often lead to a drastic change in the narrative. All the choices made by the player is carried over to the other episodes and is referred to in the later seasons [Fandom, 2019]. The choices that the player has taken during gameplay is by the end also shown in relation to what other players did (see *figure 4.13b*).

Life is Strange is developed by Dontnod Entertainment and published by Square Enix. The game consists of two seasons with a total of ten episodes and an additional standalone game with an independent narrative taking place three years before the rest of the story [Enix, 2020]. The first season released periodically throughout 2015, while the second released from late 2018 to late 2019. Only the first season is reviewed here. [Enix, 2020].

Figure 4.14: Screen capture of making choices during the game [Gamepressure, 2020]

The story revolves around Max, a photographer who saves her old friend by discovering that she can rewind time. You follow her and discover hidden secrets throughout the game [Enix, 2020]. The interesting aspect about this game is the main character's ability to rewind time, enacting a butterfly effect during gameplay. The player's action adjusts the narrative as it unfolds, but due to the main character's ability you are able to reshape it by travelling back in time, making for interesting gameplay. Gathering items and making environmental changes is represented in the form of puzzles, using the branching choices for conversation during the gameplay. The central focus is on story and character development by using choice and consequence.

4.5.2 Netflix's interactive movies

In recent years Netflix has released interactive entertainment, making it possible for the viewer to become a more active part of the whole experience by making them choose how the main

character should proceed, ranging in genres and targeted towards different audiences. In this section we will therefore only present two of them.

(a) You vs. Wild [Netflix, 2020b]

(b) Black Mirror: Bandersnatch [Netflix, 2020a]

Figure 4.15: The two movies with two decisions during viewing

Black Mirror: Bandersnatch: In 2018, Netflix released an interactive movie as an extra to one of their more controversial series *Black Mirror*, naming their movie Black Mirror: Bandersnatch. The movie lasts one and a half hours depending on the individual and their choices, but has a longer runtime if viewing multiple paths. The movie can only be played on devices which are able to run the newer versions of their Netflix application. There are five endings to the movie and multiple paths available to the viewer. For a complete overview of all the possible paths, a map was published by Garcia et al [Garcia et al., 2019]. The map shows all the different variations that the viewer is able to see by replaying the story or repeating the choices.

During the movie the viewer meets the main character Stefan Butler, a young programmer who starts to question reality when adapting a mad writers novel into a video game. Whenever Stefan needs to make a decision the viewer is able to do it for him. The borders will start to narrow and the viewer is presented with two options and a visual timer slowly decreasing as seen in *figure 4.15*. The viewer also has a third option of doing nothing and the movie will proceed accordingly. At the start of the movie, many of the choices will lead to the same path, while later on, the movie will start to branch out.

You vs. Wild: In 2019, Netflix released a series, *You vs. Wild*, consisting of one season with eight episodes following Bear Grylls as you try to survive through various missions in different terrain. The viewer is then able to make choices on how Bear should proceed when he is at a crossroad. The viewer is presented with two options and a timer, which can be seen in *figure 4.15*. This is meant as a survival series trying to uphold the feeling of realism, which can be difficult if players make a "bad" choice. Instead of performing some of the dangerous choices, Bear actually demonstrates what the outcome would be, such as touching a poisonous cactus or walking on icy water. The structure of the show does not have the same feeling of complexity or agency as Black mirror: Bandersnatch, since the mapping feels very much as a simplified Gauntlet narrative structure (see *figure4.2* and *section 4.1.1*.

4.6 Summary

This study set out to design, develop and, evaluate a decision framework and applying it to our own interactive narrative. Interactive storytelling has been around for a long time, since 1970 in the form of books and has grown tremendously (*section 4.1*), and recently adaptive games has moved into the domain of machine learning [Bontchev and Georgieva, 2017, Selvig and Schoenau-Fog, 2019], using neural networks and image recognition (*section 4.1*). This however does not change the fact that interactive games do not have a linear narrative, meaning that

there are multiple paths and perhaps different endings to one game. Therefore, it is essential to choose a branching structure which fits the needs and production level of your game (*section 4.1.1*). When selecting a branching structure, the agency of the player should be taken into consideration, since a low agency might lead to a flat experience, whereas too high agency could lead to a narrative too deeply branched, prone to combinatorial explosion [Wang, 2014, Short, 2016, Fabulich, 2011, Rickerby, 2015], making a game extremely costly and often unfeasible to produce, therefore a balance is needed (*section 4.1.2*).

Interactive narratives can be created using storylets [Kreminski and Wardrip-Fruin, 2018] instead of constructing a pre-defined graphed narrative, since it provides flexibility for the author to write small bits of story and have them dynamically arranged before or during play (*section 4.2*). To categorise them optimally, they require a set of preconditions (*section 4.2.1*), an internal structure (*section 4.2.2*) and a selection architecture (*section 4.2.3*). Short [Short, 2016] also proposed three methods to deal with the notion of storylets: Quality-based, Waypoint narratives and salience-based (*section 4.2.4*). These methods can provide more a more dynamic experience between player and narrative, or player and NPC.

Engagement is an important factor to consider when designing experiences for people. There exist many definitions and perspectives on the subjects [Kappelman, 1995,Said, 2004,Chapman, 1997, Quesenbery and Design, 2003]. From game engagement we understand that an engaging activity is subjective [Fullerton, 2018] and a playcentric approach during development can create a higher degree of engagement within the target group (*section 4.3.1*). Other factors in creating an engaging experience is challenge, which is both individual and dynamic (*section 4.3.2*). The level of challenge can be linked to the theory of *flow* [Csikszentmihalyi, 2008], which describes the state of the optimal experience, where a balance of skill and challenge is achieved and maintained (*section 4.3.2*).

It is important to consider how all of the concepts apply to a narrative. Buselle and Bilandzic address four topics [Busselle and Bilandzic, 2009]: "Mental models" is how the audience constructs the narrative, "Perspective Taking" are processes involving identification, empathy and sympathy, "Flow and Presence" is about narrative engagement 4.3.3.

There exist many tools for measuring engagement, one of the objective ones being biometrics, such as eye tracking, GSR, and heart rate, as engagement can cause physical responses in players (*section 4.3.4*). TRUE Instrumentation is also a tool which can be applied to digital games for triangulation of the data: Attitudinal feedback using in-game surveys, contextual data to provide relevance to the data being interpreted, and observations made by test facilitators (*section 4.3.4*).

Since we are dealing with people, we have to consider how these people behave and play games. Play is an old term categorised in four forms: *Agôn*, *Alea*, *Mimicry*, and *Ilinx*. These are further categorised into *ludus* and *paida* [Caillois, 2001]. These terms have formed and inspired most of the models used for identifying player types used today (*section 4.4*).

Continuation desire is the desire to continue playing, and provides a good estimate of levels of engagement in players [Schønau-Fog and Bjørner, 2012]. This models uses six different causes for engagement: Intellectual engagement, physical engagement, sensory engagement, social engagement, narrative engagement and emotional engagement.

Bartle's player type is composed of four sub-types: Achievers, Socializers, Explorers and Killers [Bartle, 2004], in which he summarized the idea of what contributes to fun for the players (*section 4.4.2*). These player types are formalized on a two-dimensional graph (see *figure 4.6*). Even though a Bartle test exists, there are significant biases associated with it, addressed in *section 4.4.2*.

ADOPTA is also another model used to measure the players motivation [Bontchev et al., 2018]. This model draws parallels to learning styles [Honey and Mumford, 1992] and existing playing styles [Stewart, 2011, Cowley and Charles, 2016], consisting of four types: Competitor,

Dreamer, Logician, and Strategist. Because the model draws from learning styles, it might not be the optimal tool if the focus is purely on the element of fun in the game (*section 4.4.3*).

The motivation type presented by Yee is compiled from a large source of data [Yee, 2016]. He defines six scales: Action, Social, Mastery, Achievement, Immersion, and Creativity. Furthermore, the scales each consist of two motivation types, yielding a total of 12 motivation types [Yee, 2016]. Each of the motivation types is further placed in a spectrum indicating the negative space of each motivation [Yee, 2019]. Yee's model is currently state of the art within the game community (*section 4.4.4*).

Researching and understanding the current technology available for the players can provide an important insight into how these products were developed and perhaps provide inspiration for our study. Looking into graphic adventure games such as *The Walking Dead* and *Life is Strange* gives an idea on how these games were designed to appeal to players and how they branching structures are utilized (*section 4.5.1*). Netflix is a global service providing film for the world and they have released a few interactive movies, such as *Black Mirror: Bandersnatch* and *You vs. Wild*. They give an idea about how they provide agency to their audience.

The background literature reviewed, we will now move on to our own contributions, starting with the first iteration of our study. This focuses on finding which factors in players have a significant impact on decision making.

Significant Factors In Decision Making In Games

This purpose of this first iteration is to determine which factors have a significant impact on the choices a player makes in a narrative game. This chapter describes the methods used for quantitatively evaluating the significance of each factor, the reasoning behind these, how the test was implemented, evaluated, and what the findings suggest.

For this iteration, we tested a text-based interactive narrative called "57 Degrees North", made by Mighty Coconut, after which each participant filled out a questionnaire inspired by Yee's 12 motivation types about their preferred ways of playing video games along with a few demographic variables. Participants were grouped according to their demographic variables (such as being of a similar gender or age) and calculated player type. The paths taken in the narrative by these groups were tested statistically against each other, trying to find which background variables made a significant impact on the path taken. Paths were tested using edit distances, specifically Levenshtein distances, which this chapter will cover.

5.1 Methods

This section describes in detail the methods and theories used to design and implement this first iteration. Firstly, we detail the notion of graph matching and path similarity though edit distances comparisons. Then we discuss which factors we have controlled for and how they are measured, before moving on detailing the questionnaire used for testing, how the test was distributed, and which statistical methods we employed.

5.1.1 Path similarity through edit distance

Mathematically, branching narratives may be expressed as a graph, where nodes are passages or storylets and edges are choices made by the player. Such a graph may be directed or cyclic depending on the structure of the story. In this view, comparing the path each player takes through the narrative (and thus the choices they make) is part of a set of problems known as graph matching [Zager and Verghese, 2008], which determines the similarity between graphs. If each node is labelled, any player's path through the graph can simply be written as a string of labels of the visited nodes, and the graph matching problem is reduced to comparing similarity between a set of strings, one string per participant. Our hypothesis is then that the more similar strings (and thus paths) are, the more similar choices players make, and inversely, if two paths are significantly different, those players make significantly different choices. Triangulating this with the independent factors will suggest which factor has a significant effect on the decision making in games.

String similarity can be computed with edit distance. This is an expression of how many operations one string a requires to become another string b. In the example of $a = exit, b =$

exist, inserting an s into string a fulfills this requirement, making $distance(a, b) = 1$. Identical strings return an edit distance of 0. There are multiple edit distance algorithms, such as Levenshtein, Hamming, Jaro, or Jaro-Winkler, each with different operations allowed. For the purposes of this study, we use Levenshtein distance implemented in Python [Haapala, 2014]. Next section describes this in detail.

Levenshtein distance: The operations allowed with Levenshtein distance are deletion, insertion, and substitution of any character in a string. The formula can be seen in equation 5.1, where $lev_{a,b}(i, j)$ is the distance between the first i characters of a and the first j characters of b [Nam, 2019].

$$lev(a,b) = \begin{cases} max(i,j) & if min(i,j) = 0 \\ min(f,x) \begin{cases} lev_{a,b}(i-1,j)+1 \\ lev_{a,b}(i,j-1)+1 \\ lev_{a,b}(i-1,j-1)+1_{(a_i \neq b_j)} \end{cases} & otherwise \end{cases} \tag{5.1}$$

5.1.2 Factors

In this iteration, we control for *player type*, *gender*, *age*, and *experience* with video games. It has previously been discussed in *section 4.4* that player type is a good indicator of the motivations behind play. However, according to Yee [Yee, 2019], several underlying demographic factors have a significant effect on choice as well, noticeably gender and age, as competitiveness is suggested to decline with age, and player type can be correlated with gender [Yee, 2019].

The reasoning for also including experience is that it is typically included in user experience surveys [Schuh et al., 2008] because it is directly tied to skill and therefore flow [Csikszentmihalyi, 2008] (*section 4.3.2*) that this would significantly influence their choices because of the unfamiliarity with the genre as a whole, such as having trouble understanding basic mechanical operations [Hunicke et al., 2004].

To get a more precise representation of player motivations and choice, these factors should be triangulated with a subjective account through qualitative data, such as a follow-up interview or observations [Schuh et al., 2008, Hoonhout, 2008, Preece et al., 2015, Nielsen, 2013, Nielsen, 1993], which we perform in the next test.

How each factor is treated

Player type is calculated based on the Player Type Questionnaire included in the test (see *section 5.1.3*), which is based on Yee's six player motivations [Yee, 2016]. Yee argue that the types inter-correlate to some degree, but here each type is treated exclusively to the others, and their potential relationships and correlations are not explored at this stage.

Age has been binned into categories of three year intervals, starting at age 18 (18-21, 22-25...) due to the Harlowe Twine format which does not allow text fields. This makes the data less rich but should not have an effect on identifying trends on a bigger scale.

Gender is nominal data with the labels *male*, *female*, *other*, *prefer not to say*. The *"prefer not to say"*-category is treated as "unknown" in the data analysis.

Experience is a 7-point likert scale, each point being a discrete time interval ranging from "1: I don't play video games" to "7: I play every day".

5.1.3 Player type questionnaire

We developed a 13-item questionnaire to determine player type, based on Yee's six motivational scales [Yee, 2016, Yee, 2019]. Yee identified six scales to measure player types, or *motivational types* in his own words [Yee, 2016], each of which is made up of two subscales. Our questionnaire has one likert item per subscale, asking participants to identify with the subscale from 1-7, where 1 is no importance and 7 is high importance. The mean of the subscales determine each participants player type score, and their calculated player type is then simply the one with the highest score, $argmax(Y_i)$, where Y is a vector of player type scores for the ith participant.

The 13^{th} item in the questionnaire is the participant bias, asking participants which player type they identify with the most. Each player type score in Y is weighted, with the biased player type having twice the weight of the others. This gives participants some agency over which type they are calculated to be, as there may exist several confounding variables which are extremely difficult to control for in a 12-item questionnaire. As discussed previously (see *section 4.4.2*), player type may also vary with game genre, which is why the 13^{th} item says: "Which of these 6 styles did you identify with the most during the game you just played?", as opposed to asking a generalized question. The questionnaire guide can be seen in table 5.1

Item	Subscale	Type	Description
1	Destruction	Action	Wreaking havoc, causing mayhem, things get destroyed
2	Excitement		Fast-paced action with surprises and thrills
3	Competition	Social	Getting a high rank among other players
4	Community		Being social and interacting with other players
5	Challenge	Mastery	Playing at the highest difficulty and mastering the game
6	Strategy		Making complex decisions; thinking and planning ahead
7	Completion	Achievement	Making an effort to get every collectible in the game
8	Power		Becoming powerful, getting the best equipment
9	Fantasy	Immersion	The feeling of being someone else or somewhere else
10	Story		Deep, interesting character development and a good story
11	Design	Creativity	Having many customization colors, styles, skins, and options
12	Discovery		Being creative and experimenting with breaking the rules
13		Bias	Which of these 6 styles did you identify with the most during the game you just played?

Table 5.1: Player type questionnaire guide

5.1.4 Distribution

Unfortunately, due to the limitations of Covid-19, we could not conduct the test physically in the lab. The test was compiled into a single HTML, uploaded to a website (www.axy.dk) and distributed online through snowball sampling. This meant that controlling the sampling distribution was impossible. However, a potentially higher sample size was achieved with 59 participants.

5.1.5 Statistical tests

For player types, edit distances have been compared with One-Way ANOVA where parametric data was found. This is due to the dataset having one independent variable (player type) but multiple levels (action, social, mastery, achievement, immersion, creativity). The post-hoc tests are pairwise Welch's T-test, which was chosen over a Student's T-test because of the great difference in player type sizes and inequality of variance, to which Welch is more robust and with a lower Type 1-error probability [Lakens, 2016]

5.2 Design

For this test an existing Twine narrative was chosen to make it more time efficient. The narrative were based on both length, branching structure and other parameters that we felt could prove important which will be explained in further detail during this section.

The narrative was "57 degrees north", made by Mighty Coconut [Coconut, 2020]. The story follows Caleb and Sasha as they strand on a volcanic island in Alaska. They find an abandoned house with a seemingly sentient robot inside, named Wilson, who convinces them to restart a satellite on top of the volcano to be able to go home. After twists and turns, the satellite is restarted but the volcano erupts, and the three of them have to get away from the islands quickly. In the end, they are picked up by fishermen.

The story features the structure branch-and-bottleneck (see *section 4.1.1*), in that the player can try out different options and obtain different information, but towards the end of each chapter the story threads merge. The story is also semi-cyclic, with a few portions of the narrative being able to loop, for instance when Caleb and Sasha first make their landing and are looking for shelter and firewood.

The story features five different endings. In short, Caleb can either die or survive, and the satellite can either be working or be shut down. The following are the different endings and their passage label:

- *ch6_090*: The satellite is working and Caleb lives. This means that the robot Wilson is online and able to hack a traffic system in Washington DC, causing a traffic accident which kills two members of the United States Geological Survey. It is implied that Wilson held a grudge and killed them as revenge.
- *ch6_100*: Same scenario as ch6_090, except that Caleb does not get off the island in time and dies in the eruption.
- *ch6_070*: The satellite is shut down and the robot Wilson cannot hack the traffic system. However, the eruption shuts down air travel across Alaska. Sasha calls her mother and through her active phone Wilson is able to be uploaded.
- *ch6_080*: The satellite is shut down and Caleb is dead. Sasha throws her phone in the water, not allowing Wilson to be uploaded.
- *ch6_081*: Same scenario as ch6_080, except that Caleb lives.

This narrative was chosen due to its complexity, length, fidelity, and availability. It is complex enough to feature distinct playthroughs, allowing us to identify different playstyles. For an average reader, the entire six chapter narrative takes around 30-35 minutes to complete, which is assumed to be long enough to engage players in the story and the characters, but not so long that it discourages participants from participating. It is written by professional story-writers with several complex details written into the narrative, pre-tested by their own playtesters, meaning that it should have sufficient quality. Finally, it was conveniently readily available online. The story is usually presented with visuals, but we used its Twine implementation which is text-based.

5.3 Implementation

This section describes in detail the implementation of this iteration, including software and programming, but as the selected narrative were already implemented, the following section focuses on accessing the participant data for further analysis rather than implementation of a narrative.

Figure 5.1: Screenshots from the visual version of 57 Degrees North, by Mighty Coconut

5.3.1 Twine

Twine is a hypertext language that allows for easy and fast implementation of text based applications, mainly used for branching interactive fiction [Foundation, 2020]. It uses its own syntax, but integrates HTML, CSS, and JavaScript, similarly to a website. Either online or through a local IDE, text is split into discrete nodes (called passages) linked by hyperlinks, not unlike a graph of storylets (see *section 4.2* on page 7). Twine has multiple *story formats* which dictate the set of methods available and what the syntax looks like. For the implementation of this study, Harlowe was used, because it is the default option as of this writing and the one most widely used, making the implementation usable with more Twine stories.

JavaScript allows Twine to send and receive data from outside sources, and thus may be used as a means of producing telemetry. Twine saves the states and variables pertaining to the story internally, and these can be accessed by first parsing them into an array that JavaScript can read:

```
if (!window.harlowe){
window.harlowe = {"State": State};
}
```

These variables can then be converted to a generic key/value pair and sent as a JSON package via an ajax form:

```
var sendData = JSON.stringify({
"currentpassage": harlowe.State.variables['currentpassage'],
"now"           : Date.now()
});
```

The Twine macro *(history:)* is an array of all the passages visited by the player. By exporting this, we get a map of where the player went in the narrative. JSON, however, does not handle string arrays well (passage name is always a string), so we used the `.join()` method in the JavaScript to concatenate all array indices into a single string, which can be sent normally. The graph path of each player then becomes one long string of passage names.

```
(set: $path to (history:))
var path = harlowe.State.variables['path'].join('');
var sendData = JSON.stringify({"path" : path});
```

A link to a Google Sheet was parsed into the ajax form, so when it was run, the JSON package was automatically imported into that Sheet. By wrapping it in Twine's own `<script>` `</script>` environment, this code can be put in any passage in Twine, executing it when that particular passage is run. For this implementation, the code was placed in the very last passage when all the variables had been recorded and the (history:) established. Each participant is a row in the Google Sheet, with columns as player-specific variables. To ensure that each participant was anonymous, but still unique, their given ID was taken from the JavaScript

function `Date.now()`, which returns the amount of milliseconds elapsed since January 1st, 1970.

5.4 Results

This test investigated which factors have a significant effect on choices made in an interactive narrative. We gathered information about the following factors: *Age, gender, video game experience, player type.*

The player type questionnaire obtained a Cronbach's α of 0.72, indicating acceptable reliability.

Descriptive statistics of the sample is found in *figure 5.2*

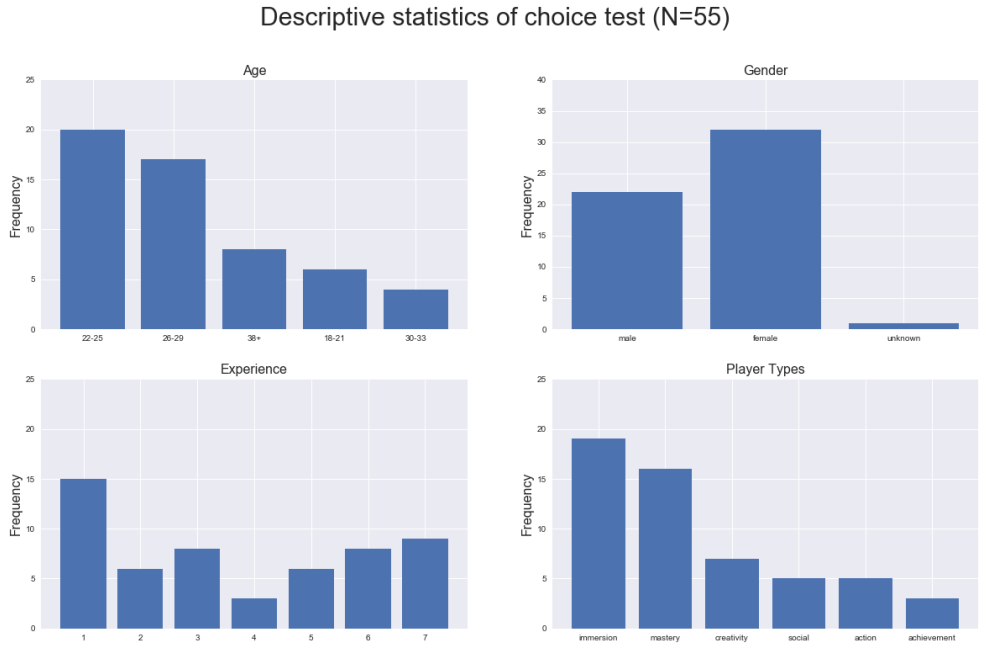


Figure 5.2: Descriptive statistics of the sample

One clear disadvantage of the obtained sample is the distribution of calculated player types. These were calculated using the player type questionnaire, and approximate an exponential distribution. 19 participants were classified as Immersion players, while only 3 were classified as Achievement players (see *figure 5.2*). This should be taken into account when analyzing the sample. Edit distances were calculated within each player type, which can be seen in the boxplot in figure 5.3.

Regarding the player type factor, a Kruskal-Wallis test showed a significant difference in edit distances between player types $H(53) = 21.75, p < .001$. A post-hoc analysis using pairwise Welch's T-tests returned the p-values found in table 5.2, where bold numbers indicate a significant result. Due to having multiple T-tests increasing the probability of a Type I error, the α used to determine significance has been adjusted using Bonferroni correction ($\alpha/M = 0.05/15 = 0.004$). This shows a significant difference in narrative paths (choices) between the Immersion player type ($M = 102.32, STD = 31.11$) and the Social ($M = 134.9, STD = 23.35$) and Mastery ($M = 112.33, STD = 25.09$) player types.

Further, pairwise Mann-Whitney U-tests showed a significant difference in edit distance across all demographic factors, as can be seen in table 5.3 below.

Due to ease of comparison, all factors have been binned into two discrete levels. Further,

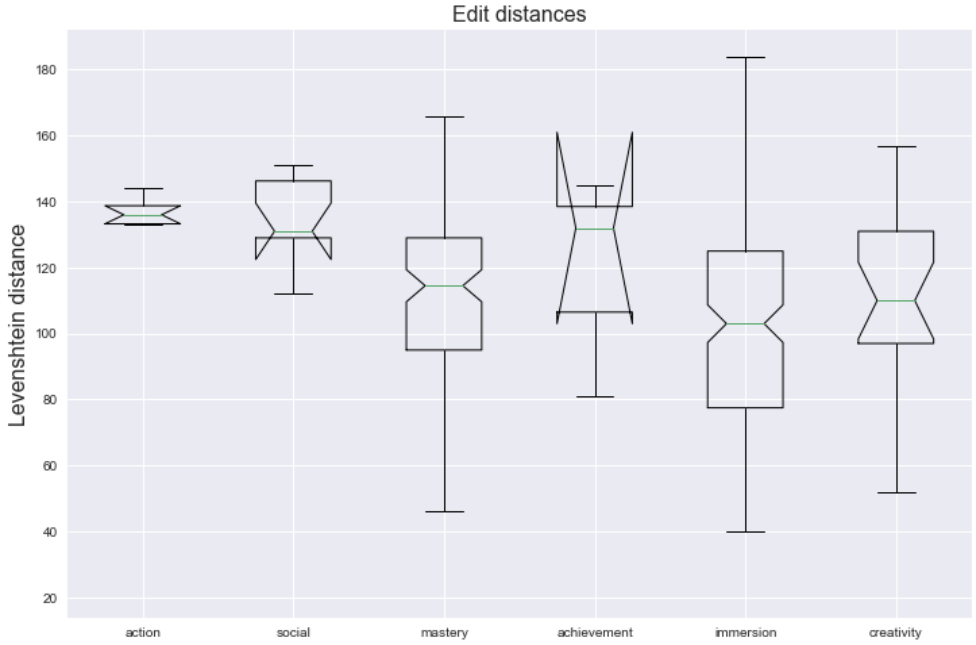


Figure 5.3: Boxplot of edit distances for player types

	Action	Social	Mastery	Achievement	Immersion	Creativity
Action		.330	.400	.914	.103	.335
Social			.014	.517	**.001**	.022
Mastery				.755	**.002**	.673
Achievement					.476	.657
Immersion						422
Creativity						

Table 5.2: P-values of post-hoc pairwise Welch's T-tests of edit distances

removing all participants who "never play video games" (which is a 1 on the Experience scale) from the calculations does not influence significance.

5.4.1 Interpretation of results

The test has determined a significant difference in narrative choices. Now, let us examine what kind of difference there exists. For this we have looked at which ending is more likely to be experienced and how many passages each participant went through, which can be assumed to indicate a longer time spent in the narrative.

The narrative in the test contains five different endings. Number of endings experienced was summed across factors in table 5.4 and table 5.5. By inspecting the table, intuitively it seems that the first two endings (ch6_90 and ch6_100), in which the satellite is still working, is more unlikely than the other three, in which it is not. Also, most participants chose the ending where Sasha calls her mother. χ^2-tests returned no significance for any factor in terms of which ending is more likely to be experienced, as seen in table 5.5.

Next, we can examine the paths through the narrative for each participant by factor. Here, we assume that a longer path equals more time spent in the narrative. For these tests, demographic factors (gender/age/experience) were not binned into two categories, but binned into the original amount (e.g. seven levels for experience). These show that no factor has a significant impact on time spent in the narrative, as seen in table 5.6. However, post-hoc pairwise

Factor	Levels (size)	df	p-value
Gender	Male (22) Female (32)		.018
Age	< 25 (26), > 25 (29)	53	.0007
Experience	Low (29), High (26)		.002

Table 5.3: Mann-Whitney U-tests of edit distances in demographic factors

	Endings					
Player type	ch6_090	ch6_100	ch6_070	ch6_080	ch6_081	Sum
Action	0	0	2	1	0	3
Social	1	0	3	1	1	6
Mastery	0	2	4	3	3	12
Achievement	0	1	1	3	0	5
Immersion	0	2	9	7	3	21
Creative	0	2	3	0	2	8
Sum	1	7	22	15	10	55

Table 5.4: Number of participants who experienced a certain ending

Student's T-tests show that the Social player type spends marginally significantly less time in the narrative than the Immersion type ($t(49) = -2.52, p = 0.018$) and the Achievement type ($t(49) = -2.14, p = 0.60$), but with an adjusted α, these p-value are not significant.

This means that a significant difference in edit distance was found, and thus that some factors create significantly different paths in the narrative. However, what those different choice are is more difficult to assess. Therefore, a second iteration was needed with in-depth qualitative interviews to determine the differences and their implications on the player experience. The next chapter, "Interviews and Personas" details this iteration.

Factor	χ^2	**p-value**	**df**
Player type	20.37	0.43	20
Gender	4.18	0.38	4
Age	15.32	0.50	16
Experience	23.82	0.47	24

Table 5.5: χ^2 for each factor's influence on which ending is more likely to be experienced

Factor	Bins	**Test**	**Stat**	**p-value**
Player type	6	One-Way ANOVA	F=1.98	0.09
Gender	2	Mann-Whitney U	U=336.5	0.39
Age	5	One-Way ANOVA	F=0.60	0.66
Experience	7	One-Way ANOVA	F=1.02	0.42

Table 5.6: Path length by factor

Interviews And Personas

The purpose of the second iteration is to determine the dimensions behind choices during a narrative. This chapter describes the process of developing our own narrative, i.e. what the significant difference between players actually are. In this chapter we describe the methods used to determine the different dimensions, the creation of five personas, and a four-scale initial Decision Dimension questionnaire based on the results from the test and the personas.

In this iteration, we created our own narrative from scratch. We then tasked players with playing through the entire narrative, which is about 12 minutes in length for the average reader, following this up with in-depth interviews asking them to identify key points in the narrative, what they did, and how they felt, as well as general attitudes about the narrative. This was done to determine where in the narrative the important choices were located, since these are of a special importance. Determining a difference in choice is less important for smaller choices, such as picking up a branch or not in the beginning, while bigger choices carry greater impact, such as killing a character or befriending it. With this information, we also included attitudinal data, to get a sense of why players performed the actions they did. This knowledge was used to inform the development of our personas, which in turn were used to inform the creation of our initial Decision Dimension questionnaire. This initial questionnaire is the one iterated upon in the last iteration, "Developing The Framework" (see *section 7*).

6.1 Design

We wanted to create an interactive narrative which could provide discrete choices. To develop the narrative we considered different aspects to create a complete and engaging narrative. This section will go through the different considerations and thoughts which occurred during the development of the narrative.

6.1.1 Story inspiration

Creating a compelling story demands a story world which the story takes place in. We had to gather inspiration about what type of story world we wanted the players to experience and create an overview of what different stories there exist. It is possible to start the designing phase with an existing story world, making it easier to further develop a story using the already existing rule set provided by the story world. An example of this can be seen in movies. *Rouge One: A Star Wars Story* uses the Star Wars universe as a story world, while the plot of the movie is different from the original Star Wars movie. Another popular choice is the DC and Marvel universe and the story world from Harry Potter with movies such as the movie series *Fantastic Beasts and where to find them.*

We therefore took a closer look into different story worlds. An option is the one classical story by the Brothers Grimm, *Little Red Riding Hood*. The story has also been used multiple times in the ICIDS (International Conference on Interactive Digital Storytelling) conference as

an example [ARDIN, 2020]. The story itself provides many elements and options, which can be of interest. An interesting area of Red Riding Hood is the journey from her home to her grandmothers house, and the scene where she is eaten by the wolf. In the story there is so many factors which could be altered and played with. We looked at different points of interest in the story which could be used:

- Her basket with wine and cake for the grandmother. This could be altered by giving the player many different items to choose between, which of course can affect future events and provide the player with different or even more options in certain situations.
- The journey from her mothers house to the grandmothers. There is an enormous amount of options here. She could perhaps stray from her path or stay on it. Maybe some events even lead to her not meeting the wolf or otherwise.
- Her meeting with the wolf. There could be different dialogue or action options for the player.
- Her dialogue with the grandmother (wolf in disguise) could also offer different paths.
- The hunter which kills the wolf when it falls asleep. An option could be providing some events which might lead the hunter to perhaps arrive earlier, preventing the wolf from eating the grandmother or perhaps some which lead the hunter to not come to the house at all.

These are just some of the main points which could be used to alter the narrative. Other stories which could be interesting to look into is the classics written by Hans Christian Andersen: *The Little Mermaid* or *The Ugly Duckling*. Inside these stories there are also many events and story elements which could be interesting to affect.

Another course of action is creating your own story, based either on an existing universe inspired from movies or books, or defining your own universe based on your rule set. This can be time demanding if you are starting on a bare foundation. Brainstorm and mind maps can be great tools to further develop your idea into something more tangible.

We decided to develop our own story based on multiple issues, but one in particular, which we think could occur when the players are playing through a narrative that is a well-known story. We believe that the player might be biased when playing through e.g. The Red Riding Hood, where the player might lean towards choices which prevents the little red riding hood from being eaten by the wolf, or perhaps the choices which fulfills the same narrative as in the original story. This means that the player might already have a determined ending in mind, which could contradict one of Csikszentmihalyi [Csikszentmihalyi, 2008, p. 61] eight components of enjoyment, *the paradox of control*, which describes how people enjoy the sense of control when the outcome is undetermined (*section 4.3.2*).This could lead to the narrative being less enjoyable for the player.

6.1.2 Overview of chosen story

This section will give an overview of the main story line of our story. During the narrative, the experience is viewed from the main character and is described in the second perspective, where some thoughts are described in the first person.

A majority of the story takes place at a facility building featuring a wild rain forest right in the center of it. The building consists of different levels, how many has not been determined. The rain forest is completely surrounded by this building and in order to get out, you will have to find the only door in order to access the building and proceed to the different levels and hopefully survive through them all. This knowledge is unknown to the player, but should hopefully unfold as the narrative proceeds.

In the following, descriptions the main character will also be described in the second person perspective.

You wake up in the middle of the rain forest unsure how you ended up there. You explore your surroundings and try to gather items and knowledge about this place. You suddenly encounter another person, who have gone through the exact same experience as you. She joins you and together you find a clearing to rest for a bit. While resting, a larger group of around ten people enter the clearing and spot you. You join forces and exchange information. You discover their background and the last thing they remember and try to find a pattern, but you are unsuccessful. When you tell them about something you discovered in the forest, one of the group members mentions something they saw when they were roaming around by themselves. Everybody decides that it will be best to rest for the day as the night is approaching. Before the night is set, you can help out with finding some food, gather some wood, or just rest until the next day. As the morning arrives, Thor, the group leader, wakes you up and you clearly see that the group is disturbed and feeling uneasy. You soon discover that one of the members are found dead. She has no clear indication of physical violence and has a symbol covered in black imprinted in her forehead. Everybody is clearly scared, but together you decide that it is perhaps best not to touch her as you do not know if it is contagious through physical touch. The group leaves her behind and ventures into the forest as described in the conversation from yesterday. You find what you are looking for and this leads you to a single door placed at the bottom of an enormous wall. You are able to enter through the door and is now in an empty corridor, with has some writing on the wall. At the end of the corridor is another door with some text on it. "Level 1" it says. As you enter through the door, the story ends.

6.1.3 Building the narrative

The narrative structure of interactive narratives is different from traditional linear narratives, since the storyline is not predetermined. This means that the authors create the setting, characters and situations/events that the narrative must address, so that the player is able to experience a unique story based on their own interaction with the storyworld.

As mentioned before, interactive narratives can quickly develop into combinatorial explosions (*section 4.1.2*), we therefore decided to find a branching structure which could support our story, but was also able to provide the agency needed for the player. The Branch and Bottleneck-style is the structure we ended up selecting (*section 4.1.1*). The structure provide a wide enough range for the player to explore and select a unique path, but it is still narrow enough to bring the player back to the main storyline.

We created the bottlenecks that all players will encounter, followed by their passage label, which can be seen in the numbered flow diagram in *appendices*.

1. Waking up *(ch1_1)*
2. Happening upon a crossroad *(ch1_6)*
3. The strange sound is louder and you see an silhouette coming closer *(ch1_22)*
4. You find a clearing in which to rest *(ch1_31)*
5. You encounter a large group *(ch1_36)*
6. You tell them about what you found in the forest *(ch1_41)*
7. You rest for the night *(nightRest)*
8. A dead member is found in the morning *(ch1_65)*
9. You find an old door *(ch1_70)*
10. You enter the second door *(ch1_75)*

These bottlenecks ensure that the branching of the narrative is not too wide, and it gives us an overview of the different paths that the players are able to take. This structure can be seen in *figure 6.1*, where every categorised area ends in a bottleneck.

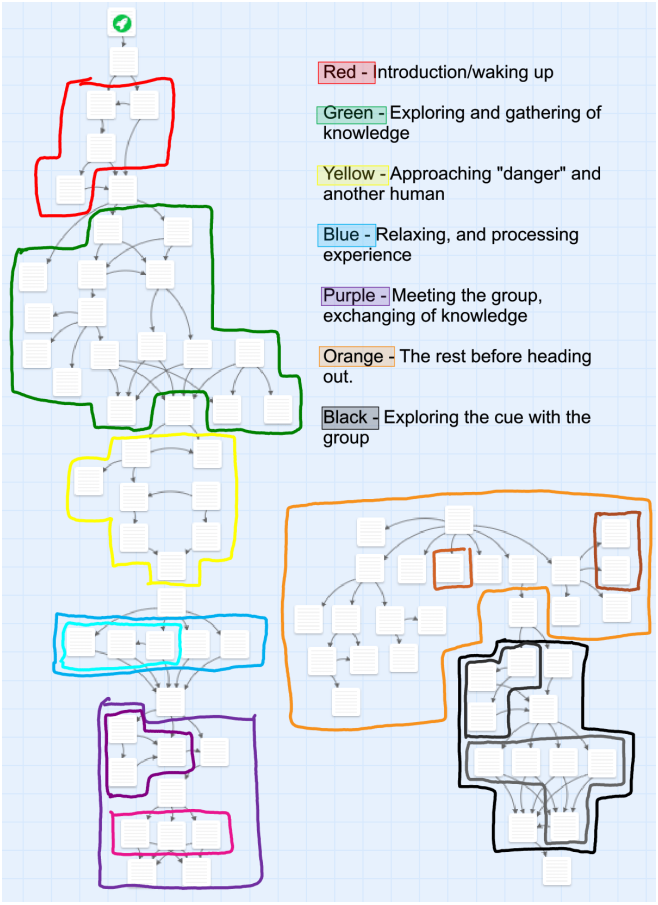


Figure 6.1: Flow diagram of the narrative in Twine, with categorisation of sections

The narrative is split into different areas, as we wanted to control the environment and have an overview of the emotions that the player might experience throughout the narrative.

- **Red** indicates the start of the narrative, where the player abruptly awakens in a new environment. This creates some excitement as to why the player is in the rain forest and how you ended up there.
- **Green** indicates an introduction phase, where the player starts to explore the surrounding environment. The player starts to gather information about the forest and finding/discovering different items.
- **Yellow** indicates the first encounter with another character, creating more excitement and perhaps getting more information about the forest. This can also be seen as the point of no return.
- **Blue** indicates a small break in action, where the player can relax for a short while.
- **Purple** indicates more excitement in the form of the player meeting a larger group of people. The player is able to exchange knowledge in order to discover more and continue.
- **Orange** indicates the interaction inside the group and highlights your contributions to its resources, before you decide to rest for the night.
- **Black** indicates the climax of the narrative, as the player discovers the door and even more information about the place.

6.1.4 Creating the plot

When working with interactive narratives the plot is determined by the choices made by the player. Throughout the narrative we can try to provide the player with the same level of information needed regardless of which path has been chosen. This ensures that no player at any time is possessing a higher degree of important information than others. Such information can be used during the narrative to affect future events, but also contributes to the mental model of the narrative for the individual player (*section 4.3.3*). Certain information may lead to a faster arrival, while possessing certain artifacts can affect future interaction by providing more options when facing certain situations. These are the artifacts and items that the player are able to wield, which also provide additional paths in certain situations:

- A piece of metal with a symbol on it, which can be used as a weapon or as a tool.
- A screwdriver that the player can use as a weapon or tool.
- A key that the player can open the door with.
- A can of peas, that the player can eat or share.

In *figure 6.1* you are able to have an overview of all the different areas of the narrative. In each color coordinated area, there is a possibility for the player to choose between different options. In some areas (blue, purple, orange and black) there are highlighted passages which are only available for players if they have chosen a certain path in previous events.

Besides players wielding artifacts, the player is affected by other variables, which can affect future events:

- Forgetting to wash the blood off of you, resulting in the group knowing that you killed a person.
- Eating nothing results in your stomach growling (no effect in the current narrative).
- Eating poisonous fruits and frogs results in feeling bad and perhaps even vomiting (no effect in current narrative).

The result of forgetting to wash the blood off of you results in a different path in the *purple* area seen in *figure 6.1*.

6.1.5 Pilot testing

Before testing the narrative, we had to ensure that it was engaging for the player and that the choices made sense in certain situations. Therefore we performed a usability test, which would assess the coherency and degree of engagement in the narrative. Due to Covid-19 and the recommended isolation of citizens, we only tested on one person using convenience sampling. This is not optimal both in terms of sample size, and sampling methods.

This test was performed on one person using think-aloud during the narrative, followed by a small unstructured interview, which would assess their general understanding of the narrative and their overall experience [Bjørner, 2015, p. 87].

Issues which were found:

- Coherence problems when jumping from one passage to another.
- Bugs about the variables being mixed up.
- Spelling mistakes and wrong wording.
- Small misunderstanding in narrative comprehension.

Coherence between passages was a problem, since two or more passages would end in one passage. To correct the issue, the passages were rewritten and extra text was added to make sure that it had more coherence when continuing.

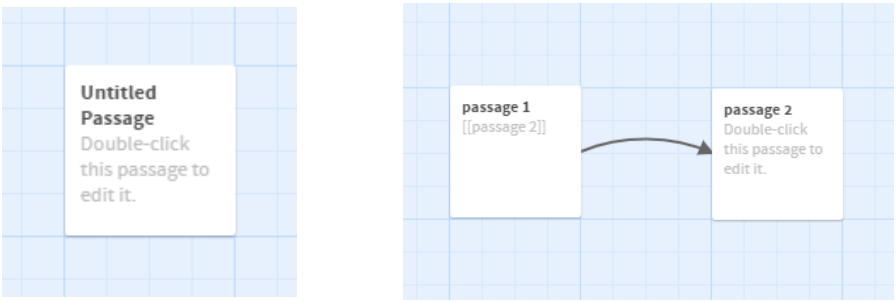
A majority of the issues were bugs, many of these were variables which were mixed up, some variables not called etc.. The participant felt that some of the words describing the atmosphere or emotion of the main character felt off at times. In order to fix this issue, the facilitator had written down (during the test) the different passages and specific words or sentences that the participant mentioned throughout the narrative. All of these were fixed by editing the corresponding passages.

After the participant had finished the narrative, they was asked to give a brief description of the narrative to assess the narrative comprehension. This gave us an insight into how the mental model of the narrative was constructed. There was a small misunderstanding in who the dead woman was (passage *ch1_65*). The participant thought that the person was someone unknown and that the person was killed and brought into the resting area to perhaps scare the group. We corrected the issue by giving a better description of the event and adding multiple names to the characters, making them easier to identify as part of the group.

6.2 Implementation

We chose to continue working in Twine, since it made implementation easier. Continuing working with this tool over Unity was mainly because of the outbreak of Covid-19, where a shift of our priorities went from a more visually impressive narrative to something which we knew worked could be distributed more easily online.

Before we dive deeper into the implementation of the narrative, we will shortly present the main functions of Twine.



(a) A single passage

(b) Linked passages

Figure 6.2: How passages is visualised in Twine

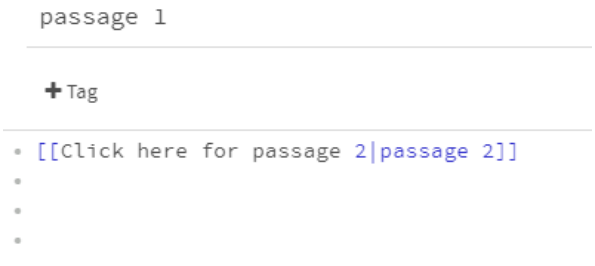
Coding in Twine works inside nodes, which are called passages. You need to name each passage with a unique ID, called a label, so you are able to link passages together by referring to their ID (see *figure 6.2b*). This is done inside the passages themselves. We decided to name ours by chapter followed by a passage number. This made it easier for data processing and writing, but made it hard to quickly identify each passage and discuss its contents when iterating.

Passages can also be seen as pages, since one passage is the page that the player is interacting with at any given time. The body of text and the hyperlink is written and established inside the passages, which can be seen in *figure 6.3*. The links are displayed as text buttons for the player and is seen as arrows in the overview (*figure 6.2b*). These links can be created in two different ways, one seen in *figure 6.3a* and *figure 6.3b*, which links using the same ID, but displays differently as seen in *figure 6.3c* and *figure 6.3c*.

The narrative was created using the passages and variables throughout the narrative. The variables are added to give the player more options in certain situations during play, meaning that the player's past choices can affect future choices.

In the list below, you can see the different variables and their functions, which were used during

(a) Linking using passage id



(b) Linking using passage id, but displaying defined text

(c) Displaying passage id

(d) Displaying the defined text

Figure 6.3: How linking operates in Twine

the narrative. Some are used once such as $left / $right that were used for indications rather than possessing a larger part in creating the dynamic flow of the narrative. Two variables which are not being used in the current version of the narrative, but only set, is $poison and $ate, since it was planned to be used for an extended version of the narrative. All of these variables are used to create a more dynamic experience for the player in the narrative both in terms of limiting or expanding the options that the player is able to take, but also in terms of information that the player is told. This is inspired by Short's quality-based narratives, which we reviewed in *section 4.2.4*. All of the variables described below are booleans.

- **$left / $right**: Knowing which direction the player took at the crossroad.
- **$symbol**: Having seen the metal piece.
- **$symbol & $weapon**: Taking the metal piece with you.
- **$weapon**: Possessing a weapon.
- **$wall**: Seeing the wall or getting told about the wall.
- **$crate**: Seeing the crate.
- **$screwdriver**: Taking the screwdriver with you.
- **$food**: Taking the canned peas with you.
- **$key**: Taking the key with you.
- **$hide**: Hiding from Maria
- **$readyToAttack**: Making yourself ready to attack Maria.
- **$maria**: Encountering Maria.
- **$maria & $killed**: Maria is killed.
- **$clean**: Cleaning the blood of yourself.
- **$ate**: Eating some food.
- **$sign**: Knowledge about the broken sign.
- **$door**: Knowledge about a door.
- **$wood**: Gathering wood.

- **$fire**: Getting a fire going.
- **$forestFood**: Finding food in the rain forest.
- **$poison**: Eating poison food, from frogs and unknown fruits.

To create multiple choices for the player, we created a loop by looping multiple passages back to one and having them display the available interaction for the player. This can be seen in *figure 6.4*, which shows all the interactions that is available to the player according to the current variable states.

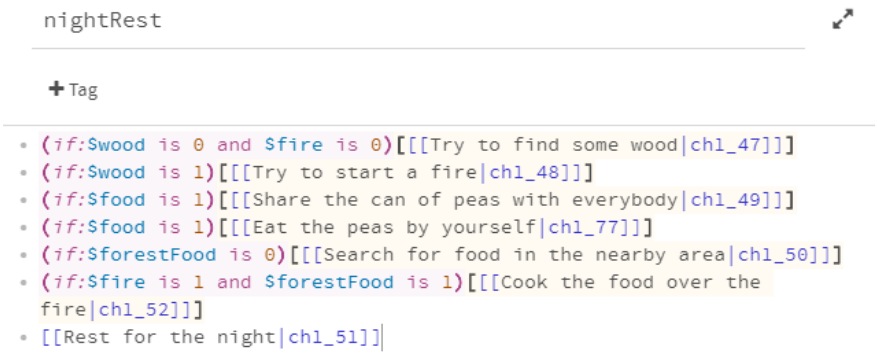


Figure 6.4: Creating a loop based on variables

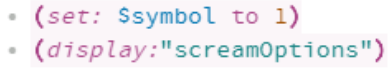


Figure 6.5: Setting a variable and displaying a passage without creating a hyperlink

In *figure 6.5*, we call the passage using the command *display* so it appears in the same page as the passage it is called from. It therefore does not create a hyperlink between them, and it will thus not show a link in the Twine editor either.

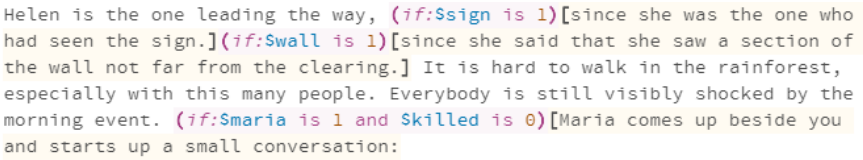


Figure 6.6: Using variables in in-text from passage *ch1_66*

The different variables are also used in-text to make one passage contain multiple paths as seen in *figure 6.6*. The passage shows the different text displayed to the player when a certain variable is enabled. Using this method we can save time and space by combining multiple paths into one passage, making the whole overview of the Twine narrative more approachable.

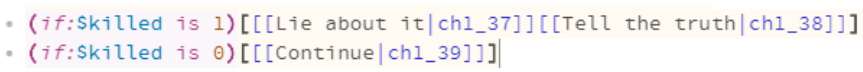


Figure 6.7: Using variables to restrict certain choices

In *figure 6.7*, certain variables are used to restrict a certain path to players, based on the decisions that they previously made.

The whole narrative consists of around 80 passages which can be seen in the provided numbered flow diagram in the *appendices*, with the different shown techniques applied throughout the narrative.

6.3 Evaluation

The test is an exploratory qualitative test measuring the player's motivation behind their choices during the narrative. This is used to determine key points in the narrative and the participants' reactions in those key points and their justification for acting that way [Bjørner, 2015, p. 21-25]. From this information we were able to derive a set of personas that were used to inform the creation of our initial Decision Dimensions questionnaire. Participants for the interview were chosen so as to be the most representative of the factors that we found to have a significant difference, namely age, gender, experience, and, to a lesser degree, player type. This means that we tried to recruit across genders, ages, and video game experience using a mixture of convenience and quota sampling methods [Bjørner, 2015, p. 61-62].

We wanted to assess two different areas during the test.

- Degree of engagement in the narrative.
- Qualitative data about the choices each player made in the narrative and why.

6.3.1 Interview questions

We performed a semi-structured respondent interview [Bjørner, 2015, p. 87]. The questions are categorised into three sections based on the areas of interest. Each question was constructed to try to identify issues or other information surrounding the areas of interest. The interview guide can be seen in detail in the *electronic appendices*.

- Comprehension
  - Can you briefly describe what the story is about?
  - What characters are in the story?
  - Who do you play as?
  - What are your general attitudes towards the story?
- Engagement
  - Can you identify certain important plot points?
  - Can you describe what you were feeling at those points? (One by one)
- Choice
  - Which decision did you take at those points in the story?
  - Can you elaborate on it?
  - What emotion/rationale was your decision based on?
  - How deliberate was this action?

6.3.2 Test procedure and equipment

Listed below are the equipment and procedure the conductor needs to possess in order to facilitate the test.

- A computer used for running the narrative in the browser
- Voice recorder

1. Facilitator presented what the participants were about to try.
2. The participant played through the whole narrative without interruptions.
3. After the narrative comes to end, the facilitator starts the recorder.
4. Facilitator would do the interview with the player, taking note of the answers.

6.3.3 Distribution

Due to the ongoing pandemic of Covid-19, recruitment was unusually difficult. This means that the test had a sample size of five participants using convenience and quota sampling [Bjørner, 2015, p. 61-62]. This is not optimal because the amount of participants do not represent all of the motivation types, but regardless of this it still gives a brief insight behind the participant' reason for choosing a path.

6.4 Results

The answers from the interview resulted in multiple key points deemed important by the participants. The summed points are mentioned below with the corresponding passage label and brief explanations of passage content and possible choices. Please note that some of these key points are only experienced by participants, whom had chosen a certain path, meaning that all participants might have unique paths.

- Getting out of bed/Waking up.
  - *ch1_1: Waking up in the middle of the rain forest (Start of the narrative).*
- Realizing that it is not a dream.
  - *ch1_6: Confirmation that the rain forest is indeed real.*
- Picking up the metal piece..
  - *ch1_7/screamOptions: Choosing to take the metal piece with you.*
- Meeting the first character: Maria.
  - *ch1_24: Hiding from her.*
  - *ch1_23: Killing her.*
  - *ch1_26: Waiting.*
- Meeting the group of people.
  - *ch1_36: Our first interaction with the group.*
- Being confronted about killing Maria by the group.
  - *ch1_38: Telling the truth about the killing.*
  - *ch1_37: Lying about the killing.*
  - *ch1_40: Continue the lie about the killing.*
- Discovering the corpse of Sara in the morning.
  - *ch1_65: Discovering the corpse*
- Maria talking about her first encounter with a corpse with an identical mark/symbol as Sara's body.
  - *ch1_66/ch1_68: Maria telling you about a similar body*
- Entering beyond the door.

– *ch1_75: Entering beyond the door (End of the narrative).*

During the post-interview, certain observations would be mentioned multiple times across participants.

- Participants would make choices as if the character were themselves vs. having distance to the character.
- Sometimes the character would have more prominent emotions towards one choice leading the player towards that path.
- Most of the participants thought the main character was a male.
- Some mentioned dueling Thor for the alpha male status.
- One mentioned having exploratory tendencies initially in the narrative.
- One participant mentioned choosing to open the door with a rock, since the metal piece might be important later on in the narrative.

For more in-depth notes see *electronic appendix*. The results from the interview and the players paths were used as inspiration for five personas, which can be seen in the *appendices*. These personas are based on the engaging and fiction-based perspective of Nielsen [Nielsen, 2013].

6.5 Discussion

The test indicates that time could be a factor of engagement and behavior, in terms of the players being more exploratory initially to investigate how they should behave and later on being more motivated by how they identify with their character. This suggests that they would move accordingly to a funnel structure, narrowing their breadth of behavior over time.

The participants would show two different ways of identifying with the main character. One being identifying themselves as the character and making choices as they would in real life. The second way was having some distance between the character and themselves, meaning the choices made were not reflective of how they would do in real life.

During the test, some participants mentioned that they would save the item for later use, since it could be important. This indicates that there might be some planning involved in making their decisions, but at the other extreme was one participant who made very spontaneous choices and was confronted with them later, meaning that the choice was based on what happened in the moment instead of planning long term.

In the narrative, a character was created to be some sort of an alpha male in the group (Thor). Some of the participants definitely felt hostile towards this character and even commented on dueling him for the position. Others did not mind him at all and were satisfied by being given the underdog position and "enjoying the ride".

Issues presented by the participants were solved before next iteration and the observations and interview answer were further developed into dimensions behind decisions during the narrative. From the personas we arrived at four initial factors on which to rank decisions. These were named the Decision Dimensions, explained in the next section.

6.6 Initial Decision dimensions

Based on the synthesis of the interview data and the personas, we arrived at 8 factors combined into 4 dimensions that should account for players' decision making in video games:

- **Identification:** The degree to which you identify with the character and make decisions for them that you would make for yourself in real life. Low identification implies that making decisions as though it is another character different from you, that you know

is fictitious and therefore are less attached to. This differs from Cohen's Identification, in which high identification indicates that the player adopts the perspective of the protagonist (*section 4.3.3*) [Cohen, 2001]. It can be argued that our scale is the inverse of Cohen's.

- **Planning:** The degree to which your decisions are informed by what comes or may come later on. A short-term decision may for instance involve killing off a character because it is fun in the moment, even though that character has resources you will need later.
- **Goal Orientation:** The degree to which your decisions are directed by a concrete goal or expressed desire. Low goal orientation implies that you are exploring the world or testing its boundaries and rules without a desired outcome in mind.
- **Competition:** The degree to which your decisions are informed by your desire to win and dominate your opponent. Low competition implies playing without a clear win-condition, such as dressing up or being creative.

6.6.1 Initial questionnaire

Based on the dimensions we developed a 20-item questionnaire with 5 items for Identification and 4 in the rest, starting with 3 items about how much the participant plays video games. For each dimension question, the participant is asked how often they act according to the statement, from 1 (very rarely) to 7 (very often).

Screening questions:

1. How often do you play video games?
2. For how long have you been playing video games?
3. Which do you mostly play? (Singleplayer/multiplayer)

Identification:

4. In video games, I tend to empathize with the characters in the story and often replace my feelings with theirs.
5. In video games, I make decision I often would not make in real life.
6. In video games, I like pretending to be someone else.
7. In video games, I imagine what it would be like if my real life self was the main character.
8. I get very emotionally invested in the story

Planning:

9. In video games, I prefer following my instincts rather than thinking all the options through in detail.
10. In video games, I do things that are fun in the moment but might be bad/detrimental in the long term.
11. In video games, I tend to act spontaneously.
12. In video games, I tend to save my resources instead of using them whenever they might be useful.

Goal Orientation:

13. I experiment with the limitations and rules of the games I play.
14. I feel like I am limited in what I want to do or achieve in the games I play.
15. I control the action in the video games I play.
16. In video games, I perform actions where I'm not certain of the outcome beforehand.

Competition:

17. I play peaceful or creative games rather than competitive or skill-based ones.
18. I pick fights with other players or characters.
19. In video games, I tend to do the thing that makes the most people happy.
20. The character I play as should be the leader or the best.

Each participant answers the questionnaire and obtains a score in each dimension, which is the mean of its item scores. In other words, each participant will have a 4-dimensional vector associated with them in the form $D = [I, P, G, C]$, where D is the decision dimension vector, composed of the four likert scales $Identification, Planning, GoalOrientation$, and $Competition$, which themselves are a set of item scores, $I = [i_1, i_2...i_n]$.

When players make a choice in the narrative, i.e. follows an edge between two passages, the passage they arrive at will have their vector D added. After all participants have traversed the narrative, each passage will then have an associated vector $\overline{D}$, which is the mean of all vectors D from visiting players. This allows us to measure which dimensions factor into a particular choice, for instance, if killing Maria in the beginning of the narrative has a higher $Competition$ dimension compared to befriending her.

However, these decision dimensions need to be validated before such a test, which is what the following chapter 7, "Developing The Framework" will go into detail about.

Developing The Framework

This chapter details the validation of our decision dimensions and finalization of the framework for evaluating player choice in video games. This is done through principal component analysis (PCA), specifically an exploratory factor analysis. These findings have been triangulated with a measure of engagement, namely continuation desire, and the demographic details of the sample, such as age and video game experience. We will begin by detailing the testing methods and distribution of the test, then describe the factor analysis and discuss our findings.

In this iteration we once again distributed our own narrative, Stuck In The Center implemented in Twine, but this time with the initial Decision Dimension questionnaire instead of the questionnaire based on Yee's types. Further, we asked continuation desire questions at regular intervals during the narrative to be able to measure the engagement levels of participants, making sure that low engagement would not be a bias. First, participants answered the initial questionnaire, then played through the narrative. Afterward, we performed PCA on the questionnaire answers and assigned the Decision Dimension vectors D to the passages in the narrative, as well as counting how many passages were visited and by how many. The PCA and the assigned vectors D and $\overline{D}$ guided our final findings of the study.

7.1 Methods

Different methods were used in order to determine the unique profiles that were assigned each participant before playing the narrative, and assessing each participant's engagement during important points in the narrative.

7.1.1 Event-based engagement accessing

Knowing the degree of engagement during the narrative for the participants is important, so we are able to further develop on the narrative and correct the key points which the participants did not find engaging. A small question was placed at certain key points in the narrative, asking each participant about the their desire to continue playing using a likert item ranging from 1 (not at all) to 7 (very much). The implementation of the survey is similar to the previous test, please refer to *section 5.3.1* for further details. The questions were placed immediately before starting the narrative, when finding the first item, immediately before meeting the group and at the end of the story (see *section 7.3* for further details).

7.1.2 Delegating a Decision Dimension profile on players

Before participants started our narrative, they went through a demographic questionnaire and our Decision Dimension questionnaire, which consisted of a 20-items and four likert scales describing our choice dimensions mentioned in *section 6.6*. The questionnaire can be seen in detail in *section 6.6.1*. After completing the questionnaire each participant will posses a unique vector D with a score in each dimensions. These vectors populate the passage of

the narrative, such that we do not rank decisions in the narrative ourselves according to the Decision Dimensions, but rather have them ranked through data.

7.1.3 Distribution

Unfortunately, due to the limitation of Covid-19, we could not conduct the test physically. The test was instead compiled into a single HTML and uploaded to a website (www.axy.dk) and distributed online through convenience and snowball sampling. It was distributed on Facebook and other social media, as well as distributed among colleagues and friends. This means that controlling the sampling distribution was impossible. In total, 31 participants were recruited.

7.2 Description of the sample

After developing the initial four-scale questionnaire, it was tested online with our self-developed narrative, Stuck In The Center. 31 participants were recruited. The details of the sample are described here.

For this test, the background demographic questions we asked were refined slightly based on feedback from participants. To calculate video game experience, we asked how often they play and for how long they have played (from "just started" to "most of my life") (see *section 6.6.1*). Their experience score is then the mean of these two scores. This distribution of participants exhibited higher experience overall compared to the sample in the first test ("Determining Significant Factors In Decision Making In Games").

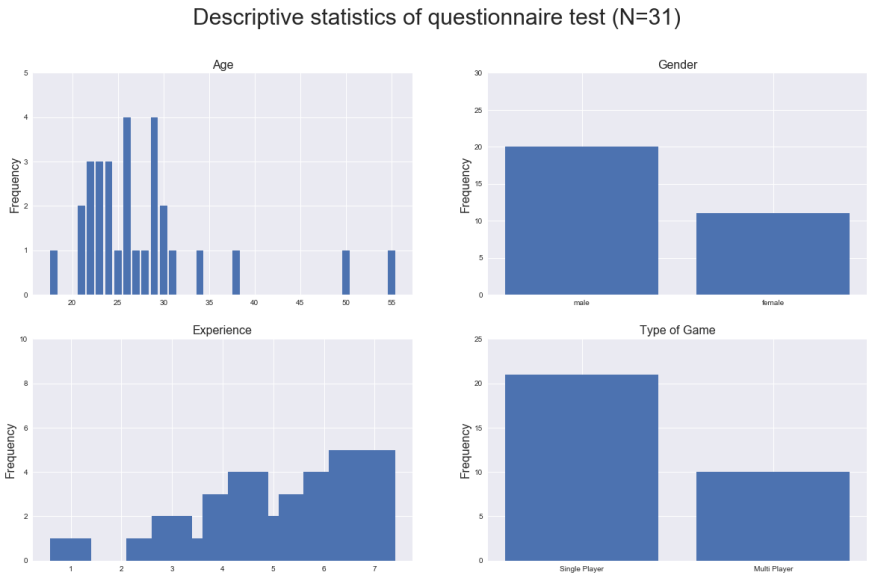


Figure 7.1: Description of the sample

7.2.1 Effect of preferred mode of play

In addition, we collected data about their preferred mode of play, between "single player" and "multi player" games, as we believe this may affect their answers. A statistical analysis of the two groups confirms this belief, seen in table 7.1. It becomes significantly more likely that a participant will prefer single player games ($m = 29.65, std = 8.4$) to multiplayer games ($m = 24.2, std = 5.61$) as their age increases, that significantly more males prefer multiplayer games, and that participants who prefer multiplayer games are significantly more experienced with video games than those who prefer single player. As shown in *section 5.4*, demographic

factors affect the choices participants make in-game, suggesting that preferred mode of play is also a predictor for behavior. The game we tested on was single player-only, which should be taken into account when evaluating the choices of the participants.

Demographic variable	**Means (STD)**	**Test Method**	**Test Stat**	**p-value**
Age	$SP = 29.65(8.4)$ $MP = 24.2(5.61)$	Mann-Whitney	40.5	.004
Gender	SP =10 male/11 female MP = 10 male	χ^2	5.99	.014
Experience	$SP = 4.73(1.5)$ $MP = 6.15(0.91)$	Student's T-test	-2.6	.014

Table 7.1: Statistical tests of mode of play and various demographic factors.
SP=Single player, MP=Multiplayer

7.3 Continuation Desire

The level of engagement through a story might have an effect on the participant's evaluation of their experience. This is why, to ensure the validity of our findings, we measured the continuation desire of the participants throughout the narrative. As described previously, the important plot points of the narrative were identified through interviews (see *section 6.4*), so before some of these, we asked the participant about their desire to continue playing, in order to better understand why they made the choices they did. For instance, a quick way out of a scenario might result from low levels of engagement. This section describes how we controlled for the mental state of our participants to maximize the validity of our findings.

In short, the continuation desire at the four discrete points in the narrative remained largely unchanged, sitting slightly above average. This can be observed in *figure 7.2*. A Kruskal-Wallis-test showed no significant change in continuation desire at $H(31) = 0.75, p = 0.86$. This suggests that players were averagely engaged, and maintained this engagement until the end. Low engagement should therefore not be considered a bias.

7.4 Principal Component Analysis

Before applying the decision dimensions to the narrative passages, we need to validate the four scales. We have done this through principal component analysis (PCA), specifically exploratory factor analysis.

However, first the dataset needs to be adequate for a factor analysis. This is tested through a Kaiser-Meyer-Olkin (KMO) test of sampling adequacy and a Bartlett's Test of Sphericity. KMO examines "the proportion of variance in our variables that might be caused by underlying factors" [Rai, 2019], meaning how well each variable regresses on all other variables [Trujillo-Ortiz, 2006]. This score ranges from 0-1, where 1 is perfectly adequate for factor analysis, and anything < 0.5 is considered unfit. Bartlett's test examines if "the observed variables intercorrelate at all using the observed correlation matrix against the identity matrix" [Rai, 2019]. A significant Bartlett's test means that the dataset is suitable. Our initial questionnaire yielded a mediocre KMO measure of 0.64 and a significant Bartlett's test at $p = 0.0218$, which is sufficient for factor analysis.

Even though our questionnaire has multiple items worded negatively, which we initially assumed we would have to flip (so that an item score of 7 is always the most positive result), the best fit for PCA was using the unflipped, raw questionnaire. Because the questionnaire has 17 items, the input data has 17 dimensions. The analysis of 17 dimensions yielded six

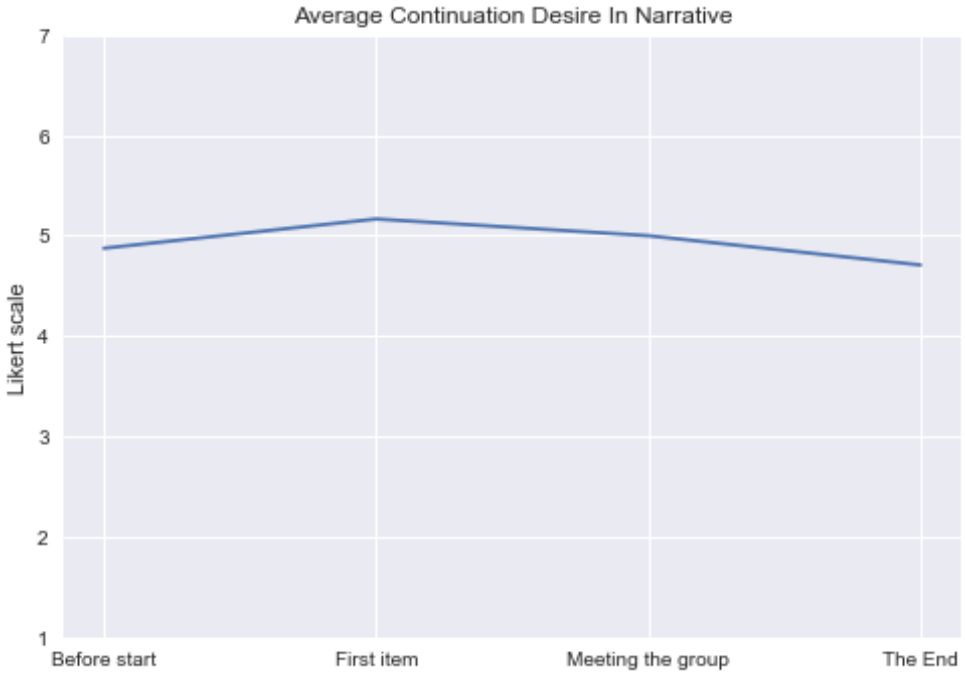


Figure 7.2: Continuation desire in "Stuck In The Center"

dimensions with eigenvalues greater than 1, suggesting that six factors are suitable to explain our construct. This is visualized in the scree plot in figure 7.3.

Running the PCA again on six dimensions with a promax (oblique) rotation returned the factor loadings for the questionnaire items seen in table 7.2. Factor loading refers to how much a variable "loads" into a factor, i.e. to what degree it correlates with the factor, factor here referring to a latent variable in the dataset that explains some portion of its variance. It is these factors that later get named and become questionnaire scales. Loadings are in the range $-1, 1$ and correspond to a correlation coefficient. An item is best explained by the factors it loads heavily into. Items can then be sorted into the factor in which it loads the most, making new questionnaire scales emerge. The table has the highest loading for each item in bold, and any secondary loadings > 0.2 also noted. The item numbers (the left-most column) corresponds to the item numbers of the initial questionnaire. For reference on the formulation of the items, please refer to *section 6.6.1*.

Further, these loadings show which items should be flipped. Item 13 and 16 both had high negative loadings in a single factor, factor 1 and factor 2 respectively, and very low loading in the rest. If flipped, they load positively and fit the model.

What these numbers suggest will be discussed in the following section.

7.4.1 Interpretation of results

In terms of internal reliability, the questionnaire returned a Cronbach's alpha of $\alpha = 0.76$, suggesting good internal reliability.

What table 7.2 shows is that the four factors of the initial questionnaire fit quite nicely into the factors derived from PCA. Identification and Planning correspond to Factor 0 and Factor 2 respectively. Two new factors have emerged, Agency and Resource Management. The initial Goal Orientation dimension can be split into two separate factors, and item 8 ("In video games, I tend to save my resources instead of using them whenever they might be useful") showed

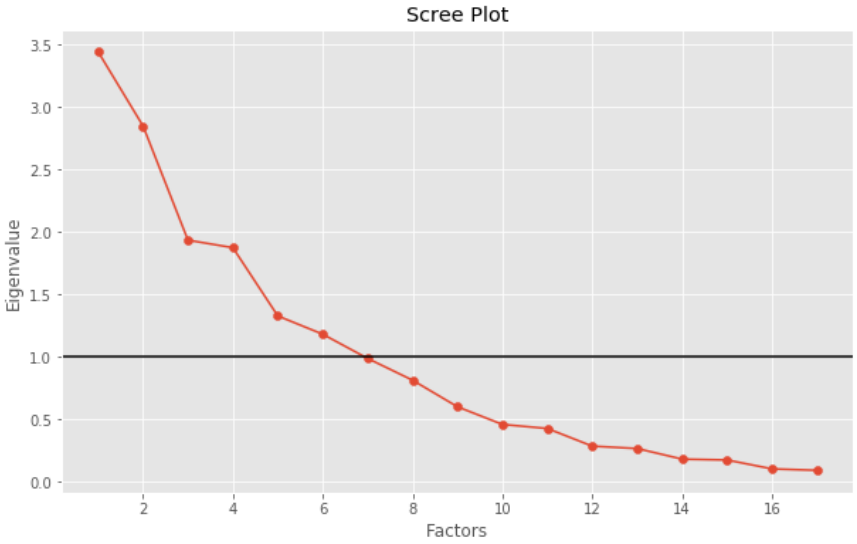


Figure 7.3: Eigenvalues of the initial four-scale questionnaire

very high loading into a single new factor, factor 5.

It can be argued that the original assumption of four dimensions (or factors) could still hold, since the eigenvalues of the 4^{th} and 5^{th} factor were relatively low (1.32 and 1.18 respectively). There is also an argument for three factors, as a "knee" can be observed between eigenvector 3 and 4 in the scree splot. This knee indicates an area where the explained variance drops quickly, so keeping any factor beyond the third one yields diminishing returns on percentage of variance explained.

However, we have settled on six factors for a few reasons. Firstly, because of the very high loading of item 8. This suggests that there is another factor we did not originally account for, that future iterations of the questionnaire and framework will have to address. Settling on three factors gives a strong validation of the original four factors we controlled for, but keeping six factors after PCA opens up the framework to the possibility of the existence of other underlying factors that may be investigated in the future. Secondly, with six factors, we preserve more of the variance in the dataset, 68%, with only 51% preserved with four factors and 40% with three.

To maximize the validity of the factors, we further suggest removing item 1 and 15. Their primary loading is relatively low, while their secondary loadings are almost of the same magnitude, but negative. Also, item 3 has a high secondary loading in factor 0 (0.44), almost as high as in its primary factor, factor 4 (0.56). If this item is placed in factor 0 instead, the original Identification dimension is preserved completely.

In conclusion, through principal component analysis of our questionnaire, we suggest that six factors, Identification, Competition, Planning, Goal Orientation, Agency, and Resource Management are the primary factors in determining the choices made in video games, and further, that a discrete choice in a video game can be characterised by ranking it on these six factors.

7.5 Assigning value to narrative choices

In the previous parts of this chapter, we demonstrated that Decision Dimensions can be applied to players. In this section, we demonstrate that they can also be used to rank narratives by assigning a Decision Dimension vector D to each choice within it. A mean vector $\overline{D}$ is assigned

Items	Factor 0: Identification	Factor 1: Competition	Factor 2: Planning	Factor 3: Goal Orientation	Factor 4: Agency	Factor 5: Resource Management
0	**0.92**	0.37				
1				**0.35**	-0.21	
2	**0.69**					
3	0.44				**0.56**	
4	**0.76**	0.22		0.24		
5			**0.68**			0.20
6	0.29		**0.83**			
7			**0.83**			
8		0.46				**0.93**
9		0.24			**0.68**	-0.20
10				**0.45**		
11					**0.73**	
12		-0.36		**0.98**		
13		**0.78**				0.21
14		**0.87**				0.19
15	**0.39**	-0.30				0.28
16			**0.42**	-0.27		
% variance	15.07%	12.81%	12.20%	11.10%	9.12%	7.78%
Acc. variance	15.07%	27.89%	40.09%	51.19%	60.31%	68.09%

Table 7.2: Factor loadings

to each storylet (or Twine passage), which is the mean of all the vectors D of the players who visited that passage. Because our narrative is directed, each choice (or "edge" in the graph definition) points to one and only one passage. Therefore, we define that edges will have the same values in their associated vector D as the values in $\overline{D}$ of the passage they point to. In programming terms, it thus becomes easy to store the Decision Dimensions of multiple choices in a single passage (or "node" in the graph definition), namely the Dimensions of all choices that point to it.

The important plot points of the narrative will now be reviewed in terms of their associated Decision Dimensions $\overline{D}$. For a justification of why certain passages are deemed as important, please refer to *section 6.4*. For reference, these are also the passages that are immediately preceded by a continuation desire question. We remind the reader that D is comprised of $[Identification, Planning, GoalOrientation, Competition, Agency, ResourceManagement]$ in that order. A summary of the findings can be found in table 7.3 and table 7.4.

Befriending or killing Maria

The initial point-of-no-return in the story comes when the player is tasked with either befriending or killing a woman they meet in the jungle. In passage $ch1\_23$ they kill her, and in passage $ch1\_30$ they befriend her after either hiding or confronting her outright. Only three participants chose to kill her. A Welch's T-test was performed on each Dimension, showing a significant increase in $Identification$ when befriending Maria[1]. This Dimension is concerned with the degree to which a player makes decisions as they would in real life, so this suggests that participants who highly identify themselves as the protagonist and put themselves into the narrative are less prone to killing strangers, which logically makes sense as this is not often seen in real life.

[1] please note that the sample sizes are highly dissimilar, and that inferential statistics on sample sizes that low should be concluded on carefully.

Heading out or resting for the night

After meeting the group of strangers and sharing stories about what the jungle contains, night falls, and the player can either insist on heading out to find the mysterious wall or resting for the night. In passage *ch*1_45 they head out, in passage *ch*1_46 they rest for the night. Pair-wise Welch's T-tests suggest no significant difference in Dimensions between these two choices.

Choosing which tool to open the door with

At the end of the story, the player encounters a door. Throughout the story, the player has had the opportunity to collect various tools, and these can be used to open the door. However, the mysterious metal piece that can be found in the beginning, will break upon use. Only after not picking up the metal piece will players be able to pick up either the key or the screwdriver, and because so few participants did not pick up the metal piece, very few got either of those two items. This is shown in this choice, as no one opted to open the door with the screwdriver and only one with the key. This is why the statistical analysis of this choice is only between *ch*1_73 (using the metal piece) and *ch*1_74 (using the rock). We did not find any significant difference in Dimension scores between these, however.

Passage Name	Visiting players	Decision Dimensions
*ch*1_23 (kill)	3	[2.33, 5.33, 3.25, 3.66, 4.77, 5.33]
*ch*1_30 (friend)	28	[4.40, 4.07.4.48, 4.54, 4.53, 4.42]
*ch*1_45 (leave)	5	[3.9, 4.0, 4.05, 4.73, 4.33, 3.8]
*ch*1_46 (rest)	26	[4.25, 4.23, 4.42, 4.41, 4.60, 4.65]
*ch*1_71 (key)	1	[3.25, 1.0, 5.25, 4.00, 2.66, 3.00]
*ch*1_72 (screwdriver)	0	[0.00, 0.00, 0.00, 0.00, 0.00, 0.00]
*ch*1_73 (metal piece)	11	[4.36, 4.04, 4.45, 4.42, 4.81, 4.36]
*ch*1_74 (rock)	19	[4.15, 4.44, 4.26, 4.50, 4.50, 4.68]

Table 7.3: Plot points and their associated Decision Dimensions

	Kill/Friend		Leave/Rest		Metal/Rock	
Dimension	***t***	***p***	***t***	***p***	***t***	***p***
Identification	4.26	**0.01**	-0.69	0.50	0.40	0.68
Planning	-1.28	0.30	-0.21	0.84	-0.62	0.53
Goal Orientation	1.32	0.30	-0.43	0.68	0.38	0.70
Competition	1.09	0.37	0.64	0.53	-0.16	0.87
Agency	-0.33	0.76	-0.41	0.69	0.58	0.56
Resource Management	-0.72	0.53	-0.82	0.44	-0.42	0.67

Table 7.4: Pair-wise Welch's T-tests of Decision Dimensions

7.6 The Decision Dimension Questionnaire

The final iteration of the questionnaire is a 20-item questionnaire, composed of six likert scales:

0. **Identification:** The degree to which you identify as the protagonist and make decisions for them that you would make for yourself in real life. Low identification implies that making decisions as though it is another character different from you, that you know is fictitious and therefore are less attached to.

1. **Competition:** The degree to which your decisions are informed by your desire to win and dominate your opponent. Low competition implies playing without a clear win-condition, such as dressing up or being creative.

2. **Planning:** The degree to which your decisions are informed by what comes or may come later on. A short-term decision may for instance involve killing off a character because it is fun in the moment, even though that character has resources you will need later.
3. **Goal Orientation:** The degree to which your decisions are directed by a concrete goal or expressed desire. Low goal orientation implies that you are exploring the world or testing its boundaries and rules without a desired outcome in mind.
4. **Agency:** The degree to which your decisions are directed by a desire to be in control or to enact control on the environment. High agency implies high initiative.
5. **Resource Management:** The degree to which your decisions are informed by your wish to conserve resources. May also be labelled frugality or prudence, and involves how willing you are to spend resources at any given moment.

The final Decision Dimension questionnaire is as follows. The items in *italic* are the ones that may be removed in the future.

- **Factor 0: Identification**
    1. In video games, I tend to empathize with the characters in the story and often replace my feelings with their.
    2. In video games, I like pretending to be someone else.
    3. I get very emotionally invested in the story.
    4. *In video games, I tend to do the thing that makes most people happy.*
- **Factor 1: Competition**
    1. I play peaceful or creative games rather than competitive or skill-based ones.
    2. I pick fights with other players or characters.
- **Factor 2: Planning**
    1. In video games, I prefer following my instincts rather than thinking all the options through in detail.
    2. In video games, I do things that are fun in the moment but might be detrimental in the long term.
    3. In video games, I tend to act spontaneously.
    4. The character I play as should be the leader or the best.
- **Factor 3: Goal Orientation**
    1. *In video games, I make decisions I often would not make in real life.*
    2. I feel like I am limited in what I want to do or achieve in the games I play.
    3. In video games, I perform actions where I'm not certain of the outcome before-hand.
- **Factor 4: Agency**
    1. In video games, I imagine what it would be like if my real life self was the main character.
    2. I experiment with the limitation of and rules of the games I play.
    3. I control the action in the video games I play.
- **Factor 5: Resource Management**
    1. In video games, I tend to save my resources instead of using them whenever they might be useful.

Discussion

This chapter will discuss the results obtained from all the tests made during the study, namely the initial test on significant factors (chapter 5: Significant factor in decision making in games), the interviews and personas (chapter 6: Interviews and personas), and the principal component analysis (chapter 7: Developing the framework). Then we will discuss possible biases and confounding variables that might have changed the outcome of our tests, and lastly we will discuss the implications of our findings, their applicability, and possible future works.

8.1 Interpretation of results

We developed a framework for quantifying and ranking decisions made by players in a video game, the Decision Dimensions. There are six dimensions: Identification, Planning, Goal Orientation, Competition, Agency, and Resource Management. Our goal was to create a quantifiable measure for choices in video games, making decisions rankable on some scales. The statistical analyses of our developed questionnaire suggest that the derived Decision Dimensions are a good measure for such a task. It may be discussed if the results from the principal component analysis point towards three, four, or six factors, as items load well into three factors and group themselves according to our initial scales. However, six factors explain almost twice the variance and one item loaded heavily into the sixth factor, suggesting that there are additional latent factors we did not initially account for, which is why we settled on six. As to the items themselves, future iterations might benefit from revising or omitting a few of the items.

Other data analysis within this study, regarding various demographic factors, support Yee's claims [Yee, 2019, Yee, 2016] that background variables such as age, gender, and video game experience all have significant influence on player motivations. For instance, we found that the preferred mode of play tends toward single player experiences as players get older, which may align with Yee's findings of competitiveness being negatively correlated with age. Yee's player motivations are found to be a less powerful tool for evaluating choice than background demographic variables, as only a few motivations exhibited significantly different edit distances when graph matching the path players took in our narrative.

Another hypothesis of this study is that player choice is more dynamic than player types and exists on a per-decision micro level. It has been difficult to reject that it does not. Interview data suggest that behavior does change over time, such as initial exploratory behavior becoming increasingly goal oriented over time, but the evidence is not strong enough to refute either Yee or Bartle in that some player traits persist through playtime. Future studies in this area might benefit from building on top of this framework and researching other variables, such as time, as additional factors. Decision Dimensions are a moderately precise tool, but perhaps different latent factors could be significantly better at predicting choices.

A big concern is that the law of large numbers is working against the design of the evaluation of

the framework. As sample sizes increase in each Decision Dimension vector $\overline{D}$, each score goes towards the mean, in this case 3.5, the likert scale being from 1 to 7. This is intuitively observed in passages with large sample sizes, as their Decision Dimension scores are all relatively close to each other at around 4.2. Therefore, the statistical findings of the assigned Decision Dimensions should, in this case, be considered with care.

8.2 Biases and errors in design

In the first test, we investigated which demographic factors made a significant difference in decisions made in the narrative 57 Degrees North. This was done through graph matching, considering the path each participant took in the narrative as a string of passage names and comparing the edit distances between strings. For edit distance, Levenshtein distance was chosen because it is robust to strings of different lengths. The downside to this method is that we showed that age, experience, and gender all affect the path taken, but it proved difficult to specify exactly what these differences were, which is why we followed up the test with qualitative data in the form of in-depth questionnaires. Further, because of the nature of the chosen statistical methods, we had to bin the demographic variables, such as binning age to "young" and "old" or experience into "low experience" and "high experience". The cut-off point for each bin might have affected the result. The importance of each plot point was controlled for in our own narrative, bottlenecking participants into certain high-stakes choices, such as killing or befriending a woman. Because the narrative used in this test was not created by us, the importance of its choices was difficult to control.

An apparent issue with the interviews and personas is that we conducted very few interviews. The goal was to interview representatives for each demographic factor, but we found it difficult to isolate the different factors and keep them from inter-correlating. As such, it is difficult to measure the degree to which each demographic factor biased the other factors for each participant, which normally would be remediated by increasing the sample size. However, generally fewer participants are required for qualitative data. For instance, Nielsen proposes five to eight participants in a standard usability test, with 80% of usability issues explained by five people [Nielsen, 1993, Nielsen, 2000].

For the final test, a good approach could have been to overpopulate each of the four initial dimensions with items and create a larger-than-usual questionnaire, perhaps with ten or more items per dimension. This way, identifying principal components might have been easier, as we would be able to discard items with very low or otherwise vague factor loadings. In general, having more iterations of the questionnaire would be beneficial, also to control for the wording of each item. A possible solution could be to pilot test the questionnaire with a think-aloud interview to see if any item was worded in a confusing manner. Further, sample size was low for a quantitative study of this nature, which we will elaborate on in the following section.

Due to the ongoing Covid-19 pandemic, a large majority of our tests had to be altered. We had limited access to our population and could not perform interviews or tests from the university campus and relied on convenience sampling and reaching out to people through different online platforms. This resulted in us not being able to control our sampling sufficiently. However, we were able to reach a wider audience and obtain a larger-than-expected sample size, resulting in a representation of wider range of the population for the first test.

In our own narrative, some description of choices could have been worded in a leading fashion, such as hinting at an important object through an unusually rich description, even though the importance of that object was meant to be hidden from participants. Writing the narrative such that each choice had an equally high perceived value is difficult to control for, but through pilot testing we iterated on a few of them, which hopefully reduced unequal weight of choices. The narrative was further changed between interviews and the final test, based on feedback from the interview respondents.

Also, the narrative was relatively short, meaning that behavior that might change over time, such as exploratory behavior versus goal oriented behavior, might not be fully represented. The narrative could further be iterated upon by replacing or removing certain paths that were either never visited or were never functioning as intended in the context of the tests.

8.3 Validity and Reliability

Bjørner outlines eight strategies ensuring a higher validity [Bjørner, 2015, p. 109-110]. Triangulation happened through theory, self-report, subjective measures and questionnaires during the evaluation for further confirmation of the findings. Detailed personas were created during the second test, providing sufficient understanding of the target group and allowing for further envelopment into their world. Biases were taken into consideration all throughout the findings and is discussed briefly in this section.

Reliability in the questionnaires was measured through Cronbach's Alpha, obtaining a $\alpha > 0.72$ for all questionnaires used for testing, which indicates good reliability. Furthermore, in the principal component analysis, a Kaiser-Meyer-Olkin and Bartlett's test indicated that the dataset was fit for factor analysis, albeit at a mediocre level.

For the interview, a test guide was created with clear instructions, making sure that the verbal delivery would be consistent across participants [Bjørner, 2015, p. 111]. The duration of the whole test was kept short, ensuring that the facilitator and interview respondents exhibited stable behavior and did not experience considerable fatigue [Bjørner, 2015, p. 111].

Conclusion

The purpose of this study was to develop a framework for evaluating choices in video games using our interactive narrative. Our research question was *"How well can the decision making in video games be modelled and quantified by latent factors in player behavior?"*. Through multiple mixed-methods iterations [Bjørner, 2015, p. 21], involving multiple tests and implementations, we developed the six Decision Dimension, on which we are able to rank choices. Bartle viewed his player types as being fixed, whereas Yee saw them as dynamic and fluent, and our contribution builds upon these ideas by suggesting that player decisions and motivations have an even finer granularity and are rankable at discrete decisions during a game session.

We developed a 20-item questionnaire for ranking players with four scales. A principal component analysis suggested that six underlying factors could be identified, thus giving rise to the final six Decision Dimensions. Further, item 13 and 16 should have their scores flipped, item 1 and 15 could be removed due to low primary factor loadings, and item 3 could be placed in either Factor 0 (Identification) or Factor 4 (Agency). Even still, the factor loadings of the questionnaire items generally fit the original four scales moderately well, suggesting that our findings from the previous iterations (interviews and personas) were acceptably valid.

With this framework we are able to not only rank players, but also each decision in a video game, provided that it is a discrete choice with a directed, finite set of options, and each option pointing to one-and-only-one new passage.

This framework may be a tool for developers seeking to either profiling their players or their game experience, tailoring the choices in a video game to a certain player profile. This study may aid in the understanding of video game player psychology.

9.1 Future works

Future studies might look into expanding upon the six Decision Dimension, creating a more elaborate questionnaire with more items per Dimension. Testing the robustness of the Decision Dimensions is also an area of great interest to us. The questionnaire was only ever tested in one narrative in one genre, so future studies might benefit from testing our framework in other genres of video games or with other stories.

To emphasize the notion of our Decision Dimension existing on a per-decision micro level, developing a machine learning algorithm that learns to categorize players continuously along these six Dimensions could be a valuable next step. Administering the questionnaire once before the beginning of the game is a simplified method of categorizing players, but we maintain the argument that this approach is valid enough to confirm our hypothesis. It is also possible that the Dimensions could be reverse-engineered, such that the Dimension scores of a particular narrative might categorize the player, instead of the Dimensions of the player categorizing the choices in the narrative. This could have great potential in the game evaluation industry, where identifying which players a company's game appeals to is vital.

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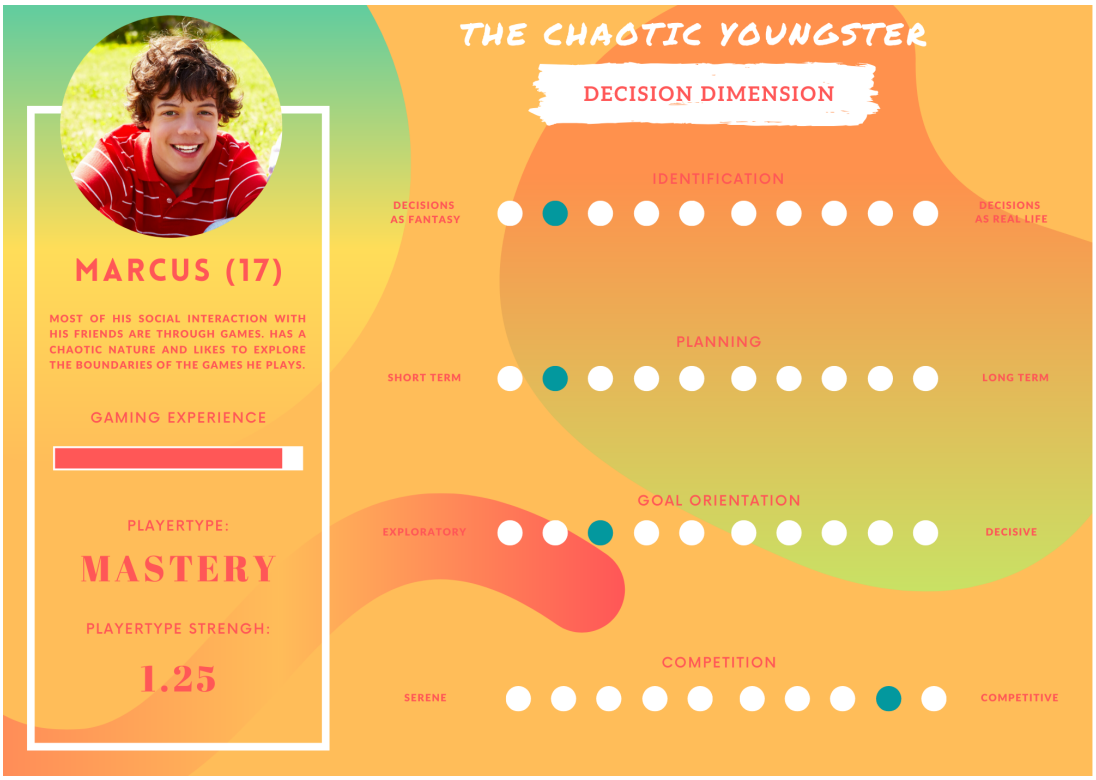
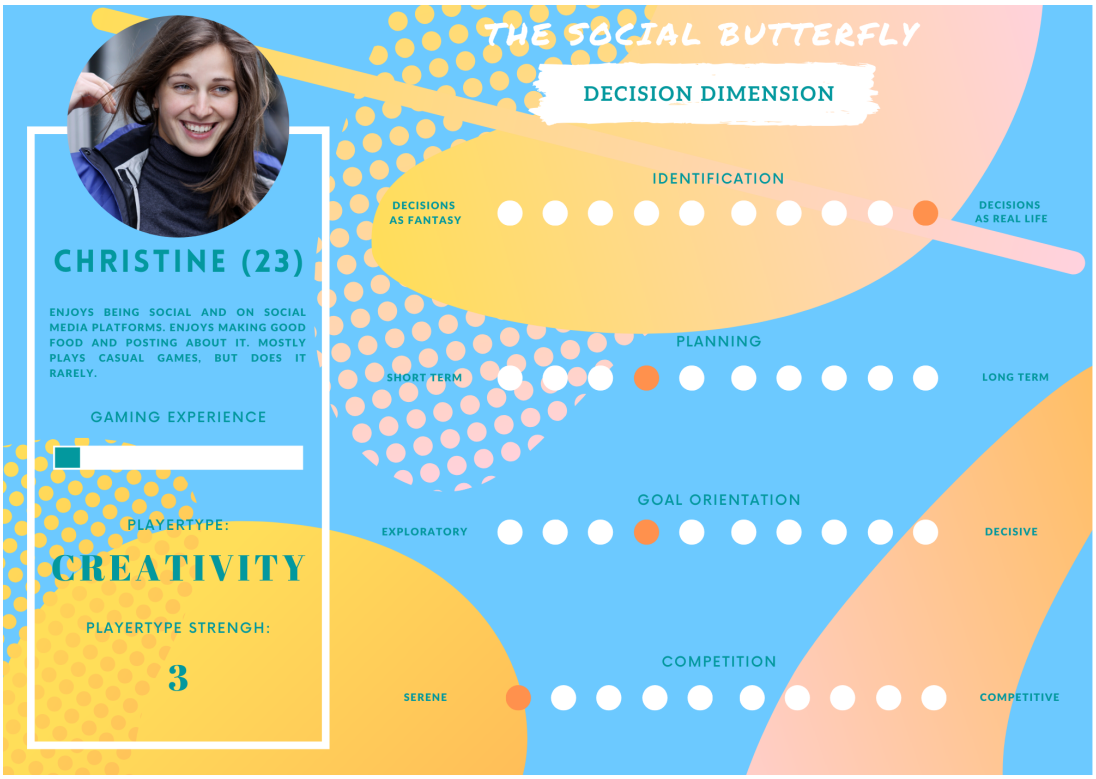
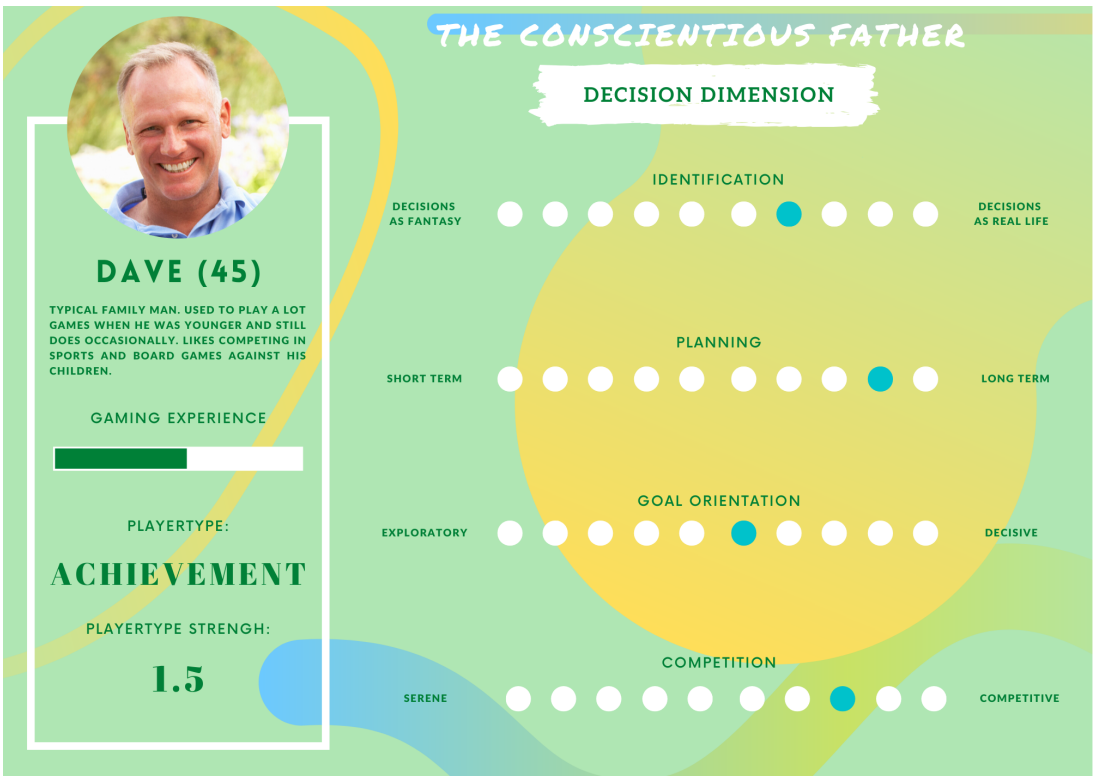
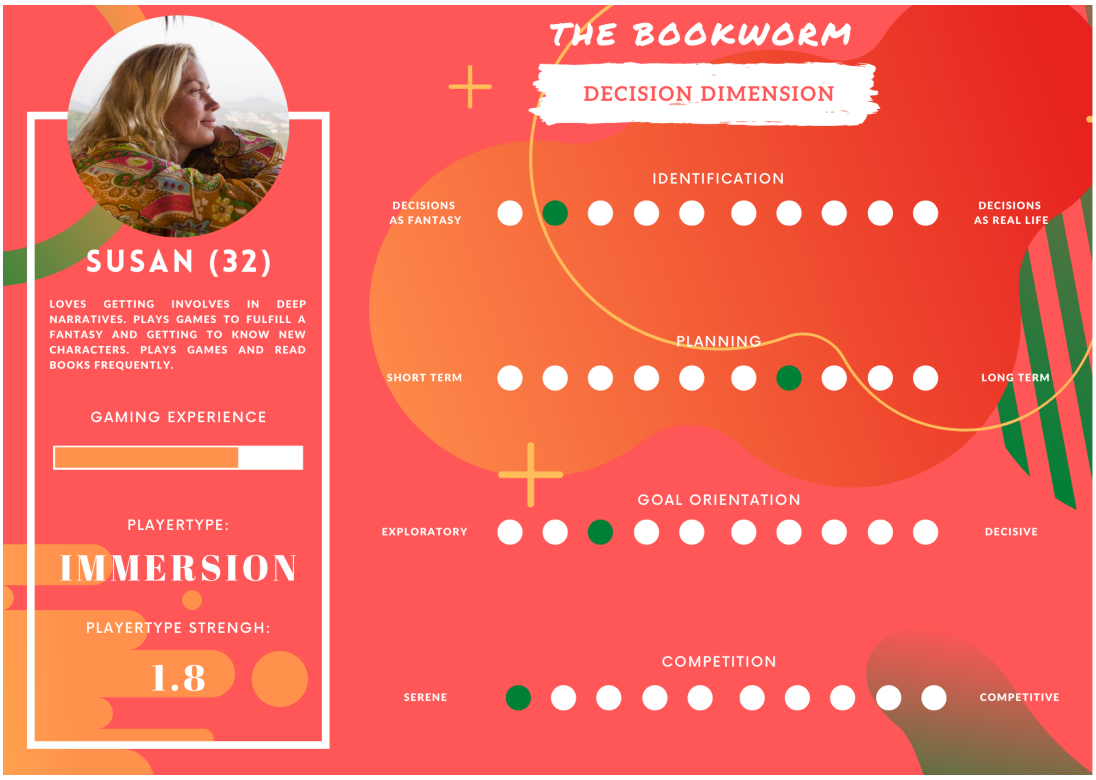
Appendices

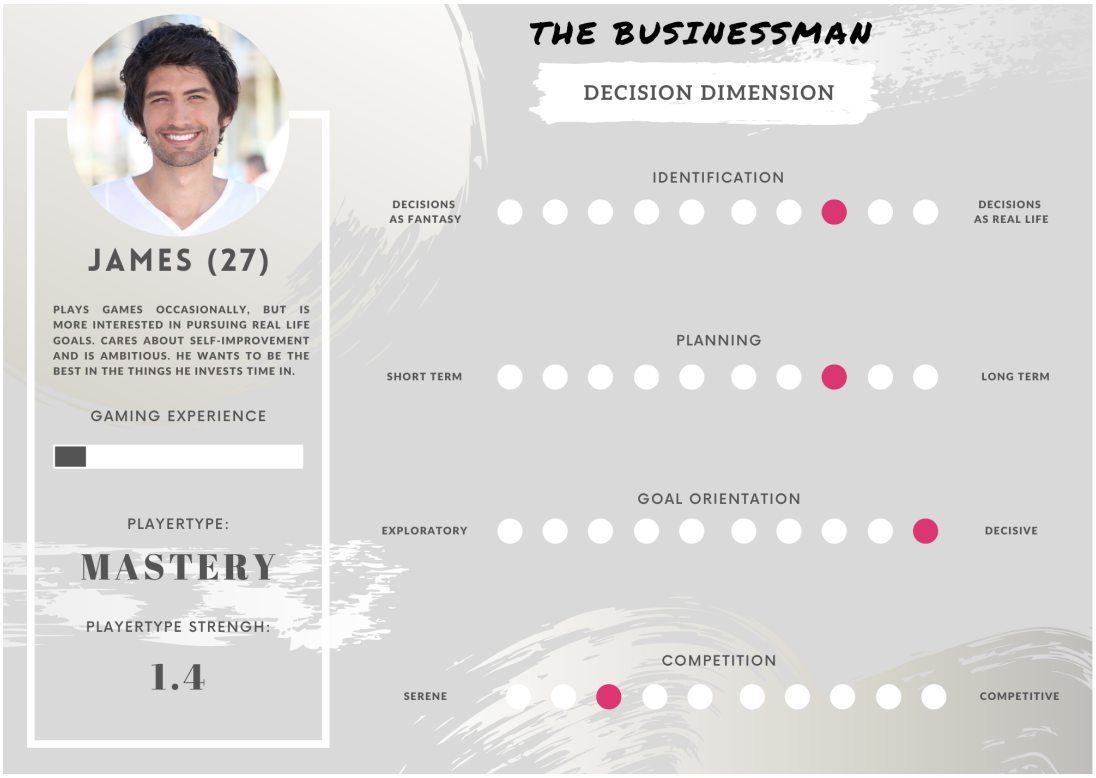
A Personas


THE CHAOTIC YOUNGSTER
DECISION DIMENSION
MARCUS (17)
MOST OF HIS SOCIAL INTERACTION WITH HIS FRIENDS ARE THROUGH GAMES. HAS A CHAOTIC NATURE AND LIKES TO EXPLORE THE BOUNDARIES OF THE GAMES HE PLAYS.
GAMING EXPERIENCE
PLAYERTYPE:
MASTERY
PLAYERTYPE STRENGH:
1.25
IDENTIFICATION
DECISIONS AS FANTASY
DECISIONS AS REAL LIFE
PLANNING
SHORT TERM
LONG TERM
GOAL ORIENTATION
EXPLORATORY
DECISIVE
COMPETITION
SERENE
COMPETITIVE


THE SOCIAL BUTTERFLY
DECISION DIMENSION
CHRISTINE (23)
ENJOYS BEING SOCIAL AND ON SOCIAL MEDIA PLATFORMS. ENJOYS MAKING GOOD FOOD AND POSTING ABOUT IT. MOSTLY PLAYS CASUAL GAMES, BUT DOES IT RARELY.
GAMING EXPERIENCE
PLAYERTYPE:
CREATIVITY
PLAYERTYPE STRENGH:
3
IDENTIFICATION
DECISIONS AS FANTASY
DECISIONS AS REAL LIFE
PLANNING
SHORT TERM
LONG TERM
GOAL ORIENTATION
EXPLORATORY
DECISIVE
COMPETITION
SERENE
COMPETITIVE


THE CONSCIENTIOUS FATHER
DECISION DIMENSION
DAVE (45)
TYPICAL FAMILY MAN. USED TO PLAY A LOT GAMES WHEN HE WAS YOUNGER AND STILL DOES OCCASIONALLY. LIKES COMPETING IN SPORTS AND BOARD GAMES AGAINST HIS CHILDREN.
GAMING EXPERIENCE
PLAYERTYPE:
ACHIEVEMENT
PLAYERTYPE STRENGH:
1.5
IDENTIFICATION
DECISIONS AS FANTASY
DECISIONS AS REAL LIFE
PLANNING
SHORT TERM
LONG TERM
GOAL ORIENTATION
EXPLORATORY
DECISIVE
COMPETITION
SERENE
COMPETITIVE


THE BOOKWORM
DECISION DIMENSION
SUSAN (32)
LOVES GETTING INVOLVES IN DEEP NARRATIVES. PLAYS GAMES TO FULFILL A FANTASY AND GETTING TO KNOW NEW CHARACTERS. PLAYS GAMES AND READ BOOKS FREQUENTLY.
GAMING EXPERIENCE
PLAYERTYPE:
IMMERSION
PLAYERTYPE STRENGH:
1.8
IDENTIFICATION
DECISIONS AS FANTASY
DECISIONS AS REAL LIFE
PLANNING
SHORT TERM
LONG TERM
GOAL ORIENTATION
EXPLORATORY
DECISIVE
COMPETITION
SERENE
COMPETITIVE


THE BUSINESSMAN
DECISION DIMENSION
JAMES (27)
PLAYS GAMES OCCASIONALLY, BUT IS MORE INTERESTED IN PURSUING REAL LIFE GOALS. CARES ABOUT SELF-IMPROVEMENT AND IS AMBITIOUS. HE WANTS TO BE THE BEST IN THE THINGS HE INVESTS TIME IN.
GAMING EXPERIENCE
PLAYERTYPE:
MASTERY
PLAYERTYPE STRENGH:
1.4
IDENTIFICATION
DECISIONS AS FANTASY
DECISIONS AS REAL LIFE
PLANNING
SHORT TERM
LONG TERM
GOAL ORIENTATION
EXPLORATORY
DECISIVE
COMPETITION
SERENE
COMPETITIVE

B Numbered flow diagram of whole narrative