Master Thesis

The relation between motivational factors and video gaming addiction

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by

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Preface

In my view, every person has patterns—things we like to do, experience, or unconsciously undergo. Our motivations direct our actions. The motivations and drives we have are a product from our movement within the world around us, and the world's influence on us. Once we can recognize and understand the reasons for our behavior, we can reflect. We can find ourselves and adjust patterns we no longer find pursuable. As a gamer myself, I am aware the potential gaming has to support our development in the sense of knowledge, understanding, and experience. By understanding our motivations, we can pursue our full potential.

During the study, I was also confronted with my behavior and patterns. By reading related psychological studies, I have come to understand my motivations better and developed a process for myself to change everyday processes and patterns. Additionally, I feel lucky to have experienced the process of game development. It allowed me to learn about new areas of expertise like 3D modeling, sound design, physics, and it combines many courses I have had during my studies, like algorithms, graphics, database management, and so on.

I want to give my special thanks to D.J. Broekens, who has been my supervisor during the thesis. I have enjoyed our meetings and discussion, and I am happy I was free to pursue the topic I found interesting. From start to end, it has been a positive and open-minded collaboration, and I liked the process we took.

I also want to give my thanks to friends and family who supported me along the way, and sometimes also told me not to forget to relax, especially in the final moments.

Daniël Swaab
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Abstract

The gaming industry is growing larger every year. Video games are useful for many applications but are also a reason for worry. Games are starting to affect the lives of people negatively. Nowadays, this is defined as Internet Gaming Disorder (IGD). We relate the players' motivations to game addiction through a survey and test our findings by using a game. The survey (n-106) showed that playtime could indicate addiction, six motivation types could be extracted, and two motivational factors correlated with addiction. By analyzing 16 games, we found that the most implemented game mechanics match these two factors. This indicates that games are developed with addictive mechanics. We test the found factors by creating a two versioned game, one with, and one without these mechanics. Because of limited player data, we could not yet confirm the found motivational factors.

Contents

1 Introduction

Do you consider yourself a gamer? How about your family, friends, or the elderly? There is a typical view on the concept of a 'gamer'. Usually, we imagine some of the following characteristics: a PC, console, headset, fanatic interaction, energy drink, and spending time playing video games. In reality, Nielsen et al. [106] show that more than 60% of the population (within the U.S.) is a gamer. We took the definition from Wikipedia [155] and adjusted it slightly:

Definition 1: *A video game is an electronic game that involves interaction with a user interface to generate (visual) feedback on a (two- or three-dimensional video display) device such as a touchscreen, virtual reality headset, or monitor/TV set.*

This means that any form of a game on any digital device with a screen is to be considered a video game. This description includes, for example, mobile applications like FarmVille[1] or Candy Crush[2], which are played by millions. It also includes games that have a different primary objective than pure entertainment. As Giessen et al [46] and Khenissi et al.[73] describe, these type of games are called *Serious Games (SG)*. In the remainder of this study, a game will always refer to a video game. Now back to you: why do you play video games, are you aware of the time you spend on video games and do you **really** enjoy playing video games?

1.1. Videogames everywhere

The number of people that play games and the amount of money they spend have increased over the years. Entertainment Software Association (ESA), Limelight[99], and Newzoo[153], researched the gaming industry. ESA shows that 60% of Americans play games daily [33]. Newzoo presents the market values of the gaming industry, considering the segments for PC, console, and mobile games. They show that the whole market is still growing, with the mobile market increase being the largest. ESA's and Limelight's research supports this statement. Newzoo [153] also predicts that the market value will keep increasing over the years. They say the current estimated market value of the video gaming industry is 137,9 Billion. To explain the ongoing increase in the video game industry, we look at how games are played and what types of games have been developed over the past years.

Games are played by using a digital device. A device that we use multiple times a day is our phone. Pelkonen et al. [113] summarize the progress mobile phones have made. Nowadays, almost everyone has a relatively powerful computer in their pocket. In addition to that, application market places (such as Google Play[3] and the App store [4]) make installation and the release of applications relatively easy, by just a few clicks. This could explain why the mobile market is growing the fastest within the game industry.

Next, we look at developments within SG's and Entertainment games. Hamari et al. [55] show that games are good for helping people learn, besides being entertaining. Therefore it is becoming a popular medium

[1] `https://www.zynga.com/games/farmville/`
[2] `https://king.com/game/candycrush`
[3] `https://play.google.com/store`
[4] `https://www.apple.com/ios/app-store/`

for transferring knowledge or offering experiences. SG's have been used in areas, we give some examples: personal needs (Wood et al. [159]), training (Smith et al. [133]), electronic sports (Dota 2 [6]), learning (Ganic et al. [47], Boyan et al.[13]), assisting (Griffiths et al. [49], Hodges et al. [57], Buurman [15]), doing research (Derriks et al. [64], Moszkowicz et al.[17]), immersion (Kardijk et al. [70], or society (Dinet et al. [108]). SG's are, however, not responsible for the ongoing growth. Figure 1.1 shows the number of papers per year found on Scopus[5], when using the search query "Serious Gaming". We see an increase from 2005 to 2013, but since then, the number of papers seems to have stabilized.

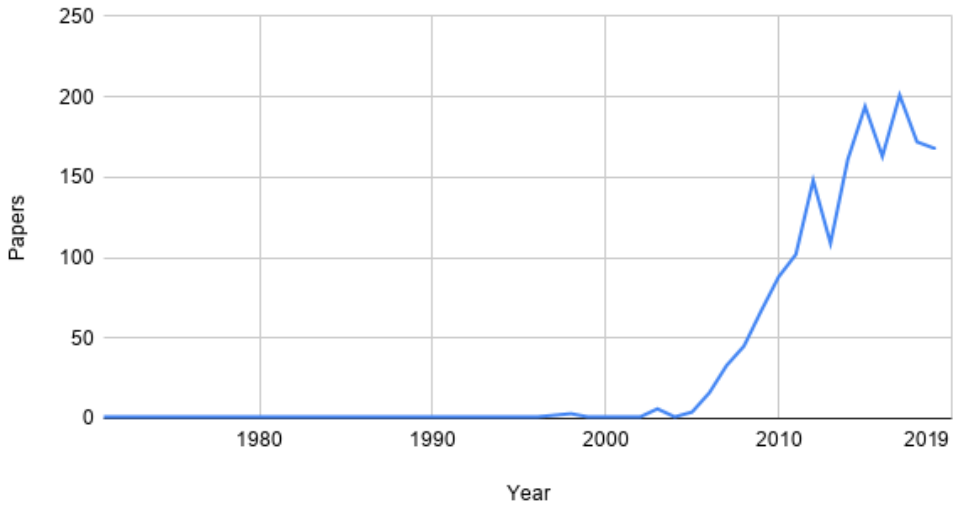

Figure 1.1: Number of published papers with the term "Serious Gaming" per year, searched on Scopus (`www.scopus.com`)

Within the entertainment segment of games, there has been a growth in the gaming type *Massively Multiplayer Online* (MMO), Dindar et al. [28]. As the name suggests, the genre focuses on creating a platform where all players can interact with each other in real-time. These games are designed to be always playable. Such online games are often cheap or even free (e.g., Dota2, Fortnite, and Team Fortress), but there are in-game mechanics that enable you to spend money. These kinds of mechanics can either directly influence the development of your gameplay: pay to win (you do not need to wait, or you get more lives or better items), or they can be purely decorative, for example, skins, backgrounds, and sounds.

1.2. The dark side of games

Subsequently, the profit these games make is correlated with the number of people playing and how much they play. Therefore multiple methods have been implemented to motivate people to invite friends, play as long as possible and return as often as possible. Some of these methods are also addictive. King et al., Lanier, and Ricchiuto show that companies have been sued for enticing players in buying loot boxes, because of their gambling nature [76],[85],[122]. Additionally, the Dutch government did its study on loot boxes [30]. They found that four of the ten analyzed loot boxes contravened the law, due to their gambling nature. These studies show that games can be engineered to be addictive. Chuck explains to students how to design addictive games [135]. Even without addictive methods, games can facilitate an escape mechanism. Wong et al. [157] showed that people use games as a coping mechanism or to spend time. This can also lead to an addiction. These addictiveness games tend to have, might be the main reason the gaming industry is growing.

Mentzon et al. [101] found that problems around video gaming are present in our current society. [99] show that a part of the gamers neglects daily tasks to continue gaming. People struggle with controlling their playing time and controlling their emotional states (e.g., the search query "video game rage compilation" shows many examples[166]). Kou et al. [81] found that *streakiness* induces negative feelings towards players' experiences in the game League Of Legends, and the website of *Gamequitters* shows multiple stories where gaming has had a negative impact on a person's life[120], and also their environment [164]. This goes beyond the goal's games initially had: being a form of entertainment. Negative consequences of gaming can be:

- Spending to much time (Wood et al. [159], neglecting other parts in life:

[5] `https://www.scopus.com/home.uri`

  - Health, Yousafzai et al. [165]
  - School/Work, Ward et al. [148], Krialy et al. [78]
  - Social, Kowert et al. [82],Yousafzai et al. [165]
  - Psychological, Kower et al. [82],Kiraly et al. [78],Kou et al., [81]
  - Financial situation as consequence, Huff et al. [59]
- Frustration or anger: it can create or amplify frustration, which then effects the player's direct environment in the real world, Nylund et al. [107].

Since December 2018, *Internet Gaming Disorder* (IGD) has been added to the International Classification of Diseases (id: 6C51) by the World Health Organisation[152]. It states three conditions: impaired control over gaming, giving it more priority over daily tasks and continue to do so, despite negative consequences. Newzoo [153]found that the larger part of players does not experience these negative consequences, or maybe they do not recognize it as such. Access to substance addictions is often regulated by an external party (the government). Digital addictions, like IGD, are harder to control. Games are accessible for anyone who has access to the Internet and playable from a young age. Additionally, some games can be played for free. The responsibility ends up at the player, their care-taker, or the game maker. Are the methods games use ethical, healthy, and the most satisfying for the players? Should we adjust the policies and principles around games and how they are built, and move to a more sustainable one? There is a need for a model that can create clarification to the players, and the game designer (Human-Computer Interaction). Such a model should answer questions like:

- Why do people play video games?
- What game mechanics satisfy player needs?
- What motivation and mechanics relate to an increase in playing time, money spending, and potential addiction?

When we can answer questions like that, we can use the model for different purposes within the field of Human-Computer Interaction (HCI). First of all, by analyzing why people play (motivation), we can create a different version of the same game tuned to the player. Secondly, by analyzing the relationship between motivations and mechanics, we can determine: which other games can be interesting for the player ("next to play"), relate this to gamification principles, and check if the mechanics found in a game map to the motivations a player has for playing that game. Thirdly, when we correlate the motivations and mechanics of addiction, we can: recognize, act, prevent, and advise people based on video gameplay. Finally, we can also classify games in different categories concerning addiction or monetizing schemes. The focus of this thesis is to define such a model and show how to use it within game development for managing addiction.

1.3. Related work

The goal is to develop a model of motivational factors that relate to addiction and validate these factors by using a game. Therefore we first look into what has been done to define and measure game addiction. Secondly, we look at how to determine a player's motivation. Next, we look at how game addiction and motivation can be correlated. Finally, we look at how we can measure game addiction or motivation from a game and use it.

1.3.1. Game addiction

IGD is now recognized as a behavioral addiction. However, Markey et al. [98] show there was much discussion on it beforehand. Earlier, addiction was best defined regarding drugs: psychoactive substance ingestion. The different consequences on addictive use led to defined effects in physical and psychological well being. When talking about excessive gaming, the source of the problem is not a drug, but a behavior. Behavior is difficult to define. Depending on the person, their environment, and perspectives (culture), behavior can be regarded as problematic or normal, Lee et al.[88]. People play for different reasons, and playing can be used to achieve goals besides entertainment. This makes it difficult to ascertain when a person plays too much. Currently, there has been defined only one other behavioral addiction, namely gambling disorder (id: 6C50[151]). Mancey et al. [95], Wood et al. [159], and Kuss et al. [84] state that gambling is in fact, closely related to gaming addiction. Johansson et al. [66] and Macey found gambling does not necessarily correlate with a gaming addiction. In both physiological and physiologic effects, multiple correlations were found between behavioral addictions and psychoactive substance ingestion, Olsen et al. [109], Han et al.[56]. They state that purely through psychological changes, there is a neuroplastic effect inside the brain, based on short-term rewards, which is supported by Egerton et al.[31]

Olsen et al. [109] also summarizes that current research is not yet conclusive about the underlying reasons for behavioral addiction. Research has been done by Grant et al. [48] and Stavro [136], on the psychological and physiologically level to relate behavioral addiction and psychoactive substance ingestion. As defined by Grant et al. [48] and WHO [152], behavioral addiction includes the following three aspects:

1. Unable to resist the urge to undertake a specific behavior in a domain.
2. Repetitive execution of that specific behavior
3. Continuing to execute the behavior, although it interferes (knowingly) with other domains.

When reading these aspects, we could argue that addiction is not necessarily a bad thing. As long as one is conscious of the domains that are influenced, and these domains are not negatively influenced, it may not hurt. However, how to define: what is too much? Furthermore: when are domains negatively influenced? Spekman et al.[134] state a distinction between IGD and extensive gaming. They found that the two are not necessarily correlated, but extensive gaming can lead to IGD. Additionally, both groups do experience negative consequences because of their game-related behavior (for example, with their partner or parent when dinner is ready).

Based on the aspects mentioned above, different scales have been developed to measure IGD, Markey et al. [98]. They revisited multiple scales and show that results still vary: there is no golden standard, opinions deviate. Lemmens et al. [89] first created a 7-item scale *Game Addiction Scale* (GAS). GAS has shown good psychometric properties and has been used by multiple other researchers, for example, Khazaal et al. [72] reconfirmed the scale with a German, Swiss, and French population. Lin et al. [92] evaluated the scale within Iranian adolescents. After that, Lemmens et al. [90] also summarized available studies and additionally reiterated over their work to create the IGD-scale. This scale contained 9-items. The nine questions are Boolean (yes/no). By summing the number of 'yes' we get an 'addiction score' (a_s). They follow the DSM-5 criteria for the cut of point. This means that when a participant answers five or more questions with 'yes', the participant is placed in the risk-group.

Another possible way of measuring addiction is by analyzing playing time(amount). Kim et al.[74] analyzed 3041 people. They stated the following: *"the risk group subjects tended to belong significantly more to the categories with a relatively high weekly online game playtime than healthy controls"*. Although playtime can differ from person to person (Lee at al.[88]), playtime does have a natural correlation to addiction. Game addiction means having difficulty stopping playing; therefore, playing to game more; therefore increasing playing time.

1.3.2. Player motivation

Player motivation is a broad topic. We found different types of models that we can relate to player motivation, including motivation theories, player engagement, player type, reward system, and game mechanics. In the following subsections, we will elaborate on these different perspectives.

Motivation theories

Psychological studies have defined different motivation theories for behavior. EMA [32] shows an overview of motivation theories. They say a person first has a motivation, then executes a behavior, which results in a level of satisfaction. They split motivation theories into two main categories: content and process theories. Content theories are about what needs people have (what). Process theories are about how motivation is initiated (how). Reoccurring motivation theories in gaming academics are: Self Determination Theory (DST) by Ryan and Deci[124] (e.g. Allen et al. [1],Derevensky et al. [27]), Skinners boxes by Fester et al. [36] (e.g., Kiraly et al. [78]) and Goal Setting Theory by Locke et al.[93] (e.g. Orji et al. [110],Phillips et al.[117] Tondello et al. [141], Ebel et al. [104]).

Ryan and Deci wrote that Self Determination Theory is about the need for competence, autonomy, and relatedness[124]. They also divide motivation in intrinsic and extrinsic motivation. Extrinsic motivations are stimulated by external factors such as reward systems, whereas intrinsic motivation comes from within the person itself. Intrinsic motivation for gameplay can be wanting to be the best. Extrinsic motivation is getting a reward when becoming the best.

Repetitive short-term rewards are known to be able to influence behavior. Skinner was the first to highlight this through his work on operant behavior, also known as Skinner boxes[36]. It showed that animals could be trained to execute a task (pressing a specific button) to receive food by using positive or negative rewards. People can also be trained to repeat specific behavior by using positive or negative reinforcement. In

nowadays literature, learning something by repetition and reinforcement is commonly known as *Reinforcement Learning* (RL). Games are full of positive and negative rewards, some examples: Lootboxes (King et al. [76]), streaks (Kou et al.[81]), daily quests (Egerton et al.[31]).

Goal-setting theory is about how goal setting can improve motivation and performance. Games can implement mechanics to create goals, like challenges, quests, or achievements.

These concepts are quite abstract and describe a general motivation model for everyone. Buurman[15] showed the relationships between game mechanics from Chou's player model[19], to different psychological theories. Some of the mechanics were related to multiple theories. Psychological and motivation theories tend to overlap, Buurman [15], EPM[32]. Therefore these forms of motivations, on their own, might not be concrete enough to describe player motivation.

Player engagement

The engagement of a player also influences motivation. What is a player's perceived enjoyment? Mihaly [22], Yannakakis et al [162], Sharek [131], and Lee et al. [87] point out that flow is one of the most critical factors for the enjoyment of the game. Flow is about the process of steering a player's experience in such a way that a player becomes as immersed as possible, Chen et al. [18] (optimizing experience). Immersion is deep mental involvement. Flow theory is about finding the balance between not too easy (boredom), and not to difficult (anxiety). Optimizing the flow of a game makes it more attractive for people to continue playing. Lee et al. [87]and Hoffman et al. [58] analyzed how motivation relates to the interaction with video gaming. Lee et al. found that flow experience is the most important motivation people have to play online games and that human-computer interaction and social interaction are two important sub-factors of flow experience. Hoffman et al. found that motivational engagement was related to gender, hours of play, task orientation, and socializing. Allen et al. [1] and Derevensky et al. [27] mention the need for DST within the game: the more a player can grow, feels in control of the game, and can relate, the more positive their experience. They also note that positive frustration should also be part of gaming, also supported by Nylund[107]. Pendersen et al. say that frustration can lead to a greater feeling of achievement. They find[112] challenge and learnability as the most important factors to making a game fun. Dindar et al. [28] find that status-seeking and achieving something that the player is not capable of in the real world are the most important aspects. In 2009 Korhonen et al. created the PLayfull Experience (PLEX) framework [79]. The framework was created to help in the design of playful experiences. A year later, Korhonen et al. revisited the PLayfull EXperience (PLEX) framework [3]. In the revision, it was compared and merged with Costello et al. 's work [21]. They defined 22 Playful Experience categories—these where then later also include by Schaffer et al. [127]. Schaffer et al. included even more models. They defined 34 elements to answer, to determine what makes video games fun. They used expert reviews to extract the elements.

The engagement between a player and a game indicates important game elements that support motivation. The play experiences are a result of playing, not the reason for playing. Therefore we cannot use these models as a basis for defining the relationship between motivation and addiction. However, the perceived enjoyment of players is important when our goal is to adjust games.

Player types

Player type models are build to create an abstract understanding of the behavior and motivation of players. Players are grouped in different (generalized) types. The most famous one is from Bartle [8]. He defined four player types: killer, achiever, socializer, and explorer. This was based on a summary of a heated discussion about what people wanted out of a multi-user dungeon game. Although widely applied, Bartle noted it's limitations: it was based on one type of game and was not supported by data. Since then, many other models have been created. In 2004, Lazzaro et al. [86] looked from a perspective of emotion. They also defined four categories: easy, hard, serious, and people fun. They also acquired data by talking with gamers. Additionally, they observed the participants' gameplay and asked non-gamers. Yee did an empirical study. He found ten types, divided over three main categories [163]. His work started with 40 questions based on other qualitative information studies, including Bartle's. He concludes that the types can also correlate and that people can play the same game for different reasons. These studies, including Yee's, were still based on MMORPG players and therefore limited to application in a broader area. In later years Yee co-founded the Quantic Foundry [38]. Quantic Foundry did a broader study, gathering data about motivation from players of different games. This resulted in 12 types divided over six categories—the details of the study where not published. Therefore we can not confirm the quality or methodology.

Marczewski's [97] developed the Gamification User Types: "a taxonomy for users in gamified systems". Six groups were created based on different psychological work, creating four intrinsically motivated types, one

extrinsic motivated type, and later on the final 'disruptor' type. This work could be generalized to different game types. Tondello et al. created a framework to use that model [142]. The model has been adopted and adjusted to fit different situations. Marcweski also defined design elements correlating to these six groups. These where later extended by Tondello et al.[143]. By using a survey and factor analyses they proposed eight groups that indicate user preference. Vahlo et al. [145] defined seven types based on analyzing game reviews, and clustering on five defined game dynamics preference categories ("assault," "manage," "journey," "care," and "coordinate"). The focus of their model was on game interaction preferences instead of player behavior. Chou wrote a book about actionable gamification. The core of this model is called the Octalysis framework [19]. This consisted of eight different categories of 'core drives'. These were also linked to specific game mechanics. It has been widely applied for gamification and game design. The exact method of the research remains unclear, therefore, just as the work from Quantic Foundry, hard to confirm.

There are many more who have tried to define player types our explain behavior, and some studies also started merging the different models. Stewart [40] showed the compatibility of different models in relation to Bartle's player types. Hamari et al. [54] compared twelve different works and merged them into seven categories. This included the work of B. Stewart [40]. They both found that many models were comparable to the other. Nacke et al. [103] also summarized multiple different concepts, including Bartle, Caillios, Chris Mark, Malone, Yee, Lazarro. Their perspective of interpretation came from the Myers-Bricks person type indicator. They related personality types towards their developed Brainhex archetypes. This resulted in seven 'brainhex' types. Worth et al. [160] created a survey based on earlier work of yee and Bartle to analyze video game behavior. They created a list of 34 questions, called the 'General Video Game behavior Questionaire' and compared this to the HEXACO-60 (which is a model of personality structure) and the SRP-III scale. (Self-report Psychopathy Scale). By using *Principal Component Analyses* (PCA), they found four main factors that correlated with some of the earlier mentioned models. In answering the questions, participants did not consider one specific game.

All of the studies mentioned above, except for Bartle[7] and Yee[163], used surveys to gather data. They applied a dimensionality reduction method (e.g., factor analyses) on the results to extract player types. However, as Yee[163] noted, people can have different motivations for different games, and player types might differ depending on the game. None of these player models have players with multiple motivations or offer a way to adjust the types based on new data. Additionally, to create the types (through factor analyses) or summaries of different player models, motivations are merged. When motivations are merged, we lose data.

Reward systems

As mentioned before, rewards are related to motivation. Motivation can be stimulated or driven by external rewards: extrinsic motivations, Ryan, and Deci [124]. Phillips et al. [116] also relate rewards to SDT. They used a focus group and did a literature review to reiterate over reward taxonomies. They defined six reward groups: access, facility, sustenance, glory, praise, sensory feedback. Tondello et al. [142] described the user type: 'player'. The 'player' characteristics are the same as the four intrinsic types, except they show to be motivated by external rewards. Wang et al. looked at game rewards systems and also explored the usage outside the gaming environment [147]. They argue that these reward systems can also be used as social tools. They used multiple surveys and analyses to propose an initial list of eight reward forms and concluded with seven reward system design considerations. Lewis et al. did a review of reward types with the focus on point systems [91]. They summarized 18 different rewards systems into eight reward types. They also argue that future work should examine the relationship between rewards and motivation more extensively. Ferro et al. compared Game Elements and Mechanics (GEMs), to personality traits (big five) by using (The Australian Personality Inventory (API), including some demographic data [34]. They developed the GEMs (rewards and mechanism) through analyzing game and game design resources. They found that a player type could not be used to predict a player's GEMs preferences. This partially due to the generalized characteristics of personality types, which not accurately represent the individual. They concluded with a list of 22 reward types.

The relation of rewards to motivation and personality show that different type of rewards should lead back to different motivations. Additionally, Orji et al. show that the use of extrinsic rewards can be useful in increasing one's intrinsic motivations. In contrast, it can decrease someone's motivations when intrinsic motivation is already high [110]. This was also supported by Ryan et al. [124]. Another danger of rewards is that a player can get used to it. Rachlin et al.[121] and Olsen et al.[109]. They describe that the effect of a reward can decrease in future repetitions, and the player will need more to get the same level of satisfaction. Kuss et al. [84] state that this can lead to bigger commitments of time. Therefore the implementation and usages of rewards should be carefully designed.

Game mechanics
Game mechanics (including rewards) are the building blocks of a game. Therefore they should also relate to motivations people have for playing a game. As mentioned before, Ferro et al. defined GEMs. This included 26 game mechanics [34], which were also compared to the big five. They found no correlations. Tondello et al. related user type HEXAD scale [142] to 59 game design elements and the big five personality traits. [143]. (comparable to Ferro et al. [34]). The 59 game design element was created through an informal literature review. Through their research, they found 8 clusters of game design elements (mechanics): socialization, assistance, immersion, risk/reward, customization, progression, altruism, incentive. Their framework was able to relate the HEXAD scale to personality traits. They state that to compare game mechanics to motivations, the motivations also have to be based on playing a game. Buurman [15] took the 49 game mechanics accompanying Chou's core drives [19] and related them to psychological theories. In 2010, King et al. tried to classify and organize the psycho-structure elements of game design [75]. At that time, this had only be done for gambling. They analyzed five different feature types concerning excessive video gaming.

In correlating game mechanics to motivations, we need to make sure our motivation model is based on reasons for playing games. The lists of mechanics can also give us an idea of what kind of motivations people have for playing.

1.3.3. Combining of different player models

There are different models for motivation and addiction. This results in different forms of relating motivation to addiction.

Clanton did a lecture on how to make addictive video games [135]. He relates it to flow, Self-Determination Strategy, and Maslow's hierarchy. Then he proposes 16 elements that help in designing an addictive game.

Johnson et al. [67] compare SDT to time spent playing. They found that autonomy and relatedness were associated with more playing time and that immersion was associated with less playing time. This shows that playtime can be related to some motivations. They also found that gaming can have a positive influence on player wellbeing.

Wan et al. [146] correlate addiction to Flow theory and Basic human need theory. They found that flow was not a proper measurement for addiction. However, the psychological needs of players of online games were close to the two-factor theory, which depicts satisfaction and dissatisfaction dimensions. Addicted players' need-gratification was similar to the dissatisfaction factor.

Kuss et al. [84] compared motivation to addiction using Yee's scale[163]. For addiction, they used the PVP scale [126]. Their results indicated that player motivations for escapism and mechanics could predict excessive video gaming better than playing time. They also state that different measures are needed for different games.

King et al. [77] extracted motivation data by using their own created model. This model was based on a multitude of prior studies. They measured addiction by the definition of the American Psychiatric Association[5] They found three factors that were significantly related to IGD symptoms: wealth, achievement, and inadequacy. They also mention the time spent playing is a product of addiction, not the reason.

We found that none of the mentioned player (type) models have been compared to addiction, except within the study of Kuss et al. [84]. Most comparison studies are with models that are too abstract. However, they do suggest playing time can give a prediction of addiction, although limited. The approach of Kuss et al. [84] shows potential but is based on an older motivation and addiction model.

1.3.4. Measuring addiction and player data through games

The use of defining a model is to subsequently apply it in the real world, in this case, a game. We know how games have been used to measure other types of addiction, like the IOWA gambling task[6], Bechara [10]. It is used to measure decision making in relation to gambling. We have yet to find academic studies that developed a game to measure addiction. We can assume the game industry has an extensive amount of data about player interaction and uses this to develop and tune their addictive mechanics. However, this data is not available to us. Secondly, the development of a game that has multiple daily users is not straightforward.

More studies have been done in measuring motivation through a game. First, we look at engagement. Lucero et al. tested the applicability of the PLEX framework (Korhonen et al. [79]) as an evaluation model for two game prototypes [94]. The two games were designed without the PLEX framework in mind and to test the usability of *Near Field Communication* (NFC) for gaming. Afterward, the games were analyzed by using the

[6] `https://www.psytoolkit.org/experiment-library/experiment_igt.html`

PLEX. They found that PLEX can assist and guide in evaluating a product. They also noted the PLEX was still limited and needed some extensions. Although this is a useful approach in measuring the player experience of a game, it only tells us what motivations are present in the game and which are not.

An emotional state is another way of measuring engagement during gameplay. It can tell something about the user experience. Measuring emotional state during gameplay requires a physically focused approach. Damrongwatanapokin et al. [24], Thin et al.[140], Yannakakis et al. [161] and Bevilacqua et al.[11][12] have analyzed methods like electromagnetic analyses, body gesture, heartbeats, and facial expression to derive emotional states of the player. The analyses are about the experience during gameplay. It might tell us something about the reasons why we continue to play, but not about the motivations why we start playing. Also, these methods are difficult to apply in the wild. Not everyone has the ability (or wants) to place a heartbeat sensor or camera on themselves during gameplay. Therefore this is not a scalable approach.

Next, we look at how to measure the psychological motivations of people. We can either measure how well a game fits towards all the factors of the motivational model (Lucero et al. [94]) or how well a person's motivation relates to the video game. Aseriskis et al. created a numerical function to measure player motivation in an oil trading game [4]. They based their function on the interaction between the user and the systems, and the corresponding entities: Users, Actions, Rules, Data entities, and Interfaces. They did motivation validation through the HEXAD model from Tondello et al. [142]. They stated that motivation might be predictable if there is a known relation between game mechanics and player type. Also, they stated that players might have overlapping player types, while player types can be limited in representing all differences between people. Wohn et al. analyzed *Social Network Games* SGNs from Facebook [157]. They identified four motivations and unpacked play into seven different types (spending real money, avatar customization, publishing, space customization, mechanics, advancement, gifting). The disadvantages are that they focused on a particular target group. They also used a survey with PCA, and players were asked only to submit their favorite game, which limits generalization.

Tondello et al. are currently working on a platform to do an "empirical evaluation of a customizable gameful system" [141]. People will be able to select certain game design elements, and they will check if this conforms to the expectation resulted from the previous survey on player motivation. It seems few studies have tried to match game mechanics to concrete player type models, or addiction, let online their combination.

1.3.5. Influencing the player

In the previous section, we described how motivation and addiction could be measured within games. When we have this data, we can try to use it to manage a player's game addiction. Preferably, by adjusting the game. The main goal is to decrease the behavior responsible for the negative consequences. We look at different methods on how to influence a player's behavior.

Rodda et al.[123], Davies et al. [25], Demetrovics et al. [26], and Mentzon et al. [101] give a good overview of measures against IGD. [123] look at behavior Change Strategies (BCS) for IGD found on the web. They summarize 19 measures that are isolated from the game (external). They divide them into different phases: pre-decisional, Post-decisional, Actional, Post-actional, and multi-phase. The most frequent strategies they found against IGD were finding alternatives (23%) and avoidance (18%). Mentzoni et al. [101] also make a distinction between measures against excessive gaming or IGD. They analyzed which measures are present, for which case, for seven different countries. Then they split them by universal (targeting general population), selective (above-average risk individuals), and indicated (engaged in excessive gaming or IGD). The mentioned measures cover a wide variety. Most focus on addictive behavior, instead of changing the games.

Han et al. [56] looked at the appliance of a medical treatment normally used for people that are substance dependent. They found an indication that the treatment reduces the graving for IGD.

Demetrovics et al. [26] analyzed 12 papers about policies towards gaming addiction. Divided into three categories: limiting availability, reducing risk, and help services. They found that the measures were less effective than anticipated. As potential policies, they say that a rating system for games, or game design that makes the games less addictive, could help.

Davies et al. [25] analyzed limiting methods more thoroughly. They compared a stopping policy to fatigue systems. In a stopping policy, the player is abruptly stopped when time is up (e.g., Tencent's Honor of Kings limits the amount and time slots children are allowed to play the game [71]). Fatigue systems adjust the game state parameters towards a more negative one to demotivate the player. They found that a stopping policy does not achieve the desired result. Stopping players in the middle of their game interrupts their flow and

can increase the desire to play more and sooner. Secondly, it does not help the person in dealing with their addiction. A fatigue policy did not lower the user experience, but increased time played. The underlying reason was probably due to the experimental setup. Players would play the game once, and the first time the game environment changes players probably experienced it as exciting and challenging, resulting in increased flow. There is no research yet on the effect of repeating this process multiple times. The first time it is new, but in subsequent sessions, the players should become more aware of the limitations and might act differently, potentially decreasing the time spent playing.

Another topic related to influencing the player during gameplay is *Dynamic Difficulty Adjustment* (DDA). DDA is about changing the game settings or environment during gameplay to optimize flow. By analyzing real-time game variables, a model can adjust the difficulty level to increase player engagement. Yannakakis et al. applied DDA to optimize player satisfaction [162]. The model they derived seemed to influence player satisfaction positively. Another way of changing the environment is by letting people compete against other people. This increases the number of possible player interactions that can serve as DDA, Hunicke et al. [60]. People might be better than you, or you are stimulated to take different approaches.

Currently, there are no proven methods to reduce game addiction without reducing the player's experience. Most methods are still focused on reducing playtime instead of understanding the motivation behind it. Limiting play time can help, but this is no tackling the core of the problem.

1.4. Research Questions

The Dutch government[30] and Chuck[135] show that games can be engineered to be addictive. Ergerton et al. show that rewards can induce addictive behavior [31], and Spekman et al. states that extensive gaming can lead to IGD[134]. Spekman also shows that this can have negative consequences on people's lives[134]. Wan et al. [146] show that addictive gaming is often associated with dissatisfaction. However, gaming can also have a positive effect on well being, Johnson et al. [67]. With a future ahead in which video gaming will increase in usage, Newzoo [153], it is important to explore more sustainable ways of video game interaction. We need to learn how to manage a player's behavior.

Measuring addiction is difficult. Behavior can be interpreted differently depending on the person, Lee et al.[88]. Markey et al. summarize that studies have not yet agreed on a standard in IGD measurement [98]. The current determination of IGD risk groups is done either through using questionnaires based on IGD scales(Lemmens et al.[89]) or measurement of the amount of playtime. Although playtime can indicate addiction, it does not attend to the core of the problem, Kim et al. [74], Johnson et al.[67], King et al.[77], and Davies et al.[25]. We need to include a player's motivation.

Motivation can be analyzed through motivational theories, engagement, player type, rewards, and mechanics. Player type models seem to represent game motivation the best with respect to individual players. However, we did not yet find a satisfactory model. A multitude of models overlap or describe some of the same aspects, Stewart [40], Hamari et al. [54], and Nacke et al. [103]. Also, these models assume motivations can be grouped, and people have only one motivation for playing games. As Yee et al. [163] state, people can differ in motivation for the same game, and also have different motivations for other games.

Studies have analyzed addiction to motivation theories and personality types, but not to motivation based on player types. Only the work of Kuss related a user typology to addiction[84]. However, the models used by Kuss have been improved over time. New IGD scales have been proposed, and the motivation model also suffered from generalization. This made it possible to say something about groups, but difficult to focus on an individual.

Tondllo et al.[143] showed that motivation and game mechanics could be related. It is also known that rewards can influence motivation, Ryan et al.[124], Orji et al.[110], and Ferster et al.[36]. This implies that we should be able to measure addiction and motivation from within a game by analyzing game mechanics. However, we found no studies where a game was able to measure game addiction or a generalized motivation model through their game mechanics. We believe there should be a limited set of core motivations that can be used as a general measure, together with a limited set of core mechanics applicable to games. Therefore we define our research question as follows:

What motivational factors relate to video game addiction and how to test this with a video game?

The main research question is split into sub-questions:

Research Question 1 (RS1): *How to model player motivation and addiction?*

Research Question 2 (RS2): *What factors of the motivation model correlate to addiction?*

Research Question 3 (RS3): *How to operationalize motivation factors in a mobile game to validate the relationship with addiction?*

The next section explains the methodology used the answer these questions.

2

Methodology

Our goal is to analyze how motivational factors relate to addiction from within a game. We need an approach that enables us to relate three models: game addiction, motivation, and mechanics. Figure 2.1 shows an abstract representation of our approach. The first step in this approach is to define the three models. In the figure, these are represented as motivation (m) in red, addiction (a) in yellow, and mechanics(f) in green.

After defining the three models, we need to be able to relate them. In the center of the figure, we see three white blocks: representing three different players, and one blue block: representing games. We see that motivation, addiction, and games are related to the players. Looking at the player blocks, we see that a player can have a variable number of games with different motivations. Also, each player has their addiction score, which can describe the risk towards an IGD. This way, we can relate motivations, to addiction and towards games, but not yet to mechanics. Mechanics are related to the games. This is because game mechanics data is objective. We can analyze a game and describe the mechanics that are implemented. Therefore, we can relate the mechanics through the games to the player, and thus to the players' motivation and addiction.

Finally, by analyzing these relations, we can determine factors of motivation and mechanics that correlate to addiction (see the red-bordered blocks in the motivation and mechanics component). The found factors within the mechanics component can then be used within the development of the resulting game (the purple block). Then, by measuring the mechanics of the game, we can analyze the effect on addiction. The remainder of this thesis is structured as follows:

1. **Model design:** A summary of academic and non-academic sources, to define a model for game addiction, motivation, and mechanics *Chapter 3*.
2. **Data collection** An online survey. Used to collect data about player motivation, addiction, and games. *Chapter 4*
3. **Data Analyses:** determine relations between player motivation, addiction, and mechanics *Chapter 5*
4. **Game experiment, Joymp:** An online (mobile) game to validate the correlation between found motivational factors and addiction. *Chapter 6*

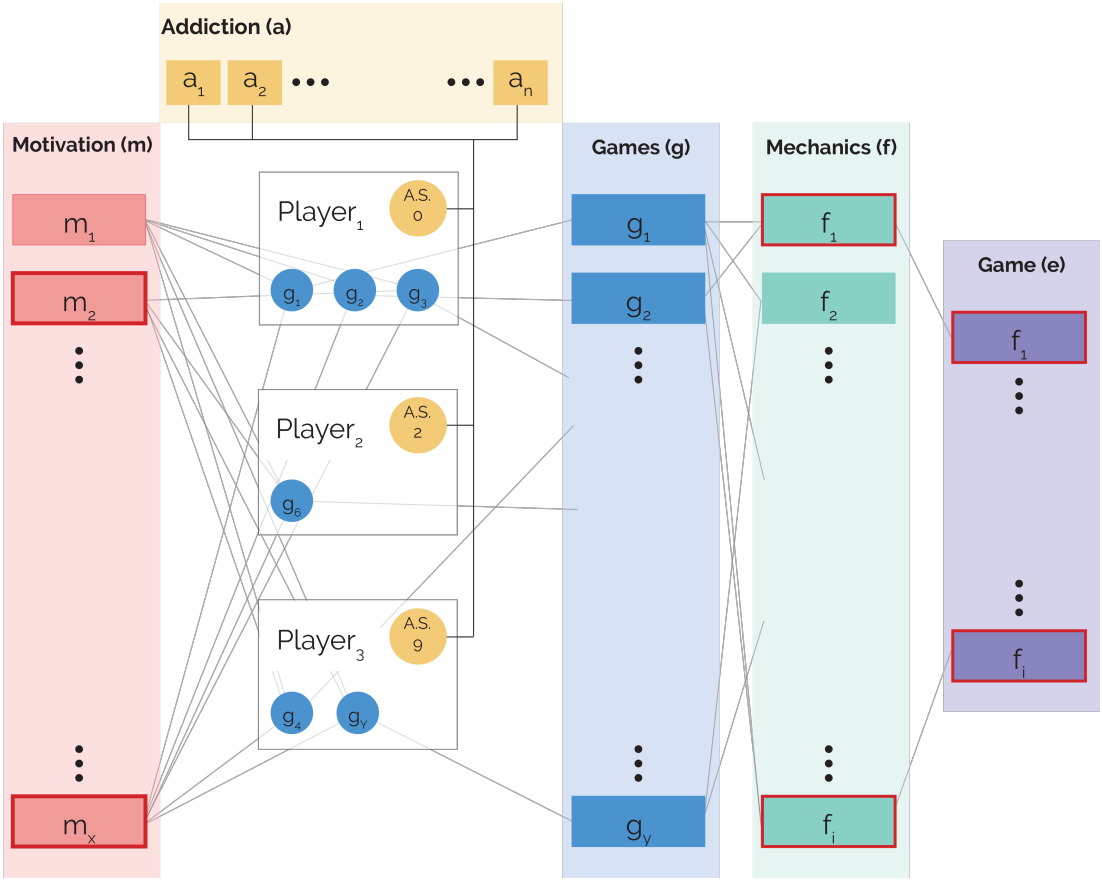

Figure 2.1: **An abstract representation of our approach** We see how addiction, motivation, and games are related by using player data. Each player has an addiction score and submits their motivations for playing a specific game. Mechanics can be extracted from games because this is objective data. Because we know which games the players have submitted, we can relate their motivation to the mechanics. Found factors between motivation and mechanics that correlate with addiction are used in the development of the game. Player data is gathered through using a survey. The number of elements in each of the components is for now unknown. Upon the release of the survey, the addiction and motivation component should have fixed elements. However, mechanics can change.

3

Model Design

We look at how to model addiction, motivation, and mechanics. These models can then be used to build a survey, which enables us to gather data. The addiction model is created based on the earlier work of Lemmens et al.[90], see Section 3.1. The motivation model is created by combining academic and non-academic sources about game design, player types, rewards, and mechanism, Section 3.2. Finally, the mechanics model was created by analyzing current popular games, Section 3.3.

3.1. Addiction Model

Lemmens et al. [90] defined a long (27-item) and short (9-item) IGD scale. We follow the 9-item scale because we prefer to reduce the effort participants of the survey have to do. The scale did not have to be adjusted for our purposes. Participants were introduced to the questions with the following sentence: 'In the past year…'. The people received notion of the research direction to be compliant with privacy rules. See Appendix B.2.2 for the full list of addiction questions.

3.2. Motivation Model

For the motivation model, we first gathered different behavior, motivation, and player models. Both from official literature and others found online. We wanted to be sure to cover as many different aspects as we could within the model. Therefore we also included models that looked at rewards, game mechanics, or game design. The exact search terms were not saved. We looked at ten player-type models, four reward models, four mechanic models, two books, a lecture, and a player experience model (total of 22). A complete overview of these can be found in Appendix A.1, Figure A.1.

Over time, many motivation models have been developed. We also found that many of them seem to overlap (Stewart [40]), or are combined (Hamari et al. [54]). We want to make sure our summery includes as many different models as we could find because we use a bottom-up approach to extract the most meaningful factors. Therefore we need to understand how these models were developed and how they relate. To create structure in this chaos, we placed the revisited studies in a timeline. Studies are connected if one uses the other in the creation of their model. This way, we can see how academic studies are related and have a precise overview of the studies included in our model. Appendix A.3, Table A.1 and Table A.2 summarize the id's, references and relations. for the different studies. The timeline is shown in Appendix A.1, Figure A.1 and can also be used in future work.

Based on this timeline, we decided to include at least all the 'final' works (a study that has not been used within another). Now, we cover all the models shown in the figure. Also, we included older works of Yee[163], Korhonen[79], and Stewert[40]. This had two reasons. First of all, due to summaries, it becomes possible that concepts are lost. Consider, for example, Hamari et al.[54]. They summarized twelve studies into seven categories. This included the work of Yee[163], who had defined twelve concepts. Secondly, these studies contained models that have had a big impact on society and further developments of player models. Take, for example, Bartle[7]. His study was included in Stewart's work [40].

Besides using published data, we also included some other models that were developed or defined by experts in the field. We consider the work of the Qualtric Foundry[38], a lecture on game design[135], a book about a hundred lenses for game development [128], and the summary of Stewart [40]. Experts in the field

have a day to day interaction with the players and their data. They also need to define the concepts in their way, which can correlate with academic studies or introduce a fresh new perspective. Because the goal is to get a general concept, we argue this approach is valid.

We then combined these models into one table. In the rows, the underlying (psychological) concept, in the columns, the different papers. See appendix A.2, Figure A.2, for a complete overview of the used models and their placement. Concepts that are the same or very closely related appear in the same horizontal area. The ordering and comparison were done by our subjective manner and could benefit from further analyses from experts in the field. Due to the scope of this thesis, and limited domain knowledge of the author in the field of psychology, the summary is shown in section A.1 is but a first interpretation and abstraction of all the previous works. It should not be assumed that works that are on the same level are the same. In our view, they are part of a more general and abstract concept. Some of the types in other studies included multiple concepts we defined in our model. If those concepts are not adjacent in the table, we would have to copy the user type multiple times to give a correct representation. We choose not to copy the type to multiple places in the sheet. This would make the overview less clear, and the focus was not to create a perfect comparison. It is more a method to get a complete idea of the generic concepts that overshadow all the different player type models. We are not sure if it is possible to create a 'perfect' summary of all these models, but in future work when collaborating with experts from the field, this could be an interesting challenge to explore. We also note we did not include all found elements in the final model. They were left out because the element had not enough support or did not represent motivation. The left out elements can be found in the lowest section of FigureA.1.

After the structuring process was completed, 44 core concepts remained. For each of these concepts, the core motivation was extracted through our interpretation. In defining the motivation, we focused on making sure each question represents a unique concept and that a player should be able to relate. Table 3.1 shows the 44 concepts and their motivations.

After that, we created questions based on these motivations. When answering the motivation questions, a participant must consider the same game, because we believe motivation differs between games. Therefore the questions where all proceeded by either: "By playing this game, I..." or by "I play this game, because I ...", to help the player form the right image. The answering of a question had the form of a 7-point-Likert like scale. We choose 7-point over 5-point because this results in a bit more variance. A summary of the question list can be found in Appendix B.2.4.

3.3. Mechanics Model

We found multiple studies that define game mechanics lists (Tondello et al. [142], [143], Ferro et al. [34], Buurman [15], Chou [19]). However, these lists are generic and not about a specific game. We could merge these lists, and use the result to check which games include what mechanics. Instead, we first define our mechanics list based on current popular games. This offers an additional comparison with important mechanics in the current game industry.

We analyzed games to create our list of game mechanics. The games were gathered by comparing six lists of most played games. The lists where created by: Microsoft [102], steam[137], wikipedia[154], newzoo[105], Ranker[42] and GameDesigning[41]. We checked a total of 16 games due to time constraints. The games were selected based on occurrence in the lists, ranking (if available), diversity, and availability to the author. Diversity was most important because we wanted to cover as many different game mechanics as possible. The final set of games was: Candy crush, Hearthstone, Dota 2, Fortnite, Overwatch, rocket league, FarmVille, clash of clans, angry birds, Skyrim, WoW, Plants vs. zombies, clash royale, pokemon go, subway surfer, fruit ninja and consisted of 9 mobile and 7 PC games. Games were analyzed by clicking through the full application and playing it. In some cases, it would require much playing time to find all the different mechanics. In this case, the Internet was used to gather information about mechanics. Outsourcing of this process to players experienced with the game is recommended.

After analyzing the 16 games, we found 40 mechanics. Table 3.2 shows a list of the 40 mechanics. Table A.3 in the appendix shows the full comparison between games and the 40 mechanics. For each game, we checked which mechanics were present. The games were analyzed per date: 10-05-2019. Thereafter we counted the number of games in which the mechanic occurred. The three highest-scoring mechanics can be seen in table 3.3. We see that the top 3 consists of repayable modes/levels/infinite gameplay(1), having a Shop where you can buy items(2), and limited-time challenges(3). Notably, the most used game mechanic is replayability. For the full list refer to Table A.4 in the appendix. Additionally, we looked at which games contained the most

	Concept	Motivation
1	Significance, Meaning, Purpose, & Legacy	I feel a sense of purpose
2	Energized	I feel excited/energized
3	Focus	I forget (am distracted) about my surroundings/environment/time
4	Guiding	I help or adivce other players
5	Self-worth & Integrity	I feel good about myself (imporant/confident/smart/powerfull/proud)
6	Exercise	I feel motivated to improve mentally or phisically
7	Identification with Player Avatar	I behave differently than in the real world / I become the character
8	simulation/Relatedness	I experience a close representation of the real world
9	fantasy	I experience a different world or reality than our own
10	story	I follow and remember the story
11	humor	I laugh about jokes or the interaction
12	coorperation	I coorperate with other players
13	Social discovery	I make contact with new people
14	Friendship	I play together with friends
15	savoring	I think back about memorable moments
16	community	I use the communicty to get further
17	Expression	I express myself through communication
18	Exploration	I explore the things I dont know
19	Curiosity	I want to discover what will happen next
20	Tension	I want it to be tense
21	Problem Solving	I solve problems
22	Strategizing	I strategize, plan or precict
23	Diverse gameplay	I play different game types/styles
24	Autonomy	I control the direction and pace of the game
25	Transparency & Feedback	I know what I can and can not do
26	Relaxation	I feel at ease/relaxt
27	Senosry Feedback/Satisfaction	I enjoy the look,feel and sound
28	Creating	I use me creativity to create, customize or imoprovise
29	Competence	I use and develop (different) skillsets
30	Goal setting	I know what to do next
31	fairness	I feel it's fair
32	Balance/Flow (challenge, pacing)	I believe that I can make progression
33	Making progress	I see that I'm making progression/learn
34	Self-Reflection	i reflect on my performance
35	Acievement	I try to complete challenges/achievements
36	Competition	I compete with or compare myself to others
37	Status	I present my gameplay to others
38	Economy	I spend money on virtual goods
39	Collecting	I try to gather or collect al items of a set
40	Rewards	I'll put in the effort for a task when i'll get a reward
41	FOMO	I prevent missing out on certain (limited) experiences or events
42	Investment/Sunken Cost Valley	I value the invistment I made in time,money or relationships and try to protect this
43	Schadenfreude	I enjoy the failing of others
44	Freedom	I'm free to do whatever I want

Table 3.1: Overview of 44 concepts and their motivations. These were extracted from the combined motivation models. See Appendix A.1, Figure A.1 for the complete overview.

mechanics. Table 3.4 shows the game containing the highest amount of mechanics, and the game containing the lowest one. We note that the MMORPG (Massive Multi Online Role-Playing Game) is the game that contains the most elements, in contrast to the Adventure games, which contains the least. For the full list refer to Table A.5

id	Method
1	replayable modes/levels / infinite gameplay
2	Welcome (back) package
3	Ranking
4	Free to play
5	Pay to win
6	DDA (e.g. Online match making)
7	Shop
8	Variety of gameplay modes
9	freemium
10	quests (get one after completing one)
11	daily quests
12	achievements
13	challenges (e.g. within certain amount of time or moves(puzzle), or challenge general)
14	in game econimcs (trading for example)
15	win/loose streaks
16	lootboxes
17	group commitment/social pressure
18	Sunken cost valley . (invesment)
19	Optimizng flow (carefull game design)
20	Rewards for inviting friends
21	In game gathering/completing
22	Daily free bonus
23	return streaks bonuses
24	limited time challenges
25	competition
26	leveling
27	limited lives
28	mobile popups/ reminders
29	Watch add for rewards
30	motivate comminuty
31	New content generation
32	leaderbord
33	limited time availability of items in shop
34	Feedback + tips on gameplay
35	Streams
36	Tournaments
37	real time (strategy) game assistance
38	community developed gameplay
39	reward progress bar for challenges
40	stats review

Table 3.2: Found game mechanics

Mechanic	Occurrence
replayable modes/levels / infinite gameplay	16
Shop	15
limited time challenges	15

Table 3.3: Occurrence of 40 found mechanics in 16 analyzed games

Number	Game
26	WoW
⋮	⋮
14	SKyrim

Table 3.4: Games order by number of game mechanics inside the game

4

Data collection

We have defined the three models and described their interaction. Now we explain how data was gathered for these models by using an online survey. The survey was created via the platform Qualtrics[1]. The survey was build up from the following parts, see Appendix B.4 for a full export of the survey:

1. Consent
2. Email
3. Demographic data
4. Definitions
5. Addiction
6. Played video games
7. Video gameplay motivation

4.1. Survey

Consent [1] Participants would have to consent to fill in the survey. The consent page included a small summary of our study and required the participant to be at least 16 years old to comply with GDPR.

Email [2] People could leave their email address to get updates and results about the study, receive a play code for the game, and receive a personal profile. Leaving an email address was not required to partake in the survey.

Demographic data [3] Depending on the results of the study, it might be interesting to analyze the demographic structure of our participants. For these reasons, participants were asked about their gender, age, and country of residence. For a summarized overview, see Appendix B.2.1

Definitions [4] We clearly defined *video games* to prevent misinterpretation. These were shown on a separate page to make sure people would take notice. Video games were defined as "games that do not pursue financial gain. (A.k.a. gambling), and are played through a digital device (e.g., PC, mobile, tablet and console)]" Participants were also made aware that a section containing questions about addiction followed, while this can be quite confronting.

Addiction [5] Consisted of 9 questions that where randomized to prevent priming. Each question is answered with yes or no. For a summarized overview, see Appendix B.2.2

We want to capture the motivation a player has for playing games. As stated before, people can play different games for different motivations. Some people play just one game, a lot. Others distribute their time more evenly over multiple games. Therefore we decided that participants can submit their motivation for up to three games. This will give a clearer view of the motivations of a person than just asking for one game.

[1] `https://www.qualtrics.com/uk/?rid=ip&prevsite=en&newsite=uk&geo=NL&geomatch=uk`

Participants will first receive the question: *"Please give a rough indication of the number of video games you played in the past year:"*. This will decide for how many games (up to 3) they will have to fill the game-related questions and the motivation questions. We decided on a max of 3 games because, for every game, the participant would have to submit 48 (4 game, and 44 motivation) additional questions to an already long survey. We should note there is a disadvantage in gathering data per game. Players' preferences are categorized per game instead of that their preferences are grouped. Because the data is more specific, more data is required to make significant conclusions about the generalized concept.

Played video games [6] Players were asked to give a rough estimation of the games they play in the past year. For each game, with a max up to three, they would have to answer four questions about the game (which game, playtime, recurrence, and money spending). For a summarized overview, see Appendix B.2.3

Video-gameplay Motivation [7] For each separate game, the participant would have to answer the same 44 motivation questions. Although this increases the number of questions the participant has to answer, it enables us to correlate the motivation towards game mechanics. The same questions for the different games were always grouped. An example of such a question is shown in Figure 4.1, for a participant who played at least three games. On the left side, we see placeholders 'Game 1', 'Game 2', and 'Game 3'. These are normally replaced by the game names the participant submits earlier in the study. In the top left, we have the question, and in the center, there is a separate row for each game to answer. This way, the player can focus on one concept and directly compare between the three games. This makes it easier because the player does not need to recall earlier submitted answers for the same question. Additionally, we assume it is easier to score things in relation to each other than to an abstract scale. We hope this also decreases the time needed per question. To prevent priming, the motivation questions where randomized for each separate survey. The questions where answered with a Likert-type like 7 scale, to increase to variance within the measure.

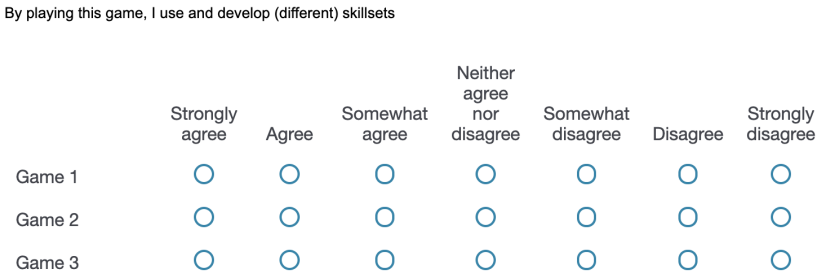

Figure 4.1: Example of a motivation question in the survey. In this case the participant has submitted at least 3 games. 'Game 1', 'Game 2' and 'Game 3' are placeholders for the game names earlier submitted by the player. On the top left the question is stated. The participant can submit an answer on a 7-point-Likert like scale for each game. In total there are 44 of these questions.

4.2. Participants

Participants were gathered by using personal connections (including snowball sampling via WhatsApp), posters within the university, social media (Facebook and Linkedin wall-post), and a Facebook promotion. Details of the Facebook promotion can be found in Appendix B.1.2. The survey online and could be accessed from anywhere through a URL. It was not recorded through which medium (device or promotion) participants accessed the survey.

Only people having age above 15 and had played at least one video-game in the past year could participate in the survey. The age limitation is due to consent regulations. There were no further restrictions to the target group, while we want to cover an as wide as possible audience.

Between participants that participated in both experiments (survey and game) a 15,- gift card was allotted. Participants were notified of the gift card before filling in the survey.

4.3. Data

Following the above survey structure, Table 4.1 shows an abstraction of the data that is received from the survey. This data can be used for analyzing addiction and motivation. Per participant, we have three questions regarding demographic data, nine questions to determine addiction, one question to determine the number of games (g_n), four questions about the game * g_n, and 44 motivation questions * g_n. The least amount of questions a participant had to answer (if they played at least one game) is 61. The maximum number of questions a participant had to answer (if they play three, or more games), is 157. Before the release of the survey, we tested the duration. We found that completing the survey for three games took 15 to 20 minutes on average, which we found satisfactory.

Demographic data *3 questions*	**Addiction data** *9 questions*	**Game data** $1 + (4 * g_n)$ *questions*	**Motivation data** $44 * g_n$ *questions*
Age	Addiction score	# played games (g_n)	*Per game:*
Gender			[1...44] Likert-scale (1-7)
Country		*Per game:*	
		Name	
		Playtime	
		Spend money	
		Game type	

Table 4.1: Abstraction of data gathered through the survey. Each column represents a different section of data. Questions where asked in the same order as the above columns, from left to right. Questions presented to the player are shown in normal typography. For the Game data, a participant submits a number(#) of played games. For each game, the Game data questions and motivation questions are repeated.

5

Data Analysis

5.1. General Survey Data

We start by analyzing the results of the survey. The data from the survey was exported to a CSV file and used within a python project. The python code is available through git. For more details about where to found the code, technical details, and structure of the code base, refer to Appendix B.3.1. First, the data is filtered. Only fully completed surveys, with consent, were kept. This resulted in $n = 106$ participants. From the 106 participants, 18(16.98%) were female, 88(83.02%) male. 85(80.19%) participants were based in the Netherlands. The rest was divided over different parts of the world. People gave an estimation of the number of games they played. The distribution of played games can be found in Figure 5.5. We see that most people do not play a lot of different games: 56(52.83%) played less than eight games. Figure 5.2 shows the distribution of ages. Most people were between 20 and 30. This is not strange, while the participants were mostly gathered from the author's direct environment. Therefore we should note this group is possibly biased.

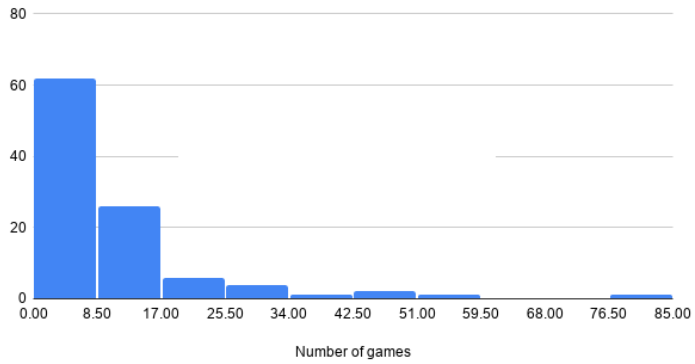

Figure 5.1: Distribution of number of games people played. 3 outliers where excluded (153,185,500)

The remaining data is then processed so that we can use it for analysis of the model. Within this process, we calculate the addiction score, the playtime per game, and the total playtime over all submitted games per participant.

Addiction Score: Summation of the 'yes' answered addiction questions. There were nine questions, so the final scores range from 0 to and with 9.

playtime: Self reported playtime was calculated using the game data questionnaire. Per game, the player answered: how many sessions (number), per time frame (day, week, month, year), duration (time). Based on these three variables, the playtime per year was calculated per game.

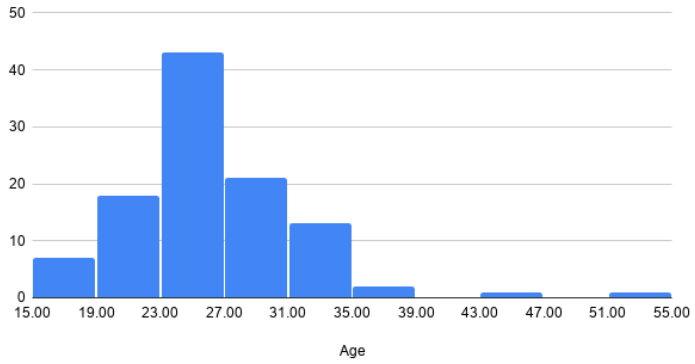

Figure 5.2: Age distribution of the people that participated in the surveys

total playtime: By summing all the playtimes of a participant, we get the total playtimes in minutes per year.

5.2. Dataset considerations

Participants could submit game and motivation data for either 1,2 or 3 games. Therefore, we can have a different number of games per participant. Depending on the way we structure the dataset, there is a possibility that certain participants influence the variables more than others. A potential solution could be multivariate factor analyses, but we choose not to because of the limited amount of data and additional complexity. Preferably we have a dataset that is as large as possible. We consider three potential datasets we could create and compare to include as much of the gathered data as possible:

1. **Full (biased:** The full dataset splits all submitted games per player into individual entries. Consider the abstracted dataset shown in figure 5.3. We have 4 participants, A, B, C, and D. They submitted respectively 3,2,4,1 games (the colored blocks are the answers to the motivation questions).

Participant	# games	Motivator Game 1	Motivator Game 2	Motivator Game 3
A	3	A1: [Q1 ... Q44]	A2: [Q1 ... Q44]	A3: [Q1 ... Q44]
B	2	B1: [Q1 ... Q44]	B2: [Q1 ... Q44]	
C	4	C1: [Q1 ... Q44]	C2: [Q1 ... Q44]	C3: [Q1 ... Q44]
D	1	D1: [Q1 ... Q44]		

Figure 5.3: Abstracted survey data. Participants can have submitted a different number of games, with a maximum of 3. For each game, there is a corresponding set of answers on the motivation questions. For participant A, these are the sets: A1, A2, and A3

We get the largest dataset by considering each motivation answer list per game as a separate entry. Meaning, if a participant has multiple games, they are considered independent and added to the dataset. See figure 5.4. This creates the maximum possible size of the dataset(almost three times as large), but it also introduces a player bias.

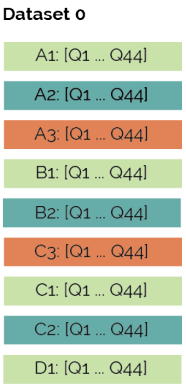

Figure 5.4: Extended data set. Each game per user is added to a new dataset and is considered independent

2. **Limit-3 ('biased')** The limit-3 dataset only includes players who have submitted three or more games so that every participant can exercise an equal amount of influence on the dataset. We look at the distribution of the number of games people have submitted, see Figure 5.5. 84 out of 106 participants (79.25%) seem to have submitted three or more games. When using this dataset, we will lose a part of the data. Risk is that a part of the gaming audience consists of people who play only 1 or 2 games, and we now miss those, introducing a bias.

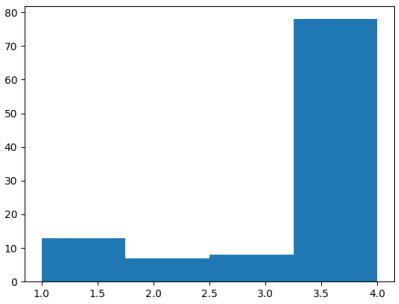

Figure 5.5: Number of games played - Distribution. One game: 13, two games: 7, three (or more) games: 84

3. **Sub ('correct')** The sub dataset is a combination of three smaller datasets (*subs*). We still want to make use of all the data we gathered. Therefore we create three subs. See Figure 5.6. We divide the motivation lists of a participant over the three sets. There are three different scenarios we have to consider: a participant submitted 1, 2, or 3 games. As Figure 5.6 shows, in the case of 3 games, we randomly divide them over the three datasets. In the case of 2 games, we copy both games again, creating a list of 4 games. Then the order is randomized, and we divide the first three over the datasets. In the case of 1 game, we copy the same game three times. This way, each dataset contains the same amount of influence from a participant. We can then use these *subs* for the same analyses and compare the results. We should note that for players who submitted two games, there can still be a small imbalance (because the third game is drawn randomly). Therefor multiple different sub-datasets should be used and compared for the same calculation.

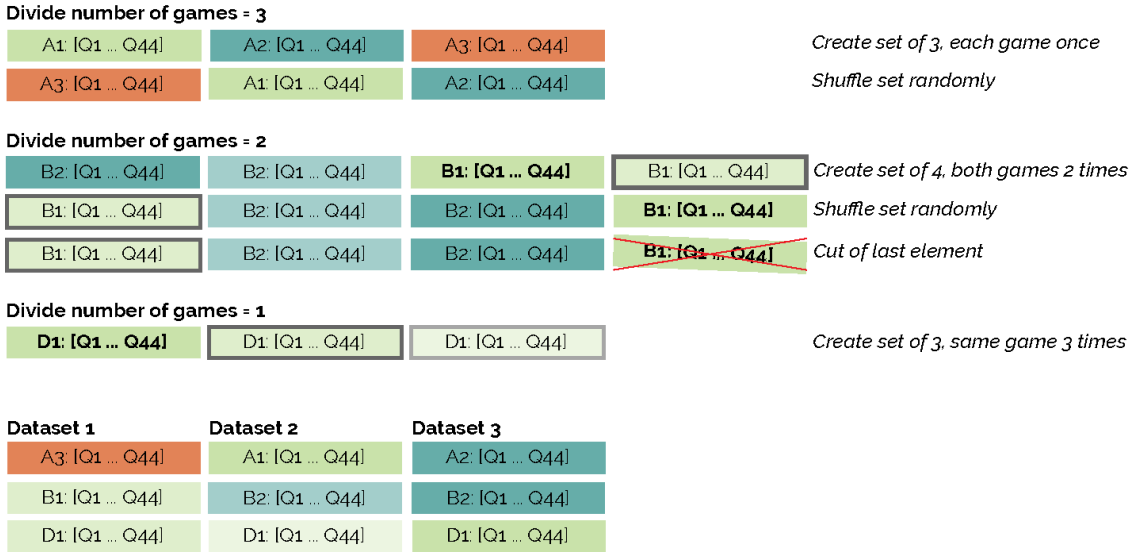

Figure 5.6: Creation process of sub-datasets. Consider the abstracted dataset again in Figure 5.3. The three colors represent the first submitted game (light green), the second submitted game (dark green), and the third submitted game (red) by the participant. Blocks with bold text have been copied, the copied block contains a black border and is in the same row. Then data is divided into three datasets to create comparable subsets. Dataset1, Dataset2 and Dataset3 contain one game per participant. Every game is included at least ones but picked in a randomized order.

Because the limit-3 database removes data from the dataset, we will not create and include this one in comparison. We will compare the *full* and *sub-datasets* to see how much a 'correct' dataset differs towards the 'biased' one.

5.3. Data Analyses

After cleaning up the data and creating the datasets, a combination of python libraries and SPSS[1] was used to do statistical analyses of the data. In some calculations, we compare the full dataset to the three subs.

We want to measure the relationship between addiction and motivations. Therefore we first inspect the distribution of the addiction data. Next, we analyze the correlation between addiction and playtime. We would suspect a positive correlation, which would mean we can use playtime as a rough measure for indicating addiction. Finally, we look into the correlation between addiction and motivation. Out of curiosity and for comparison, we also did an exploratory factor analyses on the motivation questions to see what kind of player groups we can extract. Results can be found in Appendix 5.5.1

5.3.1. Addiction

Figure 5.7 shows the distribution of the addiction scores. We see that there is enough variation within the scores, and we find that ten people are scored addictive based on the cut-of point defined by DSM-5. None of these participants is female. One person scored all nine items. We find that the scores are roughly distributed as expected when we base our expectations on the findings of Lemmens et al. [90], around 5%. Figure 5.8 shows the total summation of answer per addiction question id. Table 5.9 shows the full questions for the question ids. From the two figures, we see that more than 50% of the people answered yes to 'Q5': using a game as an escape mechanism to not think about annoying things. This supports the findings of Wohn et al.[157] that people use games as an escape mechanism.

5.3.2. Addiction and playtime

We compare addiction score and playtime by using a Pearson correlation(Both variables are linear and continuous). For each user, we have one addiction score. Addiction questions where not restricted to a specific game, but generalized for all games a participant had played in the past year. Playtime was related to a specif game. We can use the total amount of playtime for the correlation with the addiction score. We found a Pearson correlation of 0.3572, with a p-value of 0.000171. This indicates a positive correlation between addiction and playtime. In Figure 5.10, we show a scatter plot of the two variables. We indeed see an increase

[1] https://www.ibm.com/analytics/spss-statistics-software

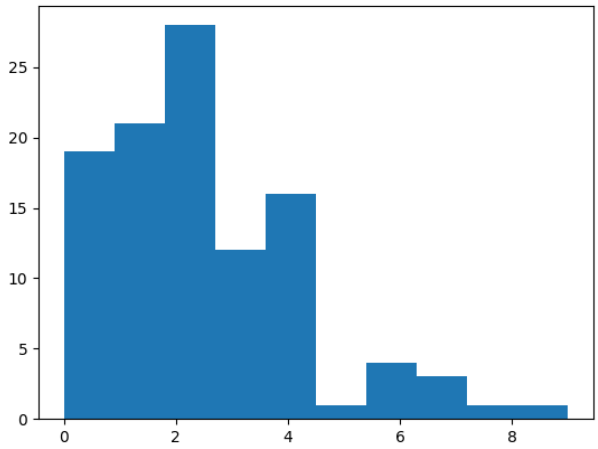

Figure 5.7: Distribution of the addiction scores for all participants

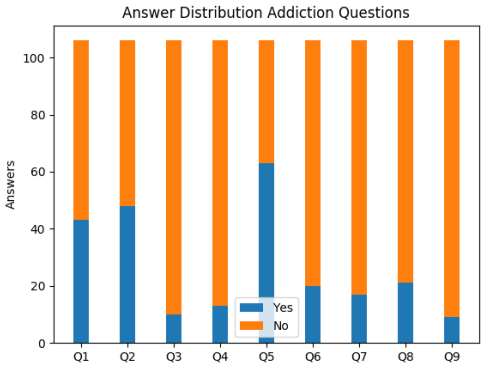

Figure 5.8: Number of 'yes' and 'no' answers per addiction question. The relating questions are shown in the right Table5.9. Total of 'yes' answers are shown in blue, 'no' answers in orange.

ID	Full Question "In the past year: ..."
Q1	Have there been periods when all you could think of was the moment that you could play a video game?
Q2	Have you felt unsatisfied because you wanted to play more?
Q3	Have you been feeling miserable when you were unable to play a video game?
Q4	Were you unable to reduce your time playing video games, after others had repeatedly told you to play less?
Q5	Have you played video games so that you would not have to think about annoying things?
Q6	Have you had arguments with others about the consequences of your video gaming behavior?
Q7	Have you hidden the time you spend on video games from others?
Q8	Have you lost interest in hobbies or other activities because video gaming is all you wanted to do?
Q9	Have you experienced serious conflicts with family, friends or partner because of video gaming?

Figure 5.9: Overview of 9-item IGD scale, following Lemmens et al.[90] definitions. The questions id's relate to the column names in the left Figure5.8

in playing time, along with an increased addiction score. Following the definition of SPSS, the strength of the correlation can be considered moderate. Our findings support the earlier conclusion regarding the relation between game addiction and playtime. The amount of gaming time people need to spend before they experience negative consequences can differ from person to person. However, a high playtime often does indicate a higher risk of addiction. Therefore we can use playtime as a first measure for signalizing IGD within a game environment.

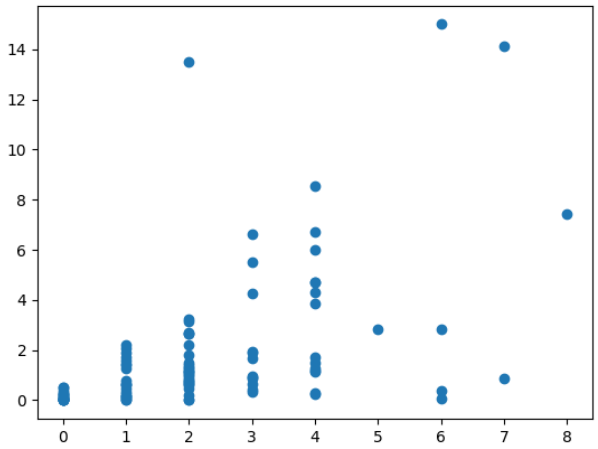

Figure 5.10: Total playtime per player per addiction score. Total playtime is presented in hours per day. Five outliers where removed because of an unrealistic amount of playing time. The cap was set at 350000 minutes per year (roughly 16 hours per day).

5.3.3. Motivation and addiction

To find the variables that correlate with the addiction score, we apply linear regression. The dependent variable is the addiction score. The independent variables are the 44 motivator questions. As mentioned before, we can not use the full dataset. Therefore we run multiple regression for multiple sub-datasets. We repeat the process of creating a sub dataset three times, creating a total of 3x3 subs. We run the nine sub sets in *SPSS* with the following parameter settings (forward, entry: 0.09, removal: 0.15). The results are shown in figure 5.11

We select factors based on which appear consistently in all the three datasets, in at least two subsets. Table 5.1 shows the two factors that remain. These two factors also have the highest correlation towards addiction scores within the full dataset.

Factor	Question	Pearson Correlation	p
F1	I play this game, because I can spend money to get the things that I want	0.473	2.897e-17
F2	By playing this game, I prevent missing out on certain (limited) experiences or events	0.404	1.223 e-12

Table 5.1: Motivational factors found through regression analyses. Correlation towards the addiction score is given.

Based on these findings, factors F_1, F_2 should increase addiction scores when implemented in a game. When we can compare these two factors to the most occurring mechanics explored in Section 3.3, we find something interesting. The top 3 mechanics consisted of:

1. replayable modes/levels/infinite gameplay
2. having a Shop where you can buy items and
3. limited-time challenges

F1 seems to relate to mechanic 2, and F2 seems to relate to mechanic 3. In other words, the most addictive mechanics appear in most games. We have no substantiating proof that games implement these methods consciously or are aware of the addictive consequences. Games may have found the best working methods to increase playing-time over time. Either way, this indicates that games are developed with methods that can induce addiction.

5.4. Motivation and Mechanics

To find the mechanics, we need to analyze the games our participants have played. We do not have enough data to make correlations between the motivations and the mechanics. Per participant, we have a maximum of three games. The participants submitted many different games. To be able to relate motivation to the mechanics, we would need a minimal amount of players who played the same game. Figure5.12 shows the

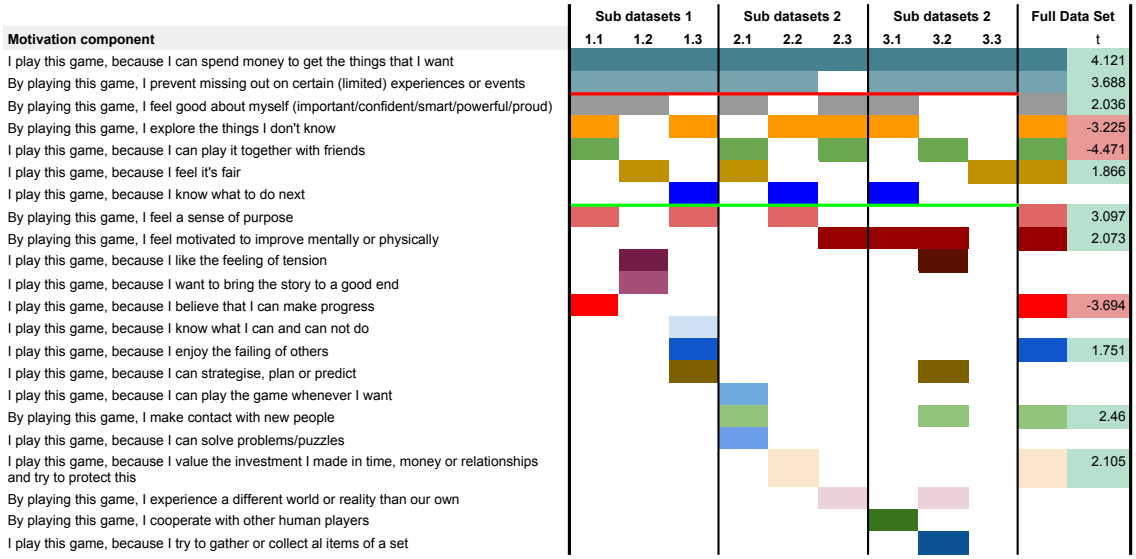

Figure 5.11: Regression analyses of three sub-datasets and one full dataset. The three sub-datasets are compared to each other. Rows are ordered by the occurrence of the motivations over all datasets. Each motivation was given a color. The color in the cells represents the motivation color. These colors will also appear in other figures. Consistency is determined by the occurrence of motivation in the subs of the sub dataset. We split them by occurred in all sub-datasets in at least two subs (above the red line), which occurred in all sub-datasets at least in one of the subs (between the green and red line), and the remaining (below the green line). The last column represents the t-values for the full dataset.

distribution of the occurrence count per game. We see that many games were only submitted once. Five games occurred at more than seven players. Most participants, twelve in total, played Rocket League. When relating the motivations to the game mechanics, we need to use the same amount of players per game to prevent bias. With the current numbers, this would not lead to significant analysis. Therefore we analyzed the found motivation factors to design our mechanics. Section 6.2 will explain this in more detail.

5.5. Motivation types

We did an exploratory factor analysis to see what kind of motivation groups we can find within our motivational model. We used the full dataset and sub-datasets again for comparison. We believe that the same person can have different motivations for different games. Therefore we believe that the full dataset can improve these findings.

5.5.1. Cluster size

First, the cluster size needs to be determined. For each of the datasets, we calculated the factor loadings. For a complete overview of the factor loadings, refer to Table B.5 in the appendix. All datasets had eigenvalues above 1.0 for at least 11 clusters. The variance of the components can be found in Figure 5.13. From the figure, we clear steps until the 4 component, less clear steps between 4 and 6, and almost no steps from 6 onward. All datasets follow the same pattern. The cumulative variance for each added component is shown in Figure 5.14. This figure shows us that from a cluster size of 6, we can explain at least 50% of the variance. From the above findings, we conclude to look at a cluster size of 6 is appropriate. We use PCA, varimax, without any rotation.

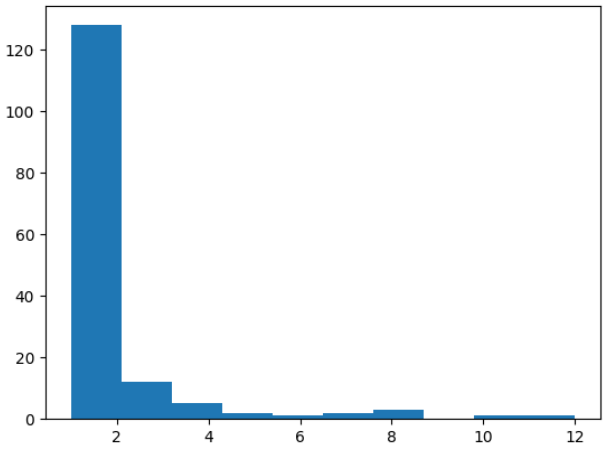

Figure 5.12: Distribution of the number of times a game was submitted by participants, over all games

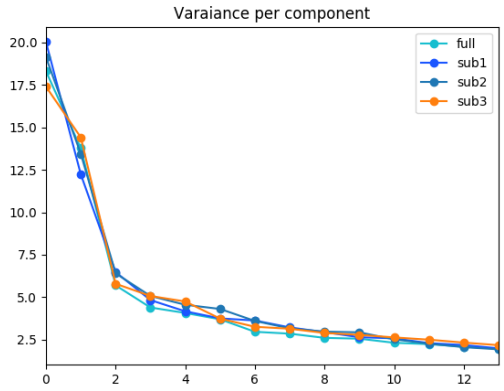

Figure 5.13: The eigenvalue per component, descending

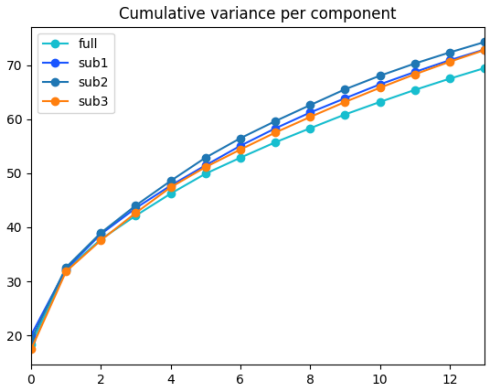

Figure 5.14: Cumulative explained variance per component for the full and subs datasets.

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5.5.2. Comparison of motivation clusters

The comparison of the clusters depends on the variables we find important. In the first place, we want to compare the sets: to which extent do they contain the same motivators? Secondly, the ranking of the motivators is important due to the factor analyses. Every motivator has a score on how well it fits within the group. We employed an adjusted version of the Jacquard Distance as a comparison metric. We have not validated the algorithm because we only use it to get a feeling for the equality of the groups.

Adjusted Jaccard Distance algorithm

A clustering created by our exploratory factor analyses (EFA) is build up from components, which contain motivators. Not all motivators need to be included in any component, and motivators can occur in multiple components. To compare the clusterings between different datasets, we look at how well the different components of a clustering map to another based on a similarity measure. (The clusterings that are compared are always of the same size (e.g., components), components can differ in motivators). In case of an optimal result, each component from C_1 maps to a different component in C_2.

The similarity measure is based on the Jaccard Distance. In the simplest form, disregarding the correlation value (r) of the EFA, a component is a set of motivators. We could compare these sets with the Jaccard Distance to determine their similarity. However, we want to include r in our comparison. We do this by creating a list with copies of the motivator in proportions to it's r.

Example: extending of set
Consider the following component (c_i) with motivators (M) and correlation value (R): $c_i = \{M : R\}$. For $M = \{A, B, C\}$ and $R = \{3/6, 2/6, 1/6\}$, the resulting list would be: $S = \{A, A, A, B, B, C\}$

Now we have per component a list of motivators proportional to the correlation value. However, the Jaccard Distance is defined as the intersection over the union of two *sets*, disregarding duplicates. Therefore we redefine the union and intersection as follows:

- **union:** is the sum of the total amount of motivators within both list (in other words, the size of the two lists added together)
- **intersection:** is the sum of the motivators that appear in both lists. A motivators value is the minimal occurrence of that motivator between the two lists, times 2. (in other words, if one list contains $M_i = 10$, and the other $M_i = 4$, the value for $M_i = 4 * 2 = 8$) We do not include all motivators if there is an appearance in both sets because this represents a difference of r within the component.

To make sure both components are equally represented, both lists are normalized before comparison. Now we can calculate the intersection over the union to determine the similarity between two components. By assigning the components of one dataset to their respective component in another dataset, based on the similarity, we can get an idea of how well the different datasets reproduce each other. This way, we can compare results between the full dataset and the subs.

5.5.3. Motivation types

Next, we execute the factor analysis with a cluster size of 6. The factor loadings for the four different datasets: full, sub1, sub2, and sub3 are respectively shown in tables B.6 to B.9 in the appendix. The minimal loading required for a motivator to be added to a component was 0.3 for a positive correlation and -0.3 for a negative.

We analyze the quality of the clusterings between the full and the subs. First, we compare how well the subs map towards the full dataset, Table 5.2. The percentages are the adjusted Jaccard measure. Mapping the components of sub2, sub3 towards to their most comparable component in the full dataset, we retrieve all components of the full dataset. 75% also with a similarity score above 70%. Sub1 retrieves 5 out of 6 components. We visualize the most similar components in Figure 5.15. We see that the further we go into the clustering, the worse the groupings get. This follows our findings from the variance diagram, Figure 5.13. Figure 5.16 shows the motivations that relate to the groupings in Figure 5.15.

Dataset	Component					
Full	*1*	*2*	*3*	*4*	*5*	*6*
Sub1	1: 75.58%	3: 77.36%	2: 76.18%	2: 42.28%	4: 59.67%	5: 95.38%
Sub2	1: 95.04%	3: 77.62%	2: 73.13%	6: 71.53%	4: 78.72%	5: 57.05%
Sub3	1: 84.93%	2: 85.06%	3: 87.62%	4: 88.89%	5: 57.93%	6: 31.61%

Table 5.2: Comparison of clusterings between the the full and subs datasets. The adjusted Jaccarrd distance was used to determine similarity. The table shows for each subset, for each component, which component in the full dataset was most equal, and also gives the similarity

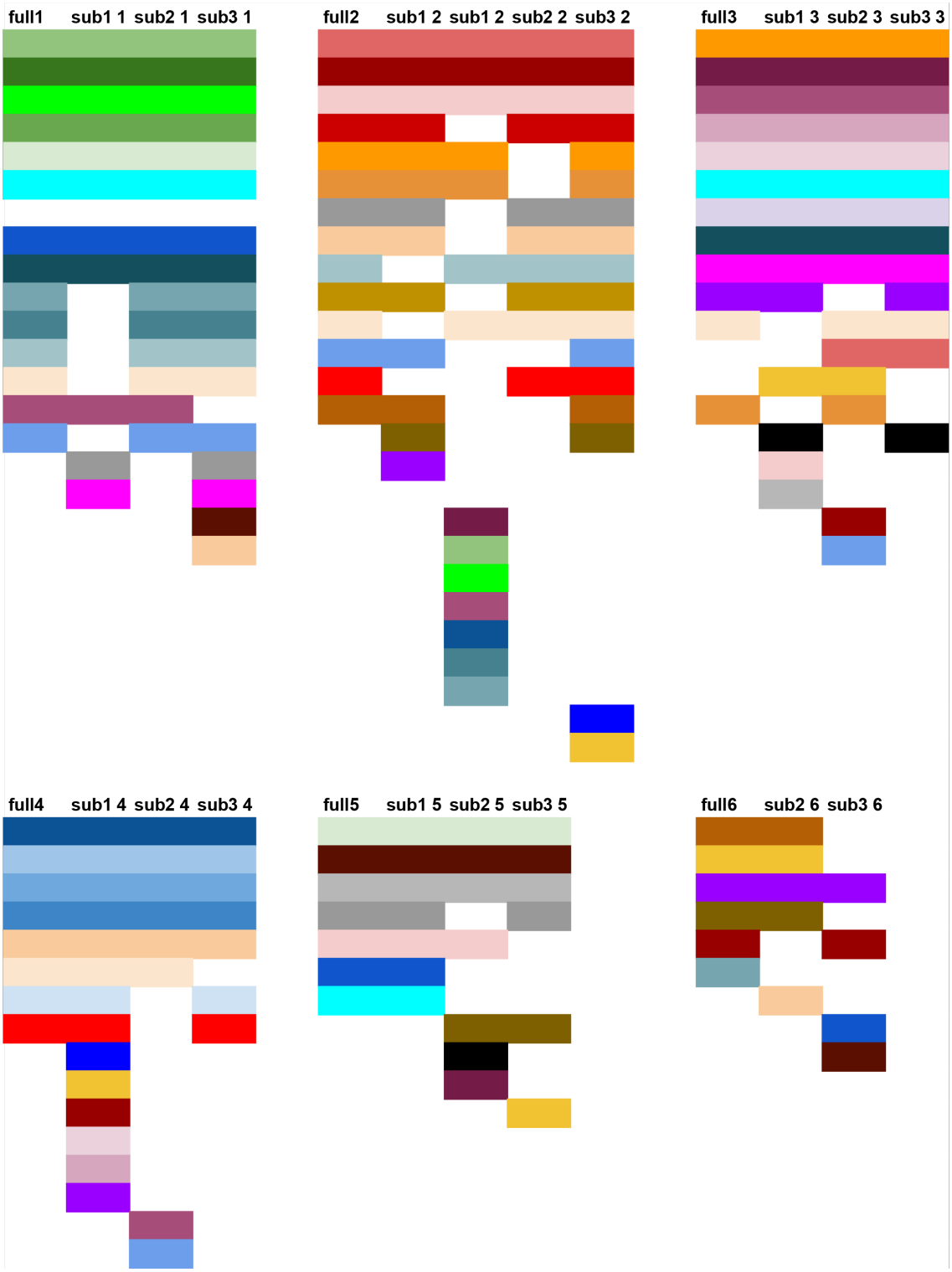


Figure 5.15: Visual comparison between the components of the different datasets: full and subs(sub1,sub2,sub3). The subs are reordered along the components found in the full dataset, as shown in Table 5.2. Each component contains motivations. Within the grouped component, motivations were ordered by occurrence. Each motivation is represented by a color. The relation between the color and the textual representation of the motivation can be found in FigureZ 5.16.

Finally, we look at how well the subs compare to each other. See Table 5.3. Overall, we find lower similarities, and we find that fewer components are retrieved. This indicates there is too little data within the subs the extract representative groupings. Therefore, we accept the introduced bias when combining the data into the full dataset.

Figure 5.16: Overview of the motivations that loaded on the 6 clusters. Per clusters all motivation are given in the same order as they are represented in Figure 5.15. The numbers refer to the component in the full dataset.

By using the full dataset, we give an impression of the motivation groups we can extract for a cluster size of six. We should note that group [1-4] account for 42.17% of the variance and group [5-6] account for 7.77% of the variance.

1. **Socializer** This type of player is motivated by social interactions and can value their representation towards others (their portrait). Example game: Fortnite.
2. **Achiever** This type is motivated by progression, development, and challenge. Example game: Candy Crush
3. **Experiencer** This type is motivated by adventure, fantasy, experience, and story. Example game: Hollow

	Sub1		Sub2		Sub3	
Component	*sub2*	*sub3*	*sub1*	*sub3*	*sub1*	*sub2*
1	71.80%	71.40%	71.8%, 38.95%	84.69%	71.4%	84.69%
2	68.88%	78.16%	68.88%	77.20%	73.66%, 39.30%	63.62%
3	53.52%, 31.32%	73.66%	53.52%	63.62%	78.16%	77.2%
4	-	-	-	24.90%	54%	71.12%
5	43.23%	54%,11.60%	43.23%	71.12%	54.81%	27.78%, 61.95%
6	56.03%	54.81%	56.03%	61.95%	-	-

Table 5.3: Similarity between the components of the sub datasets

Knight

4. **Materialist** This type is motivated by items, collecting, and completion. Example game: Farmville
5. **Performer** This type is motivated by tensions, competition, and self-reflection. Example game: Rocket League
6. **Controller** This type is motivated by relaxing, controlling, strategy, and creating. Example game: Factorio

Table 5.4 shows a comparison of our found motivational model to well-known ones within the gaming field. While we used the other models as the basis for ours, it is not strange we cover all types. However, it seems there might still be more depth possible within the clusters because some of our motivation groups cover multiple types. Secondly, we might also find other types when we have a more extensive dataset.

chou, 2016	Yee,2015-ongoing	Tondello, 2016	Current findings
Epic meaning and calling	Story(Immersion) Fantasy (immersion)		Experiencer
		Philanthropist	
Development and accomplishment	Completion (Achievement)		Materialist
scarcity and impatience		Player	
Ownership and possesion			
	Power (Achievement)		Performer
Loss and Avoidance	Destruction (Action)	Disruptor	
Unpredictability and Curiosity	Excitement (Action)		
Empowerment of creativity and feedback	Strategy (MAstery)		Controller
Development and accomplishment	Challenge(Mastery)	Achiever	Achiever
Unpredictability and Curiosity Empowerment of creativity and feedback	Discovery (creativity) Design (Creativity)	Free Spirit	
social influence	Community (Social) Competition (Social)	Socializer	Socializer

Table 5.4: Comparison to the latest well known player models, which model where also based on player surveys. Colors in column indicate the same category within that column. Rows indicate relatedness. This is not a 100% accurate mapping, but a generalized concept

6

An online game to test the relation between addiction and motivation

The goal is to create a game that can measure the relation between certain motivation factors and addiction. When we have such a game, we can decide which factors to implement, define measures for them, and start generating data to analyze. We will start by defining the basic structure of this type of game(Section 6.1): what does the game require to be able to execute measurements? Then we will explore how the selected motivation factors can be measured, what implementations they require, and how the experiment is set up, Section 6.2. After defining the required features, we go into the game design. Which mechanics can support the needed measurements and which design decisions have been made to increase and sustain the validity of the experiment, Section 6.3. Finally, we give a first impression of the possible analyses with this kind of game and summarize the results, Section 6.4.

6.1. Game Structure

To satisfy the basic requirements, the game needs to be able to save player-game interaction and have predefined how addiction can be measured.

Saving of player-game interaction can be done by making use of a database, including a user table. However, The pipeline towards the database can differ. The biggest decision we made was about when to synchronize the player data with the database. We could either chose to:

- **Store the data locally** on the devices of the players. The data will synchronize once every while with the database. This gives players the ability the play offline, increases the playability of the game. However, it also gives players the ability to cheat by removing cached data before connecting to the Internet. Additionally, it increases complexity in the development of the pipeline, and there is a bigger change we lose data.
- **Store the data directly in the database** The game will connect to the database for every required update regarding the measures. The advantage is the simplicity of the pipeline and some cheating prevention. However, it requires a constant connection to the Internet for the player to play the game, which can limit the playability of the game.

We choose to store the data directly into the database. This is less complicated to implement, and most areas where mobile games are played have good coverage of the Internet. The connection towards the database was also created using a *Application programming interface* API framework. This helps the extendability and accessibility of the games database. Because we want to save data per player, users will also have an account and required to log in, therefor also needing a connection to the Internet.

To measure addiction, we look back at the analysis of Section 5.3.2. We have shown that playtime positively correlates with addiction. Therefore we take playtime as the basis for determining the effect of factors on increased playtime and potentially addiction. We define the playtime as: *The time the player interacts with the game environment.* Because we choose playtime as the basis for measurement, this game must contain infinite gameplay. This way, there is no limit to the measurement.

For this reason, we choose to use the principle of an infinite runner game. An infinite runner game makes use of one fundamental concept: try to get as far as possible ("run to infinity"). The game usually consists of an auto-generated level that gets more difficult over the amount of distance. This keeps the game exciting and challenging over multiple replays. Because infinite runner games naturally have infinite gameplay by repeating one type of level, it also required less development than, for example, a puzzle or adventure game. Once the "level" is built, you can replay it to the end of time.

6.2. An online game to test the relation between addiction and motivation

The purpose of our experiment is to measure the relation of the two factors F_1 and F_2, defined in section 5.3.3 with addiction. More playtime means that the implemented factors are more stimulating towards the continuation of gameplay, therefore increasing the chance of addiction. To create a complete understanding of the relation, we want to answer the following questions:

q_1 Do the factors F_1 and F_2 stimulate players to play the game more?
q_2 Do the factors F_1 and F_2 stimulate the interaction with the respective in game mechanics/implementations?
q_3 How do players compare on [q_1] and [q_2] when we divide on addiction score?

To be able to measure the effect of the factors, we create two separate games (A-B testing). One of these games will form the baseline (game B), the other game is modified with elements that influence the factors (game A). The game without the implemented factors should still be exciting and challenging, and keep as many of the elements as the other version, to make sure we can relate the behavior towards the mechanics we want to measure. The game will consist of the main game that can be played repeatably. Every play round will be called a *run*. To measure F_1 and F_2, we need to map them to game mechanics.

F_1 is about the motivation to *"spend money to get the things I want"*. Therefore the game should contain something the player wants, a currency that sets values to this thing, and a place that enables the player to buy this thing. Additionally, there should be more than one thing because the sentence refers to a choice between things the players want more and less.

F_2 is about the motivation to *"prevent missing out on certain (limited) experiences or events"*. Therefore there needs to be an experience or event in the game, the player must have an incentive to partake in it, and it should be restricted in either amount or time.

Therefore we include the following mechanics in the game:

- **Assets** [F_1,F_2] both factors are based on reward. Either by being able to get the reward, the player wants through spending (F_1) or getting a reward for completing an event (F_2). Therefore we introduce items and coins (coins represent money in the game, a currency).
- **Shop** [F_1] To be able to spend coins, there needs to be a shop. The shop is the place where players can acquire different items in exchange for coins.
- **Events** [F_2] An event is a quest or challenge a player can complete. Upon completion, a reward is received.

Based on these mechanics, we can now define the design of games A and B and their differences. For the detailed formulation and differences between game A and B see Table 6.1.

For F_1, game A will contain a shop where items can be seen, and their amount and where they can buy more. Game B will see the items but without the ability to buy them. To enable the players in game A to buy the items, they need the coins. Therefore all rewards they can obtain in the game will be in the form of coins, the currency. Game B will receive the items as rewards. This way, they can still receive items without buying them, and we also remove the choice. Preferably it would also be possible for players in game A to transfer real money into coins, but due to ethical concerns and limited development time, this was not included.

For F_2, both games will contain the exact same challenges to complete. However, game A will contain coins as rewards, and challenges will be restricted in time (visible to the player). In contrast, challenges in game B will reward the players again with items, and challenges will be available until completion. Because we want the game to have the ability to be played infinitely, the same is true for challenges. There should always be a challenge to complete for the player. Players in game B have no way of removing/replacing a particular challenge. This limits them the use of challenges when a player cannot complete that challenge. Therefore both games will have the same amount of concurrent challenges, at least 2.

As mentioned before, the games must be as equal as possible. This prevents unwanted variables influencing the analyses. Therefore the amount of reward players receive should always be the same in both versions of the game for the same actions.

	Game A - [F_1, F_2]	Game B [none]
Assets	Coins, items=[Item1, ... , Item_k]	items=[Item1, ... , Item_k]
Shop	Yes	No
Spend real money	If possible	No
1 run in the game, rewards	***x*** value in Coins	***x*** value in items
Events duration	***t*** time	Untill finished
Events availability	always ***n***: if one is solved or ***t*** time passes, a new one appears	always ***n***: if one is solved, a new one appears
Events rewards	***x*** value in Coins	***x*** value in items
Event reminders	Yes	No

Table 6.1: Experiment setup

The mechanics described above are concrete and measurable. This helps us to answer questions q_1 and q_2.

To answer q_1, we need to calculate the average playtime between the two games. We can determine the playtime of a player by taking the difference between the start and end times of a session. Those can then be averaged.

To answer q_2, we need to define the interactions a player can have with the mechanics of F_1, F_2. For F_1, the player will receive rewards and will be able to go to the shop/item overview menu. When a click is required to reach this menu, we can count the number of clicks. For game A we can also track the buying behavior of a player, by tracking all the buy actions. Because buying items also relate to using items, we also track the usage of items. We would expect a higher number of clicks on the shop from game A then game B. The behavior data of buying and using items does not directly help in answering this question but can help understanding players' unexpected outcomes. For F_2, the player will receive challenges in the challenge menu. Again, when a click is required, we can count the number of clicks. We would expect a higher number of clicks in game A, then game B. Additionally we can measure the speed in which a player completes a challenge and the total number of challenges that are completed. However, completion speed is dependent on various things, for example, the player's skill or the player's awareness. Therefore we add a claim interaction to the challenges. A player would have to click the challenge to receive the reward consciously. The time between completing a challenge and claiming it, combined with preceding clicks to the menu, can give us a better indication of the interaction(the shorter the time in between, the higher the interaction).

To answer q_3, we need a person to participate in the survey as well as in the game. Then if we can relate the participant in the survey to the player in the game, we can use the same data as mentioned for q_1, q_2 to create groupings.

Table 6.2 shows the final overview of the player interaction data we are saving. We decided to include all the data mentioned above because it is little extra implementation and can it be helpful for analyses and understanding behavior. A summary of the possible measures can be seen in Table 6.3. Per group, per time window, we can compare the different measures for games A and B.

Measure	Data	Comment
Session start/end	player-id, session-id, date, time, state{start,end}	
Coins/Reward spend/Received	session-id, time, item, state{spend,receive}	*items include coins in this case*
Progression and Repetition	session-id, time, challenge-id, state{not started,started,finished, completed, claimed, missed}, progress	
Clicks to shop/event/run	session-id, time, click-type{shop,event,run}	

Table 6.2: Game data

		Measures	
Groups	**Time windows**	**Game A & B**	**Game A**
All	All	playtime	assets_bought
High Addiction Score	time range	#runs	#challenges_missed
High F1	session	#sessions	
High F2		#challenges_completed	
High F1 & F2		#challenges_click	
		assets_received	
		challenge_completion_time	
		#shop_click	
		assets_spend	

Table 6.3: Player game interaction save-data

Player groups

The experiment consists of 2 separate tests, both having an A and B group of players.

E_1 The first group include players who also participated in the survey. Participants of the survey could leave their email address to receive a play code. These players were the first set of people to receive the game. They could register with their play code. This way, we could link their motivation and addiction data to their game interaction data. Players were not required to play the game.

E_2 The second group was created in a later phase. At this time, the game also could register the players without a play code. This to increase the reach of the game and get more participants. This game was released and accessible through the Google Play store. Initially (for the survey), we wanted to target all people, because anyone can play games. However, we were limited to the age of 16 because of the GDPR. While the game itself does not save any sensitive private information, the game could be presented to anyone. Players were notified that gameplay data was saved.

As can be seen from E_1, E_2, people were never required to play the game at all. Secondly, if they play the game, there was no required amount of time they would have to invest. This is because we want to measure the playtime of players. Any requirements or obligations to play the game, or for at least a certain amount of time/repetitions would automatically affect the results.

Because players had no obligations to play, there was no controlled environment in which the player groups could be divided over versions A and B before the experiment. We do not how many people are going to play the game beforehand. Therefore people had to be divided on to go, for both tests E_1, E_2.

In dividing the people over version A and B for experiments E_1, E_2 there were a couple of things important:

- **Randomization,** [E_1, E_2] - The general gameplay (the type of game we create) will have a direct influence on the players due to their motivations for gameplay. Some prefer competition, others exploring and so on. By randomly distributing the people over two groups, we may assume both groups contain people that do like the game type, and people that do not, making the results unbiased.
- **Group size,** [E_1, E_2] - The size of the groups should be as equal as possible, to create balance.
- **Addiction score distribution,** [E_1] - To be able to answer q_3 we also need an as equal distribution as possible of the addiction score that have unbiased results.

For E_1, we can apply the following method to divide the people: If the groups are equal in size, pick a random group, otherwise add to the group with the smaller size.

For E_2, we created a more sophisticated algorithm, that primarily focuses on distributing the addiction score while still taking into account the group size and randomization. The reason for this is that we have a limited number of people that submitted the survey and wanted to receive the play code (86). Ten people had a high score on addiction. While we do not know how many are going to play the game, just dividing them randomly had a significant chance of placing the people with high addiction in the same group. We could relate every play code to an addiction score. Then we can use to addiction score on to go when dividing the players over the groups. Appendix C.2 shows the algorithm used for generating the groups.

The algorithm was tested against three other approaches. The test replicated all possible participant sizes. These were given to the algorithms, which then create two groups. The distributions of the two groups were compared by using the Kolmogorov-Smirnov statistic test. The test was repeated 50 times, and the scores where averaged. Figure 6.1 shows the results. The yellow line represents our approach. Looking at our approach, it becomes somewhat stable from 20 participants. The more people participate, the more stable to

distribution becomes. Under the 10 participants, the similarity is relatively bad. This is not strange because there are ten classes we have to distribute participants over, and the classes are not evenly distributed. The other approaches are:

- **Random drawing:** For every new player, we pick a group at random. The green line represents this approach. We see that it becomes more stable with more participants, which is to be expected, due to the law of large numbers.
- **Random division on n:** For every new player, we look at the sizes of the two groups. If they are equal, we pick a group at random. Otherwise, the new player is added to the lowest group. The red line represents this approach. We see that it stays instable over the increase of n. This happens because it only focuses on the size of the set.
- **Random split:** We shuffle the list of the n players we have to divide. We split the list in the middle, creating the two groups. When n is even, the groups are also equal. Otherwise, the difference is one person. The blue line represents this approach. We see that this approach stays relatively constant, but does not seem to increase with larger n.

We compare our algorithm to the other approaches. From Figure 6.1, we see that our approach offers the best and most stable distribution. This shows that our proposed algorithm is better than the basic forms of a random drawing for this known dataset. In future development, we should reconsider what kind of algorithm is preferred because the dataset can change.

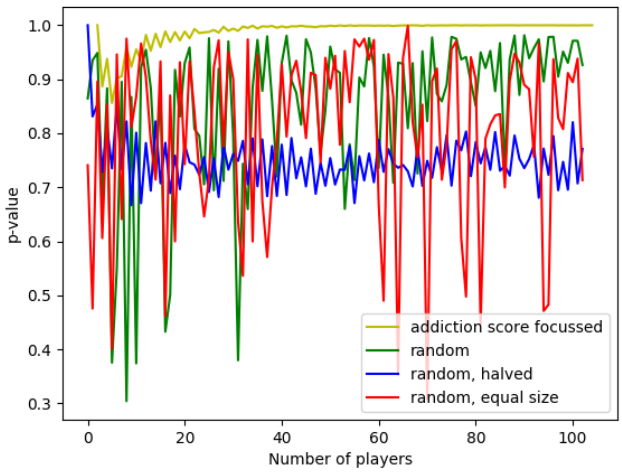
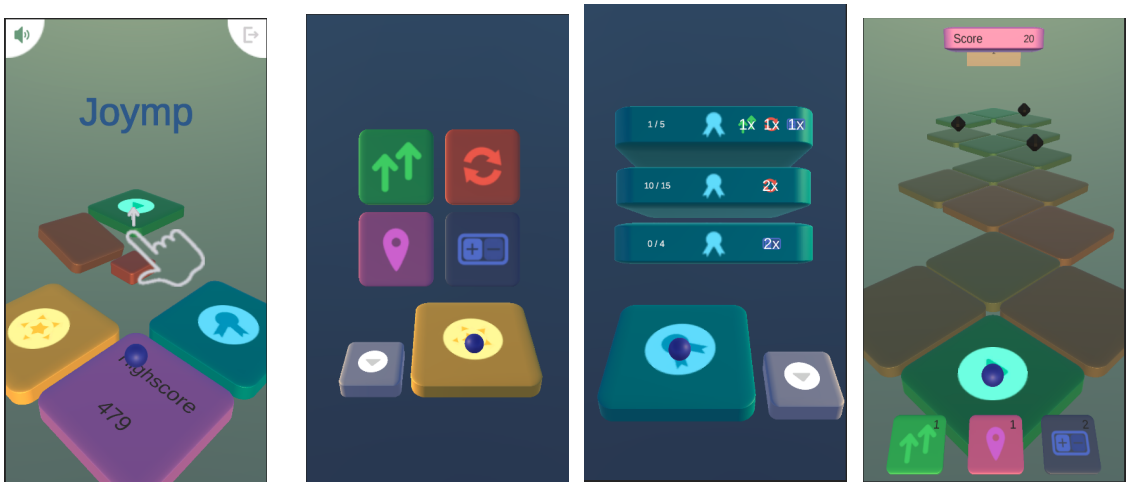


Figure 6.1: Average result of Kolmogorov-Smirnov statistic test on 50 iterations for four different algorithms

6.3. Game Design

We designed our own game so that we can build in the required features for the experiment. The name of the game is *Joymp* (a combination of joy and jump). The purpose of the game for the players is to get as far as possible. The player (the ball) should jump from platform to platform. If the ball falls, the player dies, and it is game over. We need to design certain aspects of the game that will support the experimental setup. Below we go into more details about player interaction, challenges, assets, automatic level generation (difficulty), and technology. More design decisions can be found in Appendix C.1.

Player Interaction The player interaction was chosen to be mobile. This is the quickest growing field within the gaming industry; most people have mobile phones and offer games that are simpler and require basic player interaction. The player can move the ball by swiping from a 'lower' place in the screen to a 'higher' one (like inverted angry-birds). This was chosen because this way, the game can be played with one hand, increasing playability in all kinds of different situations. During jumping, the player can also gather the black diamonds above the platforms. See Figure 6.2d for an example.



(a) Home view (b) Item view (c) Challenge view (d) Game view

Figure 6.2: Different game views

Challenges See Figure 6.2c for an example of the challenge menu. Challenges are always replaced after one is claimed, or the time has run out. This way, the player always has a challenge they can complete. Challenge types are repeated over time, but also increase in difficulty. The challenges were built in such a way that there could always be added new ones through the database in case a player would start to run out. Rewards of challenges were carefully designed, making it difficult to create a standard algorithm for generating challenges. A list of implemented challenges can be found in Appendix C.1. With more research on reward schemes, atomization of the challenges should be possible. Players would always receive the same order of challenges, with the same reward value. This prevents the order from influencing the measurement.

Assets Items help to make the game more interesting and enable rewards. We designed the items to be boosters the player can use while doing a run. See Figure 6.2b for the item view. The items included are:

- **double jump:** the player can jump an additional time while in the air.
- **replay:** after dying the player can continue from their last position
- **magnet:** Attracts the black diamonds towards the player.
- **Arc:** Before the player releases the ball, the movement arc of the ball is shown.

Each item works only for a limited time during the run and has a certain cost. An infinite runner naturally lends its system for rewards based on traveled distance. For coins or money, this is easy to implement, but for items, this is more tricky. The value of the traveled amount of distance will not always sum up exactly to the possible items. As mentioned before, the amount of reward must always be the same in both versions of the game. Therefore there is a standard reward for completing a certain level (specific hard-coded distance intervals) and extra rewards for completing challenges. A standard reward motivates gameplay and also keeps giving the playing reward when trying to complete a challenge. This also makes the challenges optional; They are not required to get money/items. The rewards received per level increase linearly over distance.

Difficulty To keep the game interesting, the game should become more difficult over distance. Difficulty can be changed by either changing the interaction between the player and the level or by changing the level. We choose tho adjust the level, in this case, the platforms, because this gave us different simple ways of creating more interesting gameplay. The changes happen within the auto-generation of the level.

Currently, the following variables can be set per level: the spawning of a platform, gab distance between platforms, platform form, platform rotation, horizontal platform movement, and platform lifetime. These variables were implemented in such a way that each variable can be adjusted independently. A variable v consists of a initial (v_i), final(v_f) and step value(v_s). It also has a chance variable(c) also with initial (c_i), final(c_f) and step value(c_s). At the start of a level, v is initialized at v_i. Then every game loop the v is adjusted with v_s, towards v_f, if c is larger than a randomly drawn number. c follows the same procedure as v, but will

always increase. Through this implementation, it was possible to create a difficulty graph for each variable. Combining these creates different types of levels with different difficulties. This way, we created a custom, challenging game experience. The parameters that adjust the v, c variables where per level the same for each player. Because of the way it was implemented, we can easily add more variables (e.g., the jump speed, or other degrees of rotation of the platforms). All the different variables were also accessible during the game loop. Therefore (with some small adjustments), future work could benefit from using the game to study Dynamic Difficulty Adjustment.

Technology An overview of the involved systems is shown in Figure 6.3. The study aimed to let anyone play the game, via any form of device, because this should not be a restrictive factor. Secondly, the development of the game should not require much domain knowledge. Therefore the platform Unity was chosen. Unity makes it possible to build for all different platforms and is one of the most user-friendly game design software tools out there. We chose to use WebGL as a basis because this should be able to run on ios and Andriod devices. The author also owns a server based on Django, which, to his prior knowledge, could run a WebGL application. The database of the server was set up with an API so that the game could send requests and save the playing data. The data in these tables can be exported to CSV and then be used to analyze the gameplay of different players. Later .apk exports were released for android phones, while these usually work better than browser-based games. There was no Apple Store license available to release the app. Because the player's interaction with the game is very different on pc/laptop versus a touch device, and behavior in the browser might differ from .apk, the type of platform the player was accessing the game from was also saved with the sessions data. More details about the technology and codebase can be found in Appendix C.3

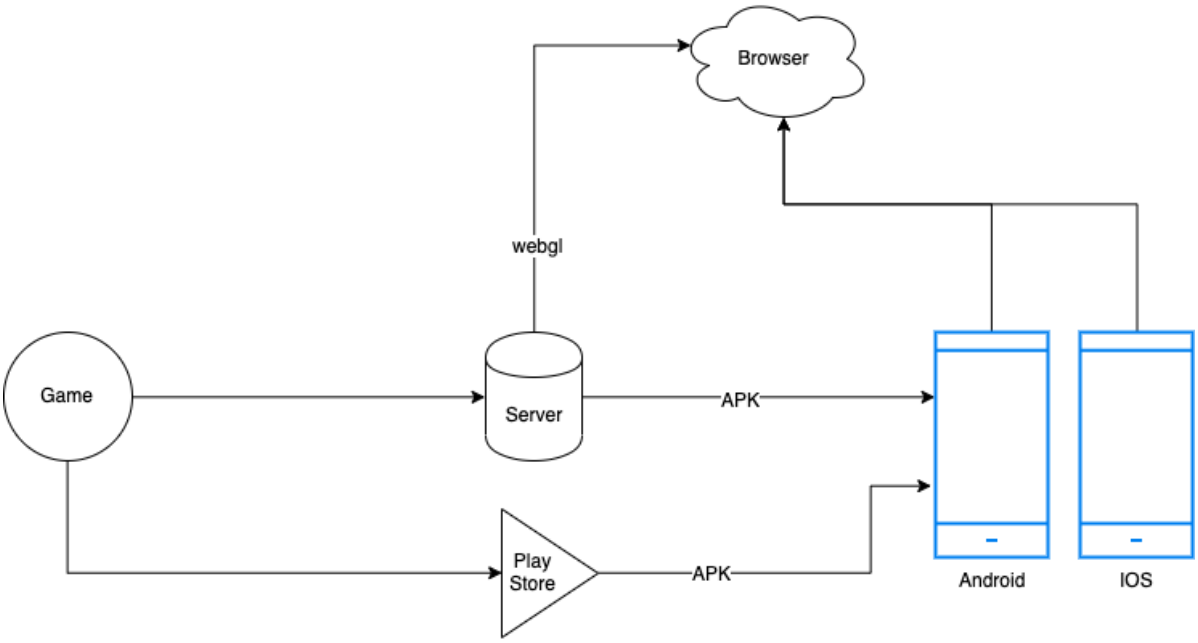


Figure 6.3: System overview

6.4. Results

The experiments have been launched in December. Both experiments would greatly benefit from more players before we can draw significant conclusions. The current state of the experiments is described below.

E_1 was released on 7 December 2019. People who participated in the earlier survey have been sent a link, from where they can access the game (N = 86). After some feedback, a new version was released on 20 December 2019. Biggest adjustments where some bug fixes and auto-login. All 86 people received a second email. Since then, 18 players have registered with their play code. An overview of group distribution can be found in Table 6.4. We apply the Kolmogorov-Smirnov statistic on the two distribution, which resulted in a p-value of 1. We may assume the two groups are from the same distribution.

Version	Addiction score										Totaal
	0	1	2	3	4	5	6	7	8	9	
A	0	3	3	1	1			1			9
B	1	3	2	1	2						9

Table 6.4: Addiction score distribution version A and B

E_2 was released on 14 December 2019 via the Google Play Store. Also, on 20 December 2019, the updated version was put through to the play store. Since then, six people have installed the game. Group A and B were evenly distributed.

In total, there have been 24 players, 12 in version A and 12 in version B. Together they played 75 sessions, with an average of 1.97 sessions per person, see also Figure 6.4, which shows the number of sessions players have played. From this figure, we also see that most people have tried out the game once or twice, but only one person has regularly played it (19 times). To the author's knowledge, that player's motivation was to test the game and give feedback thoroughly. We suspect many of the players were not interested in the game but tried it because they were related to the author. Due to the scarcity of the data and the lack of real usage, we will not further calculate the different measures, while these will not be significant or representative.

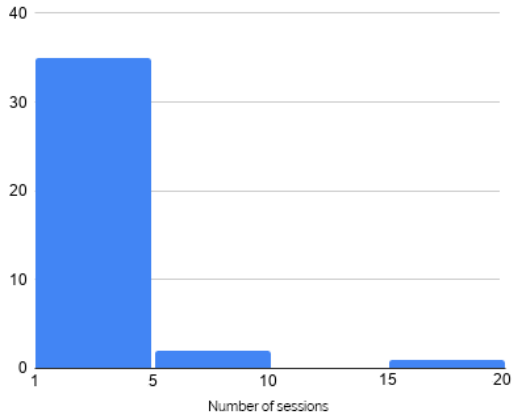


Figure 6.4: Histogram of sessions per player

Although the user base is small, we have shown how to create a game that can be used for measuring player behavior. We have shown an example of how to translate motivations towards mechanics and what aspects are essential when developing a multi-version game. We see that all aspects of the game are working, and data is sent to the server. This shows that it is possible to create a game to measure mechanics related to motivation and addiction, by analyzing, among other things, playtime.

Besides the usages of the game for the measurement of behavior, we also present a game that can be used as a starting point for further research. Consider, for example, Dynamic Difficulty Adjustment or other video gameplay-related studies.

We do recommend further studies to look for a partnership with a game that already has an active user base. Sadly iOS devices still had difficulty with running the game via WebGL. We would also recommend further researchers to make sure they have an Apple store license.

7

Discussion

The framework we proposed is an initial step but by no means a final solution. There are a couple of things that would need confirmation or further analyses before we can reliably use them. This is true for the models, the analyses, and the game.

The motivation model has been based on earlier work we found, but no search words were saved, or a systematic approach was used. This makes it difficult to confirm the inclusion of all related research. Although the studies used in this work were also backtracked to find other studies in the field, it is still possible there are others around. The model would benefit from more perspectives. Further studies could focus on extending the model(Appendix A.2) and the timeline (Appendix A.1), including search terms used. This could support and potentially extend or change the studies on which the model is based. Additionally, if most earlier research is included, it can be the base model for comparison and other model definitions. More data will give a better model and also enable us to add other player data. Consider, for example, meta-data like playtime or spending behavior. Also, demographic data can be used.

The combining of the motivational model was done subjectively without the revision of experts within the field. Although one can argue that the repetition of attributes in other models would indicate a factor, studies can use the same term for different interpretations, and sometimes attributes overlap. We had to make a hard decision to make sure we would not end up with too many or too few factors. We believe this has been satisfactory as an initial exploration of the possibilities of such a model. However, it is not complete and should be subjected to revisions and support by experts in the field.

The goal of the motivational model was to include all the different game motivations out there in 1 model. Just like that, the human psyche is not to be summarized in one model. It might be the same for the motivations of gameplay. We assumed it should be possible to create one generalized model, but the questions remain how effective this model is compared to potential environment customized models.

We defined the mechanics by decomposing the motivational factors we wanted to implement and comparing them to the mechanics we found in games and other studies. Our work has been mostly motivation based. Nevertheless, as stated in the methodology, it would be better to determine the relation to mechanics based on the games that have been played. What mechanics are in the games people play, and how do the players experience these mechanics? Do the mechanics that we expect to relate to their motivation do so, are these also the mechanics they like, and how do they relate to addiction? It could be that the reasons people play the game is different from the mechanics that adheres to the addiction. In a future study with the current dataset, we could determine which mechanics are inside which games. When relating the games to the people and their addiction scores, we could create a list of 'addictive mechanics.'

In gathering our data, we did not have a wide variety of people in the target group, and the number of participants was low for the type of model we are trying to build. This limits our results currently too preliminary findings. Secondly, due to time constraints, it was not possible to explore all the different facets that were possible with the current data. Consider, for example, including the playtime per game, or comparing the number of played games towards playtime and addiction. There is much potential when an adequate number of people have participated, and more time is invested. We would recommend an approach like Quantic Foundry [38], which is a continuous online application that gathers data and helps the participants with new game recommendations. We are also planning on the creation of such an application.

Also, because of the limited amount of data, we have not been able to make significant conclusions about player groups. A first impression (Appendix 5.5.1 shows potentially different player types based on motivation that can occur in multiple clusters. It would be interesting to see which kind of player types resolve from this model, but also to compare them to existing models. Because the current model is build up from the others, we should be able to map the data we find back to these models to confirm, support, or extend their findings. This could also be implemented as an extension of the web application. Based on the questions you answered, you can look at different player models.

In comparing the different sub-datasets, we found a variance between the results. This shows that our data sample is not large enough to extract all correlations with confidence. We were able to extract two apparent factors. However, we would like to get a complete overview of the positive and harmful relations between motivations, mechanics, and addiction. With more data, it would also be possible to analyze if the addiction components are consistent over different types of games, or player groups.

The survey could potentially be extended by asking questions about how the addiction questions related to the specific games. Was it just one of the games responsible for the addiction, or all? In our case, we asked the players about their addiction in general. It could be that just one game resulted in problematic behavior, and the others were played less extensively. This would also be useful in further analyses of the mechanics' relations towards the games.

We based our measurement of predicting addiction on playtime. Although playtime positively correlates with addiction scores, it does so for a limited number of cases. We would propose a different approach to finding addiction predicting measurements. When collaborations with different game companies can be established, there might be a possibility of using their user base, and game-related data. When users would participate in an addiction measurement, their old gameplay data can then be used to determine measures or mechanics that correlate to addiction. This way, games can be used to defer addiction patterns, which would mean there is potentially a lot of data available. Because our model asks players both their motivation and related game, the motivations can then also be related to the game mechanics.

We created our game experiment from scratch. This had as advantages we could control all aspects of the game, including platform, gameplay, mechanics, and data management. However, we wanted to measure playtime. Therefore people needed to play to the game (and continue playing) without an incentive created by us outside the game. Creating a successful game that is played regularly depends on many variables outside your control. Therefore, as we found out, chances are low, a large enough dataset can be created quickly enough to do proper analyses. Therefore collaboration with game companies would be recommended, as mentioned before.

In our current game experiment, we wanted to relate the behavior of people to their survey results. We initially wanted to measure the participants' behavior towards addiction, F_1 and F_2. Before the release, we knew we had a limited amount of potential participants ($n = 86$). Therefore we created only two groups to increase the probability of having a large enough data sample to make an analysis. Consequently, we could only measure one of the behavior relations: addiction. In future work, the other relations could also be analyzed to confirm if a player indeed is attracted by a mechanics that the player's motivation prescribes.

We have shown and highlighted some different application areas of the proposed framework. However, there are still parts of the framework that would need confirmational studies, and the framework should also be tested as a whole. We are also curious to see what other types of models could potentially be linked, consider, for example, models for learning.

7.1. Ethics

When talking about addiction, or modeling human behavior we should have some ethical considerations. Gaming companies or developers can misuse a framework that can determine what kind of mechanics or motivation leads to addiction (or attracts people). When more people play the game longer, this usually results in higher revenue. A person's motivations could also be used to influence the marketing towards that person. Additionally, our framework proposes a way of modeling individuals instead of groups. We could potentially create personalized, tailored games. Instead of adjusting advertisements within games (like on billboards), we could change player interaction variables (changing difficult). Is a game that differs from person to person fair, how would scores be compared, and how to be sure that what one predicts for one person, also works for another? Maybe some people show signs of addiction, but they experience no problems. When should we be allowed to analyze people's behaviors and act upon these findings? Secondly, we found motivational factors that indicate addictive game mechanics. We should consider if it is ethical that companies do

not notify their players of possible risks.

8

Conclusion

The video gaming industry keeps growing, through technological advancements and studies on Serious gaming. This is not without challenges. Internet Gaming Disorder is becoming an increasingly important problem, and current studies do not offer a way to relate video gameplay motivations to game mechanics, and in turn, to addiction.

We have created an initial model consisting of 44 factors to measure game motivation by doing a literature review. This model was then combined in a framework with a model for addiction. The proposed framework can relate the separate aspects of the models and can be extended with game mechanics. It forms a basis towards a system that helps in understanding players' motivation, knowing how to design games to influence motivations, and finally might be able to change playtime or increase player enjoyment. The framework is an initial concept that should be adopted over time.

Based on this framework, we created a survey to gather data. By analyzing the data ($n = 106$), we found that: playtime can indicate addiction to a certain degree, the motivations could be grouped into six types, and two motivation factors that positively correlate with addiction. Also, we analyzed 16 popular games on implemented mechanics. We found that the two motivation factors are often implemented as game mechanics. This indicates that games are being developed with addictive mechanics.

To show the applicability of the framework in a real-world example, we created a game called Joymp. We first mapped the two motivation factors to game mechanics. Then we created the game with two almost identical versions. One version contained the specific mechanic interactions related to the motivation factors. In the other version, these were left out or replaced. We show the game can measure the relation between playtime and motivation through game mechanics, potentially indicating addiction. Besides the usage within our experiment, the game can be extended, changed, and used in further research. It also contains an implementation for automatic difficulty adjustments, which makes it a testbed for Dynamic Difficulty Adjustment.

Due to the limited scope of this study, data was not conclusive enough to confirm the full framework or test the models thoroughly. Therefore it should be seen more as an exploratory proposition than a set standard.

A

Models

A.1. Timeline of related studies

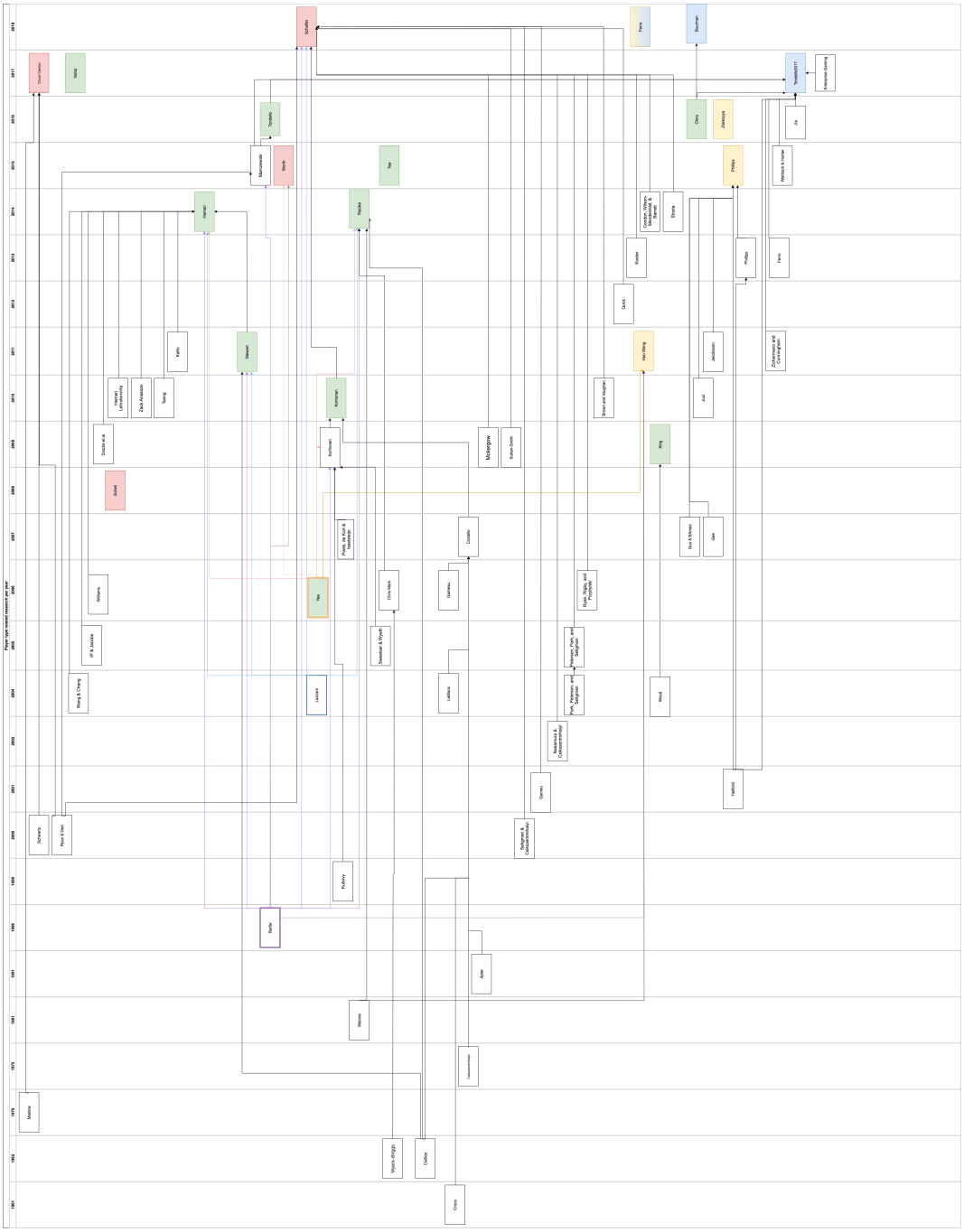


Figure A.1: Research history on understanding human behavior and gameplay. Relations represent which studies incorporate which other studies.

A.2. Motivation model Summary

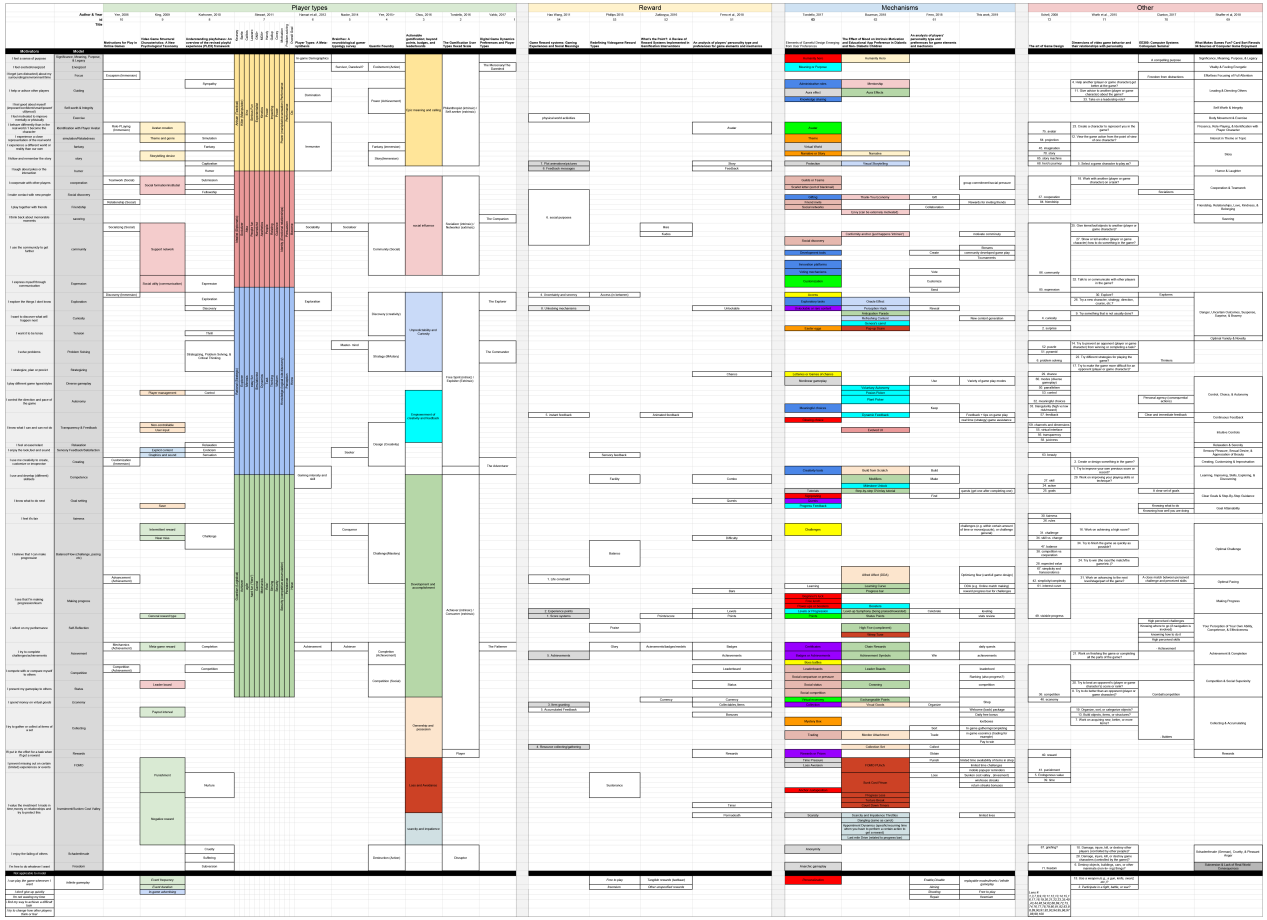


Figure A.2: Summary comparison of behavior related models. For the comparison both literature as well as online sources where used. To cover a wide range of different perspective we also included reward models, mechanics list, player models, motivation models and a game design book. The different sources where read and compared to each other. Although the image implies that elements on the same row are the same, this should not be interpreted as the truth. It was done by interpretation of the author, to get a feeling for which different aspects should at least be included in a summery. Many elements overlapped in multiple areas, which is difficult to represent in a 2d table. The rows of elements that where related where also put closely to each other. ADD: About color relation within the columns, but also color relation between mechanics and motivations

A.3. Reference data for timeline diagram and motivation model

The references used in creating the timeline and motivation model. Table A.1 shows the studies used for the user types. Table A.2 shows the studies used for rewards, mechanics, and other perspectives. The colored parts of the table are the studies used in our motivation model.

ID	Paper	Authors	Year	Used in ID	ref
1	Digital Game Dynamics Preferences and Player Types	Vahlo	2017	-	[145]
2	Actionable gamification; beyond points, badges, and leaderboards	chou	2016	65,66	[19]
3	The Gamification User Types Hexad Scale	Tondello	2016	66	[142]
4	Quantic Foundry	Yee	2015	-	[38]
5	Player Types: A Meta-synthesis	Hamari et all	2014	-	[54]
6	BrainHex: A neurobiological gamer typology survey	Nacke	2014	-	[103]
7	Personality And Play Styles: A Unified Model	B. Stewart	2011	7	[40]
8	Understanding playfulness: An overview of the revised playful experience (PLEX) framework	Korhonen	2010	1	[79]
9	Video Game Structural Characteristics: A New Psychological Taxonomy	King	2009	-	[75]
10	Motivations for Play in Online Games	Yee	2006	7,8,6,57	[163]
11	Even Ninja Monkeys Like to Play: Gamification, Game Thinking and Motivational Design	Marczewski	2015	4,66	[97]
12	Positive emotion differentiation: A functional approach	Shiota	2014	1	[132]
13	What is a positive emotion?: The psychological construction of pleasant fear and unpleasant happiness	Condon, Wilson-Mendenhall, & Barrett	2014	1	[20]
14	Theory of Fun for Game Design (2nd edition)	Koster	2013	1	[80]
15	Empirical taxonomies of gameplay enjoyment: Personality and video game preference	Quick, et al.	2012	1	[119]
16	At Least Nine Ways to Play: Approaching Gamer Mentalities	Kallio	2011	7	[69]
17	How it Shapes the Brain, Opens the Imagination, and Invigorates the Soul	Brown and Vaughan (2010)	2010	1	[14]
18	Game design as marketing: How game mechanics create demand for virtual goods	Hamari Lehndonvirta	2010	7	[53]
19	Segmenting online gamers by motivation	Tseng	2010	7	[144]
20	Virtual Identities and Market Segmentation in Marketing in and Through Massively Multiplayer Online Games (MMOGs)	Zack Ariasson	2010	7	[167]
21	The Ambiguity of Play	Sutton-Smith	2009	1	[138]
22	Positivity: Groundbreaking research reveals how to embrace the hidden strengths of positive emotions, overcome negativity and thrive	Mckergow	2009	1	[100]
23	Player Modeling using Self-Organization in Tomb Raider: Underworld.	Drachen et al.	2009	7	[29]
24	Understanding playful user experiences through digital games	Korhonen	2009	10	[79]
25	A study in play, pleasure and interaction design	Costello	2007	27	[21]
26	It is always a lot of fun!: exploring dimensions of digital game experience using focus group methodology	Poels, de Kort & Isselsteijn	2007	27	[118]
27	The Play of Man	Groos	2006	28	[50]
28	Man, Play, and Games	Caillios	2006	28,9,8	[16]
29	Beyond Boredom and Anxiety: The experience of play in work and games.	csikszent'	2006	28	[23]
30	A Structural Phenomenology of Play	apter	2006	28	[2]
31	Fourteen Forms of Fun, Gamasutra.	Garnenau	2006	28	[44]
32	A Formal Approach to Game Design and Game Research	LeBlanc	2006	28	[61]
33	The motivational pull of video games: A self-determination theory approach	Ryan, Rigby, and Przybylski	2006	1	[125]
34	Century Game Design	Chris mark	2006	8	[9]
35	Looking for Gender: Gender Roles and Behavior Among Online Gamers.	Williams	2006	7	[156]
36	Orientations to happiness and life satisfaction: The full life versus the empty life	Peterson, Park, and Seligman (2005)	2005	1	[114]
37	Segmentation of the games market using multivariate analysis	IP & Jacobs	2005	7	[62]
38	GameFlow: a model for evaluating player enjoyment in games	Sweetser & Wyeth	2005	27	[139]
39	4keys2fun	Lazzaro	2004	1,9,7,8	[86]
40	The structural characteristics of video games: A psycho-structural analysis	Wood	2004	11	[158]
41	Strengths of character and well-being.	Park, Peterson, and Seligman	2004	1	[111]
42	Lifestyles of Virtual World Residents: Living in the On-Line Game 'Lineage	Wang & Chang	2004	7	[150]
43	The Concept of Flow	Nakamura & Csikszentmihalyi, 2002	2002	1	[22]
44	Fourteen forms of fun	Garneu	2001	1	[44]
45	Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being	Ryan & Deci	2000	1,4,14,72	[124]
46	Positive psychology: An introduction	Seligman & Csikszentmihalyi, 2000	2000	1	[130]
47	On Pleasures of the Mind.	Kubovy	1999	27	[83]
48	Hearts, clubs, diamonds, spades: Players who suit MUDs	Bartle	1996	9,1,14,7,8,6, 57	[7]
49	Toward a Theory of Intrinsically Motivation Instruction	Malone	1981	8,57	[96]
50	MBTI	Myers–Briggs	1961	37	[37]

Table A.1

A.4. Mechanic model

ID	Paper	Author	Year	Used in ID	Ref
51	An analysis of players' personality type and preferences for game elements and mechanics	Ferro	2018	-	[34]
52	What's the Point?: A Review of Reward Systems Implemented in Gamification Interventions	Zakkoyya	2016	-	[91]
53	Redefining Videogame Reward Types	Phillips	2015	-	[116]
54	Game Reward systems: Gaming Experiences and Social Meanings	Hao Wang	2011	-	[147]
55	Videogame Reward Types	Phillips	2013	56	[115]
56	The Achievement Machine: Understanding Xbox 360 Achievements in Gaming Practices	jakobsson	2011	57	[63]
57	A Casual Revolution: Reinventing Video Games and Their Players	Juul's	2010	57	[68]
58	What video games have to teach us about learning and literacy	Gee	2007	57	[45]
59	Why People Buy Virtual Items in Virtual Worlds with Real Money.	Guo & Barnes	2007	57	[51]
60	Swords and Circuitry: A Designer's Guide to Computer Role-Playing Games	Hallford et al.,	2001	57,66,58	[52]
61	An analysis of players' personality type and preferences for game elements and mechanics	Ferro	2018	-	[34]
62	The Effect of Mood on Intrinsic Motivation and Educational App Preference in Diabetic and Non- Diabetic Children	Buurman	2018	-	[15]
63	Elements of Gameful Design Emerging from User Preferences	Tondello	2017	-	[143]
64	Gamification Design Elements	Enterprise Gamification	2017	66	[43]
65	Personality-targeted Gamification: A Survey Study on Personality Traits and Motivational Affordances	Jia	2016	66	[65]
66	The Gamification Toolkit: Dynamics, Mechanics, and Components for the Win	Werbach and Hunter	2015	66	[149]
67	Towards personalised, gamified systems: an investigation into game design, personality and player typologies	Ferro	2013	66	[35]
68	Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps	Zichermann and Cunningham	2011	66	[168]
69	What Makes Games Fun? Card Sort Reveals 34 Sources of Computer Game Enjoyment	Schaffer, Fang	2018	-	[127]
70	EE380: Computer Systems Colloquium Seminar	Chuck Clanton, Aratar	2017	-	[135]
71	Dimensions of video game behavior and their relationships with personality	Worth	2015	-	[160]
72	The art of Game Design	Jesse Schell	2008	-	[128]
73	The Theory of Basic Human values	Schwartz	1973	72	[129]
74	Hierarchy of needs (reviseted)	Maslow	1970	72	[39]

Table A.2

Games *Game type* Method	**Candy crush** *achieving*	**Hearthstone** *defending*	**Dota 2** *defending*	**Fornite** *defending*	**Overwatch** *defending*	**rocket leage** *defending*	**farmville** *building*	**clash of clans** *defendeing*	**angrybird** *achieving/puzzle*	**SKyrim** *adventure*	**WoW** *adventuer*	**Plants vs zombies** *defending*	**clash royaal** *defending*	**pokemon go** *adventure, collecting*	**subway surfer** *infinte runner*	**fruit ninja** *infinte runner*
replayable modes/levels / infinite gameplay	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Welcome (back) package	no	yes	no	unsure	no	unsure	yes	yes	yes	no	yes	yes	yes	no	no	no
Ranking	no	yes	yes	yes	yes	yes	possible	yes	yes	no	yes	no	yes	no	yes	yes
Free to play	no	yes	yes	yes	no	no	yes	yes	yes	no	yes/no	yes	yes	yes	yes	yes
Pay to win	no	yes	no	no	no	no	no	yes	possible	no	no	no	possible	no	no	no
DDA (e.g. Online match making)	no	yes	yes	yes	yes	yes	no	yes	yes	no	yes	yes	yes	yes	no	possible
Shop	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes
Variety of gameplay modes	no	yes	yes	yes	yes	yes	yes	no	yes	no	unsure	yes	yes	no	no	yes
freemium	yes	yes	yes	yes	no	yes	no	yes	yes	no	no	no	yes	no	yes	no
quests (get one after completing one)	yes	yes	no	no	no	no	yes	no	no	yes	yes	unsure	no	no	no	yes
daily quests	no	yes	yes	yes	yes	no	yes	yes	yes	(yes)	yes	yes	yes	no	yes	yes
achievements	no	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
challenges (e.g. within certain amount of time or moves(puzzle), or challenge general)	no	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
in game econimcs (trading for example)	no	yes	yes	no	no	yes	yes	yes	no	yes	yes	no	no	yes	no	no
win/loose streaks	yes	no	yes	no	yes	no	unknown	no rewards	yes	no	no	yes	no	no	yes	unsure
lootboxes	no	yes	yes	yes	yes	no	no	no	yes	unsure	no	yes	yes	yes	yes	no
group commitment/social pressure	yes	no	possible	possible	possible	no	yes	possible	unsure	no	yes	no	no	possibly	no	no
Sunken cost valley . (invesment)	yes	yes	yes	no	no	no	yes	yes	no	yes	yes	possible	possible	no	no	no
Optimizng flow (carefull game design)	no	no	no	no	no	no	yes	no/yes	yes	yes	yes	yes	yes	no	no	yes
Rewards for inviting friends	yes	yes	no	no	no	no	yes	no	yes	no	yes	no	no	yes	yes	no
In game gathering/completing	no	yes	no	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	possible	yes
Daily free bonus	yes	no	no	no	no	no	no	no	yes	no	no	no	yes	no	no	yes
return streaks bonuses	yes	no	yes	no	no	no	no	no	no	no	no	no	yes	no	yes	yes
limited time challenges	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes
competition	yes	yes	yes	yes	yes	yes	possible	yes	yes	no	yes	no	yes	yes	yes	no
leveling	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes
limited lives	yes	no	no	no	no	no	no	no	possible	no	no	no	no	no	no	no
mobile popups/ reminders	yes	unknown	no	yes	no	no	possible	yes	possible	no	no	unsure	unsure	no	yes	unsure
Watch add for rewards	yes	no	no	no	no	no	no	no	yes	no	no	yes	no	no	yes	yes
motivate comminuty	no	yes	no	no	yes	yes	yes	yes	yes	no	yes	no	yes	yes	no	no
New content generation	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	possible	yes	yes	yes	yes
leaderbord	yes	yes	yes	yes	yes	yes	no	yes	yes	no	yes	no	yes	no	yes	yes
limited time availability of items in shop	no	no	no	yes	no	no	no	no	no	no	yes	yes	no	yes	yes	yes
Feedback + tips on gameplay	no	no	yes	no	no	no	no	no	no	yes	no	yes	no	no	yes	no
Streams	no	no	yes	yes	yes	yes	possible	yes	yes	nyes	yes	possible	yes	yes	yes	possible
Tournaments	no	no	yes	yes	yes	yes	yes	yes	yes	no	yes	no	yes	no	no	no
real time (strategy) game assistance	no	no	yes	no	no	no	no	no	no	no	yes	no	no	no	no	no
community developed gameplay	no	no	yes	yes	no	yes	no	no	no	yes	no	no	no	no	no	no
reward progress bar for challenges	no	no	no	no	yes	yes	no	yes	no	no	no	no	yes	yes	yes	yes
stats review	no	no	yes	yes	yes	possible	no	no	no	no	no	no	no	yes	no	no

Table A.3: **Game mechanics analyses** Sixteen different games have been studied through playing the games. Mechanics that could not be found, but might appear later in the game have been search for via Internet.

Mechanic	Occurrence
replayable modes/levels / infinite gameplay	16
Shop	15
limited time challenges	15
leveling	15
New content generation	15
achievements	14
challenges (e.g. within certain amount of time or moves(puzzle), or challenge general)	14
daily quests	13
Free to play	12
In game gathering/completing	12
competition	12
leaderbord	12
Ranking	11
DDA (e.g. Online match making)	11
Streams	11
Variety of gameplay modes	10
lootboxes	9
motivate comminuty	9
Tournaments	9
freemium	9
in game econimcs (trading for example)	8
Optimizng flow (carefull game design)	8
Welcome (back) package	7
Sunken cost valley . (invesment)	7
Rewards for inviting friends	7
reward progress bar for challenges	7
quests (get one after completing one)	6
limited time availability of items in shop	6
win/loose streaks	6
return streaks bonuses	5
Watch add for rewards	5
Daily free bonus	4
mobile popups/ reminders	4
Feedback + tips on gameplay	4
community developed gameplay	4
stats review	4
group commitment/social pressure	3
Pay to win	2
real time (strategy) game assistance	2
limited lives	1

Table A.4: Occurrence of 40 found mechanics in 16 analyzed games

Additionally we looked which games contained the most mechanics. See Table 3.4. We note that the MMORPG (Massive Multi Online Role Playing Game) is one of the the games that contains the most elements, whereas the Adventure games contains the least.

Number	Game
26	WoW
26	Dota 2
26	angrybird
25	clash of clans
25	clash royaal
22	Hearthstone
22	Fornite
22	subway surfer
21	Overwatch
20	rocket leage
20	fruit ninja
20	farmville
19	pokemon go
18	Candy crush
18	Plants vs zombies
14	SKyrim

Table A.5: Games order by number of game mechanics inside the game

B

Survey

B.1. Participant gathering

B.1.1. Consent & GDPR

We followed the regulations of the Technical University of Delft in regard to privacy. TU Delft accepted the research propositions, survey structure and contents.

B.1.2. Facebook Promotion

To gather more participants for this study a facebook promotion was executed. The promotion took place for 4 days. €9,17 euro was spend. It was target on people from ages: 18 to 65+, with interests in in following key words: Onlinegames, GameSpot, AddictingGames, Game of Videogames. Automatic placement by facebook was used. It reached 36317 people and resulted in 293 clicks. An example of how such an add looked like can be found in Figure B.1

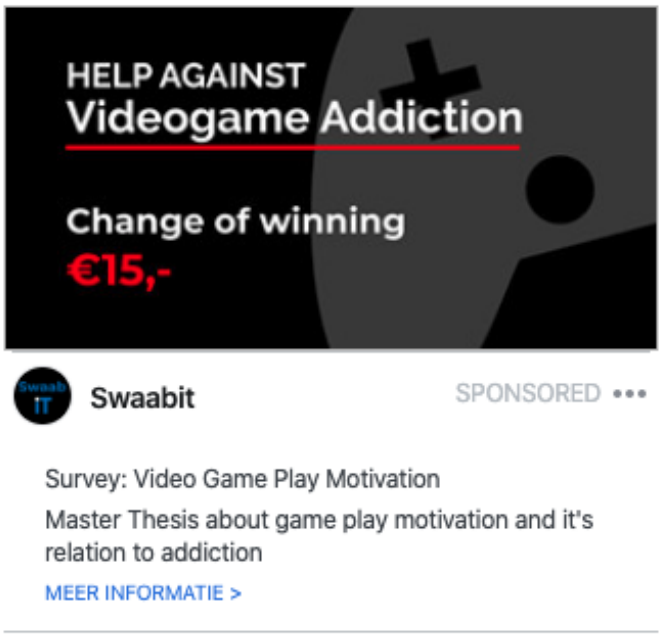


Figure B.1: Example of the Facebook add used

B.2. Question List

The following sections contain all the questions used in the survey. The important questions are shown with answer type and split per category (demographic, games, addiction and motivation).

B.2.1. Demographic questions

	Question	Answer form
1	What is your gender?	f/m/not listed + option of other
2	What is your age?	number
3	In which country do you live?	selection box + option of other

Table B.1: Demographic question

B.2.2. Addiction questions

Addiction questions as described from Lemmens et al. [90]

	Question	Answer form
	In the past year:	
1	have there been periods when all you could think of was the moment that you could play a game?	yes/no
2	have you felt unsatisfied because you wanted to play more?	yes/no
3	have you been feeling miserable when you were unable to play a game?	yes/no
4	were you unable to reduce your time playing games, after others had repeatedly told you to play less?	yes/no
5	have you played games so that you would not have to think about annoying things?	yes/no
6	have you had arguments with others about the consequences of your gaming behavior?	yes/no
7	have you hidden the time you spend on games from others?	yes/no
8	have you lost interest in hobbies or other activities because gaining is all you wanted to do?	yes/no
9	have you experienced serious conflicts with family, friends or partner because of gaming?	yes/no

Table B.2

B.2.3. Game questions

	Question	Answer form
1	Please give a rough indication of the number of video games you played, in the past year.	number
2	What are the names of the games you played most?	text
3	how often(frequency) do you play(start up) these games? (session)	number per time format(day/week/month/year)
4	how long (time in minutes) do you play per session?	minutes
5	Have you ever spend money (besides the purchase of the game itself) on these video games?	no/yes/yes, including loot-boxces

Table B.3: Game related questions. Depending on the number of games the player submits for question 1, a player will receive either 1,2 or 3 optional answer boxes for the questions 2 to 5.

B.2.4. Motivation questions

	Categorie	Question	Form
1	Meaning	I feel a sense of purpose	A
2	Energized	I feel excited/energized	A
3	Focus	I forget (am distracted) about my surroundings/environment/time	A
4	Guiding	I get to help or adivce other players	A
5	Self-worth & Integrity	I feel good about myself (imporant/confident/smart/powerfull/proud)	A
6	Exercise	I feel motivated to improve mentally or phisically	A
7	Identification with Player Avatar	I become the character	A
8	simulation/Relatedness	I experience a close representation of the (real) world we know	A
9	fantasy	I experience a different world or reality than our own	A
10	story	I want to bring the story to a good end	B
11	humor	I laugh about jokes or about the interaction	B
12	coorperation	I coorperate with other human players	A
13	Social discovery	I make contact with new people	A
14	Friendship	I can play it together with friends	A
15	savoring	I think back about memorable moments	A
16	community	I can use the community to get further	B
17	Expression	I can express myself through communication	A
18	Exploration	I explore the things I dont know	A
19	Curiosity	I want to discover what will happen next	A
20	Tension	I like the feeling of tension	B
21	Problem Solving	I can solve problems/puzzles	B
22	Strategizing	I can strategize, plan or precict	B
23	Autonomy	I control the direction and pace of the game	B
24	Transparency & Feedback	I know what I can and can not do	B
25	Relaxation	I feel relaxed	A
26	Aesthetic satisfaction	I enjoy the look,feel and sound	B
27	Creating	I can use my creativity to create, customize or improvise	A
28	Competence	I use and develop (different) skillsets	A
29	Goal setting	I know what to do next	B
30	fairness	I feel it's fair	B
31	Balance/Flow (challenge, pacing etc)	I believe that I can make progress	B
32	Making progress	I'm aware of the progress I made or the things I learned	B
33	Self-Reflection	I can reflect on my ability or performance	B
34	Acievement	I try to complete challenges/achievements	B
35	Rewards	I'll put in the effort for a task when i'll get a reward	B
36	Competition	I can compete with or compare myself to others	A
37	Social Status/Recognition	I can present my gameplay skills to others	A
38	Economy	I can spend money to get the things that I want	B
39	Collecting	I try to gather or collect al items of a set	B
40	FOMO	I prevent missing out on certain (limited) experiences or events	A
41	Investment/Sunken Cost Valley	I value the investment I made in time,money or relationships and try to protect this	B
42	Schadenfreude	I enjoy the failing of others	B
43	Freedom	I'm free to do whatever I want	B
44	Accesiblity	I can play the game whenever I want	B

Table B.4: Motivation question list. All questions where answered based on a 7-point-likert like scale. The form indicates what text went prior to the question. A indicating: "By playing this game,", B indicating: "I play this game, because"

B.3. Additional analyses

Component	Eigenvalues per dataset *full*	*sub1*	*sub2*	*sub3*
0	**8.0553**	**9.26536**	**7.19418**	**8.26266**
1	**6.06195**	**5.57764**	**6.11244**	**6.11743**
2	**2.5057**	**2.43829**	**2.66469**	**2.8719**
3	**1.93224**	**2.37421**	**2.32626**	**1.98615**
4	**1.79045**	**1.93486**	**2.10422**	**1.95303**
5	**1.62644**	**1.63883**	**1.69015**	**1.83893**
6	**1.30298**	**1.49919**	**1.47052**	**1.62893**
7	**1.25397**	**1.38552**	**1.39696**	**1.35281**
8	**1.14523**	**1.28842**	**1.28902**	**1.244**
9	**1.12373**	**1.25208**	**1.23314**	**1.19417**
10	**1.01782**	**1.13425**	**1.1497**	**1.1096**
11	0.982303	0.99941	**1.07623**	**1.04983**
12	0.915611	0.979837	**1.01979**	0.947381
13	0.863697	0.918531	0.985368	0.909584
14	0.851543	0.863338	0.919072	0.829284
15	0.783883	0.80191	0.898116	0.81026
16	0.766952	0.75723	0.788605	0.705707
17	0.734346	0.698452	0.729707	0.669176
18	0.690266	0.644649	0.695699	0.65387
19	0.665534	0.608945	0.672282	0.600736
20	0.635847	0.596397	0.618383	0.579943
21	0.584386	0.550111	0.574424	0.551748
22	0.569715	0.514893	0.530849	0.529571
23	0.556871	0.49279	0.514362	0.49436
24	0.527959	0.45813	0.466075	0.452659
25	0.499455	0.444085	0.453921	0.431497
26	0.485633	0.408116	0.419198	0.410213
27	0.441332	0.356796	0.38471	0.372907
28	0.430192	0.343804	0.371725	0.355688
29	0.406895	0.32153	0.337155	0.338522
30	0.373875	0.293816	0.318246	0.304934
31	0.352505	0.26425	0.304265	0.28905
32	0.344473	0.232963	0.294493	0.268988
33	0.33466	0.227665	0.278287	0.245906
34	0.30378	0.205567	0.255132	0.234262
35	0.297149	0.186974	0.233018	0.23162
36	0.288625	0.177951	0.211717	0.207752
37	0.271714	0.163838	0.203312	0.188692
38	0.253853	0.156972	0.183312	0.168576
39	0.222009	0.137525	0.160358	0.156056
40	0.213945	0.125681	0.158589	0.135192
41	0.196638	0.117283	0.11963	0.117102
42	0.182899	0.0941708	0.103708	0.107942
43	0.155647	0.0677489	0.0889656	0.0913914

Table B.5: Eigenvalues for the different datasets. Using varimax. The eigenvaluesabove 1.0 are highlighted.

B.3.1. Technical details

Qualtrics was provided by TU Delft and is in line with the *General Data Protection Regulation*(GDPR). It's a browser based platform, that also supports touchscreen based devices like mobile and tablets. The software was written in python version 3.7. Python was preferred over SPSS due to it's more user friendly code base,

support and author's knowledge. Access to the code base can be requested by contacting the author. The code base consist methods for: data cleaning, preprocessing, dataset formation, visualization, clustering similarity and applying factor analysis with different settings. The whole process is automated. Although the code base would benefit from more extensive documentation and some clean up, it provides a base to quickly repeat and continue on the same type of comparisons and calculations.

B.4. Full Survey

Here follows in copy of the survey without a number of questions selected. (TODO: replace with specific number of questions selected)

Informed Consent

Welcome to this research study!

We are interested in understanding the reasons why people play video games and how this might relate to internet gaming addiction. The data of the survey is used the create player profiles (based on a addiction measurement and gameplay motivators). The data gathered by playing the game is used to measure the level of susceptibility for these profiles towards certain game mechanics.

This research is excuted as part of a Master Thesis at Delft University of Technology. It contains 2 parts:

1. *This survey*
2. *The game, which will be available later on, leave your email-adress to get acces. Playing the game is optional, but would help the research a lot!*

Content: You will be presented with questions relevant to some personal information, addiction, and video gaming.

Please note

- Device: This survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.
- Progress: You can close the survey tab, progression is saved for a week.
- Duration: The study should take you around 15 minutes to complete.
- Reward: One randomly selected participant (that did both fill in the survey and played the game) will receive a gift card of 15,- euro for a web-store of choice.

Consent

Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Daniël Swaab: d.swaab@student.tudelft.nl

Please be assured that your responses will be kept completely confidential, and are in regulations with TU Delft's data protection regulations and GDPR. We believe there are no known risks associated with this research study; however, as with any online related activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by storing personal data only on protected servers or anomyzing the data thoroughly.

By clicking the button below, you acknowledge that your participation in the study is voluntary, you're at least 16 years old, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

- ◯ I consent, begin the study
- ◯ I do not consent, I do not wish to participate

Block 4

Email Adress

The survey would like to collect your email-address for sending you :

1. Your personal gameplay acces code! (This way your survey data and game play data can be related). *Important for participating in the second part of the study.*
2. Updates about the research and results of the study.
3. Your personal profile

I would like to receive emails about:

- [ ] 1. A code to play the game
- [ ] 2. Updates and results of the study
- [ ] 3. My personal profile

What is your email address?

Block 2

Personal Information

Do you agree with your data (age, gender, current country of residence, addiction and motivators data) being shared through a public repository at the end of the research project?

- ○ I consent, my: age, gender, country of residence addiction and motivator data me be shared through a public repository
- ○ I do not consent

What is your age?

What is your gender?

- ○ Male
- ○ Female
- ○ Other:

In which country do you currently reside?

Block 4

Definitions

All the questions in the survey are related to playing video games. These are games that:

- do **not** pursue financial gain. (A.k.a. gambling)
- are played through a digital device (e.g.: pc, mobile, tablet, console)

Addiction

This study wants to correlate gameplay motivators and gameplay addiction. Therefore the next section is used to get an indication of your level of addiction towards video gaming. Be aware that these question can be quite confronting.

Block 5

Questions in regard to addiction

In the past year:

	Yes	No
Have there been periods when all you could think of was the moment that you could play a video game?	○	○
Have you felt unsatisfied because you wanted to play more?	○	○
Have you been feeling miserable when you were unable to play a video game?	○	○
Were you unable to reduce your time playing video games, after others had repeatedly told you to play less?	○	○
Have you played video games so that you would not have to think about annoying things?	○	○
Have you had arguments with others about the consequences of your video gaming behavior?	○	○
Have you hidden the time you spend on video games from others?	○	○
Have you lost interest in hobbies or other activities because video gaming is all you wanted to do?	○	○
Have you experienced serious conflicts with family, friends or partner because of video gaming?	○	○

Block 10

Played Video Games

The following quesitons are about which video games you play and how much you play them.

Please give a rough indication of the number of video games you played, in the past year.

Number: ____

What are the names of the games you played most?

Game name 1
Game name 2
Game name 3

What is the name of the game you played most?

Game name:

Block 9

On average:

- how often(frequency) do you play(start up) these games? (session)
- how long (time in minutes) do you play per session?

	Number of sessions (frequency) Number	Recurrence per	Average time per session Minutes
${q://QID36/ChoiceTextEntryValue/1}			
${q://QID30/ChoiceTextEntryValue/1}			
${q://QID30/ChoiceTextEntryValue/2}			
${q://QID30/ChoiceTextEntryValue/3}			

Have you ever spend money (besides the purchase of the game itself) on these video games?

	No	Yes, including Loot-boxes	Yes
${q://QID36/ChoiceTextEntryValue/1}	○	○	○
${q://QID30/ChoiceTextEntryValue/1}	○	○	○
${q://QID30/ChoiceTextEntryValue/2}	○	○	○
${q://QID30/ChoiceTextEntryValue/3}	○	○	○

Block 11

Video gameplay motivators

This is the last part of the survey. The following 44 questions are about your motivation to play video games. When answering these questions consider your most played game(s) you mentioned before:

- **${q://QID36/ChoiceTextEntryValue/1}**
- **${q://QID30/ChoiceTextEntryValue/1}**

- **${q://QID30/ChoiceTextEntryValue/2}**
- **${q://QID30/ChoiceTextEntryValue/3}**

Block 8

By playing this game, I feel a sense of purpose

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I feel excited/energised

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I forget (am distracted) about my surroundings/environment/time

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I get to help or advice other players

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I feel good about myself (important/confident/smart/powerful/proud)

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I feel motivated to improve mentally or physically

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I become the character

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I experience a close representation of the (real) world we know

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I experience a different world or reality than our own

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I want to bring the story to a good end

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I laugh about jokes or about the interaction

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I cooperate with other human players

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I make contact with new people

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I can play it together with friends

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I think back about memorable moments

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I can use the community to get further

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I can express myself through communication

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I explore the things I don't know

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I want to discover what will happen next

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I like the feeling of tension

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I can solve problems/puzzles

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I can strategise, plan or predict

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I control the direction and pace of the game

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I know what I can and can not do

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I feel relaxed

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I enjoy the look, feel and sound

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I can use my creativity to create, customise or improvise

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I use and develop (different) skillsets

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I know what to do next

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I feel it's fair

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I believe that I can make progress

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I'm aware of the progress I made or the things I learned

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I can reflect on my ability or performance

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I try to complete challenges/achievements

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I'll put in the effort for a task when i'll get a reward

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I can compete with or compare myself to others

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I can present my gameplay skills to others

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I can spend money to get the things that I want

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I try to gather or collect al items of a set

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

By playing this game, I prevent missing out on certain (limited) experiences or events

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I value the investment I made in time, money or relationships and try to protect this

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I enjoy the failing of others

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I'm free to do whatever I want

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

I play this game, because I can play the game whenever I want

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disa
${q://QID30/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID36/ChoiceTextEntryValue/1}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/2}	○	○	○	○	○	(
${q://QID30/ChoiceTextEntryValue/3}	○	○	○	○	○	(

Block 9

Done!

○ Submit the survey

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Motivator	Component					
	1	*2*	*3*	*4*	*5*	*6*
I cooperate with other human players	0.779	0.014	-0.105	-0.057	0.093	0.036
I make contact with new people	0.769	0.111	0.054	0.119	0.118	-0.112
I can play it together with friends	0.748	-0.058	-0.14	-0.155	0.114	0.036
I can express myself through communication	0.711	0.22	0.149	-0.053	-0.032	-0.021
I get to help or advice other players	0.71	0.208	0.088	0.125	0.039	0.039
I can present my gameplay skills to others	0.665	0.072	-0.207	0.077	0.388	0.103
I can compete with or compare myself to others	0.609	-0.033	-0.42	0.037	0.355	-0.027
I can solve problems/puzzles	-0.406	0.354	0.193	0.219	-0.124	0.098
I prevent missing out on certain (limited) experiences or events	0.4	0.215	0.156	0.224	0.048	-0.333
I can spend money to get the things that I want	0.385	0.283	0.256	0.238	0.107	-0.139
I use and develop (different) skillsets	0.089	0.656	-0.011	0.037	0.244	0.076
I feel a sense of purpose	0.113	0.645	0.272	-0.032	-0.01	0.115
I feel motivated to improve mentally or physically	0.183	0.631	-0.027	0.101	0.21	-0.002
I can reflect on my ability or performance	0.163	0.562	-0.191	0.147	0.357	-0.106
I can use my creativity to create, customise or improvise	0.013	0.508	0.097	0.003	-0.03	0.427
I explore the things I don't know	-0.084	0.49	0.386	0.165	-0.068	0.135
I believe that I can make progress	-0.005	0.444	0.106	0.309	0.007	0.069
I experience a close representation of the (real) world we know	0.04	0.425	0.32	-0.032	-0.103	0.025
I feel good about myself (important/confident/smart/powerful/proud)	0.245	0.417	0.116	0.087	0.381	0.25
I can use the community to get further	0.407	0.417	0.131	0.191	0.049	0.077
I'm aware of the progress I made or the things I learned	0.211	0.402	0.072	0.385	0.004	0.15
I value the investment I made in time, money or relationships and try to protect this	0.312	0.359	0.303	0.347	-0.051	-0.08
I feel it's fair	-0.047	0.303	0.004	0.055	0.039	0.222
I become the character	0.061	0.159	0.732	0.052	0.138	0.071
I want to bring the story to a good end	-0.331	0.141	0.695	0.16	-0.098	-0.058
I want to discover what will happen next	-0.269	0.112	0.639	0.277	-0.109	0.05
I experience a different world or reality than our own	0.038	0.06	0.595	0.154	-0.027	0.124
I laugh about jokes or about the interaction	0.263	-0.046	0.414	0.045	0.112	0.077
I enjoy the look, feel and sound	-0.093	0.037	0.402	0.156	0.134	0.263
I think back about memorable moments	0.307	0.063	0.4	-0.033	0.129	0.093
I try to gather or collect al items of a set	-0.024	0.095	0.211	0.631	-0.082	-0.134
I'll put in the effort for a task when i'll get a reward	0.132	0.182	0.15	0.475	0.06	0.238
I try to complete challenges/achievements	-0.079	0.056	0.268	0.471	-0.002	0.086
I can play the game whenever I want	-0.055	-0.031	-0.043	0.394	0.014	0.12
I know what I can and can not do	0.188	0.297	0.048	0.353	0.095	0.121
I like the feeling of tension	0.184	0.077	0.103	0.045	0.634	-0.086
I feel excited/energised	0.177	0.162	0.154	-0.046	0.511	0.181
I enjoy the failing of others	0.401	0.072	-0.055	-0.048	0.405	-0.084
I control the direction and pace of the game	-0.129	0.218	0.272	0.272	0.031	0.488
I'm free to do whatever I want	0.031	0.124	0.384	0.109	-0.151	0.468
I can strategise, plan or predict	0.13	0.251	0.006	0.101	0.254	0.459
I feel relaxed	-0.061	-0.002	0.139	0.113	-0.245	0.321

Table B.6: Full dataset overview of factor loadings on 6 components

Question	Component					
	1 2	*3*	*4*	*5*	*6*	
I can play it together with friends	0.793	-0.114	-0.022	-0.077	-0.009	-0.031
I can compete with or compare myself to others	0.776	0.024	-0.242	-0.012	-0.014	-0.288
I cooperate with other human players	0.775	-0.028	0.005	0.084	0.053	0.027
I can present my gameplay skills to others	0.736	0.045	-0.167	0.184	0.081	-0.199
I can express myself through communication	0.733	0.217	0.167	-0.024	-0.129	0.195
I make contact with new people	0.718	0.12	0.05	-0.102	0.113	-0.023
I get to help or advice other players	0.714	0.187	0.194	0.018	0.12	0.319
I enjoy the failing of others	0.504	0.028	-0.022	-0.065	-0.153	-0.24
I can use the community to get further	0.466	0.358	0.097	0.031	0.218	0.074
I feel good about myself (important/confident/smart/powerful/proud)	0.44	0.4	0.03	0.369	0.043	-0.178
I can solve problems/puzzles	-0.435	0.303	0.059	0.112	0.382	0.213
I feel excited/energised	0.365	0.141	0.172	0.275	-0.008	-0.189
I can spend money to get the things that I want	0.33	0.243	0.234	-0.036	0.28	-0.009
I prevent missing out on certain (limited) experiences or events	0.307	0.307	0.185	-0.169	0.158	-0.057
I feel a sense of purpose	0.032	0.681	0.245	0.134	0.033	0.073
I feel motivated to improve mentally or physically	0.267	0.63	0.004	0.055	0.035	-0.013
I use and develop (different) skillsets	0.069	0.612	0.102	0.15	0.072	-0.047
I can reflect on my ability or performance	0.281	0.601	-0.088	0.082	0.042	-0.318
I believe that I can make progress	-0.052	0.468	0.126	0.169	0.23	0.096
I can use my creativity to create, customise or improvise	-0.031	0.455	0.078	0.353	0.131	0.161
I'm aware of the progress I made or the things I learned	0.268	0.421	0.097	0.32	0.211	0.195
I experience a close representation of the (real) world we know	0.033	0.382	0.34	0.019	0.024	0.16
I know what I can and can not do	0.119	0.337	0.056	0.303	0.32	0.123
I feel it's fair	-0.05	0.321	-0.015	0.171	-0.03	-0.033
I become the character	-0.101	0.286	0.741	0.109	0.052	-0.164
I want to bring the story to a good end	-0.452	0.153	0.646	0.044	0.295	-0.048
I think back about memorable moments	0.232	-0.026	0.564	0.052	-0.014	-0.02
I laugh about jokes or about the interaction	0.221	-0.169	0.533	0.168	-0.004	0.099
I explore the things I don't know	-0.179	0.426	0.514	0.157	0.202	0.237
I want to discover what will happen next	-0.339	0.15	0.51	0.282	0.3	0.12
I experience a different world or reality than our own	0.033	0.241	0.449	0.216	0.142	-0.005
I can strategise, plan or predict	0.157	0.24	-0.01	0.614	0.154	-0.147
I'm free to do whatever I want	-0.014	0.097	0.274	0.549	0.019	0.448
I control the direction and pace of the game	-0.177	0.288	0.171	0.515	0.203	0.253
I enjoy the look, feel and sound	-0.064	0.103	0.271	0.445	0.024	0.039
I know what to do next	-0.085	0.268	0.105	0.324	0.183	0.05
I try to gather or collect al items of a set	0.027	0.041	0.212	-0.045	0.656	0.0
I try to complete challenges/achievements	-0.012	0.017	0.193	0.077	0.626	0.024
I'll put in the effort for a task when i'll get a reward	0.108	0.2	-0.03	0.345	0.557	-0.088
I can play the game whenever I want	0.006	0.049	-0.141	0.162	0.416	0.142
I value the investment I made in time, money or relationships and try to protect this	0.244	0.332	0.331	0.137	0.355	0.06
I like the feeling of tension	0.336	0.108	0.222	0.129	0.06	-0.454
I feel relaxed	-0.021	0.052	0.015	0.053	0.092	0.427

Table B.7: Sub1 dataset overview of factor loadings on 6 components

Questions	Component					
	1	*2*	*3*	*4*	*5*	*6*
I make contact with new people	0.831	0.107	0.033	0.005	-0.088	0.092
I cooperate with other human players	0.766	0.145	-0.275	0.107	0.073	0.02
I get to help or advice other players	0.764	0.198	-0.028	0.021	0.047	0.055
I can play it together with friends	0.734	0.031	-0.309	0.129	0.024	-0.038
I can express myself through communication	0.725	0.137	0.071	-0.085	0.01	0.114
I can present my gameplay skills to others	0.714	0.185	-0.374	0.244	0.026	0.037
I prevent missing out on certain (limited) experiences or events	0.515	0.055	0.169	-0.0	-0.319	0.221
I can spend money to get the things that I want	0.475	0.222	0.239	0.036	-0.17	0.164
I think back about memorable moments	0.447	0.012	0.138	0.242	0.2	-0.191
I laugh about jokes or about the interaction	0.432	-0.144	0.184	0.293	0.053	0.095
I enjoy the failing of others	0.415	0.153	-0.201	0.321	-0.261	-0.068
I feel a sense of purpose	0.209	0.7	0.242	-0.032	0.077	-0.053
I feel motivated to improve mentally or physically	0.156	0.673	0.023	0.236	-0.243	0.127
I use and develop (different) skillsets	0.136	0.66	-0.063	0.264	-0.063	0.002
I can use my creativity to create, customise or improvise	0.078	0.591	0.057	-0.066	0.288	-0.017
I can reflect on my ability or performance	0.134	0.561	-0.239	0.197	-0.218	0.084
I can strategise, plan or predict	0.167	0.48	-0.056	0.122	0.357	-0.041
I can use the community to get further	0.446	0.466	0.096	0.098	0.022	0.159
I feel good about myself (important/confident/smart/powerful/proud)	0.276	0.453	-0.008	0.281	0.162	0.068
I feel it's fair	-0.122	0.432	-0.002	0.007	0.167	0.028
I explore the things I don't know	0.079	0.431	0.381	-0.039	0.125	0.151
I experience a close representation of the (real) world we know	0.127	0.374	0.262	-0.062	0.053	-0.029
I want to bring the story to a good end	-0.179	0.068	0.793	0.0	0.005	0.068
I want to discover what will happen next	-0.122	0.033	0.675	0.056	0.132	0.274
I become the character	0.254	0.087	0.649	0.194	0.108	-0.193
I can compete with or compare myself to others	0.49	0.051	-0.615	0.231	-0.186	0.05
I experience a different world or reality than our own	0.151	-0.039	0.529	0.231	0.285	0.194
I can solve problems/puzzles	-0.287	0.283	0.312	-0.206	0.11	0.102
I feel excited/energised	0.154	0.291	-0.013	0.64	0.093	-0.053
I like the feeling of tension	0.232	0.135	0.028	0.54	-0.211	-0.193
I enjoy the look, feel and sound	-0.088	0.005	0.317	0.491	0.286	0.176
I control the direction and pace of the game	-0.016	0.272	0.181	0.234	0.608	0.074
I'm free to do whatever I want	0.065	0.222	0.212	-0.078	0.511	0.164
I feel relaxed	-0.184	-0.041	0.058	-0.02	0.392	0.119
I try to gather or collect al items of a set	0.076	-0.006	0.377	-0.197	-0.052	0.533
I believe that I can make progress	0.036	0.394	0.128	0.029	0.133	0.473
I value the investment I made in time, money or relationships and try to protect this	0.415	0.263	0.249	-0.022	-0.069	0.428
I can play the game whenever I want	-0.024	-0.079	-0.092	0.028	0.056	0.421
I'm aware of the progress I made or the things I learned	0.311	0.389	-0.001	-0.044	0.221	0.402
I try to complete challenges/achievements	0.062	-0.002	0.226	-0.18	0.132	0.363
I know what I can and can not do	0.252	0.112	0.037	0.238	0.077	0.36
I'll put in the effort for a task when i'll get a reward	0.275	0.203	0.166	0.031	0.159	0.32

Table B.8: Sub2 dataset overview of factor loadings on 6 components

Motivator	Component					
	1	*2*	*3*	*4*	*5*	*6*
I can play it together with friends	0.777	-0.119	-0.037	-0.165	0.094	0.091
I cooperate with other human players	0.759	-0.061	0.07	-0.181	0.108	-0.008
I make contact with new people	0.754	-0.005	0.285	0.013	0.123	-0.059
I can present my gameplay skills to others	0.659	-0.096	0.064	0.132	0.385	0.134
I can compete with or compare myself to others	0.651	-0.3	-0.054	0.2	0.28	0.0
I get to help or advice other players	0.649	0.051	0.265	0.19	-0.046	0.063
I can express myself through communication	0.593	0.162	0.408	-0.024	-0.126	-0.127
I can solve problems/puzzles	-0.423	0.16	0.231	0.093	-0.022	0.183
I enjoy the failing of others	0.352	-0.055	0.169	0.008	0.346	0.136
I become the character	0.055	0.729	0.134	-0.064	0.144	0.12
I experience a different world or reality than our own	0.037	0.712	0.058	0.09	-0.138	0.046
I want to discover what will happen next	-0.255	0.691	0.193	0.053	-0.005	-0.024
I want to bring the story to a good end	-0.388	0.618	0.188	-0.012	0.003	-0.109
I enjoy the look, feel and sound	-0.1	0.558	0.041	0.073	-0.003	0.036
I'm free to do whatever I want	0.077	0.521	0.008	0.159	-0.27	0.196
I control the direction and pace of the game	-0.019	0.452	0.035	0.396	-0.071	0.343
I think back about memorable moments	0.297	0.391	0.108	0.041	0.202	0.08
I try to complete challenges/achievements	-0.177	0.383	0.095	0.354	0.089	-0.058
I explore the things I don't know	-0.135	0.35	0.341	0.177	0.068	0.142
I laugh about jokes or about the interaction	0.259	0.326	0.014	0.041	0.238	0.089
I value the investment I made in time, money or relationships and try to protect this .17	0.3	0.596	0.179	-0.064	-0.094	
I feel a sense of purpose	0.035	0.307	0.574	-0.018	-0.065	0.156
I feel motivated to improve mentally or physically	0.059	-0.08	0.572	0.109	0.11	0.312
I can reflect on my ability or performance	0.067	-0.158	0.56	0.307	0.434	0.129
I use and develop (different) skillsets	0.049	-0.11	0.557	0.117	0.228	0.289
I can spend money to get the things that I want	0.299	0.222	0.47	0.096	0.109	0.039
I can use the community to get further	0.178	0.162	0.469	0.114	0.046	0.112
I prevent missing out on certain (limited) experiences or events	0.313	0.077	0.461	0.17	0.157	-0.345
I believe that I can make progress	-0.017	0.027	0.423	0.348	0.023	0.052
I feel good about myself (important/confident/smart/powerful/proud)	0.222	0.194	0.384	0.179	0.261	0.321
I experience a close representation of the (real) world we know	-0.057	0.308	0.383	-0.047	-0.01	0.05
I try to gather or collect al items of a set	-0.098	0.288	0.235	0.659	0.05	-0.096
I'm aware of the progress I made or the things I learned	0.007	0.016	0.334	0.445	0.128	0.111
I can play the game whenever I want	-0.039	-0.022	-0.003	0.431	-0.197	-0.043
I'll put in the effort for a task when i'll get a reward	0.173	0.27	0.167	0.43	0.047	0.189
I know what I can and can not do	0.187	-0.028	0.354	0.387	-0.059	0.25
I know what to do next	0.03	0.053	0.08	0.374	0.124	0.361
I like the feeling of tension	0.165	0.077	0.135	-0.012	0.579	0.061
I feel excited/energised	0.201	0.218	0.053	0.016	0.575	0.224
I feel relaxed	-0.046	0.316	0.035	0.114	-0.506	0.133
I can use my creativity to create, customise or improvise	-0.084	0.131	0.39	-0.047	-0.161	0.572
I can strategise, plan or predict	0.143	0.092	0.09	0.042	0.117	0.534
I feel it's fair	-0.025	0.035	0.187	0.016	0.058	0.388
I forget (am distracted) about my surroundings/environment/time	-0.198	0.315	-0.075	0.106	0.169	0.364

Table B.9: Sub3 dataset overview of factor loadings on 6 components

C

Game Development

C.1. Game Design

App versus Website
At the start of the game development we had to decide to focus on a browser based application or an mobile application. We choice to focus on a browser based application because this is more accessible towards the general public, and releasing a app for iOs can have many complications. To be sure that iOs players could also play the game web browser was preferred. A disadvantage of a browser game is the experience a user has. First of all running something in a browser keeps the browser active and adjusts the screen size, secondly the user has to take 2 to 3 extra steps to play the game: start a browser, type in the url, go to the url. A solution for this problem is the 'Add website to homescreen' functionality most browser incorporate nowadays. The user only does this ones, and after that the interaction is the same as with other mobile application. After releasing the application we found out certain iOs devices still had trouble running the program, and we suspect for future work it would be better to focus on mobile application development instead of webgl.

Infinite gameplay
We need to have infinite gameplay, because we want to measure playtime. The infinite runner model applies well. A player will not have limited tries per day, because this would restrict the amount of playtime a player can have. A player will however receive limited lives to continue playing a level the moment the player dies. This helps the player continuing where the player last was, but also leaves the player the option to start over.

Session time & Double Logins
Session time is difficult to measure because of the browser based game. Browser have less feedback towards the mobile phone's core system, in comparison to mobile applications. While we are able to measure when a player start a session, it is not possible to determine when a player stops, they can switch to a different application or tab without closing the game. This way it is possible it keeps running in the background. A possible solution would be to record the last action a user has taken, and see that as the ending of a session. However, this raises a new problem. We need to logout the user to be able to start a new session. What if the user goes away for a moment, and has to redo the login every time? This is not preferred. Concurrently we have the problem that a person can login at the same time via two different mediums. This would result in many possible cheats, because the data is only refreshed with the latest user interaction. If a player would open 2 session, spend everything in one, then do a basic action in the other, it would have regained all it's previous inventory and progression. Therefore we choose to work with a keep alive key that is synchronized only when you want to reach the database. While the key is saved on your device it is not possible to access the game on the same account anymore. The moment a new login happens, a new keep a live row is created. This way every keep alive key's date and time will represent the the end time of a session.

Notifications
In the beginning of playing a game a player needs some directions and help to understand how the game works. We prefer to have as little text as possible within the game, because this is not very interactive or attractive. Therefore we sensory feedback to guide the player. The sensory feedback consisted of objects that blink or sound upon achieving something.

Challenges and their rewards

Table C.1 shows what challenge where available to the user, in what order, with what reward and with what time constraint.

						items			
						300	100	400	200
order	name	Description	goal	completion time	coinValue	doublejump	replay	arc	magnet
0	Welcome Bonus!	*A free gift for starting the game, enjoy!*	0	0.5	400	1	1		
1	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	10	0.5	200				1
2	Travel a distance	Just by moving in any directions, in any run, you're your making more distance. Keep on joymping until you complete the distance!	800	0.5	300	1			
3	You Go Get them	Every completed challenge counts. Keep it going!	5	3	600	1	1		1
4	Play play play!	You just gotta play. Each run is counted. What are you waiting for?	15	1	200		2		
5	Beat your highscore!	Just as it says, surpass yourself!	1	1	400			1	
6	Spend those Magnets!	Spend the number of Magnets mentioned below in 1 run!	4	3	400				2
7	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	30	2	600	1	1		1
8	Joymp Joymp Joymp	You just gotta Joymp. Each joymp is counted. What are you waiting for?	100	1	600		2	1	
9	Boostless Reach	Reach the level shown below without using any boosters in your run	2	1	600	2			
10	Spend those Double Jumps!	Spend the number of DoubleJumps mentioned below in 1 run!	5	3	600	2			
11	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	50	2	700	1	2		1
12	Travel a distance	Just by moving in any directions, in any run, you're your making more distance. Keep on joymping until you complete the distance!	2000	2	800	1	1	1	
13	Spend those Arcs!	Spend the number of Arcs mentioned below in 1 run!	5	3	800			2	
14	You Go Get them	Every completed challenge counts. Keep it going!	6	5	1000	1	1	1	1
15	Boostless Reach	Reach the level shown below without using any boosters in your run	3	3	700	1		1	
16	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	100	4	900	1	2		2
17	Play play play!	You just gotta play. Each run is counted. What are you waiting for?	30	2	800		4	1	
18	Beat your highscore!	Just as it says, surpass yourself!	1	4	1400	2		2	
19	Travel a distance	Just by moving in any directions, in any run, you're your making more distance. Keep on joymping until you complete the distance!	5000	3	1000	1	1	1	1
20	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	200	4	1700	2	1	2	1
21	Spend those Double Jumps!	Spend the number of DoubleJumps mentioned below in 1 run!	10	4	2000	5	1	1	
22	Joymp Joymp Joymp	You just gotta Joymp. Each joymp is counted. What are you waiting for?	1000	3	2100	3		3	
23	Boostless Reach	Reach the level shown below without using any boosters in your run	4	4	1700	2	1	2	1
24	Beat your highscore!	Just as it says, surpass yourself!	1	4	2000	2	2	2	2
25	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	500	5	2200	3	1	2	2
26	Spend those Magnets!	Spend the number of Magnets mentioned below in 1 run!	10	4	1800	1	1	1	5
27	Spend those Arcs!	Spend the number of Arcs mentioned below in 1 run!	10	4	2600	1	1	5	1
28	Boostless Reach	Reach the level shown below without using any boosters in your run	5	6	2700	3	2	3	2
29	Travel a distance	Just by moving in any directions, in any run, you're your making more distance. Keep on joymping until you complete the distance!	10000	6	1700	2	1	2	1
30	Spend those Double Jumps!	Spend the number of DoubleJumps mentioned below in 1 run!	20	6	4400	10	2	2	2
31	Play play play!	You just gotta play. Each run is counted. What are you waiting for?	100	4	3000		10		10
32	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	1000	10	2700	3	2	3	2
33	You Go Get them	Every completed challenge counts. Keep it going!	6	30	5000	5	5	5	5
34	Travel a distance	Just by moving in any directions, in any run, you're your making more distance. Keep on joymping until you complete the distance!	15000	20	2400	3	1	3	1
35	Beat your highscore!	Just as it says, surpass yourself!	1	20	3000	3	3	3	3
36	Joymp Joymp Joymp	You just gotta Joymp. Each joymp is counted. What are you waiting for?	5000	20	3800	1	1	8	1
37	Gather Diamonds	Gather the black diamonds floating above the platforms, by hitting into them!	2000	20	3700	4	3	4	3
38	Spend those Magnets!	Spend the number of Magnets mentioned below in 1 run!	20	20	3600	2	2	2	10
39	Boostless Reach	Reach the level shown below without using any boosters in your run	6	20	4000	4	4	4	4

Figure C.1: Overview of ordered challenges and their rewards

C.2. Player group dividing algorithm

The algorithm needs to make sure that division of higher addiction score happens as equally as possible. Besides the division of the higher addiction scores, we also need the two groups to be as much as possible: equal in size, equal in addiction score distribution. There is no way for us to calculate the perfect solution. We do not know many people will play and what their addiction scores are. We have to decide in real-time on only the preceding decision. We need a simple algorithm that can quickly determine the group a player should be placed in. Because variables are dependent on each other, we need to prioritize what we found most important. The following code is the core of the algorithm.

```
// Based on the addictionn score we determine which group should be added right now
    static int DetermineGroupNumber(string playcode, int groupA, int groupB)
    {

        Dictionary<int, int> group1 = CreateGroupDict(groupA);
        Dictionary<int, int> group2 = CreateGroupDict(groupB);

        int addictionScore = BackendController.un_used_play_code[playcode].addiction_score;

        // groupA. Check for variance within groups
        if (group1[addictionScore] == group2[addictionScore])
        {
            // groupB. Check for n
            if (group1.Values.Sum() == group2.Values.Sum())
            {
                // 3. Check for average
                if (group1.Values.Average().Equals(group2.Values.Average()))
                {
                    // 4. Check for highest set addiction score count;
                    for (int i = 9; i >= 0; i--)
                    {
                        if (group1[i] > group2[i])
                        {
                            return groupB;
                        }
                        if (group1[i] < group2[i])
                        {
                            return groupA;
                        }
                    }
                    // Comming here means the sets are completly equal, so pick one random:
                    return Random.Range(0f, 1f) > 0.5 ? groupA : groupB;
                }

                return (group1.Values.Average() > group2.Values.Average()) ? groupB : groupA;
            }

            return (group1.Values.Sum() > group2.Values.Sum()) ? groupB : groupA;
        }

        return (group1[addictionScore] > group2[addictionScore]) ? groupB : groupA;
    }
```

As can be seen we have basic if-else structure of checks to determine the group. This is a effective and fast solution for prioritizing certain variables. Before the first iteration of the algorithm, we know the distribution of the addiction scores of the players. This is shown in table C.1. In total there are 86 possible participants. Only 9 people had high addiction scores. We see that the addiction score from 5 to 9 are sparse. Because we want to measure the effect on addiction, the most important characteristic of the 2 groups should be that

the variance between the a_s is as low as possible. Therefore the first check compares the number of existing elements for the current players a_s in both groups. By adding to the lowest one, we make sure distribution are kept and also the number of people are distributed equally. If they have an equal amount of that addiction score, we then give priority to the overall amount of players in the groups. If not equal we will pick the lowest, if equal we go to the next check. This check evaluates the average of the two groups. If they have the same amount of players within the current addiction score, and also within the overall view, we can stimulate equal distributions by adding to the lowest average of a_s. If even the average is equal, we will focus on the highest addiction score count, to make sure these are divided equally. We start by the highest addiction score and go downwards, to see were the first difference is. The group that least amount of the high a_s, will receive the player. If after this loop the groups are still equal, it means they are exactly the same. Therefore as last measure, we pick randomly one of the two groups.

Addiction score	0	1	2	3	4	5	6	7	8	9
n	16	18	20	11	15	1	4	2	1	1

Table C.1

C.3. Technical Details

The game was created by using unity. The most recent version of the game can be found online[1] or in the play store [2]. Code written for unity was in c#. The code base consists of 2 parts: communication with the server, and the game interaction. Access to the code base can be requested by contacting the author. WebGL should be able to run on different types of servers. In the current server stack we used Django as basis, with Django rest api and a react as front end. Django is easy scalable and the server was also available to the author. Game development combines a lot of different areas of expertise. From running and connecting a game to a server, to 3D modeling and game engines. Libraries and software used for creation of this game are:

- Blender (3d object creation + shattering construction)
- C# library Leantwean (tweaning (moving objects))
- Unity (GUI, engine, animations, community)
- Adobe Audition (sound design)
- Adobe Illustrator (icon creation)
- Adobe Photoshop (image editing)
- Django (server backend)
- React (server frontend)
- Django Rest API + Mysql (Database)
- WebGL (browser based game)
- Andriod Play (launching app)
- Jetbrains rider (c# development)

Besides the many different software programs, the coding of the game had it's own challenges. Consider for example: physics calculation of the player to determine an arc, accurate interaction mapping from 2D (phone) to a 3D (game world) plane, different devices and platforms and automatic level generation with controlled difficulty.

C.4. Continuation of the game

During development of the game there was limited time and infinite possibilities. The full list of implementations (count around 100) and open issues can be found in a coda-document. For access contact the author. A summery of other concepts, ideas or extensions can be found below.

Challenges

- 'X-distance over the last runs'
- achieve x-distance x-times
- achieve x-distance within x-runs

[1] `dswaab.nl/game`

[2] `https://play.google.com/store/apps/details?id=com.Swaabit.Joymp`

- 'jump x-times on certain platforms during a run (make very small difficult platforms)
- 'move through something'
- 'near miss something'
- 'hit order of platforms' (with this color?)

Boosters
- Hold to releasue super power/jump
- specific colors give specific things/powerr ups/safe
- accessories (color, sparkles, etc)
- coin spawner
- color influencer

Items
- Ball color (can handle certain ground types better/worse)
- Ball speed
- Ball power
- Ball looks (like sparkles)

Platforms interaction
- size of platforms: smaller/bigger/stranger shapes
- moving platforms (up/down, rotation)
- number of platforms in the vicinity
- Specific colors of platforms
- Increase speed
- Lower platform life time
- Types of platforms: ice, sand, bouncer, water, normal, balancer, sticky

Bibliography

[1] Johnie J. Allen and Craig A. Anderson. Satisfaction and frustration of basic psychological needs in the real world and in video games predict internet gaming disorder scores and well-being. *Computers in Human Behavior*, 84:220–229, jul 2018. ISSN 07475632. doi: 10.1016/j.chb.2018.02.034. URL https://linkinghub.elsevier.com/retrieve/pii/S074756321830092X.

[2] M.J. Apter. A structural-phenomenology of play. *Adult play: A reversal theory approach*, pages 13–29, 1991. An optional note.

[3] Juha Arrasvuori, Marion Boberg, and Hannu Korhonen. Understanding Playfulness: An Overview of the Revised Playful Experience (PLEX) Framework. *Design & Emotion 2010 Conference, Design and Emotion Society*, (January):1–12, 2010.

[4] Darius Ašeriškis and Robertas Damaševičius. Player type simulation in gamified applications. *CEUR Workshop Proceedings*, 1856:1–7, 2017. ISSN 16130073.

[5] A.P. Association. *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)*. American Psychiatric Publishing, 2013. ISBN 9780890425572. URL https://books.google.nl/books?id=-JivBAAAQBAJ.

[6] Matthew Bailey. Dota 2 prize pool tracker, 2018. URL http://dota2.prizetrac.kr/.

[7] Richard Bartle. Hearts, clubs, diamonds, spades: Players who suit muds. 06 1996.

[8] Richard Bartle. Hearts, clubs, diamonds, spades: Players who suit MUDs. (August), 2014.

[9] C.M. Bateman and R. Boon. *21st Century Game Design*. Charles River Media Game Development Series. Charles River Media, 2006. ISBN 9781584504290. URL https://books.google.nl/books?id=IdRqQgAACAAJ.

[10] Antoine Bechara, Antonio R. Damasio, Hanna Damasio, and Steven W. Anderson. Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, 50(1-3):7–15, April 1994. doi: 10.1016/0010-0277(94)90018-3. URL https://doi.org/10.1016/0010-0277(94)90018-3.

[11] Fernando Bevilacqua. *Game-calibrated and user-tailored remote detection of emotions: A non-intrusive, multifactorial camera-based approach for detecting stress and boredom of players in games*. 2018. ISBN 9789198418798.

[12] Fernando Bevilacqua, Henrik Engström, and Per Backlund. Changes in heart rate and facial actions during a gaming session with provoked boredom and stress. *Entertainment Computing*, 24(October 2017):10–20, 2018. ISSN 18759521. doi: 10.1016/j.entcom.2017.10.004. URL https://doi.org/10.1016/j.entcom.2017.10.004.

[13] Andy Boyan and John L Sherry. The challenge in creating games for education: Aligning mental models with game models. Child development perspectives. *Child Development Perspectives*, 5(2):82–87, 2011.

[14] S.L. Brown and C.C. Vaughan. *Play: How it Shapes the Brain, Opens the Imagination, and Invigorates the Soul*. Avery, 2009. ISBN 9781583333334. URL https://books.google.nl/books?id=ESQDsgqfgusC.

[15] Buurman. The Effect of Mood on Intrinsic Motivation and Educational App Preference in Diabetic and Non- Diabetic Children. 2018.

[16] R. Caillois and M. Barash. *Man, Play, and Games*. Sociology/Sport. University of Illinois Press, 2001. ISBN 9780252070334. URL https://books.google.nl/books?id=bDjOPsjzfC4C.

[17] Jean-Charles Simonin Charles Moszkowicz. Pokemon biodiv – discover and preserve biodiversity, 2016. URL https://www.galileo-masters.eu/winner/crowdsourced-surface-elevation-mapping-gamification/.

[18] Jenova Chen. Flow in games (and everything else). *Communications of the ACM*, 50(4):31, 2007. ISSN 00010782. doi: 10.1145/1232743.1232769.

[19] Y.K. Chou. *Actionable Gamification: Beyond Points, Badges, and Leaderboards*. Createspace Independent Publishing Platform, 2015. ISBN 9781511744041. URL https://books.google.nl/books?id=jFWQrgEACAAJ.

[20] Wilson-Mendenhall C. D. & Barrett L. F. Condon, P. What is a positive emotion? the psychological construction of pleasant fear and unpleasant happiness. *Handbook of Positive Emotions*, pages 60–81.

[21] Brigid Costello and Ernest Edmonds. A study in play, pleasure and interaction design. (January):76, 2007. doi: 10.1145/1314161.1314168.

[22] Mihaly Csikszentmihalyi and Jeanne Nakamura. *The Concept of Flow*, pages 89–92. 01 2002. ISBN 9780195135336. doi: 10.1007/978-94-017-9088-8_16.

[23] M. Csikszentmilhalyi, I. Csikszentmilhalyi, R. Graef, J.H. Holcomb, and J. Hendin. *Beyond Boredom and Anxiety: The Experience of Play in Work and Games*. The Jossey-Bass behavioral science series. Jossey-Bass Publishers, 1982. URL https://books.google.nl/books?id=Vs8YngEACAAJ.

[24] Thanat Damrongwatanapokin and Koji Mikami. Fatigue Prediction and Intervention for Continuous Play in Video Games. *2018 International Conference on Cyberworlds (CW)*, pages 451–453, 2018. doi: 10.1109/cw.2018.00089.

[25] Bryan Davies and Edwin Blake. Evaluating existing strategies to limit video game playing time. *IEEE Computer Graphics and Applications*, 36(2):47–57, 2016. ISSN 02721716. doi: 10.1109/MCG.2016.25.

[26] Zsolt Demetrovics, Fanni Bányai, Mark D. Griffiths, Ágnes Zsila, Hae-Kook Lee, Seung-Yup Lee, Zsofia K. Takacs, Daniel L. King, and Orsolya Király. Policy responses to problematic video game use: A systematic review of current measures and future possibilities. *Journal of Behavioral Addictions*, 7(3):503–517, 2017. ISSN 2062-5871. doi: 10.1556/2006.6.2017.050.

[27] Jeffrey L Derevensky, Nancy L Heath, Marina Milyavskaya, Jessica Mettler, and Devin J Mills. How do passion for video games and needs frustration explain time spent gaming? *British Journal of Social Psychology*, 57(2):461–481, 2018. doi: 10.1111/bjso.12239.

[28] Muhterem Dindar. Do people play MMORPGs for extrinsic or intrinsic rewards? *Telematics and Informatics*, 35(7):1877–1886, oct 2018. ISSN 07365853. doi: 10.1016/j.tele.2018.06.001. URL https://linkinghub.elsevier.com/retrieve/pii/S0736585318303940.

[29] A. Drachen, A. Canossa, and G. N. Yannakakis. 2009 ieee symposium on computational intelligence and games. pages 1–8, Sep. 2009. ISSN 2325-4289. doi: 10.1109/CIG.2009.5286500.

[30] Dutch Gaming Authority. Study into loot boxes. A treasure or a burden? 2018. URL https://www.kansspelautoriteit.nl/nieuws/alle-nieuwsberichten/2018/april/artikel-0/.

[31] Alice Egerton, Mitul A. Mehta, Andrew J. Montgomery, Julia M. Lappin, Oliver D. Howes, Suzanne J. Reeves, Vincent J. Cunningham, and Paul M. Grasby. The dopaminergic basis of human behaviors: A review of molecular imaging studies. *Neuroscience and Biobehavioral Reviews*, 33(7):1109–1132, 2009. ISSN 01497634. doi: 10.1016/j.neubiorev.2009.05.005.

[32] EPM. Theories of motivation, 2019. URL https://expertprogrammanagement.com/2019/06/theories-of-motivation/.

[33] ESA. THE STATE OF ONLINE GAMING – 2019, 2018. URL https://www.theesa.com/esa-research/2018-essential-facts-about-the-computer-and-video-game-industry/.

[34] Lauren S. Ferro. An analysis of players' personality type and preferences for game elements and mechanics. *Entertainment Computing*, 27(January):73–81, 2018. ISSN 18759521. doi: 10.1016/j.entcom.2018.03.003. URL https://doi.org/10.1016/j.entcom.2018.03.003.

[35] Lauren S. Ferro, Steffen P. Walz, and Stefan Greuter. Towards personalised, gamified systems: An investigation into game design, personality and player typologies. In *Proceedings of The 9th Australasian Conference on Interactive Entertainment: Matters of Life and Death*, IE '13, New York, NY, USA, 2013. Association for Computing Machinery. ISBN 9781450322546. doi: 10.1145/2513002.2513024. URL https://doi.org/10.1145/2513002.2513024.

[36] C. B. Ferster and B. F. Skinner. *Schedules of reinforcement*. Appleton-Century-Crofts, 1957. doi: 10.1037/10627-000. URL https://doi.org/10.1037/10627-000.

[37] The Myers & Briggs Foundation. Mbti basics, 2019. URL https://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/home.htm?bhcp=1.

[38] Quantic Foundry. Game motivational model, 2019. URL https://quanticfoundry.com/#motivation-model.

[39] Douglas Frame. Maslow's hierarchy of needs revisited. *Interchange*, 27(1):13–22, January 1996. doi: 10.1007/bf01807482. URL https://doi.org/10.1007/bf01807482.

[40] Bart Stewart (Gamasutra). Personality and play styles: A unified model, 2011. URL https://www.gamasutra.com/view/feature/134842/personality_and_play_styles_a_.php?page=4.

[41] GameDesigning. The 20 most popular video games of all time, 2019. URL https://www.gamedesigning.org/popular-video-games/.

[42] Ranker Games. The most popular video games right now, 2019. URL https://www.ranker.com/list/most-popular-video-games-today/rankerMaslow-games.

[43] Enterprise Gamification. Gamification design elements, 2015. URL http://www.enterprise-gamification.com.

[44] Pierre-Alexandre Garneau. Fourteen forms of fun, 2001. URL https://www.gamasutra.com/view/feature/227531/fourteen_forms_of_fun.

[45] James Gee. What video games have to teach us about learning and literacy. *Computers in Entertainment*, 1:20, 10 2003. doi: 10.1145/950566.950595.

[46] Hans W. Giessen. Serious Games Effects: An Overview. *Procedia - Social and Behavioral Sciences*, 174:2240–2244, 2015. ISSN 18770428. doi: 10.1016/j.sbspro.2015.01.881. URL http://dx.doi.org/10.1016/j.sbspro.2015.01.881.

[47] Isabela Granic, Adam Lobel, and Rutger C.M.E. Engels. The benefits of playing video games. *American Psychologist*, 69(1):66–78, 2014. ISSN 0003066X. doi: 10.1037/a0034857.

[48] Jon E Grant, Marc N Potenza, Aviv Weinstein, and David A Gorelick. Introduction to Behavioral Addictions. *The American Journal of Drug and Alcohol Abuse*, 36:233–241, 2010. doi: 10.3109/00952990.2010.491884. URL https://www.tandfonline.com/action/journalInformation?journalCode=iada20.

[49] Mark Griffiths. Video games and health. *Bmj*, 331(7509):122–123, 2005. ISSN 0959-8138. doi: 10.1136/bmj.331.7509.122.

[50] K. Groos and E.L. Baldwin. *The Play of Man*. Appleton, 1919. URL https://books.google.nl/books?id=0659AAAAMAAJ.

[51] Yue Guo and Stuart Barnes. Why people buy virtual items in virtual worlds with real money. *ACM SIGMIS Database*, 38:69–76, 10 2007. doi: 10.1145/1314234.1314247.

[52] Neal Hallford, Jana Hallford, and Andre LaMothe. *Swords and Circuitry: A Designer's Guide to Computer Role-Playing Games*. Premier Press, 2001. ISBN 0761532994.

[53] Juho Hamari. Game Design as Marketing. *International Journal of Business Science and Applied Management*, 5(1):14–29, 2010.

[54] Juho Hamari and Janne Tuunanen. Player Types: A Meta-synthesis. *Proceedings of Nordic Digra 2012 Conference: Games in Culture and Society*, pages 29–53, 2012.

[55] Juho Hamari, David J. Shernoff, Elizabeth Rowe, Brianno Coller, Jodi Asbell-Clarke, and Teon Edwards. Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, 54:170 – 179, 2016. ISSN 0747-5632. doi: https://doi.org/10.1016/j.chb.2015.07.045. URL http://www.sciencedirect.com/science/article/pii/S074756321530056X.

[56] Doug Hyun Han, Jun Won Hwang, and Perry F. Renshaw. Bupropion sustained release treatment decreases craving for video games and cue-induced brain activity in patients with internet video game addiction. *Experimental and Clinical Psychopharmacology*, 18(4):297–304, 2010. ISSN 10641297. doi: 10.1037/a0020023.

[57] Larry Hodges, Jeong Hwan Lee, Barbara Olasov Rothbaum, Samantha Smith, and Larry Price. A controlled study of virtual reality exposure therapy for the fear of flying. *Journal of Consulting and Clinical Psychology*, 68(6):1020–1026, 2005. ISSN 0022-006X. doi: 10.1037/0022-006x.68.6.1020.

[58] Bobby Hoffman and Louis Nadelson. Motivational engagement and video gaming: A mixed methods study. *Educational Technology Research and Development*, 58(3):245–270, 2010. ISSN 10421629. doi: 10.1007/s11423-009-9134-9.

[59] GRAHAM HUFF and FRANCES COLLLINSON. YOUNG OFFENDERS, GAMBLING AND VIDEO GAME PLAYING. *The British Journal of Criminology*, 27(4):401–410, 1987. doi: 10.1093/oxfordjournals.bjc.a047690. URL https://doi.org/10.1093/oxfordjournals.bjc.a047690.

[60] Robin Hunicke. The case for dynamic difficulty adjustment in games. pages 429–433, 2007. ISSN 1173-8804. doi: 10.1145/1178477.1178573.

[61] Robin Hunicke, Marc Leblanc, and Robert Zubek. Mda: A formal approach to game design and game research. *AAAI Workshop - Technical Report*, 1, 01 2004.

[62] Barry Ip and Gabriel Jacobs. Segmentation of the games market using multivariate analysis. *Journal of Targeting, Measurement and Analysis for Marketing*, 13(3):275–287, April 2005. doi: 10.1057/palgrave.jt.5740154. URL https://doi.org/10.1057/palgrave.jt.5740154.

[63] M. Jakobsson. The achievement machine: Understanding xbox 360 achievements in gaming practices. 11, 02 2011.

[64] Ingrid van Namen Jeroen Derriks. Crowdsourced surface elevation mapping through gamification, 2016. URL https://www.galileo-masters.eu/winner/crowdsourced-surface-elevation-mapping-gamification/.

[65] Yuan Jia, Bin Xu, Yamini Karanam, and Stephen Voida. Personality-targeted gamification: A survey study on personality traits and motivational affordances. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, CHI '16, page 2001–2013, New York, NY, USA, 2016. Association for Computing Machinery. ISBN 9781450333627. doi: 10.1145/2858036.2858515. URL https://doi.org/10.1145/2858036.2858515.

[66] AGNETA JOHANSSON. Problems With Computer Games Without Monetary Reward: Similarity To Pathological Gambling. *Psychological Reports*, 95(6):641, 2005. ISSN 0033-2941. doi: 10.2466/pr0.95.6.641-650.

[67] Daniel Johnson, John Gardner, and Penelope Sweetser. Motivations for videogame play: Predictors of time spent playing. *Computers in Human Behavior*, 63:805–812, 2016. ISSN 07475632. doi: 10.1016/j.chb.2016.06.028. URL http://dx.doi.org/10.1016/j.chb.2016.06.028.

[68] J. Juul. *A Casual Revolution: Reinventing Video Games and Their Players*. MIT Press, 2010. ISBN 9780262013376. URL https://books.google.nl/books?id=heEsCwAAQBAJ.

[69] Kirsi Pauliina Kallio, Frans Mäyrä, and Kirsikka Kaipainen. At least nine ways to play: Approaching gamer mentalities. *Games and Culture*, 6(4):327–353, 2011. doi: 10.1177/1555412010391089. URL https://doi.org/10.1177/1555412010391089.

[70] Joanne Kardijk. Watersnoodmuseum haalt overstroming binnen met virtual reality, 2016. URL https://www.deondernemer.nl/nieuwsbericht/111800/watersnoodmuseum-pronkt-met-virtual-reality-dankzij-multimediabedrijf-uit-burgh-haamstede.

[71] David Katzmaier. Chinese video game limits play time for children under 12, 2017. URL https://www.cnet.com/news/chinese-video-game-limits-play-time-for-children-under-12/.

[72] Yasser Khazaal, Kyrre Breivik, Joel Billieux, Daniele Zullino, Gabriel Thorens, Sophia Achab, Gerhard Gmel, and Anne Chatton. Game addiction scale assessment through a nationally representative sample of young adult men: Item response theory graded-response modeling. *Journal of Medical Internet Research*, 20(8):1–16, 2018. ISSN 14388871. doi: 10.2196/10058.

[73] Mohamed Ali Khenissi, Fathi Essalmi, and Mohamed Jemni. Comparison Between Serious Games and Learning Version of Existing Games. *Procedia - Social and Behavioral Sciences*, 191:487–494, 2015. ISSN 18770428. doi: 10.1016/j.sbspro.2015.04.380.

[74] Na Ri Kim, Samuel Suk-Hyun Hwang, Jung-Seok Choi, Dai-Jin Kim, Zsolt Demetrovics, Orsolya Király, Katalin Nagygyörgy, Mark. D. Griffiths, So Yeon Hyun, Hyun Chul Youn, and Sam-Wook Choi. Characteristics and psychiatric symptoms of internet gaming disorder among adults using self-reported DSM-5 criteria. *Psychiatry Investigation*, 13(1):58, 2016. doi: 10.4306/pi.2016.13.1.58. URL https://doi.org/10.4306/pi.2016.13.1.58.

[75] Daniel King, Paul Delfabbro, and Mark Griffiths. Video game structural characteristics: A new psychological taxonomy. *International Journal of Mental Health and Addiction*, 8(1):90–106, 2010. ISSN 15571874. doi: 10.1007/s11469-009-9206-4.

[76] Daniel L. King and Paul H. Delfabbro. Predatory monetization schemes in video games (e.g. 'loot boxes') and internet gaming disorder. *Addiction*, 113(11):1967–1969, 2018. ISSN 09652140. doi: 10.1111/add.14286.

[77] Daniel L. King, Madeleine C.E. Herd, and Paul H. Delfabbro. Motivational components of tolerance in Internet gaming disorder. *Computers in Human Behavior*, 78:133–141, 2018. ISSN 07475632. doi: 10.1016/j.chb.2017.09.023. URL https://doi.org/10.1016/j.chb.2017.09.023.

[78] Orsolya Király, Katalin Nagygyörgy, Mark D. Griffiths, and Zsolt Demetrovics. *Problematic Online Gaming*. Elsevier, 2014. ISBN 9780124077249. doi: 10.1016/B978-0-12-407724-9.00004-5. URL http://dx.doi.org/10.1016/B978-0-12-407724-9.00004-5.

[79] Hannu Korhonen, Markus Montola, and Juha Arrasvuori. Understanding playful user experiences through digital games. 01 2009.

[80] Raph Koster. *Theory of Fun for Game Design*. O'Reilly Media, Inc, Usa, 3 edition, 2013. ISBN 9781449363215.

[81] Yubo Kou, Yao Li, Xinning Gui, and Eli Suzuki-Gill. Playing with Streakiness in Online Games: How Players Perceive and React to Winning and Losing Streaks in League of Legends. *Proc. of CHI*, pages 1–14, 2018. doi: 10.1145/3173574.3174152. URL https://docs.wixstatic.com/ugd/489dee{_}742128c27c7f4013ad3d5cc07cae6b64.pdf.

[82] Rachel Kowert, Jens Vogelgesang, Ruth Festl, and Thorsten Quandt. Psychosocial causes and consequences of online video game play. *Computers in Human Behavior*, 45:51–58, 2015. ISSN 07475632. doi: 10.1016/j.chb.2014.11.074. URL http://dx.doi.org/10.1016/j.chb.2014.11.074.

[83] Michael Kubovy. On the pleasures of the mind. *Journal of The American Psychoanalytic Association - J AMER PSYCHOANAL ASSN*, 53:134–154, 01 1999.

[84] Daria J Kuss, Jorik Louws, and Reinout W Wiers. Online Gaming Addiction? Motives Predict Addictive Play Behavior in Massively Multiplayer Online Role-Playing Games. doi: 10.1089/cyber.2012.0034. URL www.liebertpub.com.

[85] Liz Lanier. Lawsuit targets epic's 'predatory' loot boxes in 'fortnite', 2019. URL https://variety.com/2019/gaming/news/lawsuit-loot-boxes-fortnite-1203152894/.

[86] Nicole Lazzaro. Why We Play Games : Four Keys to More Emotion Without Story. pages 1–8, 2004.

[87] Ming-Chi Lee. Understanding the behavioural intention to play online games. *Online Information Review*, 33(5):849–872, 2009. ISSN 1468-4527. doi: 10.1108/14684520911001873.

[88] Yu Hao Lee and Donghee Yvette Wohn. Are there cultural differences in how we play? Examining cultural effects on playing social network games. *Computers in Human Behavior*, 28(4):1307–1314, 2012. ISSN 07475632. doi: 10.1016/j.chb.2012.02.014. URL http://dx.doi.org/10.1016/j.chb.2012.02.014.

[89] Jeroen S. Lemmens, Patti M. Valkenburg, and Jochen Peter. Development and validation of a game addiction scale for adolescents. *Media Psychology*, 12(1):77–95, 2009. ISSN 15213269. doi: 10.1080/15213260802669458.

[90] Jeroen S. Lemmens, Patti M. Valkenburg, and Douglas A. Gentile. The Internet Gaming Disorder Scale. Psychological Assessment. *American Psychological Association*, 15(2):1040–3590, 2015.

[91] Zakkoyya H. Lewis, Maria C. Swartz, and Elizabeth J. Lyons. What's the Point?: A Review of Reward Systems Implemented in Gamification Interventions. *Games for Health Journal*, 5(2):93–99, 2016. ISSN 2161-783X. doi: 10.1089/g4h.2015.0078.

[92] Chung-Ying Lin, Vida Imani, Anders Broström, Kristofer Årestedt, Amir H. Pakpour, and Mark D. Griffiths. Evaluating the psychometric properties of the 7-item persian game addiction scale for iranian adolescents. *Frontiers in Psychology*, 10, February 2019. doi: 10.3389/fpsyg.2019.00149. URL https://doi.org/10.3389/fpsyg.2019.00149.

[93] Edwin A Locke and Gary P Latham. Goal setting theory, 1990. In *New developments in goal setting and task performance.*, pages 3–15. Routledge/Taylor & Francis Group, New York, NY, US, 2013. ISBN 978-0-415-88548-5 (Hardcover); 978-0-203-08274-4 (PDF).

[94] Andrés Lucero, Jussi Holopainen, Elina Ollila, Riku Suomela, and Evangelos Karapanos. The playful experiences (PLEX) framework as a guide for expert evaluation. (April 2014):221, 2013. doi: 10.1145/2513506.2513530.

[95] Joseph Macey and Juho Hamari. Investigating relationships between video gaming, spectating esports, and gambling. *Computers in Human Behavior*, 80:344–353, 2018. ISSN 07475632. doi: 10.1016/j.chb.2017.11.027. URL https://doi.org/10.1016/j.chb.2017.11.027.

[96] Thomas W. Malone. Toward a theory of intrinsically motivating instruction. *Cognitive Science*, 5(4):333–369, oct 1981. doi: 10.1207/s15516709cog0504_2. URL https://doi.org/10.1207/s15516709cog0504_2.

[97] A. Marczewski. *Even Ninja Monkeys Like to Play: Gamification, Game Thinking and Motivational Design*. CreateSpace Independent Publishing Platform, 2015. ISBN 9781514745663. URL https://books.google.es/books?id=RoHpjgEACAAJ.

[98] Patrick M Markey and Christopher J Ferguson. Internet Gaming Addiction: Disorder or Moral Panic? doi: 10.1176/appi.ajp.2016.16121341. URL https://ajp.psychiatryonline.org/doi/pdf/10.1176/appi.ajp.2016.16121341.

[99] Erik J. Martin. The state of online gaming - 2018. 2018. ISSN 15252531. doi: 10.1097/01.NEP.0000000000000047.

[100] Mark Mckergow. Positivity: Groundbreaking research reveals how to embrace the hidden strengths of positive emotions, overcome negativity and thrive. *InterAction - The Journal of Solution Focus in Organisations*, 1, 01 2009.

[101] Rune Mentzoni, Hiroshi Sakuma, Young Yim Doh, Daniel L. King, Ståle Pallesen, Anise M. S. Wu, Paul H. Delfabbro, Natacha Carragher, and Daria J. Kuss. Policy and Prevention Approaches for Disordered and Hazardous Gaming and Internet Use: an International Perspective. *Prevention Science*, 19(2):233–249, 2017. ISSN 1389-4986. doi: 10.1007/s11121-017-0813-1.

[102] Mircosoft. Most played games, 2019. URL https://www.microsoft.com/en-us/store/most-played/games/xbox.

[103] ß Lennart E. Nacke, Chris Bateman, and Regan L. Mandryk. BrainHex: A neurobiological gamer typology survey. *Entertainment Computing*, 5(1):55–62, 2014. ISSN 18759521. doi: 10.1016/j.entcom.2013.06.002. URL http://dx.doi.org/10.1016/j.entcom.2013.06.002.

[104] Steve Nebel, Sascha Schneider, Janine Schledjewski, and Günter Daniel Rey. Goal-Setting in Educational Video Games: Comparing Goal-Setting Theory and the Goal-Free Effect. *Simulation & Gaming*, 48(1):98–130, 2017. doi: 10.1177/1046878116680869. URL https://journals.sagepub.com/doi/pdf/10.1177/1046878116680869.

[105] NewZoo. Most popular core pc games | global, 2019. URL https://newzoo.com/insights/rankings/top-20-core-pc-games/.

[106] Nielsen. U.s. games 360 report: 2017, 2017. URL https://www.nielsen.com/us/en/insights/report/2017/us-games-360-report-2017/.

[107] Adam Nylund and Oskar Landfors. Frustration and its effect on immersion in games : A developer viewpoint on the good and bad aspects of frustration. 2015. URL http://www.diva-portal.org/smash/record.jsf?pid=diva2{%}3A821653{&}dswid=3926.

[108] Mateusz Koœlacz Larissa Goethal Olivier Dinet, Przemys³aw Szurmak. Faver: Enabling strangers to do each other favours for rewards based on their location, 2016. URL https://www.galileo-masters.eu/winner/faver-enabling-strangers-favours-rewards-based-location/.

[109] Christopher M. Olsen. Natural rewards, neuroplasticity, and non-drug addictions. *Neuropharmacology*, 61(7):1109–1122, 2011. ISSN 00283908. doi: 10.1016/j.neuropharm.2011.03.010. URL http://dx.doi.org/10.1016/j.neuropharm.2011.03.010.

[110] Rita Orji, Gustavo F. Tondello, and Lennart E. Nacke. Personalizing Persuasive Strategies in Gameful Systems to Gamification User Types. pages 1–14, 2018. doi: 10.1145/3173574.3174009.

[111] Nansook Park, Christopher Peterson, and Martin E. P. Seligman. Strengths of character and well-being. *Journal of Social and Clinical Psychology*, 23(5):603–619, October 2004. doi: 10.1521/jscp.23.5.603.50748. URL https://doi.org/10.1521/jscp.23.5.603.50748.

[112] Christopher Pedersen, Julian Togelius, and Georgios N. Yannakakis. Modeling player experience for content creation. *IEEE Transactions on Computational Intelligence and AI in Games*, 2(1):54–67, 2010. ISSN 1943068X. doi: 10.1109/TCIAIG.2010.2043950.

[113] Tommi Pelkonen. Mobile games: An emerging content business area. In *E-Content*, pages 109–125. Springer-Verlag. doi: 10.1007/3-540-26387-x_6. URL https://doi.org/10.1007/3-540-26387-x_6.

[114] C. Peterson, N. Park, and M. Seligman. Orientations to happiness and life satisfaction: The full life versus the empty life. *The exploration of happiness*, 6:161–173, 01 2005. doi: 10.1007/978-94-007-5702-8_9.

[115] Cody Phillips, Daniel Johnson, and Peta Wyeth. Videogame reward types. (October):103–106, 2014. doi: 10.1145/2583008.2583025.

[116] Cody Phillips, Daniel Johnson, Peta Wyeth, Leanne Hides, and Madison Klarkowski. Redefining Videogame Reward Types. (November 2018):83–91, 2015. doi: 10.1145/2838739.2838782.

[117] Cody Phillips, Daniel Johnson, Madison Klarkowski, Melanie Jade White, and Leanne Hides. The Impact of Rewards and Trait Reward Responsiveness on Player Motivation. (November):393–404, 2018. doi: 10.1145/3242671.3242713.

[118] K. Poels, Y.A.W. Kort, de, and W.A. IJsselsteijn. "it is always a lot of fun!" : exploring dimensions of digital game experience using focus group methodology. In *Proceedings of the International Academic Conference on the Future of Game Design and Technology : FuturePlay 2007, November 15-17, 2007, Toronto, Canada*, pages 83–89, United States, 2007. Association for Computing Machinery, Inc.

[119] John Quick, Robert Atkinson, and Lijia Lin. Empirical taxonomies of gameplay enjoyment: Personality and video game preference. *International Journal of Game-based Learning*, 2:11, 01 2012.

[120] Game Quitters. Real stories from gaming addicts, 2019. URL `https://gamequitters.com/blog/case-studies/`.

[121] Howard Rachlin, Ray Battalio, John Kagel, and Leonard Green. Maximization theory in behavioral psychology. *Behavioral and Brain Sciences*, 4(03):371, 2010. ISSN 0140-525X. doi: 10.1017/s0140525x00009407.

[122] Madeline Ricchiuto. Square enix is facing a class action lawsuit in japan over hoshi no dragon quest's loot boxes, 2018. URL `https://www.bleedingcool.com/2018/02/03/square-enix-facing-class-action-lawsuit-japan-hoshi-no-dragon-quests-loot-boxes/`.

[123] Simone N. Rodda, Natalia Booth, Michael Vacaru, Brenna Knaebe, and David C. Hodgins. Behaviour change strategies for internet, pornography and gaming addiction: A taxonomy and content analysis of professional and consumer websites. *Computers in Human Behavior*, 84:467–476, 2018. ISSN 07475632. doi: 10.1016/j.chb.2018.03.021. URL `https://doi.org/10.1016/j.chb.2018.03.021`.

[124] Richard Ryan and Edward Deci. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American psychologist*, 55:68–78, 02 2000. doi: 10.1037/0003-066X.55.1.68.

[125] Richard M. Ryan, C. Scott Rigby, and Andrew Przybylski. The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, 30(4):344–360, November 2006. doi: 10.1007/s11031-006-9051-8. URL `https://doi.org/10.1007/s11031-006-9051-8`.

[126] Ricardo A. Tejeiro Salguero and Rosa M. Bersabé Morán. Measuring problem video game playing in adolescents. *Addiction*, 97(12):1601–1606, December 2002. doi: 10.1046/j.1360-0443.2002.00218.x. URL `https://doi.org/10.1046/j.1360-0443.2002.00218.x`.

[127] Owen Schaffer and Xiaowen Fang. What Makes Games Fun? Card Sort Reveals 34 Sources of Computer Game Enjoyment Completed Research. *Twenty-fourth Americas Conference on Information Systems,*, pages 1–10, 2018.

[128] Jesse Schell. *The Art of Game Design: A Book of Lenses*. A. K. Peters, Ltd., USA, 2nd edition, 2014. ISBN 1466598646.

[129] Shalom H Schwartz. Basic Human Values : An Overview Basic Human Values : Theory , Methods , and Applications Introduction to the Values Theory. *Jerusalem Hebrew University*, 48:49–71, 2006. ISSN 1128-0689. doi: 10.1080/026999499377664.

[130] Martin Seligman and Mihaly Csikszentmihalyi. Positive psychology: An introduction. *The American psychologist*, 55:5–14, 02 2000. doi: 10.1037/0003-066X.55.1.5.

[131] David Sharek and Eric Wiebe. Using flow theory to design video games as experimental stimuli. *Proceedings of the Human Factors and Ergonomics Society*, (1):1520–1524, 2011. ISSN 10711813. doi: 10.1177/1071181311551316.

[132] Michelle Shiota, Samantha L. Neufeld, Alexander F. Danvers, Elizabeth A. Osborne, Oliver Sng, and Claire I. Yee. Positive emotion differentiation: A functional approach. *Social and Personality Psychology Compass*, 8(3):104–117, 2014. ISSN 1751-9004. doi: 10.1111/spc3.12092.

[133] Roger Smith. The long history of gaming in military training. *Simulation and Gaming*, 41(1):6–19, 2010. ISSN 10468781. doi: 10.1177/1046878109334330.

[134] Marloes L C Spekman, Elly A. Konijn, Peter H M P Roelofsma, and Mark D. Griffiths. Gaming addiction, definition and measurement: A large-scale empirical study. *Computers in Human Behavior*, 29 (6):2150–2155, 2013. ISSN 07475632. doi: 10.1016/j.chb.2013.05.015. URL http://dx.doi.org/10.1016/j.chb.2013.05.015.

[135] Chuck Clanton stanfordonline. Elements of addictive game design, 2017. URL https://www.youtube.com/watch?v=iVgMILETn8Q.

[136] Vasileios Stavropoulos and Elwin Hu. Introduction to Behavioral Addictions. *InPsych*, 40, 2018. URL https://www.psychology.org.au/for-members/publications/inpsych/2018/april/Mind-games.

[137] Steam. Steam charts, 2019. URL https://steamdb.info/graph/.

[138] B. Sutton-Smith. *The Ambiguity of Play*. Harvard University Press, 2009. ISBN 9780674044180. URL https://books.google.nl/books?id=AgA8q0TCKeIC.

[139] Penelope Sweetser and Peta Wyeth. Gameflow: A model for evaluating player enjoyment in games. *Computers in Entertainment*, 3:3, 07 2005. doi: 10.1145/1077246.1077253.

[140] Alasdair G. Thin, Lisa Hansen, and Danny McEachen. Flow experience and mood states while playing body movement-controlled video games. *Games and Culture*, 6(5):414–428, 2011. ISSN 15554120. doi: 10.1177/1555412011402677.

[141] Gustavo F. Tondello and Lennart E. Nacke. Towards customizing gameful systems by gameful design elements. *CEUR Workshop Proceedings*, 2089:102–110, 2018. ISSN 16130073.

[142] Gustavo F. Tondello, Rina R. Wehbe, Lisa Diamond, Marc Busch, Andrzej Marczewski, and Lennart E. Nacke. The Gamification User Types Hexad Scale. (October 2017):229–243, 2016. doi: 10.1145/2967934.2968082.

[143] Gustavo F. Tondello, Alberto Mora, and Lennart E. Nacke. Elements of Gameful Design Emerging from User Preferences. pages 129–142, 2017. doi: 10.1145/3116595.3116627.

[144] Fan-Chen Tseng. Segmenting online gamers by motivation. *Expert Syst. Appl.*, 38:7693–7697, 06 2011. doi: 10.1016/j.eswa.2010.12.142.

[145] Jukka Vahlo, Johanna K. Kaakinen, Suvi K. Holm, and Aki Koponen. Digital Game Dynamics Preferences and Player Types. *Journal of Computer-Mediated Communication*, 22(2):88–103, 2017. ISSN 10836101. doi: 10.1111/jcc4.12181.

[146] Chin-Sheng Wan and Wen-Bin Chiou. Psychological Motives and Online Games Addiction: ATest of Flow Theory and Humanistic Needs Theory for Taiwanese Adolescents. *CyberPsychology & Behavior*, 9 (3):317–324, 2006. ISSN 1094-9313. doi: 10.1089/cpb.2006.9.317.

[147] Hao Wang and Chuen-Tsai Sun. Game Reward Systems: Gaming Experiences and Social Meanings. 2011. ISSN 01631829. doi: 10.1103/PhysRevB.51.8115.

[148] Michael R. Ward. "Cutting class to play video games". *Information Economics and Policy*, 42:11–19, 2018. ISSN 01676245. doi: 10.1016/j.infoecopol.2017.10.001.

[149] K. Werbach and D. Hunter. *The Gamification Toolkit: Dynamics, Mechanics, and Components for the Win*. EBL-Schweitzer. Wharton School Press, 2015. ISBN 9781613630686. URL https://books.google.nl/books?id=RDAMCAAAQBAJ.

[150] Leo Whang and Geunyoung Chang. Lifestyles of virtual world residents: Living in the on-line game "lineage". *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society*, 7:592–600, 11 2004. doi: 10.1089/1094931042403091.

[151] WHO. Disorders due to addictive behaviours, 2018. URL https://icd.who.int/browse11/l-m/en#/http%3a%2f%2fid.who.int%2ficd%2fentity%2f499894965.

[152] WHO. 6c51 gaming disorder, 2018. URL https://icd.who.int/browse11/l-m/en#/http://id.who.int/icd/entity/1448597234.

[153] Tom Wijman. Mobile revenues account for more than 50% of the global games market as it reaches $137.9 billion in 2018, 2018. URL https://newzoo.com/insights/articles/global-games-market-reaches-137-9-billion-in-2018-mobile-games-take-half/.

[154] Wikipedia. List of most-played video games by player count, 2019. URL https://en.wikipedia.org/wiki/List_of_most-played_video_games_by_player_count.

[155] Wikipedia. Video games, 2019. URL https://en.wikipedia.org/wiki/Video_game.

[156] Dmitri Williams, Mia Consalvo, Scott Caplan, and Nick Yee. Looking for gender: Gender roles and behaviors among online gamers. *Journal of Communication*, 59(4):700–725, December 2009. doi: 10.1111/j.1460-2466.2009.01453.x. URL https://doi.org/10.1111/j.1460-2466.2009.01453.x.

[157] Donghee Yvette Wohn and Yu Hao Lee. Players of facebook games and how they play. *Entertainment Computing*, 4(3):171–178, 2013. ISSN 18759521. doi: 10.1016/j.entcom.2013.05.002. URL http://dx.doi.org/10.1016/j.entcom.2013.05.002.

[158] Richard Wood, Mark Griffiths, Darren Chappell, and Mark Davies. The structural characteristics of video games: A psycho-structural analysis. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society*, 7:1–10, 03 2004. doi: 10.1089/109493104322820057.

[159] Richard T A Wood and Mark D Griffiths. Time Loss Whilst Playing Video Games: Is there a Relationship to Addictive Behaviours? 2007. doi: 10.1007/s11469-006-9048-2. URL https://link.springer.com/content/pdf/10.1007{%}2Fs11469-006-9048-2.pdf.

[160] Narnia C. Worth and Angela S. Book. Dimensions of video game behavior and their relationships with personality. *Computers in Human Behavior*, 50:132–140, 2015. ISSN 07475632. doi: 10.1016/j.chb.2015.03.056. URL http://dx.doi.org/10.1016/j.chb.2015.03.056.

[161] Georgios N. Yannakakis and Julian Togelius. Experience-driven procedural content generation. *IEEE Transactions on Affective Computing*, 2(3):147–161, 2011. ISSN 19493045. doi: 10.1109/T-AFFC.2011.6.

[162] Hallam J Yannakakis GN. Real-time Game Adaptation for Optimizing Player Satisfaction. Transactions on Computational Intelligence and AI in Games. 1(2):121–133, 2009.

[163] Nick Yee. Motivations for Play in Online Games. 9(6), 2006.

[164] Kimberly S Young. Internet addiction: evaluation and treatment. *Bmj*, 319(Suppl S4):9910351, 1999. ISSN 1756-1833. doi: 10.1136/sbmj.9910351.

[165] Shumaila Yousafzai, Zaheer Hussain, and Mark Griffiths. Social responsibility in online videogaming: What should the videogame industry do? *Addiction Research and Theory*, 22(3):181–185, 2014. ISSN 14767392. doi: 10.3109/16066359.2013.812203.

[166] Youtube, 2019. URL https://www.youtube.com/results?search_query=video+game+rage+compilation.

[167] Peter Zackariasson, Nils Wåhlin, and Timothy Wilson. Virtual identities and market segmentation in marketing in and through massively multiplayer online games (mmogs). *Services Marketing Quarterly*, 31, 06 2010. doi: 10.1080/15332969.2010.486689.

[168] G. Zichermann and C. Cunningham. *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps*. O'Reilly Series. O'Reilly Media, 2011. ISBN 9781449397678. URL https://books.google.nl/books?id=Hw9X1miVMMwC.