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BitPet - Increasing Social and Physical Activity by Taking Care of a Digital Pet

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BitPet - Increasing Social and Physical Activity by Taking Care of a Digital Pet

Master Thesis

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Abstract

The Norwegian population has become more inactive, and an increasingly larger part of the population is now overweight. The recent Covid-19 pandemic has isolated many individuals. Even before the pandemic, there have been reports of an increased sense of loneliness among students in Norway. Exergames have been proven to increase activity and reduce social anxiety among players, and therefore a well-designed exergame can be part of a solution to these issues.

This study started by reviewing existing exergames, game design principles, and an exergame under development called BitPet. In the light of this review, game features for BitPet were conceptualized and developed with the aim of motivating players to engage in social activity and physical activity.

The finished game features were tested on users to verify if BitPet and these features could motivate the players to engage in social activity and physical activity.

The results showed that taking care of a digital pet is not enough on its own to motivate players to increase their social and physical activity, at least not with strangers. Moreover, players appear to be highly skeptical of engaging in physical activity with strangers through an exergame like BitPet. The results also showed that players seemed to be positive towards engaging in physical activity with friends through an exergame like BitPet. However, no players had the opportunity to do so throughout the experiment. BitPet, or games like it, appear to have the potential to motivate players to increase their social and physical activity. The experiment had very few participants, and the results produced in this study are not enough to conclude with very high certainty. More research in this field is needed.

Sammen drag

Den norske befolkningen har blitt mer inaktiv, og en økende del av befolkningen er nå overvektig. Den nylige Covid-19 pandemien har isolert mange individer. Selv før pandemien ble det rapportert om en økt følelse av ensomhet blant studenter i Norge. Treningsspill har vist seg å kunne øke aktivitet og redusere sosial angst hos spillere, og derfor kan et godt designet treningsspill være en del av løsningen på disse problemene.

Denne studien begynte med en gjennomgang av eksisterende treningsspill, spilldesign-prinsipper, og et treningsspill som er under utvikling, kalt BitPet. I lys av denne gjennomgangen ble nye egenskaper ved spillet BitPet oppfunnet og utviklet med det formål å motivere spillere til å engasjere seg i sosial og fysisk aktivitet.

Det ferdige spillet ble testet på brukere for å verifisere om BitPet og disse nyutviklede egenskapene ved spillet kunne motivere spillerne til å være i mer sosial og fysisk aktivitet.

Resultatene viste at å ta vare på et digitalt dyr ikke er nok til å motivere spillerne til å øke sosial og fysisk aktivitet, i hvert fall ikke med fremmede. Spillere synes å være veldig skeptiske til å være i fysisk aktivitet med fremmede gjennom treningsspill som BitPet. Resultatene viste også at spillerne er positive til å spille spill som BitPet med venner. Dette var det likevel ingen som fikk prøvd ut gjennom eksperimentet. Bitpet og spill som BitPet ser ut til å ha et potensial for å kunne motivere spillere til å øke sin sosiale og fysiske aktivitet. Eksperimentet som ble gjennomført i denne studien hadde veldig få deltakere, og resultatene fra denne studien er dermed ikke nok til å konkludere med stor nøyaktighet. Dette området innenfor treningsspill trenger mer forskning.

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Part I

Introduction

This part introduces the research project, research method and motivation behind the project.

Chapter 1

Motivation

Lack of physical activity and obesity is a problem in Norway and many other countries. It is a problem that has emerged as the quality of life and income has improved. The recent study "*Self-perceived health, body mass and risk behavior among adolescents in Nord-Trøndelag County 2017-19*" [39] shows that the problem is still getting worse in Norway, also among the younger part of the population. The latter is important as it means the problem is not improving with newer generations. With the relatively recent success of exergame Pokémon Go and the vast use of handheld devices such as smartphones and tablets, there is interest in researching how exergames can be made successful. If one can understand what makes an exergame captivating by users, this might play an important role in combating modern-day society's health concerns.

In addition to physical health concerns, there is also the issue of mental health. There has been a growing focus on mental health issues, especially revolving around loneliness among university students in Norway [36]. The recent outbreak of Covid-19 has pressured people to self-isolate to a large degree and has encouraged socializing in smaller groups only. I believe video games can help people make social connections and make interacting with strangers less intimidating. I want to explore and find out if this is the case.

With this project I was given an opportunity to explore both video game design and learning more about the connection between physical activity, social activity and video games. Since I personally enjoy working out and play video games, I found this project motivating to explore.

Chapter 2

Project and Context

The project description was as follows:

[Game Technology] AR Game to Motivation Socialisation and Physical Activity In this project, the goal is to develop an game concept that will motivate the users to socialize and being physical activity using Augmented Reality. This project is part of a larger project with the goal of commercialising a concept.

The project will involve a study of existing theory, game concepts and technology, design and development of a game concept (both front-end and back-end) and an evaluation of the concept involving real users. Front-end will be developed in Unity.

The larger project that this master's thesis is a part of is BitPet (see Chapter 15). BitPet is a game that involves taking care of a digital pet. It supports multiplayer interaction, but it did not have any multiplayer features involving physical activity at the start of this thesis. This project involves developing such features. BitPet started as the idea xPet by Alf Inge Wang, founder of Kahoot!, and professor of game technology at the Norwegian University of Science and Technology (NTNU). The game has since been established as a company after the concept went through a feasibility study at NTNU's School of Entrepreneurship [44].

The work on this thesis began by reviewing existing exergames and research on game development. During this research, it became clear that there is a lack of research on players' mentality towards social interaction with strangers and friends. This is also lacking in the field of exergames. Because of this, it was decided to focus slightly more on the social aspects of exergames rather than the physical aspects.

Ideas for potential features for BitPet were brainstormed after the review process, followed by a development phase and an experiment. In the end, the results from the experiment were used to answer the research questions asked in Chapter 3.

Chapter 3

Research Questions and Method

This chapter introduces the goal of the research, research questions, and method.

3.1 Research Questions

This project will be using the **Goal, Question, Metric** research method proposed by Basili [5]. This method works by defining a goal for the project, followed by research questions, which will fulfill the goal when answered. Each question has a metric that helps answer the questions.

The research goal for this project is defined as: *Investigate how a multiplayer exergame revolving around taking care of a digital pet can impact how players feel about socializing with friends and strangers, as well as how it can impact their physical activity.*

This research goal was decomposed into the following research questions:

RQ1: How do people perceive playing exergames with strangers?

Knowing which feelings and thoughts people already have regarding interacting with strangers when playing exergames can help understand how to break down or support existing ideas among players. If people are afraid of playing with strangers, one can put more emphasis on making the game feel safe to motivate players to play these games with strangers.

RQ2: Will playing exergames make people more comfortable interacting with strangers?

If people change their opinions around socializing with strangers after playing an exergame, that might indicate that exergames can serve as a tool to make players more socially active, at least with strangers.

RQ3: When given a choice, are people more inclined to play exergames with people they know rather than strangers?

This question will uncover if the thoughts and ideas people have around socializing with strangers actually correspond with their actions when playing exergames.

RQ4: Can taking care of a digital pet motivate people to be more physically active and socially active?

Knowing how much of an influence the pet in the exergame and its well being makes to the player's behavior when playing the exergame can help determine if it is playing an exergame in general or if taking care of the pet is what motivates players to make their decisions around whom to interact with when playing the exergame.

RQ5: Are people willing to overcome social anxiety to take care of their digital pet?

Answering this question will shed light on the link between the will to take care of the digital pet and how they feel about playing with strangers. This question will specifically look at players who feel anxious about interacting with strangers.

3.2 Research Method

This section will describe the research method that will be used in this project.

3.2.1 About the Methods

As mentioned in Section 3.1, this project will be using the Goal, Question, Metric research method proposed by Basili. The goal and questions have already been defined, but this section will elaborate on the metric part. In order to answer the questions, the research method requires a set of metrics that allows the questions to be answered in a *measurable* way. In this project, different types of data will be collected. This is done through an experiment, two questionnaires, and semi-structured interviews (see chapters 22, 21, and 23). Having different types of data allows for triangulation of data (see Section 3.2.3). The experiment requires a game to be tested by players, and this game must be developed. For this project, the game BitPet already exists, but game features will be developed for this game. Before developing these features, an extensive literature review will be conducted to learn about game design principles and what research has already been done in the field of game design and exergames.

3.2.2 Literature review

The literature review done before the development phase of this project focused on physical exercise, games' effect on socializing, exergames, game design prin-

ciples, player types, and technology related to the previously mentioned topics. The purpose of this review is not only to learn what researchers have already discovered within the field and to apply it to my own research and game development but to convey this knowledge, and the ideas on the topic to the reader [97]. This can help readers understand this study and terms used within it, such as *exergames*, but also understand why the game features were developed the way they were.

3.2.3 Triangulation of Data

The data collected during this project consists of *qualitative* and *quantitative data*. Qualitative data is data that is observed or that describes a phenomenon. For this project the qualitative data will come from interviews and questionnaires (see sections 3.2.6 and 3.2.5). Quantitative data can be counted, such as the number of participants who answer a specific answer of a questionnaire. Or the number of players who perform a certain act in the game. The questionnaires and the game data from the experiment will generate quantitative data for this project.

Comparing qualitative and quantitative data is a type of validation process. It is commonly referred to as the triangulation method [1]. If both data sources point to the same conclusion, it is a more reliable conclusion. The game data, questionnaire data, and interviews will be compared to answer the research questions in this project. This is done in Chapter 25.

3.2.4 Experiment

BitPet is a game that requires players to take care of a digital pet. This is done by feeding it and taking it for walks. For a full description of BitPet see Chapter 15. During this project, new game features will be developed for BitPet. The experiment conducted in this project involves the players testing the game BitPet with the developed features. While the players test the game, data will be stored in the back-end database supporting the game. This raw data is analyzed as quantitative data in chapters 24 and 25. Examples of data that are presented are *how many players use played multiplayer mode*, and *how many players logged in to the game consecutively*. As mentioned in Section 3.2.3 this data will be compared to the qualitative data from the interviews and questionnaires in order to decide which data is most representative of how players perceive being in social and physical activity with strangers and friends.

3.2.5 Questionnaires

Two questionnaires are used in this study, Questionnaire Pre and Questionnaire Post (see Chapter 21). The participants will answer one before testing BitPet and one after. These questionnaires mainly gather quantitative data. In the questionnaires, mainly two types of questions are used. In the first type, respondents are given a statement to which they have to state to which degree

they agree or disagree with the given statement. The other type is questions where the respondents answer the alternative that fits them the best, or questions where the respondent enters text answers such as how many times they perform a specific action like walking. In the end, a wide range of numbers is collected representing how many participants agree or disagree with different statements and how many perform certain acts. These results can be compared with the experiment's data to see if the players' actions and beliefs correspond. A weakness with the questionnaires is that they can often be found boring to answer, so the results are not necessarily a good representation of what the respondents genuinely believe. Interviews are an excellent tool to balance out the weaknesses of questionnaires.

The qualitative data collected from the questionnaires are the open text answers where participants can write whatever they want. These questions are typically phrased such as "Do you have any comments about your experience from playing *BitPet*." These questions tend to receive very different answers and will often shed more light on how the participants perceive topics or phenomena. As such, they cannot be used quantitatively but rather qualitatively.

3.2.6 Interviews

For this project, semi-structured interviews are used. That means the interviews have a series of planned questions, but if any answers from the interviewee inspire a new question that was not thought of beforehand, it can be asked. They also allow for more conversation between the interviewer and the interviewee rather than simply a series of questions and answers. For a more detailed description of the interview process used in this project, see Chapter 23.

The interviews gather qualitative data. The questions are mainly open-ended to let the participants reveal their thoughts and feelings about the game they have tested and their perception of what it is like to engage in social activity with strangers. This data can be compared to the players' actions in the game and the questionnaires' respondents' reasons for their actions. The qualitative data can either confirm the quantitative data or reveal conflicting answers, resulting in increased certainty of positive conclusions or conclusions requiring more research. The interview's weakness is that the interviewee might feel uncomfortable revealing their true thoughts when facing an interviewer. In addition, they are more time-consuming, and fewer interviews were conducted during this study than the number of respondents recruited for the questionnaires. The data revealed is more in-depth, but the strength of numbers is lost. Therefore, this study's qualitative data is mostly used to confirm or deny the quantitative data.

3.3 Summary of Research Questions and Method

This chapter has introduced the *research goal* along with five research questions. The various data collection methods have been described, as well as the

triangulation method which will be used to compare the collected data. This comparison and analysis of the data will increase the certainty of the results. In the end, the data can be used to answer the research questions. An experiment will be used to gather game data. Two questionnaires will be given to the participants, one before and one after the experiment. Lastly, some participants will be interviewed about the experiment.

Chapter 4

Report outline

This chapter serves as a reader's guide. It will summarize what each part of the report so the reader can decide which parts are of interest.

Part I introduces the project, research questions and method, and this reader's guide.

Part II is an extensive literature review about existing exergames and game design principles. It is not necessary to understand the rest of the report, but theory from this literature review is applied in development phase.

Part III presents some ideas I have come up with for potential features in exergames. Some of these were discussed when deciding which features to develop in Part IV.

Part IV presents what BitPet was at the start of this project, how the features to be developed for BitPet were planned, and what my contributions to BitPet became. It also presents the requirements for the application.

Part V explains which data will be collected during the experiment, and how the data will be collected.

Part VI presents the results from the experiment, a discussion of these results, and the conclusion and future work.

Part II

Prestudy

This part contains the extensive literature review that was done before beginning to work on features for BitPet. The review begins with a definition of physical activity and exercise, followed by technology that can be used to monitor physical activity. Similarly, exergames are reviewed and defined, followed by technology that can be used for exergames.

The next part of the prestudy reviews existing research about game design, types of games, and player types. The last part of the prestudy reviews existing research on how exergames affect players' social activity and mental well-being and reviews existing exergames.

The information collected in the prestudy inspired some ideas for potential features for the game BitPet. These are presented at the end of this part.

Chapter 5

Physical Activity and Exercise

This chapter will clarify what is meant by physical activity and exercise and highlight some recommendations proposed by various parties to maintain a healthy body.

5.1 Defining Exercise and Physical Activity

In a study Clementina et al. conducted with patients, they found that patients and health care workers often have different conceptions of the word *exercise* [14]. Sometimes, either party may believe one refers to planned, structured, and organized events involving physical activity when talking about exercise. The medical personnel actually want to assess the amount of total physical activity engaged in each day [14]. The section about defining exergames (see Section 7.1) mentioned how different terminology regarding this very topic had been an issue. The definition presented in Section 7.1 regarding exergames involves the following part about physical activity: "*physical exertion or movements that are more than sedentary activities and also include strength, balance, and flexibility*".

For this project's exergame, the goal is to increase the player's physical activity and social activity. When talking about **physical activity** in this setting, it refers to *movement that are more than sedentary activities*, and as such, it also involves **exercise** as *physical exertion or movements that are more than sedentary activities*.

5.2 Exercise for Health

The Norwegian Directorate of Health promotes guidelines for physical activity for adults and the elderly and children and younger people. The guidelines listed below are a minimum recommendation, and it is stressed that physical activity beyond the minimum recommendation is beneficial for health.

For adults and elderly, they recommend a minimum of 150 minutes of moderate-intensity activity or 75 minutes of high-intensity physical activity per week [56]. These recommendations are the same as the ones promoted by the World Health Organization (WHO) [54]. WHO also lists the following benefits as strongly documented benefits of being physically active [54]:

- have lower rates of all-cause mortality, coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon and breast cancer, and depression;
- are likely to have less risk of a hip or vertebral fracture;
- exhibit a higher level of cardiorespiratory and muscular fitness;
- and are more likely to achieve weight maintenance, have a healthier body mass and composition.

For children and younger persons, they recommend a minimum of 60 minutes of moderate to hard physical activity per day, where at least three days a week, the 60 minutes is hard physical activity [55]. For children, the activity is encouraged to include activities of play with other children. This is because they claim it will help develop social skills as well as physical skills.

5.2.1 Defining Degrees of Physical Activity

Section 5.1 discussed the definitions of physical activity and exercise. The terms "moderate" and "high" intensity physical activity are still unclear.

According to the Norwegian Directorate of Health (translated from Norwegian), *moderate physical activity* refers to *activities that causes a higher respiratory rate than usual, for example walking quickly*, and *high intensity* refers to *activities that cause much higher respiratory rate than usual, for example, running*.

WHO has released a document that explains their recommendations in detail. In this document, they define *intensity* as *Intensity (How hard a person works to do the activity). Intensity refers to the rate at which the activity is being performed or the magnitude of the effort required to perform an activity or exercise.* [57].

They define *Moderate-intensity physical activity* as *activity that is performed at 3.0–5.9 times the intensity of rest. On a scale relative to an individual's personal capacity, moderate-intensity physical activity is usually a 5 or 6 on a scale of*

0–10 and Moderate-intensity physical activity as activity that is performed at 6.0 or more times the intensity of rest for adults and typically 7.0 or more times for children and youth. On a scale relative to an individual’s personal capacity, vigorous-intensity physical activity is usually a 7 or 8 on a scale of 0–10.

5.2.2 Recommended Activities

Along with the guidelines provided by the Norwegian Directorate of Health are some recommended ways to achieve the physical activity levels. They include actively working out or having spare time recreational activities that involve physical activity such as hiking, dancing, swimming. For adults having a physically demanding job can be sufficient for physical activity. Children are recommended to partake in organized social events such as team sports or play during recess at school.

One noteworthy recommendation that applies to adults and children alike is using transport to be physically active. Walking, running, and cycling to get from a place to a destination is recommended as a physical activity to promote one’s health. Also, visiting friends and running errands in the local area fall under the same category. These last two activities, namely walking as a way of transporting oneself and visiting friends and running errands, are everyday activities that can be exploited in this project as the aim is to increase both physical and social activity of players through an exergame.

5.3 Summary of Physical Activity and Exercise

This chapter has defined what physical activity and exercise mean in the context of this project. It has highlighted how much physical activity WHO, and the Norwegian Directorate of Health recommends different age groups to perform. It has also made clear what the different intensities of physical activity mean.

Chapter 6

Technology for Monitoring Physical Activity

This chapter discusses technology developed to monitor physical activity. These technologies can be used as input devices for exergames. BitPet already uses technology for monitoring physical activity, such as GPS and step counters from smartphones built in health apps. Knowing how these tools work could be helpful when developing features that are based on them. In addition, reviewing other tools for monitoring physical activity could lead to potentially finding new ways to monitor physical activity for BitPet, or ideas for new features involving new technology.

6.1 ANT+

ANT+ is an ultra-low-power (ULP) wireless protocol used to send information wirelessly from one device to another [47]. It operates on the RF frequency from 2400MHz to 2524MHz. ANT+ is described as a set of mutually agreed-upon definitions of what type of information is being transferred. Different *device profiles* have been defined, such as a heart rate device. A heart rate device will communicate information that describes heart rate. ANT+ can be used for fitness equipment to track metrics during exercise. Some of these metrics include metrics for cycling, such as cadence, power, and torque frequency. For running, it can be foot speed and distance, temperature, and heart rate. The devices used to transfer the data can be made very small to fit within a small wearable like a chest strap or a bracelet.

6.2 Health Tracking on smart phones

Many smartphones have health tracking applications on them nowadays, either already installed or can be downloaded. They might not be considered tech-

nologies in themselves, but they can be used for this project, so I have chosen to list the most prominent ones here.

6.2.1 Google Fit

Google Fit is an app for android devices that utilize the smart phone's hardware to gather fitness data [58]. This is data such as steps walked, runs, and cycling. It can also register routes the user has moved, and it can collect data from other tracking devices the user has synced with its phone, such as heart rate monitors or fitness watches. Their own website does not provide much information, but the Android Play store entry for the app has provided the information in this section. Google Fit is not necessarily a technology in itself, but it is a tool that can be used to gather data. The data from Google Fit can be connected to other apps and could, for instance, be used to gather data for the application that is to be worked on for this project. The Google Fit service has been used to monitor players' physical activity when playing games such as Pokémon GO.

6.2.2 iOS Health

iOS Health is an app that is very similar to Google Fit. It is an app for the operating system for iPhones, iOS. It keeps track of different kinds of health data, such as steps walked and floors ascended, nutrition, sleep analysis, heart rate variability, and weight [66]. It can be paired with an *Apple Watch* to gather data automatically, such as sleep data [67]. It also works with some other third-party devices such as Garmin and Xiaomi [66]. The app does support communication with other apps, such as *Strava*, *Garmin Connect*, and *Google Fit*. This can be useful for this project as it is a mobile game that might be using steps or other health data to progress in the game world. Like Google Fit, iOS Health has also been used to monitor player's physical activity when playing exergames, including Pokémon GO.

6.2.3 Samsung Health

Samsung Health is another fitness tracking app like the iOS Health and Google Fit mentioned in the sections above. It, too, tracks data such as steps walked, performance over time, mindfulness, and nutrition. Samsung's own website about the app has exercise suggestions such as walking stairs in your home or doing push-ups against the walls. It also states that social interaction around exercise can be a source of motivation. As such, Samsung Health allows you to track progress and challenge friends to step goals, where you can track your opponent [85] (see Figure 6.1). Samsung Health supports the use of other apps, sharing data, and other devices such as smartwatches [85]. This app is relevant to this project as it may be a way to gather data for the game this project is about.

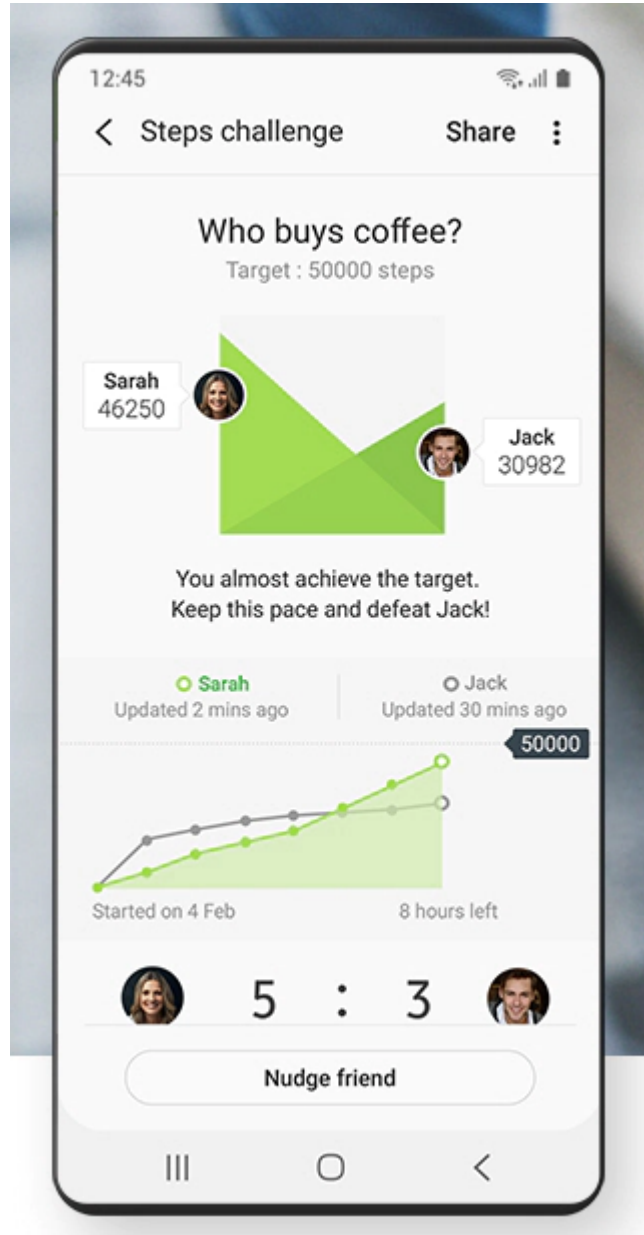


Figure 6.1: Samsung Health - challenging a friend to a step goal - from Samsung Website



Figure 6.2: Stryd device on a shoe

6.3 Stryd

Stryd is a device for measuring the distance a runner has run or walked and speed and pace. Stryd explains how this works on their website: *”Stryd tracks your foot through three dimensional space and records the accelerations, impacts, and forces that are being applied. From that information, we calculate power, as well as provide other commonly used run metrics like distance, pace, cadence, ground contact time, vertical oscillation, etc. All of our calculations have been validated with high resolution motion capture systems, dual force plate treadmill, and metabolic testing.”* [64]

Stryd is compatible with multiple fitness watches such as Garmin, Coros, Apple, Suunto, and Polar. For an extensive list and detail, see their site [50]. This means Stryd devices could be used to track everyday exercise such as walking and potentially give an accurate measurement of energy expenditure. These are input variables that could be used in this project to determine player physical activity. It is not a common item to own, however, and it is rather expensive, but the technology is ready and available and could be considered for future projects.

6.4 Gesture, Motion and voice Tracking

As mention in Section 8.3 Microsoft has developed tools for gesture motion and voice tracking with their Kinect devices. There is also Sony’s PlayStation Move and VR described in Section 8.2. None of these apply to this project as this project is confined to a mobile phone device.

Android and iOS, which are the most used smartphone operating systems, both offer their respective voice assistants Siri and Google Assistant. They allow voice input to control the phone without actually looking at the screen. This could allow the player to use their phone whilst being in an area where they have to be fully aware of their surroundings. This could also aid users who cannot use their fingers to precisely navigate the display on their device, or it could be used in conditions where the screen is hard to operate, such as rainy conditions. The possibilities voice assistants offer could be considered in such use cases for this project and exergames in general. Focusing on the task at hand is also important to achieve GameFlow and is mentioned in Section 7.3.

6.5 Summary of Technology for Monitoring Physical Activity

This chapter has discussed technology that allows the collection of data related to physical activity. These include both hardware and software solutions that monitor the hardware available in smartphones. Since the project uses smartphones running Android and iOS, this project's obvious choices will be the health tracking alternatives available on these smartphones.

Chapter 7

What Are Exergames?

This project is about exergames. The word exergame might be unclear. This chapter will make it clear what exergames are, and reviews some existing research about exergames.

7.1 Defining Exergames

The information in this chapter is mostly from the paper *Defining Exergames & Exergaming* that was published in 2010, written by Oh and Yang [13]. Oh and Yang reviewed existing research on the topic and attempted to determine what was commonly regarded as exergaming and exergames. They summarize their findings with a proposed definition of exergames and exergaming as: [13]

“we propose the new definition of exergaming as an experiential activity in which playing exergames or any videogames that requires physical exertion or movements that are more than sedentary activities and also include strength, balance, and flexibility activities.”

“exergames are any number of types of video games / multimedia interactions that require the game player to physically move in order to play.”

Some of the different words they found used to describe such games include:

- exertainment
- dance simulation video game,
- interactive video game
- activity promoting video game
- active video game
- physical gaming

- (kin)aesthetic video game
- physical activity-change game

The problem with the different definitions is that parts of their wording do not necessarily imply physical activity or exercise. This is even though they were all used as definitions for video games that had the purpose of improving a player’s health or promote physical activity. Mostly researchers with a background in health sciences used terms other than *exergame*. The problem with the researchers from the computer field was that they used the term exergame and spoke of exercise without defining what exercise or physical activity is. To avoid any of this confusion, for this project, when talking about exergames and exergaming, the definition used is the one proposed by Oh and Yang above.

7.2 Gamification of Exercise

Hamari et al. defines gamification and it’s goal as [18]:

”A process of enhancing a service with affordances for gameful experiences in order to support the user’s overall value creation” and ”to support the user’s overall value creation by providing gameful experiences”.

Furthermore, they define a game, and it’s goal as[18]:

”Free, no material interest, voluntary, uncertain, governed by rules, interesting choices, mastery, flow” and ”to create experiences such as flow, intrinsic motivation, achievement and mastery”.

In other words, gamification is related to making activities more like games. In their study, Hamari et al. researched how social motivations impacts the attitude towards gamification services. When discussing their results, they state [18]:

”The results indicate that social motivations, especially related to social influence and whether the users find reciprocal benefits from using gamification, are strong predictors for how gamification is perceived and whether the user intends to continue using the service and/or recommending it to others. Additionally, these relationships were further positively influenced by the degree to which users are exposed to other users in the service.”

In their study, a social network service created for exercising was being used. The players could level up, earn achievements, and complete goals. They could also interact by giving each other likes. This study is very relevant for this project as it investigated how the social aspects intertwine with a gamified service revolving around exercise. Our project aims to create a game of everyday

exercise and investigate how exergames (a gamified exercise) can increase social interaction. From the results of Hamari et al. [18], it would appear as though social interaction will have a positive effect on the attitude towards the gamified service itself. This might indicate that an exergame that successfully increases the amount of social interaction a player experiences will also increase the likelihood of keeping its players playing the game.

7.3 Different Considerations During Game Design

Sinclair et al. reviewed existing exergames and attempted to establish success factors for designing exergames [11]. The authors emphasize that the exercise itself has to be *rigorous enough* to provide the player with exercise, but also easy enough so the participant will *willingly return to the game* at a later day. They refer to guidelines regarding how hard a workout needs to be to improve an individual's health. Health guidelines are discussed in Section 5.2

Two main factors are proposed: *Attractiveness* and *Effectiveness*. Attractiveness is related to flow and how the game is fun to play. An interesting point they mention is that the input device needs to be of a nature that allows for continued concentration on the game, which is important to reach and maintain a flow state. Effectiveness deals with how effective the exergame is at providing sufficient exercise. Heart rate is stated to be an absolute measure of fitness/intensity balance and is thus suggested to be used as a measure of the effectiveness [11].

The authors present a dual flow system. The system (see Figure 7.1) has two separate grids, where challenge and skill make out the axes of the first system and intensity and fitness in the latter. When the balance of challenge and skill and intensity and fitness is properly tuned, a flow state is reached.

The last important factor they mention is the role of feedback in exergames. Not every player will have the same fitness, and as such, feedback can be used by tuning the exercise challenge when it is too hard for the player. Alternatively, the game can be designed such that the input device involved in the exercise is of such a nature that allows the player to maintain a level they see fit for their fitness or skill level. Dance Dance Revolution is mentioned as an example in their paper.

It can be mentioned that Pokémon Go (see Section 13.10) was released after this paper was written. Pokémon Go has solved the input device problem by having the exercise simply be walking. This allows concentration at all times, and most players will be able to walk. According to the health guidelines mentioned in the paper by Sinclair et al. [11], this might, however, not be an adequate exercise to provide a health-improving exercise. On the contrary, the Norwegian Directorate of Health mentions 30 minutes of fast walking five days a week as enough exercise to maintain health [56].

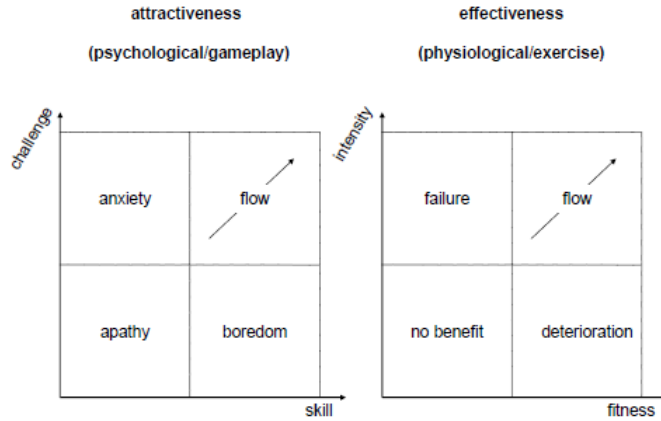


Figure 7.1: A dual flow model for exergaming [11]

7.4 Virtual Reality and Augmented Reality as a Tool for Exercise

Some research has been carried out on the effectiveness of using Virtual Reality and Augmented Reality for exergames. One study in Hong Kong deliberately wanted to check the effects of using Virtual Reality and Augmented Reality based training as preventative measures to improve the physical performance of a healthy population. It was compared to traditional training programs and no-exercise controls [35]. The results showed that it was effective to increase the frequency of physical activity, and it had a small to moderate effect on physical performance. There were no significant psychological outcomes. Another has shown that using VR whilst riding a stationary bike improves the enjoyment and self-efficacy and decreases the perceived exertion [38].

7.5 Summary of What Are Exergames

This chapter has discussed what exergames are. It has been defined as games requiring the user to physically exert themselves beyond sedentary physical activity. The chapter has also highlighted considerations during the design of exergames, where the key takeaways are to balance challenge and skill, and intensity and fitness of the users.

Chapter 8

Technology for Exergames

This chapter discusses technology developed for exergames. This project will involve experimenting with participants playing BitPet. Knowing which technology has been used for exergames in the past with success can help decide which technology to use for gathering qualitative data during the experiment and help to produce an enjoyable exergame. If new technology that is not already utilized in BitPet is identified, it could lead to ideas for potential features for BitPet.

8.1 Eyetoy

The EyeToy is a camera developed by Sony for the PlayStation, [53]. The camera (see Figure 8.1) uses computer vision and gesture recognition to register the movements of a player, as well as sound. Games created for this camera take the player's gestures and movements as inputs, thus creating exergames. The original camera has sold more than 10 million units [65]. The EyeToy was first released with the game EyeToy Play, which featured 12 different activities within the game. As for exercise, a study was carried out comparing EyeToy Play to DDR (see Section 13.6.1), which found DDR to be more effective for moderate to vigorous physical activity (MVAP) [12]. The difference was quite notable, with 80.84% of time spent playing DDR with a heart rate in the zone valid as MVAP, to 53.45% when playing EyeToy Play.

The PlayStation 3 received a successor for the EyeToy called PlayStation Eye, but it offered no drastic changes from the predecessor. EyePet and SingStar are examples of games that utilized the PlayStation Eye. The PlayStation 4 had its own successor as well called PlayStation Camera. The PlayStation Camera is compatible with PlayStation VR and PlayStation Move controllers (see Section 8.2 and Figure 8.4). Commander Cherry's Puzzled Journey and SingStar are examples of games that utilize the PlayStation Camera.



Figure 8.1: The original EyeToy camera for PlayStation 2

8.2 PlayStation Move and PlayStation VR

In October 2016 Sony released *PlayStation VR* (PlayStation Virtual Reality, *PSVR*). To use PSVR a player needs a PSVR Headset, a PlayStation Camera, and PlayStation Move controllers (see figures 8.3, 8.4 and 8.2). The headset has a screen mounted on the inside to display the gameplay for the player. On the outside, the headset transmits light through LEDs that the PlayStation Camera can receive and use to calculate the direction the player is facing and the player's position. The PlayStation Move controller has a sphere on the tip of the controller that is lit up from the inside with LEDs. The PS Camera can also track these controllers in the same way that the headset is tracked. PlayStation VR has been researched as a tool for exercise (see Section 7.4). *Star Wars Squadrons* is a game released in 2020 that utilizes PlayStation VR for the PS4.

8.3 Kinect Hardware

Kinect is a motion-sensing input device developed by Microsoft. It was released in 2010 for the Xbox 360. It uses RGB cameras and infrared projectors to calculate depth and has a microphone to support voice input. This allows the Kinect to support motion, gesture, and voice detection of up to four persons at a time [71]. Microsoft has also developed a Kinect for the newer console XBOX ONE, as well as one to use with Windows OS (see Figure 13.11). There is also an Azure Kinect Development kit that features a gyroscope and accelerometer for spatial tracking [48]. One of the more popular games that used Kinect is *Kinect Adventures*.



Figure 8.2: PlayStation Move controller



Figure 8.3: PlayStation VR Headset



Figure 8.4: PlayStation Camera for the PlayStation 4



Figure 8.5: Nintendo Wii to the right with the Wii Remote controller on the left



Figure 8.6: Nintendo Wii Balance Board for Wii Fit

8.4 Nintendo Wii

The Nintendo Wii was released in November 2006. The Wii introduced the Wii Remote controller (see Figure 8.5), a device that detected motion in three dimensions [103]. The Wii became a huge success and has sold over 100 million units [52]. Nintendo later created the Wii Balance Board (see Figure 8.6). The Balance Board was a stationary board that informed the Wii of the player's position and center of balance on the board. The Nintendo Wii was often bundled with the game *Wii Sports*, which is also the most sold Wii game.

8.5 Nintendo Wii U

After the success of the Nintendo Wii, Nintendo developed the Nintendo Wii U. Wii U only sold 13 million units, a big step down from the Wii, [52]. The Wii U combined the Wii Remote's motion control with a handheld screen that

is reminiscent of the Nintendo DS, and the later released Nintendo Switch. The handheld screen is called a Wii U Gamepad. The screen on the Gamepad mirrored what was visible on the TV. It was a remote screen wirelessly connected to the Wii U. The Wii U is backward compatible with Nintendo Wii, which means it could be used to play the exergames already existing for Wii. The Wii U was often bundled with the game Super Mario Kart 8, which had the option of utilizing the Wii U and its motion control as a steering wheel.

8.6 Nintendo Switch

Continuing the handheld controller with a screen and motion controls, Nintendo developed the Nintendo Switch and released it in 2017. This time around, the actual hardware running the games is located inside the handheld controller, which means the controller is not simply a screen like the Gamepad with the Wii U. Nintendo Switch has already sold more than 60 million units, making it another huge success for Nintendo [52]. The Switch has two controllers connected to the screen, which can be detached and used similar to the Wii Remote controllers for the Wii (see figures 13.9 and 13.10). The controllers are called *Joy-Cons* and contain an accelerometer and a gyroscope for motion tracking. It also provides haptic feedback in the form of rumbling or vibration. One of the most popular exergames released for the Nintendo Switch is RingFit Adventure. This game uses the two detachable controllers in various ways, connecting them to one's leg to detect players' movement with their feet and a ring held by players with both arms to detect arm movements. The game is an adventure game where the player levels up a character through different levels, requiring physical activity. For more information about this game, see Chapter 13.

8.7 Summary of Technology for Exergames

Throughout the years, different technologies have been developed to support exergames. An important aspect when it comes to the hardware for exergames is the input device. It needs to be simple to use so the player can focus on the game. For this project, the technology has already been decided to be Android and iOS smartphones.

Chapter 9

Game Design

This section summarizes existing research on different aspects of game design. This concerns the techniques and elements that make games fun, engaging, and enjoyable. Since this thesis will include developing game features for BitPet, it is essential to know how to produce games that are enjoyable to play.

9.1 What Makes Games Fun

Prensky has created a list of twelve elements he considers important for making video games the most engaging pastime activity (see Table A.1 in Appendix A.1) [6].

In summary, Prensky states that games need to be: fun, have rules, goals, outcomes, and feedback, win states, challenge, problem-solving, interaction, representation, and a story. Lastly, they need to be a form of *play*.

Prensky defines the element of fun in games to be a source of *enjoyment and pleasure*, whilst its connection to *learning* is that it should create *relaxation and enjoyment* [6].

For this project, the goal is to create a game that is motivating to play. The game is not necessarily supposed to teach the players anything, but the relationship between fun and learning can be considered when designing tutorials or feedback mechanics.

Prensky defines *play* as: *something one chooses to do*, something *intensely and utterly absorbing*, and something that *promotes the formation of social groupings* [6].

In his paper, he explains how activities can be playful; this means that they *elicit involvement and give pleasure*. With this definition, he explores playful work for adults and playful learning for children. The conclusion is that when an activity is made playful, the workers or learners enjoy the activity more, and it reduces stress among workers and increases productivity [6].

For this project, it would be ideal if the exercise could be turned into a playful activity. The elements that make out fun and play appears to have a lot in common with elements of flow, especially the ones involving *the sense of the duration of time is altered, a deep, effortless involvement that removes awareness of the frustrations of everyday life and the ability to concentrate on the task* [9].

Prensky highlights a magazine called *Next Generation* from 1997 that listed six game design elements "found in every successful game throughout history." According to them, a good game design is balanced, creative, focused, has character, tension, and energy. For a more detailed description of these and 11 game design elements Prensky discusses from Falstein, see Appendix A.1.

Games usually appeal to specific audiences. Culture and age play a major role. Usually, the games and influential times one grows up with in the teenage years will impact which games one enjoys the most. When designing games, one must know the intended audience.

Lastly, Prensky talks about video games' language; these are design principles that are so common that you can expect them to be in a video game. Today some of these elements might not be as relevant anymore. An example is cheat codes. While still common in the early 2000's nowadays, cheat codes are seldom found. Instead, there is usually a micro-transaction that allows you to buy funny costumes or extra resources to progress more quickly through a game. Many games developed today are also mobile games, which often do not have more ways to do a certain action to avoid confusion. See Appendix A.1 for Prensky's list of language in video games.

9.2 Flow

Flow as a concept was introduced by Csikzentmihalyi [3]. It is not directly related to games but describes a state of being. When one experiences flow, one is very immersed in a task, and the sense of the duration of time is altered. Good video games allow the user to experience flow.

Flow experiences has eight elements [9]:

1. a task that can be completed;
2. the ability to concentrate on the task;
3. that concentration is possible because the task has clear goals;
4. that concentration is possible because the task provides immediate feedback;
5. the ability to exercise a sense of control over actions;

6. a deep but effortless involvement that removes awareness of the frustrations of everyday life;
7. concern for self disappears, but sense of self emerges stronger afterwards; and
8. the sense of the duration of time is altered

9.3 GameFlow

Sweetser et al. state that player enjoyment is the most important goal for computer games:

”Player enjoyment is the single most important goal for computer games. If Players do not enjoy the game, they will not play the game” [9].

Sweetser et al. has proposed a model of player enjoyment in games. It is based on flow because flow is a very broad concept about enjoyment in general, and flow theory is based on the premise that the elements of enjoyment are universal [9].

9.3.1 How to achieve flow in games

Sweetser and Wyeth’s model, called GameFlow model, results from a comprehensive review of literature on usability and user experience in games. It also has eight core elements: concentration, challenge, skills, control, clear goals, feedback, immersion, and social [9]. They present a mapping from Flow to games literature. This mapping is presented in table 9.1.

Sweetser and Wyeth explain in detail how each criterion can be achieved. They present a table that can be used as a checklist to either help develop or evaluate games for enjoyment (see Table A.2 in Appendix A.2). The following list summarizes a few key points for each criterion as they explain them in-depth beyond the table.

1. Concentration - The game must absorb all concentration from the player, so they get totally immersed.
2. Challenge - The game must not be too easy nor too hard.
3. Player Skills - Players must be able to develop skill and mastery.
4. Control - Players must feel a sense of control of their actions.
5. Clear Goals - Players should be provided with a clear goal.
6. Feedback - Players must receive appropriate feedback at appropriate times.

7. Immersion - Players should feel deep but effortless involvement in the game.
8. Social Interaction - Games should support and create opportunities for social interaction.

In summary, the player needs a clear task they can concentrate on, with a challenge that is as close to the player’s skill level as possible, with clear goals. The goals’ progress should be tracked through feedback, and the player should feel in control of the task. Finally, the player should feel immersed and absorbed in the game. The social interaction element does not have a mapping in flow-theory, but it is mentioned as important for user experience and usability [9].

Table 9.1: Mapping the Elements from Games Literature to the Elements of Flow - table from [9]

Games Literature	Flow
The Game	A task that can be completed
Concentration	Ability to concentrate on the task
Challenge Player Skills	Perceived skills should match challenges and both must exceed a certain threshold
Control	Allowed to exercise a sense of control over actions
Clear goals	The task has clear goals
Feedback	The task provides immediate feedback
Immersion	Deep but effortless involvement, reduced concern for self and sense of time
Social Interaction	n/a

To see if the GameFlow model captures the elements of what makes a game enjoyable, Sweetser and Wyeth evaluated existing games that share the same genre. The games received a score depending on how well they achieve the GameFlow model elements. The final score was very close to average public reviews of the games. This indicates that the GameFlow model works. Sweetser and Wyeth also state that it might not apply to all genres of games.

9.4 Reward Systems

To create a game that motivates the player to keep playing, it can be regarded as important to have a well-designed *reward system*. The goal of the reward system should be to create a positive experience for the players.

There are different types of reward systems that impact the players in their respective ways. The term "intrinsic" can be used to describe a reward that comes from the game itself, for example, having fun, and extrinsic rewards can be an actual reward in a game, such as an in-game item [15].

Reward systems can make players play a game without actually enjoying the action of play itself, but they play to achieve the reward. Reward systems can be used to allow players to compare themselves to other players. They can also be used to provide a sense of progress in the game. As such, the reward system can act as part of the feedback system. These are all elements tied to experiencing flow (see Section 9.3).

In their paper about reward systems, Wang and Chuen provide a list of eight different forms of reward [15]: score systems, experience point reward systems, item granting systems, resources, achievements, feedback messages, plot animations and pictures, and unlocking mechanisms. For a more detailed description see Appendix A.3

Wang and Chuen define four attributes for reward systems [15]:

1. The social value of a reward
2. The extent of how the reward affects gameplay
3. The suitability of a reward for collection and review
4. The time required to earn and or receive a reward

Wang and Chuen proposed a dual-axis system to classify rewards systems (see Figure 9.1). On one end of the first axis, there is "self," and at the other end, there is "others." This helps classify to whom the rewards of the rewards system are meant for. The other axis goes from casual in one end to progress in the other end. This axis says something about what the reward will be used for. This gives four reward categories: *review*, *advancement*, *cooperate/compete*, *sociality*.

9.4.1 Social Aspects and Fun

Games are seldom played alone. Even single-player games have their players discuss and compare achievements with others [15]. To earn rewards, players must locate information, and sharing this information encourages social interaction. Some games also require cooperation to unlock certain rewards. Thus a reward system can deliberately encourage social interaction. Interest in rewards can be increased by withholding details about them. There is some uncontrollable aspect as well the sense of learning once the information is unveiled. Players enjoy learning [15]. A good balance between risk and reward is also needed; higher risk can yield higher rewards.

Reward systems can provide a goal for the player itself, but it can also help keep players excited over the course of a game. The pleasure of anticipation for a reward can help provide a sense of fun [15]. A tactic to abuse this is to remind players of potential rewards.

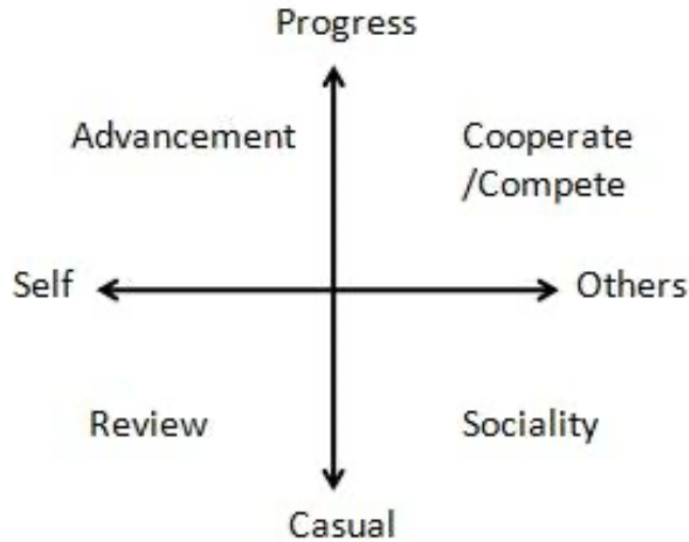


Figure 9.1: Wang and Chuen proposed this dual-axis system to classify rewards systems.

9.4.2 Designing Reward Systems

When designing reward systems, it is important to know the target customer motivation. Different players like different types of rewards. Reward quality should increase in rate with the skill level to keep players at the margin of ability; they should be predictable enough to maintain a fun level of anticipation, but occasional surprises are good; the goals can help giving direction about what to do next [15].

To support flow theory, reward systems can be designed by dividing large long term goals into short term goals or a series of shorter reward yielding tasks. This a way to achieve the flow requirement of clear short-term goals. The shorter goals can still retain a larger context [15].

9.4.3 Suggested Reward System for Mobile Device Exergame

I propose an idea for a reward system for a mobile phone exergame.

The first one is a system where the steps walked in real life directly impact the player's access inside the game world. By walking more steps in real life, the player can walk further in the game. I propose an RPG or semi Open World-

like game where both exploration and quests and a story style game can play out. The player will have a circle surrounding the avatar, which will grow if more steps are walked in real life. If many steps are walked, then the circle can be much greater than the view distance. I propose that the center of the circle becomes the player's position at midnight or related to key-locations in the current part of the story that the player is at, making progress more likely, or encouraging exploration in the case where it resets to the player's location in the game world at midnight. By walking during the day, the player will increase the amount of access they have in the game. This might encourage players to keep walking every day, thus engaging in physical activity if the game itself is motivating enough to play. If access is controlled correctly, it can create both elements of control and "chance" because the player may not know where it should leave the avatar for the next day to best progress in the game.

An additional feature of this reward system is one that promotes social play. If a player finds another player that plays the same game, they can choose to link up by physically using NFC communication on their devices. This could pool their daily steps, setting both players access in the game to equal their combined steps - regardless of where they are in the game. This can motivate players to not only walk on their own but also play the game together. Even if they play on separate devices or stories, they will be co-located in real life. This might also help players motivate each other to reach a certain number of steps to combine their numbers to a certain larger number.

This could be further changed to allow for a weekly accumulation of steps to provide more busy players with a wider timeframe to gather steps and play later. However, it should still require a high enough activity level that it makes players walk more on average every day, not just live their ordinarily sedentary lives and gather steps inactively; since the goal of this reward system is to promote physical activity and social interaction.

9.5 Scripting and Emergence

Sweetser et al. talks about two sides of games called *scripted* and *emergent* games [8]. Sweetser claims that games should not be entirely scripted nor completely emergent, as too much of either is bad. A scripted game refers to it being designed so that everything that happens is by the designer script. The player plays the game in the exact way the designer has intended for it to be played. The opposite is emergent games where the game world is designed with game world rules, such as physics, and the player plays the game the way they want.

One of the biggest drawbacks of scripted games is that they limit *fantasy*. On the opposite end, a completely emergent game would possibly have no story to experience. A mix of the two concepts would be ideal, where there is a story to play but enough room to immerse oneself in the game. Emergent games

where the story is not set in stone also tend to have higher replayability.

Sweetser also mentions how an emergent game with rules defined can be made similar to the real world, making it intuitively what the game rules are and what is possible to do in the game world. In a scripted game world, every object must be carefully designed to do everything the script requires. This may lead to a tedious design process when the number of objects in the game increases, but it can also lead to unintuitive game worlds where the player is confused about why certain things are possible, and others are not.

The balance between scripting and emergence will also impact the player's feel of control, which is important to achieve gameflow as mentioned in table A.2.

9.6 Summary of Game Design

This chapter has focused on elements found to make video games fun and how to make sure these elements can be included in a game. Fun in video games is closely related to having fun in general, and as such, one can design games with GameFlow in mind. GameFlow is an adaptation of flow theory made for video games. Reward systems are an important mechanism to support the GameFlow model, as it supports both social aspects and can help break a large goal into shorter tasks that the player can focus on. The rules in games are a part of what defines a game and allow the user to focus on their task. By carefully defining the rules, one can achieve a balance between a scripted game and an emergent game, which can allow players to experience control and fantasy.

Chapter 10

The Magic Circle and Pervasive Games

This chapter briefly explains the concepts of the magic circle and pervasive games. It discusses and suggests how exergames can be tied to pervasive games and how it might help keep these concepts in mind when designing exergames. BitPet is a game that shares many similarities with Pokémon GO. Pokémon GO is an AR game, and as will be made clear during this chapter, AR games are pervasive games. Getting a clear idea of what pervasive games are and what players enjoy about them can be helpful when designing game features for BitPet.

10.1 The Magic Circle

In the article written by Stenros about the magic circle [20], the author discusses different ways researchers have tried to conceptualize the magic circle. The magic circle is essentially the border between non-play activities and play. It can be a physical distinction, such as a soccer field. Still, it is also a social concept where the players themselves have a common understanding of the current situation being a playful situation. An example is that one could walk across a soccer field without actually playing, but once two teams organize and agree that a soccer match is taking place, both teams have entered the magic circle, and the soccer field physically confines it. The rules of play are not necessarily always defined, and as such different players might have different understandings of where the magic circle begins and where it ends. This concept of ambiguity around the borders of play is what pervasive games and brink play exploits.

10.2 Pervasive Games

In the paper by Stenros [20], pervasive games are described as games on the border of the magic circle. The line separating play and non-play activities bends and extends itself or can get blurred. This phenomenon in itself is thought to be an alluring aspect of pervasive games, piquing interest among players. In augmented reality games, this manifests itself in the fact that the game elements are rendered onto the real world. This can enhance the player's fantasy, as they might suddenly be living inside the game, as the game takes place in the physical world. Stenros also highlights the concept of *brink play*. Brink play occurs when players are aware that they are playing on the very edge of the magic circle, which can be intriguing. This can often be exciting due to the social aspects of play versus non-play. When playing at the edge of the magic circle, one might forgive social interaction that is not considered acceptable in non-play situations. Because the players are aware of this, they enjoy the so called brink-play. This might be a dangerous aspect of games as well, as these social borders can be subjectively different, and this should be kept in mind when designing pervasive games. They run the risk of crossing into the domain of brink-play.

In the paper produced by Magerkurth et al. [7], they describe pervasive games as *games that are no longer confined to the virtual domain of the computer but integrate the physical and social aspects of the real world..* The paper dates back to 2005. Since then, a lot has happened to the world of computer games, especially when it comes to devices' portability. In their paper, they showcase some games and technologies that are limited by their portability. Nowadays, GPS and smartphones allow location aware pervasive games using AR to be produced with much greater ease. Pokémon Go is, for instance, a pervasive game that uses AR and is location-aware, and it is arguably the most successful exergame and AR game to date (see Section 13.10).

When it comes to exergames, by definition described in Section 7.1, they are not all automatically pervasive games. A game can qualify as an exergame by simply having the input device require the player to perform actions such as cycling on a stationary bicycle to allow the game to continue running. While this involves the player doing something physically in the real world, it is not much different from just pushing a button for input. It is the actual play-activity that needs to take place in the physical domain and the virtual one. However, one could also argue that an exergame could be a pervasive game by using a different definition of pervasive games, such as the one presented in the paper by Stenrose [20]. By this definition, it only needs to blur the lines of where the magic circle is. As such, an exergame involving a stationary bike and a video-game taking place entirely in the virtual domain could be designed where a social play-activity takes place in the virtual domain. This play activity could have rules or act out to make the player unaware of where the borders between play and non-play are. An example would be communication between players, this can be a part of the play-activity, or it could be something beyond.

Regardless of which definition is used for pervasive games, it is noteworthy that blurring the lines of where play and non-play activity occurs can be an element of game design that makes games interesting and fun. Exergames are also often closely related to pervasive games, and as such, it might be possible to design them with this element in mind to make them more engaging and motivating to play. It is also noteworthy in itself that Pokémon Go is a pervasive exergame.

10.3 Summary of The Magic Circle and Pervasive Games

This chapter has explained what the magic circle and pervasive games are. The magic circle is the line between activities labeled as play and those that are not. This line can vary and can sometimes be hard to define. Pervasive games are games that exist on the very border of the magic circle. These games can benefit from the excitement players might experience when crossing the line between play and non-play. Pervasive games involving social interaction might introduce the risk of hurting other players' feelings or making a fool out of oneself when bordering the magic circle. These games are often referred to as brink-play. Pokémon GO is another example of a pervasive game, where the excitement comes from bringing the game world into real life.

Chapter 11

Player Types

This chapter introduces the concept of *player types*. This chapter aims to provide a basis of knowledge about the concept of player types or typologies. The information presented is found in the articles *Player Types: A Meta-Synthesis* [19] by Hamari et al., and *Hearts, clubs, diamonds, spades: Players who suit MUDs* by Bartle [4]. The first paper is a review of research on player types, and the other is one of the papers that was reviewed by Hamari et. al.

If BitPet is going to be popular with a broad audience, it will have to cater to different players. Different players enjoy different aspects of games. Reviewing existing research about player types and what motivates different player types can help design game features for BitPet that motivate players to play the game and engage in more physical and social activity through BitPet.

11.1 Segmenting Players into Typologies

The idea of player types is to segment the player base into as homogeneous groups as possible whilst having distinct differences between the groups. One can design game features or even entire games for specific target audiences made up of a certain player type. Segmenting players into groups is called creating player typologies.

According to Hamari et al., there four overarching categories for segmenting a population [19]:

- Geographic segmentation - dividing people into groups based on place of residence, for example country or city.
- Demographic segmentation - dividing people into groups based on descriptive features, such as age, gender, education, occupation or social status.
- Psychographic segmentation - dividing people into groups based on their attitudes, interests, values and lifestyle. An example could be a social extrovert who enjoys watching soccer with friends.

- Behavioral segmentation - dividing people into groups based on how they behave towards a certain product or how they interact with it.

In video games, psychographic and behavioral typologies are the most common [19].

11.2 Existing Player Typologies

This section introduces different player typologies mentioned in the paper written by Hamari et al. [19]. For a summary of the existing ones, see the summary in Section 11.5.

11.2.1 Hardcore and Casual

The terms *hardcore* and *casual* are often used by researchers to describe players. This type of segmentation belongs to a psychographic typology. Researchers have used traits such as level of dedication, game knowledge, and immersion, along with time spent on the game, to classify players as either hardcore or casual. It is often hard to place players in only two categories. Therefore it has been suggested to rather use these traits as part of a bigger player model.

11.2.2 Segmentation by In Game Behaviour

Hamari et al. mention four other player types using behavioral segmentation on game logs from players playing a Tomb Raider game[19]: **Veterans** - players who die rarely and finish the game quickly; **Solvers** - take their time to solve the puzzles encountered during the play; **Pacificsts** - players who die mostly from enemies (as opposed to e.g., falling), and are fairly fast at completing the game; **Runners** - players who have a very swift play-through of the game.

11.2.3 Segmentation by Progress

A different way to segment players with a behavioral basis is to segment them based on their progression in the game, similar to customer loyalty programs. This way, game content can be designed for players at a specific progression.

11.2.4 Segmentation by Motivational Factors

Yee proposed three main factors motivating gamers to play games and suggested a player typology based on these three factors: Achievement, Social aspects, and Immersion. Zachariasson took these three factors and expanded them. This led to player typologies based on the player's motivations: Progress & provocation,

Mentality	Sub Categories
Social Mentality	<ul style="list-style-type: none"> - Playing with Children - Playing with Mates - Playing for Company
Casual Mentality	<ul style="list-style-type: none"> - Killing Time - Filling Gaps - Relaxing
Committed Mentality	<ul style="list-style-type: none"> - Gaming for Fun - Immersive Play - Gaming for Entertainment

Table 11.1: Kallio et al. proposed this player typology. Players are segmented by their mentality [19].

Power & domination, Helping & support, Friends & collaboration, Exploration & fantasy, Story & escapism [19].

Tseng started with two motivational factors, a need for exploration and a need for conquering. Through the results of a survey, he segmented players into three groups, *aggressive gamers* scoring high in both factors, *social gamers* scoring high on need for exploration, but low on conquering, and *Inactive gamers* scoring low on conquering and in the middle on exploration.

11.2.5 Segmentation by Mentalities

Kallio et al. looked at which mentality a player had when playing a game. Kallio proposed three mentalities: **Social Mentality**, **Casual Mentality**, and **Committed Mentality**. The mentality a player has says something about why or how they are playing a game. Based on the mentality, Kallio proposed three subcategories for each mentality leading to a player typology. This can be seen in Table 11.1

11.2.6 Bartle’s Player Types: Killer, Achiever, Socialiser and Explorer

Bartle proposed four player types: Killer, Achiever, Socialiser, and Explorer. These were placed on a dual-axis system, where depending on players behaved in the game, they would fall into one of the four categories (see Figure 11.1).

The four types can be explained as such [19] [4]: **Killers** prefer action and are player-oriented; **Killers** are interested in doing things to people; **Achievers** prefers action and are world-oriented; **Achievers** are interested in doing things to the game; **Explorers** prefer interaction and is world-oriented; **Explorers** are

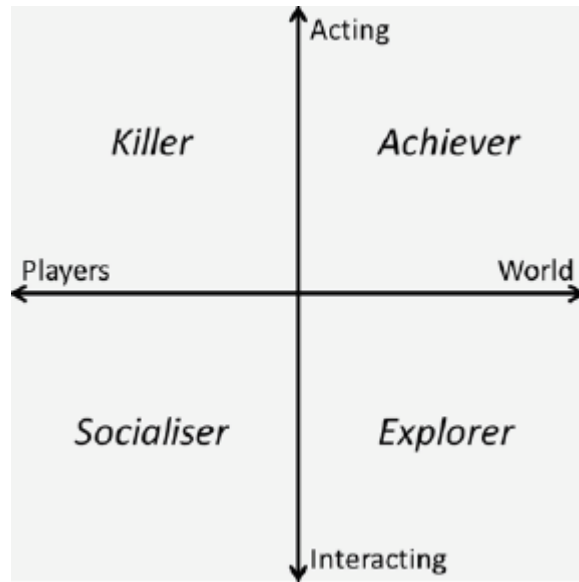


Figure 11.1: Bartle's player type axes [19]

interested in having the game surprise them; **Socialisers** prefer interaction and are player-oriented; **Socialisers** are interested in interacting with other players.

These player types are intended to be used as part of a larger player-model, and one can score players on a scale within each player type. For more about Bartle's types see Section 11.3.

11.3 Game Design for Bartle's Player Types

A concept Bartle explains that is not covered in sections 11.1 and 11.2 is the idea of a game balance when it comes to player types. A perfectly stable game has an equilibrium of the four player types.

To change the balance of a game, Bartle suggests making changes to one of the four aspects of his dual-axis system (see Figure 11.1): the players, the world, interacting, and acting.

Emphasizing the players can be achieved by providing plenty of communication tools for players and not implementing much else. For the opposite effect, remove the communication tools.

Emphasizing the world can be achieved by increasing the game world's size, making it harder for players to meet and communicate. This forces players to traverse more land and thus act towards the game world.

To emphasize interacting with the game, one can reduce the amount of freedom for players, make paths in the game the players have to follow.

Lastly, acting can be emphasized by increasing the amount of doing-to actions rather than doing-with actions.

Bartle lists some specific measures that can be taken to emphasize the four aspects already mentioned (see Appendix A.4). It should be noted that his ideas may not apply to every type of game. They do, however, serve as a guideline for direct changes to games to cater to specific players.

The ideas presented here regarding changing the player balance in a game are specific for Bartle's player types. Many of the ideas presented in the previous section all originate or build upon from the ideas and research presented by Bartle in his paper [4]. To adjust the player balance when using a different player typology, one would have to identify which elements in the game support which player types. Afterward, these can be tuned to adjust the player balance.

11.4 Player Types for this project

For this project, different kinds of player typologies may be considered. Although it is not normal to segment players by demographic and geography, it might be preferred in this project. This is because the game is based on walking in the real world.

Depending on where one is in the world, there might be different rules and regulations, which means game content must be altered or targeted for specific audiences. This would be a geographic basis.

One can also argue that demographics will play an important role since some demographics are better suited for walking in more demanding areas or longer. A young adult would probably be more suited to walking for an hour than a senior recovering from a hip fracture. This type of player typology could be relevant for designing the game's challenge or game feature.

Since the project's goal is to develop a game feature that increases both physical and social activity, using both a psychographic and a behavioral basis would make sense as well, as one would have to create game content that players with different levels of extroverted or introverted traits find enjoyable.

11.5 Summary of Player Types

This chapter has explained how one can create different player typologies by segmenting players into groups based on some defining features. A reason to do this would be to clarify what content one should produce for which players.

Different researchers have suggested many different typologies over the years.

By knowing which player types exist within a game, one can tweak the game's content to manage the balance of players from each existing player type. Hamari et al. [19] does bring up an interesting point that should be considered when designing games using player typologies: If you design your game with player typologies in mind, you might end up getting more players that fit into the player typologies. In other words, as a designer, one might be creating an effect that reinforces itself. It also brought up that most research on the area is based on Bartle's ideas, and the area of player types needs further research.

Chapter 12

Exergames, Socialising and Mental Well Being

This chapter introduces some research on the psychological effects that have been observed in studies on exergames. The results discussed in this chapter are mostly from the exergame Pokémon Go. BitPet shares aspects with Pokémon GO, so knowing how Pokémon GO has impacted players' social activity can be very helpful when designing game features to motivate BitPet's players to increase their social activity. Exergames and their effects on socializing is a field that still lacks research, and investigating BitPet's effect on social activity is the primary goal of this thesis. Therefore it is essential to know what has already been done within the field. Knowing which areas have and have not been researched can reveal which areas could be interesting to investigate further.

12.1 Pokémon Go and Social Interaction

Pokémon Go has been subject to many research projects. Some of these projects have looked at the game's impact on the social interaction of its players. The game has been proven to increase social interaction between humans and between dog owners and their dogs [28]. Pokémon Go strengthens social ties between family or household members [28] [29] [32]. Pokémon Go make players feel less anxious about interacting with strangers [28], it makes them facilitate casual conversations with strangers [29], and can help players make new friends or intensify friendships [26] [32]. Location-Based Mobile Games (LBMG) can be used to increase social interaction, and has been suggested as a tool to develop social skills [31]. Pokémon Go, which is an LBMG, has also been shown not to be negatively associated with social anxiety [26].

12.2 Studies on Exergames effect on Mental Well Being

A systematic review on the topic of exergames' effect on mental health in children and adults with obesity showed a positive effect on self-efficacy and self-esteem. The authors also conclude that more research on the topic is needed [34].

A different systematic review looked at exergames effect on reducing anxiety levels. While it showed promising results, it showed no better results than other non-exercise interventions [40].

A third systematic review looked at the social effects of exergames on older adults. From their conclusions [37]: *"Exergame studies showed promising results for enhanced social well-being, such as reduction of loneliness, increased social connection, and positive attitudes towards others"*

An experiment has been carried out to investigate the effect exergames have on older adults' mental well being. Playing exergames increased participants' positive affect and decreased negative affect. A noteworthy observation from this study is that playing exergames alone for older adults saw a greater decline in negative affect than when playing with peers or youth [41].

A study on players aged 12 to 100 years investigated social, digital gaming habits. The study found the most social gamers to be younger players with higher achieved education, were more dedicated to gaming, and spent more time gaming. Male gamers were also more social than female gamers. The study found that digital gaming adapts more to life than the other way around [21].

12.3 Making Friends

A study by Hall [30] investigated how many hours it takes to get to know a new person and to consider them as a friend. Friendship status was considered by looking at hours spent together, shared activities, and everyday talk. Friendship closeness was shown to be a function of time spent together and type of activity. The proportion of time spent working together in a class was negative for friendship closeness, but the proportion of time spent hanging out or watching TV or *gaming* was positive for friendship closeness.

This suggests that keeping players busy playing a game for extended periods of time interacting with the same players is positive for creating or intensifying friendships.

12.4 Summary of Exergames and Psychological Well Being

Exergames are proven to have positive effects on both psychological well-being and being a tool for establishing new friendships or intensifying existing friendships and family ties. More research on the area is needed, but nothing indicates that exergaming is negative for psychological well being. Exergames have also been proven to help reduce social anxiety and helped players communicate with strangers.

Chapter 13

Existing Exergames

This part lists and discusses existing exergames that have relevance for this project. It briefly introduces different exergames and lists their unique features. Knowing which games have seen success and why they have been successful can help identify which game features should be developed for BitPet. Looking at existing games can serve as an inspiration. Once potential ideas for game features for BitPet have been produced, knowledge of existing successful exergame can help choose which features have the most potential of motivating players to be more social and physically active.

13.1 WeChat WeRun

WeChat is the world's largest standalone mobile app with over one billion users [102]. It can be used for pretty much anything you can do on your phone by using mini-programs that run inside the application. Third-parties can develop these programs. As a result, all kinds of services are available on the app, like messaging, food ordering, maps, transport, and inevitably games. One exergame I have tried on this app is "WeRun". The app is using the health information being tracked by the mobile device, specifically the pedometer. By allowing WeRun to access this data, it places you on a leader board with all your other contacts that have also chosen to use WeRun. The highest-ranked player is the person with the most steps for the given day. The app also lets every player chose a personal picture to be their own background picture. The app will always display the personal picture of the highest-ranked player of the day on any person's device (see Figure 13.1). This motivates players to climb the leader board among their friends and be rank number one on their friends' leader board to show off their own picture on other players' devices. Every evening the app will send a push notification to anyone who has the game activated in their WeChat application, displaying your three contacts with the most steps for that day.

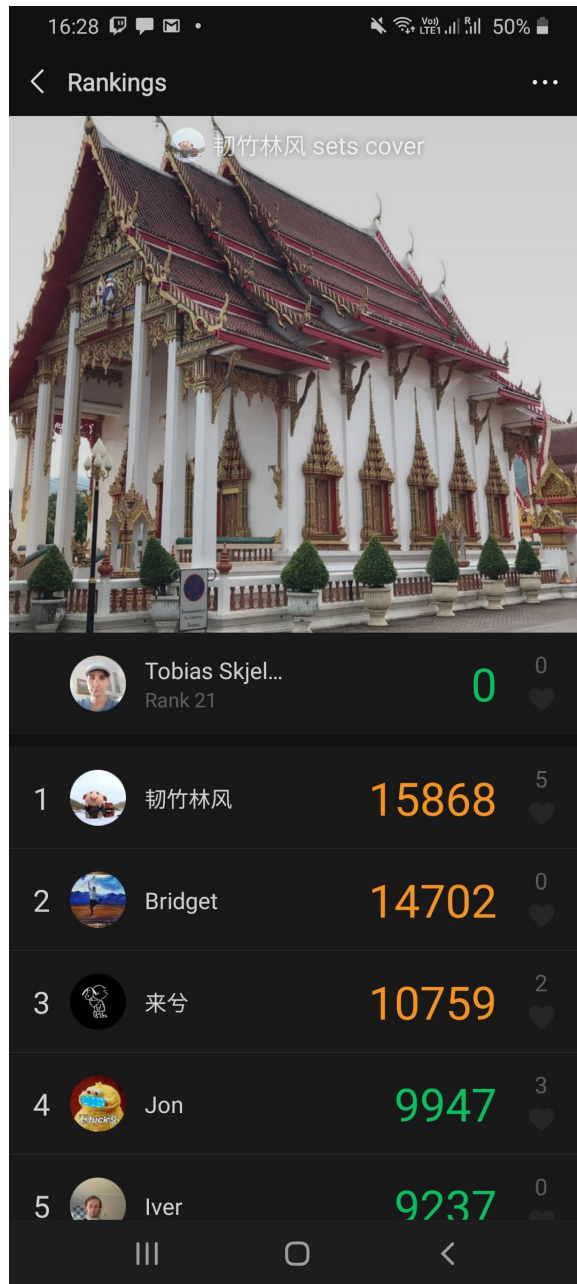


Figure 13.1: WeChat WeRun daily leaderboard - your friend with the most amount of steps sets the cover photo on your device for the given day

I have not been able to find research on this app on the Internet. Still, from personal experience, I can tell my social group when I lived in China would walk extra distances or choose to take the stairs to compete for a higher rank on the leader board every day while I lived there for five months.

13.2 Zwift cycling and running game

Zwift is a massively multiplayer online cycling and running exergame that was originally released in 2014. At the time of release, it was only made for running. The cycling version of the game allows players to ride a stationary bike whilst watching their avatar ride in a virtual world. One can participate in races with other players or cycle freely in the open world. The same holds for the running version, except you run rather than riding a bike.

13.2.1 Zwift Cycling

The game has a somewhat high entry barrier as a relatively large amount of equipment is required to play the game. A bicycle is needed to play the game, either a regular bike or a stationary one. The bicycle has to be connected to what Zwift refers to as a trainer. The trainer is a device that creates resistance and allows the bicycle to stay put whilst being used, so one can ride the bicycle on the spot inside the living room, for instance (see Figure 13.3). The cheapest option for sale on Zwift's own website costs \$499 USD as of fall 2020. The last thing needed to play Zwift is downloading the actual game and paying a monthly subscription fee.

13.2.2 Zwift Run

Zwift has also released Zwift Run. Zwift Run is like Zwift cycling, except the player runs on a treadmill instead of cycling with a resistance machine. A player has to wear a wearable device called a *RunPod*. The player also needs access to a treadmill, and a device with Zwift installed, positioned in front of the treadmill. The RunPod device needs to be placed on the shoe; it can be placed on the shoelaces by treading the shoelace through the RunPod (see Figure 13.4). The RunPod is considerably cheaper than the trainers for Zwift cycling, with the cheapest option starting at \$39.99 USD. There is also currently no subscription fee for playing Zwift run.

13.3 Stolpejakten - Pole hunting

In Norway *Stolpejakten* was created in 2014 [89]. Stolepjakten is an orienteering activity where different poles are placed inside and around cities in Norway. By downloading an app for smartphones like Android and iOS, one can access a map that shows where the poles are placed. Upon reaching a pole, one can use



Figure 13.2: Zwift cycling game

the phone's camera to scan a QR code placed on the pole with the mobile phone. This registers the pole as visited, and one is entered into a drawing of prizes [88]. The poles have four different levels of difficulty ranging from easy to hard. According to Wikipedia, which cites a document from the organization that can no longer be accessed online, there are more than 150 000 registered users of stolpejaken [86]. In Bergen, one of Norway's largest cities with more than 289 000 inhabitants [49], two months after Stolpejakten was released, there were already more than 10 000 registered users, and more than 205 000 poles scanned [90]. In Bodø there were 400 registered users in 2019 [87]. One year later, there were more than 5000 registered users [74]. The ones responsible for the project in Bodø has released some data about the usage. An interesting observation is that they have had a lot of success across all age groups, especially among the younger generation (see Figure 13.5a). Sunday is the most popular day of the week to go pole hunting, almost twice as popular as Friday. Apart from this, there is a relatively even spread of visits per day of the week (see Figure 13.5c). Lastly, the number of visits to poles in Bodø was very high in the beginning compared to a few months later (see Figure 13.5b). This might indicate a lot of enthusiasm at the beginning that died off as people were familiar with the concept, or perhaps more likely that people had already visited all the poles and were not willing to revisit the same poles—the element of not knowing where the target might no longer be motivating. However, the level of engagement has



Figure 13.3: Wahoo Snap - Trainer for bicycle to be used with Zwift



Figure 13.4: Runpod used to track running in Zwift Run

managed to remain very constant after the initial drop in number of visits.

This application is interesting as it quite successfully managed to innovate a concept, orienteering, that is already a gamification of walking. It also shows that it is possible to have people from all age groups get outside and walk despite not having any fancy computer graphics or anything else. Simply having a goal to reach might serve as enough motivation to perform the physical activity. However, it should be noted that one could ride a bicycle to reach some of the poles in some locations or even drive a car. Still, some poles are located in places where it is impossible to drive or ride a bicycle, you have to walk, so it is not likely that this is a common occurrence.

13.4 Exergames by Nintendo

This section presents some of the most popular exergames created by Nintendo.

13.4.1 Wii Sports and Wii Fit

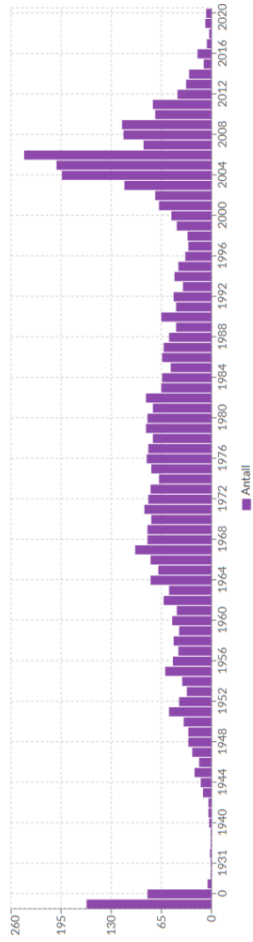
The Nintendo Wii (see Section 8.4) is one of the most sold entertainment systems for exergames. It was released with the game *Wii Sports*, an exergame that allowed players to play five different sports simulations, golf, bowling, boxing, tennis, and baseball. Nintendo later released *Wii Fit* [104] in 2012, which has sold more than 22 million copies [99]. This second success was another exergame that utilized a *Wii Balance Board* (see Section 8.4). *Wii Fit* lets players exercise with yoga, strength training, aerobics, and balance games. Nintendo also created an enhanced version of *Wii Fit* called *Wii Fit Plus* that featured extra activities and workouts [105]. This game also had a greater focus on using the *Wii Remote* along with the *Balance Board*.

13.4.2 Wii Fit U

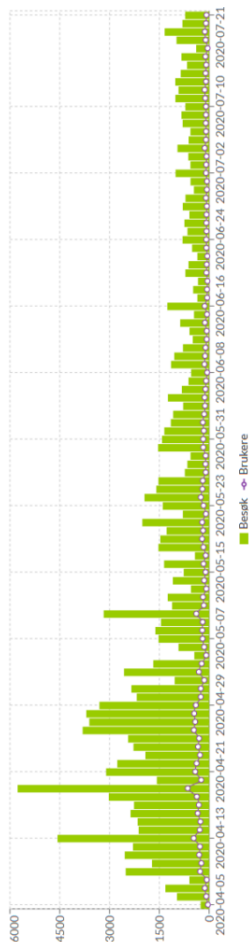
Nintendo developed a new exergame *Wii Fit U* for the Nintendo Wii U (see Section 8.5), continuing the theme from the Nintendo Wii version. This game also used the *Wii Fit Balance board* [106]. *Wii Fit U* introduced a new dance activity, along with all the previous activities from *Wii Fit*. The game also tracked steps taken, elevation and calories burned. *Wii Fit U* allowed players to play online with friends and gym communities; this was intended to keep players motivated. I was unable to find any statements about the amount of copies sold. Still, the fact that the *Wii U* console sold fewer units than the number of copies of *Wii Fit* for the *Wii* indicates it was much less successful than its previous version *Wii Fit*.

13.4.3 Exergames for Nintendo Switch

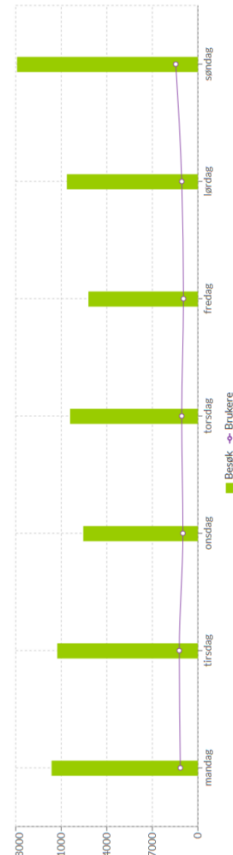
Ring Fit Adventure was released for the Nintendo Switch in October 2019. The game has already sold more than 4 million copies [43], making it one of the most



(a) Stolpejakten - registered users in Bodø by year of birth - picture from [74]



(b) Stolpejakten - visits to poles Bodø - picture from [74]



(c) Stolpejakten - visits to poles by day of the week - picture from [74]

sold games on the console within a year of its release. The game features more than 100 levels in 20 different worlds where the goal is to defeat a bodybuilding dragon. This is achieved by performing real-life exercises holding a ring with one of the Nintendo Joy-Cons strapped into the ring and the other one strapped to one's leg (see Figure 13.6). This allows the game to register body movements. The game also allows you to create customized workout routines, which is also the RPG element of the game. The actual game content involves leveling up your avatar as you progress through levels and defeat enemies, [83] [82]. An interesting aspect here is that the developers seem to have successfully created an RPG style exergame that is popular on a large scale. There appears to be

little to no actual research performed on this game as of yet, so the number of sales is the only reliable metric. The Covid-19 virus situation causing many people to stay indoors in their homes might have helped the sales, as there has been a surge in sales during 2020, even causing a shortage of supply [76].



Figure 13.6: With one Joy-Con in the ring and one strapped to the leg the avatar can mimick the player's movements

Nintendo released a simple exergame in June 2020 called *Jump Rope Challenge* [68]. The game is straightforward, only portraying a character jumping on the screen as you jump in real life. By holding the Nintendo Switch Joy-Cons, the game detects whether you are jumping or not. The game supports up to two players playing at a time, which allows another player to join whilst one might be trying to reach a new high score. The game also lets the player select a daily goal of the number of jumps. Finally, the game allows you to look back on the past days and see how many jumps were reached. See figures 13.7 and 13.8 for example screenshots.



Figure 13.7: Nintendo Jump Rope Challenge - screenshot of game play from Nintendo website



Figure 13.8: Nintendo Jump Rope Challenge - players can choose a daily goal - screenshot from Nintendo website



Figure 13.9: Nintendo Switch



Figure 13.10: Nintendo Joy-cons detached from the Nintendo Switch.

13.5 Kinect Games

According to Amazon Best Sellers in the category video games for the XBOX 360 Kinect the most popular games for this version of the Kinect were *Kinect Adventures!*, *Kinect Sports*, *UFC Personal Trainer*, *Kinect Sports Season Two*, and *Dance Central* [46]. *Kinect Adventures!* features twenty different adventures the players could play through. The game requires a bit of space to play as, according to a critic: a lot of the game's success relies on the frantic of multiplayer [72]. The same review also complains that the gameplay can become exhausting. A study on one of the activities in the same game called *River Rush* has been done where it was compared to playing *XaviX J-Mat* and *Gamercize*. It turned out that the girls recruited for the study did not play at recommended moderate or intense physical activity levels when playing *Gamercize* or *River Rush*. Still, when using the *XaviX J-Mat*, they were playing at moderate levels.

Kinect Sports and *Kinect Sports Season Two* are both sports games developed by Rare. They feature different sports that can be played in single or multiplayer. *Kinect Sports* won a BAFTA Family Game of the Year award. *Kinect Sports* has been proven to increase heart rate and energy expenditure above resting levels typically observed when playing regular video games [17]. The same study highlights that the activity levels are within the limits of what is considered moderate physical activity as defined by the UK guidelines, and the energy expenditure can be compared to a walk at 4.8 km/h pace, which is com-

parable to regular walking. These results are relevant to this research project, as that is what this project aims to achieve, have players walking around. Unfortunately, the paper says nothing about the enjoyment of playing the sports game; the paper suggests that playing video games is a fun activity. Another study did include the player's enjoyment as a metric and found that inactive early adolescents, regardless of sex, enjoyed playing six *sports exergames* with a Kinect and achieved activity levels equivalent of moderate exercise [23].



Kinect for XBOX ONE



Kinect for windows



Kinect for XBOX 360

Figure 13.11: Kinect for XBOX ONE, XBOX 360 and Windows

13.6 Dancing Games

This section presents some of the most popular dancing games created to date.

13.6.1 Dance Dance Revolution

One of the earlier exergames released that has also achieved large-scale success is Dance Dance Revolution, released in 1998 [51]. The game is a music video game where the player stands on a platform that has four arrows as large buttons on the floor, see Figure 13.12. The buttons each point to a direction, forward, right, backward, and left. As the music plays, arrows corresponding to the buttons on the floor will appear on the screen in front of the player in sync with the song's beat or tones. The player then has to move their feet and tap the correct button simultaneously as the arrows reach a certain point of the screen. The player is awarded immediate feedback on how well-timed the button tap was, with messages such as "great," "good," or "miss" flashing on the screen. The game is still popular today and can be found in arcades worldwide; although there are new versions of the machine and new songs, the gameplay remains the same. Dance Dance Revolution has successfully helped people lose weight [98]. A study has been carried out investigating the effectiveness of using DDR to boost the amount of physical activity performed by overweight or obese children, but the researchers concluded with their positive results being questionable [16]. This means it might not motivate players to play and engage in physical activity over time. However, DDR does raise players' heart rate above the level needed to be considered an effective aerobic workout even at the easiest level of play [10].

13.6.2 Just Dance - Video Game Series

Just Dance is a video game series published by Ubisoft. The first game was released in 2009 and has since had an annual release every year [70]. There is also a mobile phone version of the game (see Section 13.6.3). The first two games were only available for the *Nintendo Wii* and used the *Wii Remote* controller to register dance moves. The third release was available on *XBOX 360* using the Kinect and *PlayStation 3* using the PlayStation Move controllers. This third release also supported Karaoke on XBOX and PlayStation using the microphone in the PlayStation Eye and the Kinect [70]. For more information about the Kinect and Playstation Eye see sections 8.2 and 8.3.

An interesting detail about Just Dance is that the games focus more on upper body movements than Dance Dance Revolution, which uses the dance mat or platform with pressure pads to step on. Some researchers were curious about the effects of using a controller for feedback for dance games. Due to a lack of access to the gaming consoles supporting Just Dance in Taiwan at the time of the study, dancing videos were popular to watch and dance to. For the study, the researchers had more than a hundred students of different sex dance



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<https://commons.wikimedia.org/w/index.php?curid=45384772>

Figure 13.12: Dance Dance Revolution Physical Machine

in mixed groups to videos of the game *Just Dance 3* without any controllers. The results showed that the exercise was equivalent to moderate exercise. There were no significant differences in heart rate, blood pressure, step counts, body movements, or perceived psychological effects [22].

13.6.3 Just Dance Now - Mobile Game

The *Just Dance* video game series has released a game for mobile devices [101]. The game uses the phone to detect the player's dance moves. The game allows for unlimited amounts of players as long as they have a smartphone that supports the game. Lastly, to play the game, a television or computer with a screen is needed to launch the game. By entering the website for the game, a code will be displayed. Upon activating this code in the app, the screen hosting the code will turn into the game, showing the players the moves to perform, whilst holding the device in the right hand. See Figure 13.13.



Figure 13.13: Screenshot from launch trailer - players playing *Just Dance Now*

The game's 2020 release supports playing by using a mobile phone as a controller instead of a PlayStation Move controller, Kinect, or Joy-Con [100]. It also supports *Just Dance Unlimited*, which is a streaming service for songs to dance to. It has more than 500 songs available at the time of writing. Access can be bought for different lengths of time, with the cheapest option being 24 hours of access for \$2.99 USD, and the most expensive being a year of access for \$24.99 USD [69].

13.7 Exermon

Exermon is an exergame for mobile phones developed by Høivik and Olsen as part of a research project [25]. The game design and idea revolve around training in real-life whilst training an in-game avatar called an *exermon*. The game itself is split into three parts, training, fighting, and planning.

Physical exercise happens during training. During physical exercise, there is little interaction with the game itself. It is only used to record the exercise and provide the user with feedback on their training - the player can see the results of their training in the game.

In the game's fighting part, the player boxes against an in-game opponent by swiping across the screen. The difficulty of the fight is designed to fit the player's current points or progress. There are three different modes to fight. A weekly boss fight designed to be beatable by performing the week's training, a ranked mode where one faces off different opponents and attempts to take the number one spot, and a mode where one can compete against friend's exermons.

The planning part of the game shows the player's progress and the choices or actions available to them at the current time.

The exercise of the game is focused on bodyweight strength training exercises. Different exercises give their in-game avatar different points, depending on which exercise was performed. To track the exercises, the phone's accelerometer and proximity sensors were used.

An experiment was carried out as part of their research, where they had 24 participants play their game. They found that the player's motivation was affected positively by the rewards systems and the social aspects of the game. They also found that most players enjoyed playing the game, and 41.7% of the players increased their exercise amount. The game had some issues tracking the actual physical exercises due to the hardware restrictions.

From the evaluation of exermon written by Wang et al. [33], the following conclusion is presented about the game: *"The effect of the game is to boost the motivation for doing physical training, and not to motivate those who are not interested in doing strength exercises in the first place. A weakness with the approach is that the strength exercises themselves are not directly related to the game's fantasy but rather have an indirect effect on the fantasy through evolving the monsters. Future research includes investigating exergame concepts where the exercises and the fantasy are tightly integrated, as well as examining the long-term effects of such exergames."* [33].

13.8 Fitogotchi-ntnu

Dalseth created, tested, and reviewed an exergame for smartphones called Fitogotchi [27]. The game is inspired by Tamagotchi (see Section 13.9). In the game developed, the player has to take care of a pet (a Fitogotchi) by performing exercise in real life through walking, cycling, or running. Taking care of the fitogotchi levels up three different stats, which improves its performance in an endless runner style game that can be played in the game. An endless runner is a game where the player runs across terrain that is generated endlessly, and the longer you run, the higher score is achieved. Fitogotchi had five different worlds one could run in (see Figure 13.14).

The rewards in the game for physical exercise in the real world are balanced such that walking will yield fast progression at the beginning of the game, but running and cycling will yield larger rewards than walking later on in the game. This was designed to ease players into the game and motivate them to exercise more rigorously after getting to know the game.

After development, a four-week experiment was conducted with participants from Norway and Korea, with 43 participants' data seen as valid for results. They found that the game was enjoyable by participants, and the social aspects of competing against friends for a high score were among the most important



Figure 13.14: One of the worlds from the endless runner in Fitogotchi by Dalseth [27].

factors. The players used detours when transporting themselves to planned destinations or choosing to walk instead of taking public transport to play the game. Only one participant actively exercised for the sole purpose of playing the game. Most players lost motivation over time to play the game; this is believed to partly be due to poor balancing of the challenge of the game. The results showed improved physical activity among participants, especially among the participants that did not regularly work out before the experiment. These increased levels of physical activity were evident in the week after they had stopped playing as well.

The results from this project are quite similar to the ones produced in the exermon project (see Section 13.7), and the results related to balancing the challenge correctly can be helpful for this project.

13.9 Tamagotchi

Tamagotchi is a game and device created by the Japanese company Bandai. While it can be called a game, it is also referred to as a digital pet, as the device and game's premise is to keep a pet alive. It was first released in 1996 and had sold more than 82 million units by 2017 [92]. The different Tamagotchi game devices all have three buttons and a screen (see Figure 13.15). Different versions of Tamagotchi will have different pets and minigames on them; all operated through the three buttons. The pets have different stats that are represented through their respective meters, *Happy meter*, *Hunger meter*, *Bracelet meter* and *Discipline meter*. If the stats drop too low, the pet can die, but it can also die of old age; either death results in restarting the game. Tamagotchi allows players to interact with other player's Tamagotchi. This was originally done through infrared connection, but it can be done with near field contact (NFC)

on modern versions. The first NFC devices were the *Tamagotchi4U*. These devices were not backward compatible with the infrared versions and allegedly made them sell poorly [91], though there is no hard source on this matter. The NFC version allowed players to download new features through NFC, [93], and interact with other players' devices and mobile phones. Bandai still produces and sells Tamagotchi on their website as of the time of writing this project [81].

13.9.1 Tamagotchi mobile

Bandai has released mobile versions of Tamagotchi, *Tamagotchi L.I.F.E. (2013)*, *Tamagotchi L.I.F.E. Angel (2013)*, *Tamagotchi L.I.F.E. Tap and Hatch (2013)*, *Tamagotchi Classic -Original- (2015)* and *My Tamagotchi Forever (2018)*. These were all available on both iOS and Android, [91]. The latest version was updated in September 2020. The latest Android version has more than 5 million downloads and 59 000 reviews, which averages 4.1 out of 5 stars. The game is free to download but features in-app purchases. All previous games of Tamagotchi for mobile has been shut down, and there is little reliable information available. According to comments on page [94], the last of the previous games shut down in 2019, and there are no longer official Bandai websites with information about them. It seems like most information available is from crowdsourced fansites. It might seem to indicate that the games have not been a huge success, but they have gathered multiple millions of downloads, proving there is at least interest in a mobile game of this kind. However, it is unclear if the interest and motivation to play persist over time or if it is simply millions of people downloading the games out of nostalgia for old toys of their childhood.

13.9.2 Tamawalkie

Bandai released a product called *Tamawalkie*. It features a pedometer and a clip on the back of the device, used to clip the Tamawalkie to one's belt. The device was only released in parts of Asia [95]. There is a lack of information on exactly how this product works. Still, from the fandom site [95] and a video created by Erica Griffin [59], it seems like the Tamawalkie works not by raising a Tamagotchi character, but by traveling around the United States. The player has to keep the pet happy and fed, but it is unclear exactly how the player moves from city to city. From the sources mentioned, it seems as though this is what the pedometer on the Tamawalkie is for. By walking in real life, the Tamagotchi can move from city to city. There is a step counter on the Tamawalkie that displays the player's steps during a given day.

13.9.3 Relevancy for this project

Tamagotchi shares some concepts with the game this project is based upon. There is the idea of a character or pet that has stats that change depending on the gameplay completed by the player. By performing the right gameplay, the pet will be nurtured. There is the social aspect of playing with friends,



Figure 13.15: Tamagotchi device - red arrows points out the three buttons

interacting with other players' pets. Finally, there is the exercise aspect seen in Tamawalkie. The success of Tamagotchi indicates that the concept of keeping a pet alive through other actions is something that motivates players to play a game. The lack of information about the Tamawalkie and the fact that there have not been any more Tamawalkie devices since its inception in 2008 indicates that it was not a widely successful product. The concept of using steps to progress within a game has still seen huge success with Pokémon Go (see Section 13.10). Pokémon Go also shares some concepts of digital pets, but it is not identical to Tamagotchi. There might still be ways to successfully create an immersive and motivating game that uses concepts from the Tamawalkie.

13.10 Pokémon Go

In 2016, Pokémon Go [78] was released for smartphones. The game makes use of the phone's GPS location to track the player's movements within the real world, which corresponds to a location in the artificial game world. The game world is displayed as a map of the world (see Figure 13.16). The game also utilizes the phone's camera and gyroscope to display an augmented reality (**AR**) when the player chooses to interact with the game world. The player can walk around, and when the player is close to anything on the game world map that it can interact with, they can start the AR mode. This will display wild pokémon that can be caught or other players' pokémon that can be battled (see Figure 13.17). Pokémon are monsters that players collect in the game, and the premise is to

”catch them all.” Some pokémon can evolve, but this can only be done when the player has collected enough candy of the given pokémon’s type. These candies can be collected by walking in the real world. The game thus has two mechanics that promote exercise. The first one is to actually get to a different location within the game world, as this corresponds to the real world. The other is to walk to collect the aforementioned candies.



Figure 13.16: Pokémon Go Virtual world with a map that corresponds to a map of the real world.

According to a paper reviewing the effects of Pokémon Go on physical activity levels on players [24]: *”active users of the game had an average increase in daily steps of 1,473, which was 25% higher than before playing the game. Another interesting result from this study is that the game has been able to ”increase physical activity across men and women of all ages, weight status, and prior activity levels”*

In addition to using the mobile phone’s hardware, the creators behind Pokémon Go (Niantic) has also created a device called Pokémon Go Plus. This is a Bluetooth Low Energy wearable device in the shape of a wristband. The device is connected to the phone through Bluetooth and will allow the user to interact with the game world by pressing a button on the bracelet. The player will not know the result of the action before they log in to the game on their phone. This introduces an element of surprise which can be used for game design (see Section 9.4).

In a study conducted by Wang, it was shown that playing Pokémon Go leads



Figure 13.17: Pokémon Go AR mode - a wild Pokémon can be seen and caught through augmented reality.

to multiple positive effects such as *”improved wellbeing and emotions, increased motivation for being outdoors, being socially and physically active, reduced psychological distress, and improved cognitive performance”* [42]

Also, they conclude that *”the game increased social motivation, reduced social anxiety, increased social interaction, and improved and strengthened social relationships. The social benefits were found for friends, families, between dogs and dogowners, and between generations and among strangers. The studies also showed that the game design of Pokémon Go encourages social play and encounters.”* [42]

The study was conducted by collecting a large number of search results for Pokémon Go and then excluding or including the results for further inspection if the results were research articles and relevant in the sense that they focused on physical activity and mental health or social interaction. The same study shows that research on Pokémon Go suggests that all players have an increase in physical activity at the start of playing the game. Still, it decreases over time, sometimes being completely back to the same state as before starting to play by week six. The study also sheds light on the different motivations players have to play the game, including having fun and an immersive experience, getting physical exercise, social interaction, and Nostalgia for the Pokémon universe.

The same article by Wang highlights some of the reasons why people stopped playing Pokémon Go; The reasons for why people stopped playing the game included technical challenges, slow progress in the game that required more

effort increasingly, and lack of variation and content.

Pokémon Go can be regarded as the most successful exergame of all time, and the research on this game and why it has been successful, and where it has had trouble can be very valuable for this project.

13.11 Summary of Existing Exergames

This chapter has discussed different styles of exergames that have seen varying degrees of success. A game's success can be measured in units sold and how effective the game is at motivating a player to keep playing, and to which degree the players actually physically exert themselves. The games discussed vary from being played on a stationary entertainment system, using exercise equipment as input devices, to games involving everyday activities such as walking. The most successful exergame to this day is one of the newer games discussed, Pokémon Go (see Section 13.10). The game has not only captivated a large demographic, but it has also been proven to have an impact on the number of steps walked by its players on an everyday basis. This project will develop new features on a game that shares many aspects with Pokémon Go. Some of the success factors identified in the existing exergames include finding suitable choices for *input device, the difficulty of both gameplay and physical exertion, the barrier of entrance, interesting content, and social features*. Many of these factors are also parts of or closely related to the game design theory discussed in Chapter 9.

Chapter 14

Ideas for Potential Features in Exergames

This chapter describes some ideas for features I have come up with that could be implemented in an exergame. The rationale behind these ideas is that they will help keep players motivated to keep playing the game over time and contribute to both physical activity and social interaction in and of themselves.

14.1 Boost Rewards Through Social Interaction

This idea is a kind of daily challenge and reward. Every day a player will get a mission to complete. This can, for instance, be to complete a specific physical exercise. It could be to go for a walk with a set amount of steps or measured distance, or a bicycle ride. It could also be completing a strength training exercise or other sports exercises related to the exergame being played. By the completion of the goal, the player will receive a reward. This reward can be opened immediately, granting the player a reward of varying degrees, or it can be upgraded by performing an extra activity. The catch is that the extra activity must be completed with another player. This will make players interact if they wish to receive greater rewards.

Here is a specific example. Imagine a walking exergame where the game's exercise part revolves around walking, using the pedometer or GPS location to measure the player's walking. Upon reaching a target destination, the player receives a reward in the game in the shape of a chest. The player is offered a choice to open the chest for a reward immediately or walk 2 kilometers with a friend to upgrade the reward. The friend would also be granted a part of the reward without the original player's expense. Upon completing the social extra activity, both players receive a reward. The result is that both players performed a physical activity, and they were interacting socially.

By allowing a player to choose not to perform the extra activity, the exergame can cater to players who prefer to play alone. The reward could also be altered to have an extra physical activity to increase the reward without the social aspects to encourage further exercise.

It should be considered which rewards the different players should receive to cater to different player types such as collector type players and achievers (see Chapter 11). Since the player chooses between upgrading the reward or not, the player will feel a sense of control. Showing the player what the reward would have been without upgrading it could also boost their motivation to boost their rewards in the future, as the instant feedback shows them how much their reward increased by performing the extra activity. See Section 9.1 for the importance of feedback in games.

14.2 Push Notifications with Different Social Options and Rewards

This idea is about getting push notifications whenever one is close to another player playing the same exergame. The exergame style must be a game where the player walks around in the real world. When near another player, the player will be notified that there is a player nearby, and they are given a range of actions they can choose to perform. An important feature is that if one player receives a range of actions to choose to perform on another player, the other player will also receive the same options and push notification simultaneously. This makes the game a game of speed and reactions, where the outcome depends on which player reacts to the notification first and dependent on which actions the players choose to perform.

14.2.1 Action: kill

One action is to kill another player. If a player chooses to kill another player, the other player will be notified that they have been killed and can lose some "general type points." The killing player will receive a reward in a category of rewards tied to killing players. This type of action can please both killer type players and achievers trying to receive all rewards. The killing player will also receive "general type points." Killing as an action in and of itself might be too aggressive, but it could be changed to something like "trick" or "taunt."

14.2.2 Action: befriend

This action is friendly. If player A first selects the action "befriend," and the other player, player B, selects the same action, both players will become friends with each other. They will receive a reward for being friendly and gain points in a category of rewards tied to befriending players. Both players will also receive "general type points." The reward will be higher than if they chose to kill the

other player. However, if player B chose to kill player A, then player A will not receive any reward. This means the game might be weighted in killer's favor, which means that choosing to kill other players might be the safest strategy to gain points and lower the opponents (other players) points.

Part III

BitPet

BitPet is an existing game which this project uses for researching its effect on players' social and physical activity. This part describes in detail what BitPet is and how this project will expand on BitPet by developing game features that players will test. The planning phase for the development and what was actually developed on the front end and the backend, and the use of game design principles from the literature review are presented. This part also covers the project's requirements and testing.

Chapter 15

BitPet

This chapter explains what BitPet is and what its features were at the project start. Since this project uses BitPet as a foundation, this chapter only covers what BitPet was like when this project began. When mentioning BitPet in the rest of this paper, it refers to what BitPet became during this project due to the researcher’s contributions to the code.

15.1 What Is BitPet?

BitPet is a multiplayer exergame game that is currently under development [44]. BitPet has its inspiration from several games including Tamagotchi, NintenDogs, and Pokémon GO. Mathias Grønstad governs the project with the assistance of Alf Inge Wang. In short, the game focuses on taking care of a digital pet. This project involves developing game features for BitPet. However, since BitPet is currently under development, this project had to select a version of BitPet as a starting point for further development. The version of BitPet selected for further development in this project is the version of BitPet explained in this chapter.

From BitPet’s own website they tell their origin story as: *“BitPet™ started as the idea xPet by Alf Inge Wang, founder of Kahoot!, and professor of game technology at the Norwegian University of Science and Technology (NTNU). The idea for the game is based on research in co-located social engagement using game technology, and how video games can motivate physical activity. The concept went through a feasibility study at NTNU’s School of Entrepreneurship, where Mathias Grønstad studied. He commenced prototyping in December 2019, and BitPet AS was founded in September 2020. Since then, we have received several grants from; NTNU Discovery, Innovation Norway, and the Research Council of Norway. BitPet also placed 2nd out of 110 entries in the MyGalileoSolution contest hosted by the European GNSS Agency [44]”*.

15.2 BitPet’s Game Concept

This section describes what BitPet’s game concept is. The core of BitPet is taking care of one or many digital pets. Upon logging in to the game for the first time, a player is given a pet (see Figure 15.9). A pet has four different stats, stamina, hunger, happiness and most importantly, health (see Figure 15.11). These stats have points going from 0 to 100. If a stat has 100 points, it means the pet’s needs within that stat is met, and vice versa if the stat has 0 points. If the stamina, happiness or hunger gets too low, the health stat will slowly start dropping. If the same stats are kept at a high score, the health stat will slowly increase. From receiving the pet and onwards, the stats will update every hour, and the goal of the game is to keep the pet alive. To increase the hunger points, the player can feed the pet with food (see Figure 15.9). Food can be bought with coins (see Figure 15.6), which can be earned by walking around in the real world. To increase happiness, the player must pet their pet, by stroking across the pet on the screen. Lastly, the stamina stat can be increased by walking. The game uses the phone’s step counter to monitor the amount of steps a player walks.

15.3 State of BitPet at Project Start

As development for this master thesis project began, the newest version of the code behind BitPet was cloned. This included both the back-end server and the front-end application. From this point in time, no new updates from the team behind BitPet were introduced to the cloned code. All code implemented from this point would be the researcher’s contribution to the project. At project start, BitPet was a fully functioning smartphone game. It could track player’s steps walked in a day as well as their GPS location. Accounts could be created, and these accounts could own pets, food, and currency. The currency could be spent on new pets and food (see figures 15.6 and 15.12). Players could view their pets in a lobby (see Figure 15.11), and they could view their pet’s stats. The stats included health, hunger, stamina, and happiness. By tracking the steps walked, BitPet would simultaneously increase the pet’s stamina stats. On the home screen, users could pet their selected pet by swiping a finger across their pet on the screen. This action would increase the pet’s happiness. BitPet had a map function that showed the player’s selected pet on a computer-generated map of their real-world location (see Figure 15.2). This map is generated with the use of a Unity Plugin called GO Map [63]. BitPet also had a 3D world where users could run around as their pet from a first-person perspective (see Figure 15.5). Lastly, it had an AR mode, where players could view their selected pet rendered on top of the real world (see Figure 15.4). The server stored all information about the players and their belongings and updated all pet’s stats every hour. If a pet reached zero health, it would die.

15.3.1 State of Server and Back End

The server and back end of BitPet is a Ruby on Rails server with a PostgreSQL database [79] [84]. The server stores user information and game state information. At the project start, the server and database had support for creating user profiles, pets belonging to users, food for pets, and currencies to purchase new pets and food. In addition, it included logic and an API to make interactions and updates to all these existing entities. For a brief introduction to Rails, see Section 15.4. For a more detailed description about the database, see Chapter 19.

The BitPet team was running the server on Heroku at the time of the project start. On Heroku, one can use an add-on called *Heroku Scheduler* which can execute commands for a Heroku Application at planned times during runtime [62]. This scheduler was used to update the stats of pets once every hour (see Section 15.3.2 for information about these stats).

15.3.2 State of Front-End Application

BitPet’s front-end application is made with Unity version 2020.1.13f1. When developing with Unity, one can write code in C# to handle logic. The visible front end is designed in the Unity Editor application, where drag-and-drop functionality can be used to position UI elements on the screen. The game runs in 3D space, displayed on 2D screens. BitPet can run on both iOS and Android smartphones. In Unity, scenes are used to define parts of a game. Typical use is to split different states of the game into different scenes. An example is a scene for a menu view, a different scene for a login view, and a different scene for a game view. To optimize performance, one can split the gameplay into many different scenes as well. It is often done to reduce the amount of memory used at a time.

At the project start, the game had the scenes listed in Table 15.1.

In the Pet Selection or Lobby view (see Figure 15.11), the user can see their currently selected pet. From here, the user can choose to select a different pet of their pet selection to view. In the lobby, the user can also see their selected pet’s stats: hunger, happiness, stamina, and health. If the health stat reaches zero, the pet dies. The health increases if the happiness, hunger, and stamina are above zero but decreases if one of them is zero. The higher the stats are, the faster the health will increase, and the lower they are, the faster it will decrease. To increase the hunger stat, the player must feed the pet. Stamina increases if the player walks steps in the real world. The happiness stat can be increased by petting the pet in the lobby. It is done by swiping a finger across the pet on the screen.

Scene Name	Scene Description
Main Scene	Entrypoint for the application. Loads resources then changes to Lobby Scene
Lobby Scene	Login and Account creation views
First Time Pet Selection	A view presented to the user when they select their first pet.
Pet Selection Scene	A view for selecting which pet to view in the lobby among the user's collection of pets.
Pet Shop Scene	A view for buying new pets, food for pets and in game currency.
New Pet Shop Scene	This is a new view for purchasing pets. This view uses a 3D rendered view instead of a flat UI type view. This view could be viewed in the version of BitPet used at project start but had no objects to interact with within the game.
Gameplay Scene	This scene is used to access a 3D world where the user can run around as their selected pet.
Map Scene	A view of a 3D rendered map where the selected pet is rendered in the center of the view. It uses GPS coordinates to decide which part of the real-world map to render. If the GPS coordinates update, so does the world map rendered.
Scene Popup	A view that appears on top of other views to display information relevant to the user, for example, error messages.

Table 15.1: Scenes that existed in BitPet at project start.

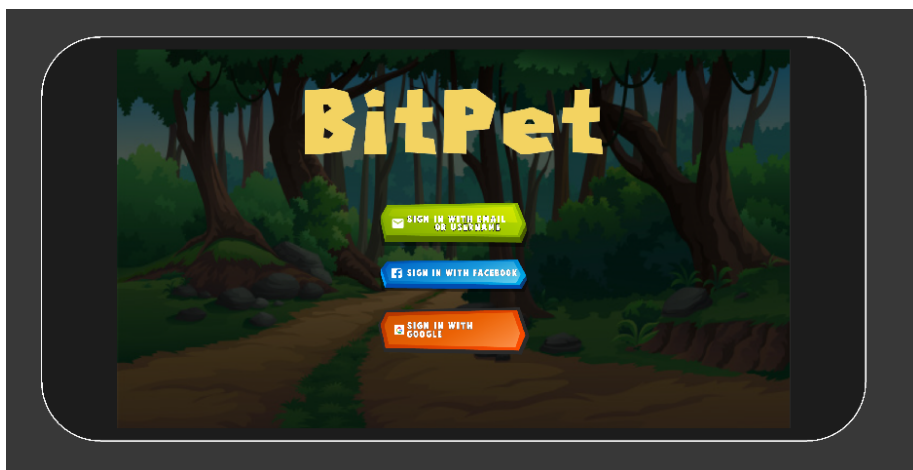


Figure 15.1: BitPet Login screen. Users have the choice between three different login methods. They are username, Facebook and Google.



Figure 15.2: The map view. This is the view presented to the user when clicking the map button.

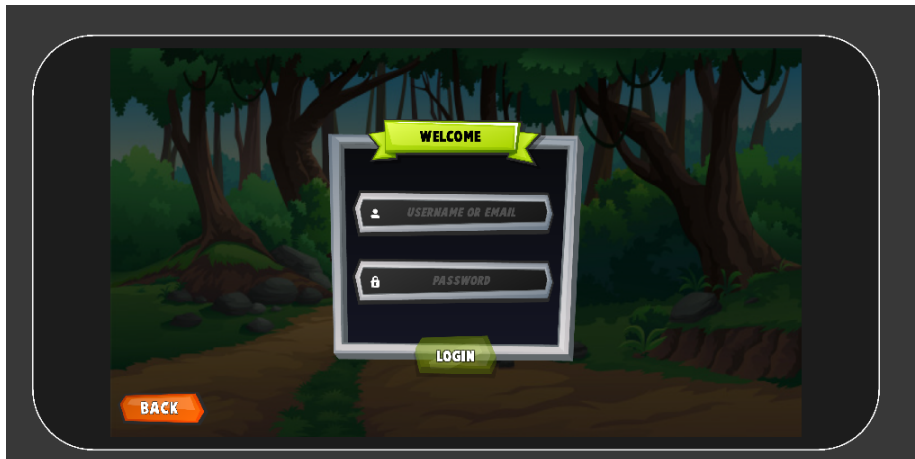


Figure 15.3: BitPet Login Screen



(a) BitPet pets in AR (1/2).



(b) BitPet pets in AR (2/2).

Figure 15.4: Two figures showing AR pets in BitPet.

15.4 Brief Description of Ruby on Rails

Rails 5 is a framework for Ruby code servers [84]. This section is a short description of some key concepts of how it works.

When using Rails one uses something called a Model or an ActiveRecord. The ActiveRecord is a class in Ruby code to represent an insert in a database table. When used in an MVC pattern, it corresponds to the M in the MVC pattern. It is mostly used to validate that data passed into the Model object instance is correct. When the server runs, it creates instances of these ActiveRecords, which hold the data from the corresponding rows in the server's database. The Rails API has many methods that can be invoked on the ActiveRecords. Some of these methods correspond to SQL statements. The result allows for swift backend development where the developer only has to write the server code and not the actual database commands.



Figure 15.5: BitPet 3D world. Users can explore a 3D world from their pet's first person perspective.



Figure 15.6: BitPet Pet food shop. Users can purchase food for their pets.



Figure 15.7: BitPet Pet shop. Users can purchase new pets.



Figure 15.8: When feeding a pet, it shows an animation and the pet's hunger stat increases. This image has the UI for the lobby produced during this project, but the feeding animation is identical to how the feeding animation was at project start.

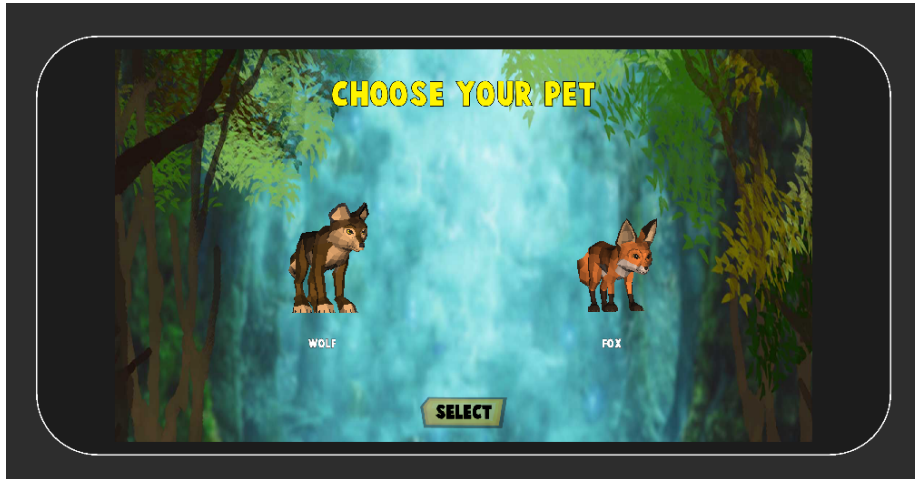


Figure 15.9: Selecting a pet. When a user first logs into the game they are prompted to select their first pet. They can choose between a wolf and a fox.

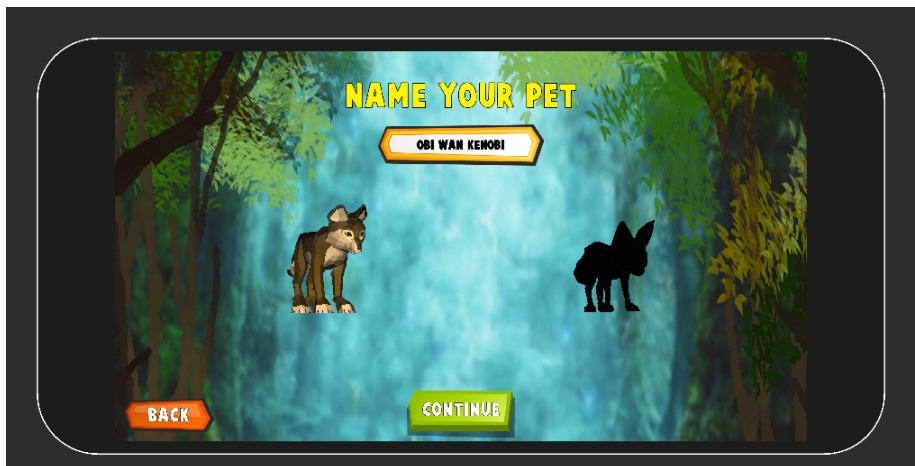


Figure 15.10: When purchasing a new pet, it must be given a name.



Figure 15.11: The pet selection lobby. This is the main screen of the game. Player can view their pet's stats and access other game features from this screen.



Figure 15.12: BitPet coin shop. This is the shop for purchasing in-game currency.

15.5 Summary of What Is BitPet?

At the project start, BitPet was a fully functioning game. It supported creating user profiles, pets for these profiles, and currency and items to purchase with this currency. The server updated the status of pets every hour, and players could track their steps walked and view their position in the real world on a computer-generated map. This version of BitPet lacks purpose and engaging gameplay. The version of BitPet described in this chapter was used for the rest of this research project.

Chapter 16

Planning My Contributions

This chapter describes how the planning phase for this thesis was carried out.

16.1 Planning Phase

The planning phase for this project started by getting to know the different technologies and software practices used in the existing version of BitPet. This was done for two main reasons. Firstly, any code that would be written would have to work with the existing code. Secondly, knowing the existing restrictions of the code would limit the scope of possible features to develop for BitPet.

Discussions with the team behind BitPet and my advisor were essential for choosing the direction for the project. The team knew how the code worked and could explain some of the patterns used. The project's goal was already defined, and the game was going to be a multiplayer game revolving around pets. Any ideas and concepts were discussed with my advisor and BitPet's CEO. After two weeks, I came up with a concept for a game feature supported by existing technology that seemed feasible to implement and supported the research goal. For this feature see Section 16.3.

16.2 How the Chosen Feature Was Selected

After coming up with ideas for possible BitPet game features, they were discussed with my advisor. The feature to be developed had a few criteria at the project start. It had to be family-friendly so that players of all ages could play this feature. This criterion was not strictly necessary to this project, but since BitPet was already designed to be family-friendly, it made sense to stay within the same boundary. The feature had to fit with the existing fantasy of BitPet. The feature had to give the player an incentive to be physically active and socially active. Lastly, a more broad criterion was that the feature had to adhere to the game design principles discussed in the prestudy.

To determine if an idea could fit this project, we asked the following questions. Does the idea fit with the existing fantasy world of BitPet, and or does the idea expand upon the existing fantasy world of BitPet? What type of audience does the idea fit? How does the proposed feature give an incentive for the player to be socially and physically active? Will it be possible to implement this feature? Will it be possible to implement this feature within the project's timeframe?

16.3 Chosen Feature 1: Missions

The first chosen feature is a mission feature. The idea is that the player receives a target location they have to reach in the real world. Upon reaching the target location, the mission is complete, and the player receives a reward. Here is how the feature idea responds to the questions used to assess feature ideas.

Does the idea fit with the existing fantasy world of BitPet, and or does the idea expand upon the existing fantasy world of BitPet? This basic format can be used with different fantasy aspects that fit the world of pets in BitPet. For instance, instead of simply telling the player to go to some given location, the player can be told there is some event happening at the given location. One such event could be "There is a sale on pet food at the new pet shop in town."

What type of audience does the idea fit? As long as the locations the players are told to approach are in publicly accessible and safe areas, the feature is suitable for anyone.

How does the proposed feature give an incentive for the player to be socially and physically active? Because the player has to reach a real-world physical location, it incentivizes walking to the location. A weakness of the design is that a user could choose to drive a car to the location and thus miss out on physical activity. For the socially active part, the feature seemed feasible to be made multiplayer since it could be possible for multiple players to walk to the same location and have them interact somehow. Providing better rewards for completing multiplayer missions rather than single-player missions provides an incentive to be socially active.

Will it be possible to implement this feature? The BitPet code already supported tracking a player's GPS location and drawing computer-generated maps of the real world, as well as placing virtual objects on this map. It seemed possible to implement this feature.

Will it be possible to implement this feature within the project's timeframe? Given the existing infrastructure, it was deemed plausible to implement it within the timeframe.

16.4 Chosen Feature 2: Daily Log-in Streak

The second feature chosen for development was a daily log-in streak function. It works so that whenever the player logs in on consecutive days, a counter increases by one number, informing the user that they have a daily log-in streak running.

This feature did not need a thorough evaluation because it would require very little work to implement. The first feature already satisfied the requirements for a feature for BitPet and would help answer the research questions. The streak feature is a feature that has seen much popularity in Snapchat, and it seemed interesting to check if it could work in exergames as well.

16.5 Other Ideas Explored for BitPet Features

This section highlights some of the other ideas explored before deciding which feature to develop.

16.5.1 Walking With a Pet

The idea was simply "Take a pet for a walk." This idea was scrapped as it would fit into the mission feature. The mission feature is essentially taking a pet for a walk, but it is expanded beyond a simple walk.

16.5.2 Finding Missing Pets

This idea was that players could lose their pets, and other players could go looking for them. Upon finding a pet, the player would have to return the pet to the original owner. This idea was scrapped because the fantasy about a missing pet could be combined with the mission feature.

16.5.3 Picking up a Pet's Feces

The idea was that one could walk one's pet, and sometimes it would have to poop, just as dogs do in real life. One would have to pick up the feces in AR-mode and find a nearby trashcan to drop the feces in. The idea was scrapped as it seemed rather limited, and other ideas had a greater incentive for multiplayer interaction.

16.5.4 Augmented Reality Interaction

This idea was based around having one's pet interact with other player's pets in AR mode. This would give the pets a reward and better stats. This was thought to encourage users to socialize, but the idea was scrapped because it would require 3D-modelling work and AR work, which I was not too familiar

with. In addition, it was judged to be bad for players who prefer to play single-player. With a lack of choice between single-player and multiplayer, it would be difficult to see what players prefer to play when given a choice.

16.6 Summary of Planning My Contributions

The planning phase of this project involved getting to know the existing version of BitPet and brainstorm ideas for potential features for BitPet that could help answer the research questions. After some ideas were conceptualized, they were discussed with my advisor. Eventually, a mission feature and a streak function were selected as the main feature to be developed.

Chapter 17

My Contributions

This chapter presents my contributions to BitPet. This includes the features developed, and some minor changes to existing UI in BitPet.

17.1 Feature: Mission

The mission feature consists of three parts: Receiving a task, completing the task, and receiving a reward. The task part consists of two different types of tasks. It is either an instruction to walk to an exact location or an instruction to walk an exact amount of steps. Completing the task involves reaching the destination or walking the required steps. Lastly, the reward is received upon completion. In order to make the mission feature more exciting, it is surrounded by fantasy. This means that a mission is not just a text that says "Go to location x ," but instead, it is a more elaborate story such as "A pet is missing, it was last seen at location x , perhaps you should investigate?". For all the stories written for missions see Chapter 18.

17.2 The Map and Mission View

This section explains what the map and mission view is and what UI it has.

All missions take place in the map and mission view in BitPet. The view started out as a copy of the map view mentioned in Section 15.3, and which can be seen in Figure 15.2. The view uses GO Map to render a map that represents a real-world location. In BitPet, the phone's GPS location is used to render a GO Map [63] of the user's actual location. To this view, a UI that supported creating and viewing missions was implemented. The user can click a button for either single-player missions or multiplayer missions. Upon clicking the *single-player missions* button (see Figure 17.1), a list-view pops up on the screen and shows currently available missions if the user has already created any single-player missions (see Figure 17.2). If the user does not currently have a mission, they

can create a new mission by clicking the *Get new mission* button. Once the user has a mission, they can choose to plant a *mission marker* on the map by first selecting a mission in their mission list and then clicking a *plant mission marker* button. Doing so renders a needle pin object on the map at the mission location (see Figure 17.3).

When a user has a mission marker planted on the map, the user can display an arrow pointing towards the mission marker by clicking a *singleplayer marker* button (see Figure 17.1). This arrow assists the user in finding the correct path to walk. The marker only points directly towards the mission and does not take roads or possible obstacles such as rivers into account.

Multiplayer missions have the same UI but their own set of buttons in the map and mission view. A *multiplayer missions* button opens a list of multiplayer missions (see figures 17.10a, 17.10b, and 17.10c), a *multiplayer marker* button renders an arrow that points towards the multiplayer marker on the map (see Figure 17.4). In addition all multiplayer buttons and rendered arrows and markers have a pink color scheme, while the single-player UI has a yellow color.

The last part of the UI in the map and mission view are three buttons for changing the location shown on the rendered map and an exit button (all can be seen in Figure 17.1). The exit button takes the user back to the pet selection lobby. The location buttons are used to move the location the GO Map is currently centered on. When clicking the *show me singleplayer location* button, the map will move to the single-player mission marker and center the view on it. Clicking the *show my location* button moves the view back to the player's real-life position. The *show me multiplayer location* button does the same as the single-player except for the multiplayer mission marker. If a user has not planted a single-player marker or a multiplayer marker, these buttons will not move the camera. They will instead display a message telling the player they need to plant a marker first, along with instructions on how to do so.

A user can only have one multiplayer marker and one single-player marker planted at any given time. The user can also only display one of the directional arrows pointing towards a marker at a time, but they can choose to change which arrow to display at any time. At any given time, the user can also choose to plant a new missions marker, single-player or multiplayer, and replace the previous marker.

17.3 Location Missions

This section explains what a location mission is, how they are generated, and how their design fits game design principles.

17.3.1 What are Location Missions?

Location missions tell the user to reach a target location and are the main idea behind the mission feature. Upon reaching the target location, the player is



Figure 17.1: The BitPet Map and Mission view. Here the arrow is pointing towards the mission marker, showing the player where to walk in the real-world.

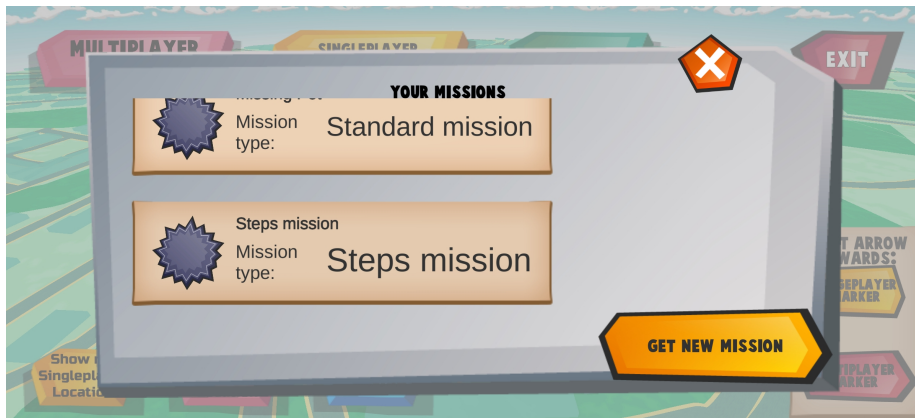


Figure 17.2: The view that displays single-player missions. The list has a standard (location) and a step-mission.

rewarded. Every location mission has a short mission text that tells a short story about some fantasy such as "a missing pet." For more information about the fantasy, see Chapter 18. The text always mentions seeking out the target location. When selecting a location mission from the single-player missions list, the mission inspector (see Figure 17.5) is opened. From the mission inspector, the user can perform a few different actions: view the reward for the mission, plant a marker on the map that shows the target location, read the mission text, receive help, and make a mission multiplayer.

Since the mission inspector has many UI elements, I chose to hide away the mission text behind a button that reads "click to read mission text." This is because the mission text is usually quite big compared to the screen size, and



Figure 17.3: A mission marker needle pin has been planted. The user is previewing the mission location, the arrow does not point towards the marker when previewing the location.



Figure 17.4: A pink multiplayer mission marker is planted. The pink arrow points towards the marker. This is contrast to the yellow for single-player.

users might want to access the inspector for other purposes than reading the mission text. If the text is not taking up the entire mission inspector, it will be easier to access the other functions. Clicking the button will display a dialogue with the mission text (see Figure 17.6)

When clicking the help button, a dialogue is displayed that tells the user they have to walk to the target location to complete the mission (see Figure G.1 in Appendix G). Upon generating a new mission, the location's name is saved and is displayed in this help dialogue. Since real-world locations are used, it might

help users to understand where the target location is. The user is also suggested to search up the location in a different map service if the tools (directional arrow, location name, and preview location button) in BitPet are not sufficient to understand where the location is.

A mission can be made multiplayer by clicking the *make mission multiplayer* button in the mission inspector (see Figure 17.5). Suppose the user already has three multiplayer missions. In that case, the user will be informed that the mission could not be made multiplayer because they already have three missions that are multiplayer missions. To understand why the user can only have three multiplayer missions, see Section 17.3.5.

In the game, a location mission is referred to as a standard mission. This is opposed to the other mission-type step-mission (see Section 17.4). In hindsight, it should have been labeled as location-mission rather than standard mission. They were called standard missions in the game because the code and UI were developed with the thought that a wide range of mission types would be developed. While creating the mission feature, "standard mission" was kept as a placeholder value when developing. Eventually, there was no more development time left for the project before the user testing, and it was left in as I thought it would be better to have the same name "standard mission" appear in every mention of a location mission. If I had changed from standard mission to location mission, I ran the risk of forgetting to change some mentions of standard mission, and it could confuse players if the two terms were mixed around.



Figure 17.5: Inspecting a location mission in BitPet. They are called standard missions.

17.3.2 How Location Missions Are Generated

New location missions are generated by using the *Place Search* which is part of the Google Locations API [75] [77].

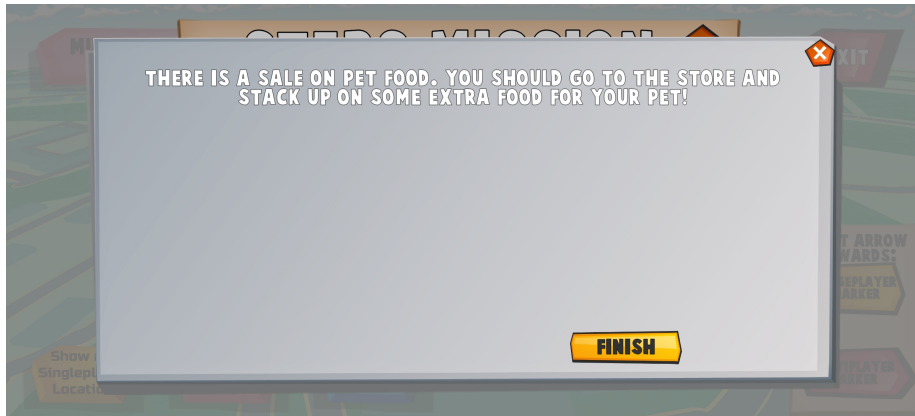


Figure 17.6: The mission text is shown after clicking the mission text button.

The BitPet application sends the current GPS location in latitude and longitude to the BitPet server. The server sends a request to the Google Places API, searching for a type of location within a five-kilometer radius of the GPS location. Google returns a list of the requested type of location, and the server then selects the first of them and saves the GPS location of the selected location along with the name of the location. The server calculates the reward by first finding the distance between the user's GPS location and the selected location and then applying some maths (see Section 17.3.4). Lastly, the server returns a JSON object to the BitPet application, which then displays the mission in the mission list.

Because this service is depending on the Google Places API, the only possible type of location to be generated are cafés, bakeries, parks, city halls, gyms, churches, libraries, museums, pet stores, post offices, restaurant, supermarkets, tourist attractions, zoos, and universities. Google Places API supports a few more types of places, but I selected these as they seemed friendly to people of all ages, and most cities will have some of these types of locations. The server will first try to receive a list of cafés from Google. If no locations are returned, the server retries with the second entry in the list above, bakeries. The server continues like this until all types of locations have been tried or until Google returns a non-empty result. If the server receives a result, it will check if the locations received from Google exists in the previous 15 completed missions for the player. If it does, the server will move on to the next type of location in the list. The service was designed this way in order to make the mission locations varied for the players.

If no results can be retrieved from Google after all location types have been tried, the server will return a step-mission instead (see Section 17.4).

17.3.3 Location Missions and Design Principles

The location missions attempt to hide exercise by immersing the user in the story behind the mission. The idea is that the user will be curious about what they will find at the target location and forget about walking. Walking is not a very strenuous activity, but it still offers exercise. As such, it should conform to the intensity not being too great in order to fit within the flow area of the dual-flow graph (see Figure 7.1, in Section 7.3). Walking is also helpful for using energy, which there is an abundance of in developed countries causing obesity [39]. Spending energy means that even if the player's fitness is excellent, there is still a benefit for the player as many people need to spend more energy than they consume in a day to avoid excess weight gain.

17.3.4 Location Mission Rewards

Mission rewards were hard to design because the game's difficulty level is the same for all players, regardless of their fitness level. When choosing how many coins the players should receive upon mission completion, the cost of necessary items in the game, and the amount I expected would be reasonable to walk were used as the main factors. Since the goal for the players is to keep their pets alive and healthy, the rewards received for playing an adequate amount should let the players keep their pets alive. I felt players should not have to complete location missions every day to keep their pets alive. It would be very punishing if your pets died after missing a mission completion a single day. I still think players had to log in to see their pets every day or at the very least every other day to keep them alive. This is because it would increase the resemblance to a real pet.

For the location missions, the distance between the user's location at the time the user requested a new mission and the mission location was used to calculate the mission reward. If players walk longer, they should receive a better reward. Therefore the reward was set to be calculated with Equation 17.1.

$$coinreward = distance * 5 + 35. \quad (17.1)$$

Since missions would never be further away than 5 kilometers, this means a single-player location mission would always yield between 35 and 60 coins. This is more than enough to purchase enough food for one or two pet's survival for a couple of days. Players can play one location-mission every two or three days and keep their pet alive, but they cannot make enough coins to purchase many pets. This allows for the most engaged players to complete multiple missions to purchase more pets. Having more pets requires more coins to purchase enough food for them all. This means that completing many missions is required to both purchase more pets and to keep them alive.

17.3.5 Limitations to Location Missions

The location missions are limited to places of the location types used by the BitPet server known to the Google Places API. This means that players living in very remote areas may not complete any location missions at all, let alone receive one. Using the Google Places API also costs money. Since I only had a certain amount of credits I received from Google as a student, I had to make sure no users spammed the server with new mission requests. One eager user could potentially use up all credits if they lived in a remote area since a single call to the BitPet server could lead to 15 requests to Google. It could become so many because the server loops through the location types whenever the previous request yields no result (see Section 17.3.2). A second scenario that could cause many requests is users who were unhappy with their newly received mission location or simply curious about which other locations can be received as missions. This type of user could choose to click the button to receive new missions repeatedly. To prevent both of these scenarios, the client first asks the server if the user has a mission that exists and is uncompleted and generated within the last 24 hours. If yes, that mission is returned and displayed to the user. If the user does not have a step-mission, the create new mission button is still visible but will only request a step-mission from the server. If the user has a mission of both types, the button is made invisible. The final scenario is for users who live in remote areas who cannot receive a location mission. For these users, the server returns a step-mission instead. Upon receiving the mission, the button will still be visible since the user only has a mission of one type. Upon requesting a new mission, the client will see that the player has a step-mission, so it once again requests a location mission. The server cannot find a location mission and returns a step-mission. When the client now has two step-missions, it will turn off the create new mission button until the previous two step-missions are complete or until 24 hours have passed.

Since location missions can be made multiplayer, it is possible for players to "get rid of" unwanted missions if they make them multiplayer. To avoid players doing this repeatedly and use too many Google Credits, and to avoid filling up the local area multiplayer missions list with too many missions, players can only own three multiplayer missions. Once a player has made three mission multiplayer, they cannot make a new single-player location mission multiplayer until the previous three are completed or expired after 24 hours. In the end, this means a single user can make at most four calls to the server that are sent to the Google Places API every 24 hours.

The solution I implemented to the final scenario revolving around the act of turning single-player missions into multiplayer missions introduces a new problem in itself. If a player starts out in city A and creates three multiplayer missions and a single-player location mission, it means the player cannot create a new mission until 24 hours have passed. If the player now moves to city B, they are left only being able to partake in locally created multiplayer missions by other players or completing their own step-missions. To solve this problem,

one could look at where the player was located and allow the player to create a new location mission if their current location is greater than a set distance away from their previous missions. I did not have time to implement this solution as I only realized the problem existed a day before the user testing was supposed to begin.

17.4 Step-Missions

This section covers step-missions. It will explain what they are, how they work, and how their rewards are calculated.

17.4.1 What Are Step-Missions?

Step-missions are missions that require the user to walk a varying number of steps. Once the user has walked the required number of steps, they are rewarded with coins. Step-missions expire at midnight. Any uncompleted steps-missions will be removed from the user, and they can receive a new mission by asking the server for one with the "get new mission" button in the single-player mission list. The first steps-mission generated on a new day always has less than or equal to 1000 steps required for completion. Every subsequent step-mission generated within the same day will have a possibility of requiring a greater amount of steps than the previously completed mission. Step-missions do not have different stories for creating a fantasy as location missions do. Instead, they have a simple text that says, "Walk X steps today to complete this mission. Great exercise for your pet." where X is the required amount of steps (see Figure G.2). This short text does build on the fantasy that you have a pet that needs to be taken for a walk.

In the mission list they appear with a text stating that it is a step-mission (see Figure 17.2). If a user is viewing a step-mission in the mission inspector they are presented with three buttons (see Figure 17.7): *CLICK TO READ MISSION TEXT*, *NEED HELP?*, and *MAKE MISSION MULTIPLAYER*. Clicking the *NEED HELP* button will open a dialogue that tells the user how to complete the mission, how many steps are required, and how many they have left to walk (see Figure G.2). The *MAKE MISSION MULTIPLAYER* button has no functionality for step-missions and should have been removed from the step-missions, as step-missions cannot be made multiplayer. Unfortunately, I forgot to remove the button from this view before the user test.

17.4.2 How Step-Missions Are Generated

When the client asks the server for a new step-mission, the server checks if any step-missions have already been completed on the same date. If no mission has been previously completed, a new steps-mission is generated with a required amount of steps being a random number between 500 and 1000.

For every subsequent step-mission completed within the same date, the server



Figure 17.7: Inspecting a steps-mission in BitPet.

generates a new random number between 500 and 1000 for every completed mission and adds them all together to become the required amount of steps for the mission.

17.4.3 Step-Missions Rewards

Similar to Location-missions, it was hard to gauge how much players should be rewarded for step-missions. This was primarily due to the varying degree of fitness between users. Since step-missions can be completed while completing a location mission, the rewards were lowered for step-missions. This has a negative effect on players who are in remote areas where location-missions cannot be generated (see Section 17.3.5), as they cannot complete step-missions while completing a location mission. It means it could be harder for these players to receive enough coins to keep their pets alive. I figured most players would not be in this situation, so for the sake of user testing what BitPet would be like in a working scenario, I went ahead with lowered rewards for step-missions.

The equation for calculating the coin-reward for step-missions can be seen in Equation 17.2.

$$\left\lceil \frac{steps}{200} + 5 \right\rceil \quad (17.2)$$

Using this equation would give players around 50 to 60 coins for completing six step-missions a day, which would be around 4500 steps a day on average (given it increases in intervals of a random integer between 500 and 1000, which will be 750 steps on average). This is approximately the same as the reward for a single location mission, and this reward was deemed to be appropriate. For me, 4500 steps equate to around 35 minutes of walking a day, so it should be doable for most players. For details on why the coin reward is deemed fitting, see Section 17.3.4.

17.4.4 Issues With Step-Missions

In BitPet, the tracking of steps walked by the player is done by the Phone's operating system. If the player opens the BitPet lobby (see Figure 17.18), the game checks how many steps the player has walked within the current date. The amount of steps is sent to the server. The issue with this is that when the player has the map and mission view open, they will not update the number of steps that have been walked. The player could walk the required amount of steps for a step-mission and not have the mission complete unless they went to the home screen and back to the mission screen. For clarity, the steps are tracked but will not be updated to the server for mission completion before the user returns to the lobby.

17.5 Multiplayer Missions

This section explains what multiplayer missions are, how they are created, completed, what their rewards are, and some issues with the design.

17.5.1 What Are Multiplayer Missions?

Multiplayer missions are single-player location missions turned into multiplayer missions. Whenever a user has a single-player location mission, they can press the button that says *MAKE MISSION MULTIPLAYER* (see Figure 17.5). A player is set to be the owner of a multiplayer mission if they created the mission. A player may only be the owner of three multiplayer missions at a time. In brief, they can only have three missions in order to not fill up the multiplayer-mission list with too many missions at a time and to reduce the number of requests to the server. For a more detailed explanation of why this rule of max three missions was implemented, see Section 17.3.5.

When a mission is made multiplayer, other players can see the mission in the multiplayer missions list if the target location is within 5 kilometers or their current position (see Figure 17.8 for the empty list, and Figure 17.10a for a visible mission). Any mission that is full or has been completed or expired will not be shown in the mission list. Any missions the user owns are colored green (see Figure 17.10c). This is to make it more visible to the user. If a user has joined a mission but is not the owner, the mark on the left side of the mission item in the list is colored pink (see Figure 17.10a). If the user has not joined a mission, it is colored purple (see Figure 17.10b).

To complete a multiplayer mission, both joined players have to reach the target destination. When a player has reached the location, the server is notified that the player has arrived, and the player receives feedback (see Figure G.3). Once both players have reached the destination, the server generates two four-character codes, one for each player. In order to complete the mission, one of the two players have to enter the other player's code in their own "enter code" view accessible from the multiplayer mission inspector (see figures 17.9a

and 17.11a). Upon completion, both players are rewarded. I forgot to add a notification that actually informs the player that they received a reward, but the player who enters the correct code receives feedback about the code being correct (see Figure 17.11b). If a player attempts to access the enter code screen before both players have arrived at the destination, various texts will show for the player explaining which players have reached the location (see figures G.6a, G.6b, and G.6c).

Since completing a mission requires both players to meet at the target location, I created a system for players to plan when to meet. Any joined player may suggest a time to meet at the target location (see Figure 17.12a). To begin suggesting a time, a player has to click the "suggest time to meet" in the multiplayer mission inspector. This time will show up in the other players' mission inspectors (see figures 17.14, and G.5b). The other player may accept or reject the suggested time in a separate view (see Figure 17.13) accessed by clicking the *accept or reject meeting time* button in the multiplayer mission inspector (see Figure G.5b). Once accepted, the agreed meeting time is displayed for both users as *agreed meeting time* in the multiplayer mission inspector (see Figure G.5a). Any player can still suggest a new time, and the new suggested time will appear for the other player, and they can once again accept or reject it (see figures G.5c, and 17.12b).

The mission texts created for fantasy and immersion are identical when the missions are made multiplayer from single-player location missions. Ideally, they would be changed to accommodate multiplayer mode, but I did not have time to implement the change.

To avoid players accidentally leaving missions, a confirmation dialogue has been implemented (see Figure 17.9b). The help button in the multiplayer mission inspector reveals the dialogue seen in Figure G.4.

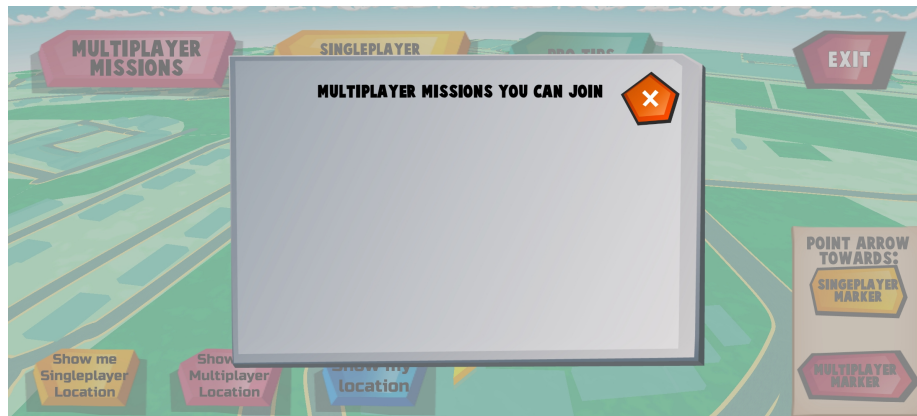
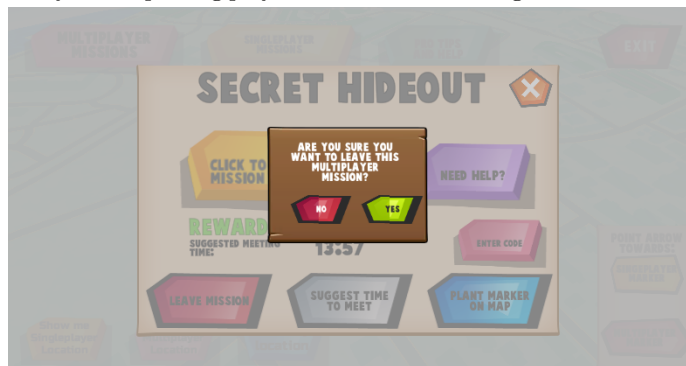


Figure 17.8: The view that displays multiplayer missions. Here there are no missions available



(a) Inspecting a multiplayer mission that has been joined by the inspecting player. No time has been agreed to meet.



(b) Players are asked to confirm leaving a multiplayer mission to prevent accidentally leaving missions.

Figure 17.9: Inspecting a mission one has not joined, and a joined mission with no suggested meeting time.

17.5.2 Multiplayer Mission Rewards

Multiplayer missions have a bonus reward of 100 coins. This is in order to create an incentive to complete the multiplayer missions rather than single-player location missions. This equates to around two single-player location missions. This reward is in addition to the regular reward, which is copied from the single-player mission when it is made multiplayer. When trying to complete a multiplayer mission, players run the risk of not completing the mission because of the other player. In such an event, no return is yielded. This will be conflicting with the design principles for GameFlow (see Table A.2) of having the player be in total control of its actions, but at the same time, it does support social interaction and adds challenge.

17.5.3 Issues With Multiplayer Missions

When multiplayer missions are created from single-player missions, the reward is also created. This means the reward is created with the location of the owner in mind. When a new player joins the mission, the reward will be identical for this player. The result is that the player might have a longer or shorter distance to walk to get to the target location, and the reward might not be adequate for the effort the player has to make to complete the mission. The cutoff distance for whether a mission shows up or not is at 5 kilometers, so most players will, in any case, at least not be extremely far away from the target location.

A more severe issue with the multiplayer missions now is that the client will load missions from the server for the list of multiplayer missions based on the player's current location as they open the view. If a player joins a mission, then moves to a new location greater than 5 kilometers from the mission location, re-opening the list of multiplayer missions will not show the mission. This is an issue I had not thought of until after the user test began.

Since BitPet does not give the player's phone any notifications, the communication for agreeing a time to meet for multiplayer missions might be very hard to execute. It requires the player's to actively open BitPet and check if a new player has joined the mission and if they have accepted, rejected, or suggested a new time to meet. I did not have time to learn how to implement and implement notifications before the user test began.

17.6 Various Changes Made To Existing Screens

Some elements that existed in BitPet had to be removed for this project to avoid confusion. Players taking part in this experiment would not have the option to log in using FaceBook log-in or Google log-in. This is to ensure anonymity when storing the game-data. Therefore the log-in screen was changed to only have the option of logging in with username or email (see Figure 17.15). Although the button says e-mail, the users log in using only a username. The button was kept from the original BitPet project to save time.

In the pet selection screen, or lobby/home screen as it is often referred to throughout this thesis, some elements have also been removed (see Figure 17.16). The shop button marked with "new" has been removed, as it had no functionality. The map button in the left hand of the screen was removed, and replaced with a new button in the top-right corner. The screen the original map lead to is made unavailable, and instead a new map screen that built on code existing for the original map has been used. The pet selection screen also has two new help-buttons called "HELP" and "STATS INFO", these display helpful information for the user about the stats and what to do in the game (see figures 17.19 and 17.20. Lastly, the pet-selection screen also shows the daily streak and amount of steps walked (see Figure 17.18).

In the shop screen, the option to purchase actual in-game currency has been

removed, and there are only two options left, the option to buy pets and food (see Figure 17.17).

17.7 Feature: Daily Streak

This feature is a gameplay feature that resembles the Snapchat daily streak system. The Snapchat daily streak system works by increasing the number next to friends' names whenever they send each other a picture (a snap) on consecutive days. Missing a day resets the streak counter to zero. The daily streak I implemented in BitPet is a log-in streak. If a player logs in on consecutive days, the counter increases. The counter can be seen in Figure 17.18. It works by sending a signal to the server every time the user accesses the pet selection (lobby) screen. The server checks if the user has visited this screen the previous day. If the user has done so, the server increments the log-in streak counter saved on the server for the user by one. If the user did not log in the previous day, it is reset to zero. The feature is meant to motivate players to log in and see their pets every day.

17.8 Summary of My Contributions to BitPet

This chapter has presented the mission feature and its variations that I have developed for BitPet. This is a feature where the player is told to walk to a specific location, and receives a reward upon reaching the destination. If the player wants to, they can change the mission to be a multiplayer mission, which allows other players to join the mission. The new multiplayer mission requires both players to reach the target location and exchange a four-digit code with each other to receive a reward that is greater than regular mission rewards. The final variation of the mission feature is the step-mission. The step-mission requires the user to walk a certain amount of steps to complete the mission for a reward. Completing multiple step-missions within a single day increases the amount of steps required by every consecutive step-mission completed. The chapter has also presented the fantasy surrounding the missions, and UI that has been built to support the completion of missions. The daily-log in streak feature is a counter that increases by every consecutive day a player logs in. The chapter has also covered scrapped ideas, and problems or limitations related to the different features.



(a) The multiplayer mission has a pink icon in the list of missions when one has joined another player's mission. It also states that one has joined it and how many players are joined.

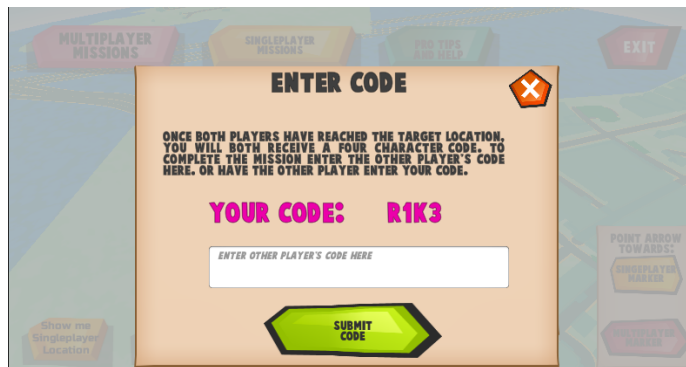


(b) The multiplayer mission has a blue or purple icon in the list of missions when one has not joined another player's mission. It also states how many players have joined.

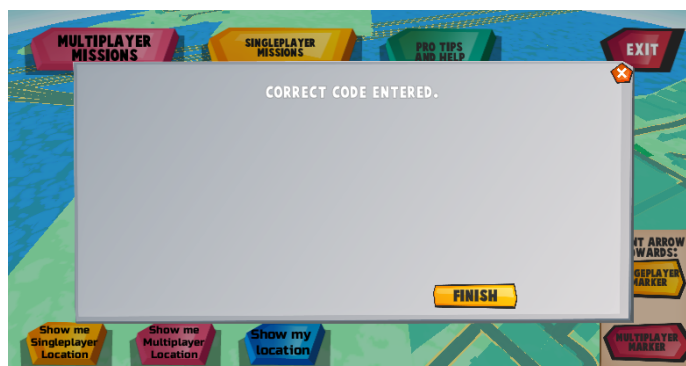


(c) The multiplayer mission in the multiplayer mission list becomes green when one is the owner of the mission, making it very distinct from other missions. It also states how many players are joined, and that one is the owner.

Figure 17.10: The multiplayer mission list with a owned mission, a mission that has not been joined, and a joined mission.



(a) Enter code screen after both players reached the target location.

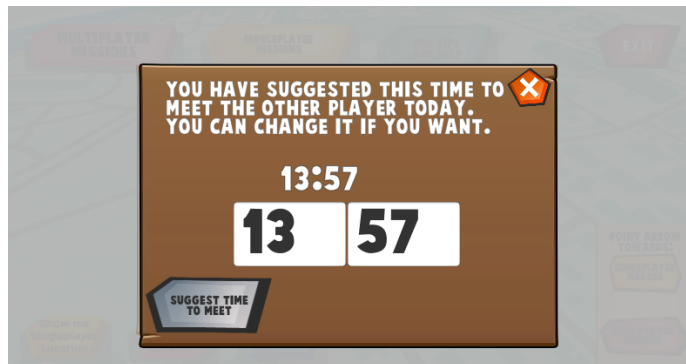


(b) A player has entered the correct code for a multiplayer mission and receives feedback.

Figure 17.11: Enter code panel and feedback upon correct code.



(a) A player can suggest a time to meet another player in a multiplayer mission.



(b) A player has already suggested a time to meet, but entered the suggest time screen again. They can suggest a new time.

Figure 17.12: Suggest time screen with no time suggested, and with a time suggested.

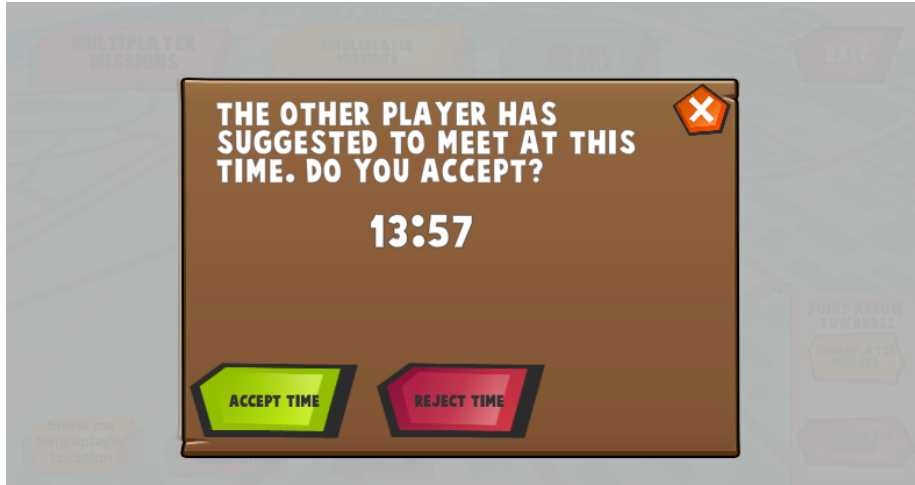


Figure 17.13: Accept or reject screen is shown with the suggested time from the other player.



Figure 17.14: Inspecting a multiplayer mission that one has not joined.

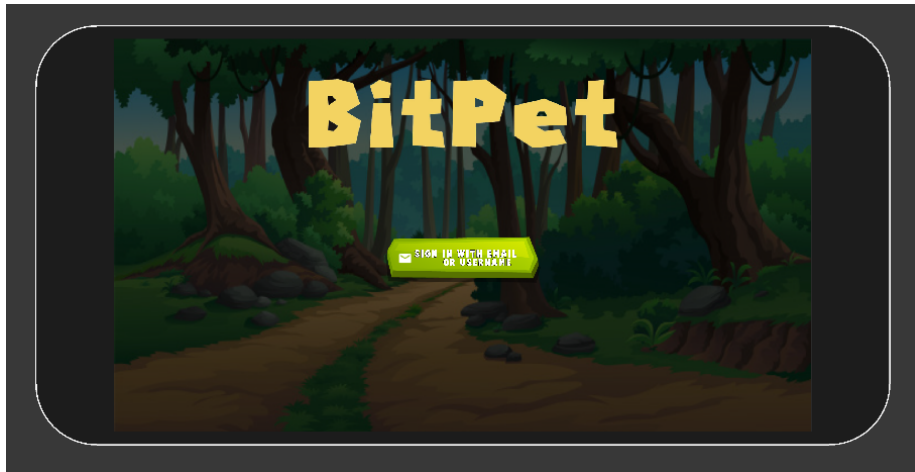


Figure 17.15: BitPet Login screen. Only the email login is available during user testing. Users actually log in with anonymous usernames after clicking the button.



Figure 17.16: BitPet Pet Selection view. Serves as the home screen. The original map button and new shop button have been removed.



Figure 17.17: BitPet shop. The coin shop is removed for the user testing.



Figure 17.18: Daily log-in streak displayed in BitPet



Figure 17.19: Help dialogue displayed in the lobby after clicking the HELP button.

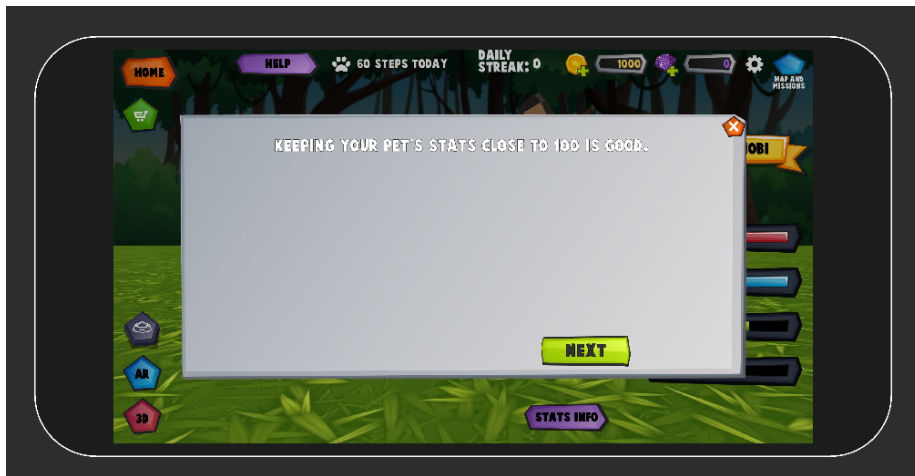


Figure 17.20: Info about the stats displayed in the lobby after clicking the STATS INFO button.

Chapter 18

BitPet Fantasy and Design Principles

This chapter explains how design principles were used to develop the mission feature for BitPet. It also presents the fantasy and how the texts for the mission feature were made to fit with the existing fantasy of BitPet.

18.1 BitPet Mission Texts

This section lists the mission texts written for the mission feature. They can be read in Table 18.1. The missions display the **mission text** when the mission text button is clicked in the mission inspector (see Figure 17.5). The **reward text** is displayed upon reaching the mission marker and target location. The texts were written to fit around the fantasy of owning a pet. When writing the mission texts, it was essential to involve the pet in the mission text somehow. This is to strengthen the idea that player is taking care of their pet, or taking their pet for a walk to the target location.

Table 18.1: Mission texts written for the mission feature. The default mission is only displayed if the game is not told which mission to display. This should never happen.

Mission #	Mission Text	Reward Text
M1	<p>Browsing social media you see an image of the area around you. On close inspection you notice it is a post about a missing pet. The post even has a reward for finding the pet. The pet was last seen in your vicinity. Think of the poor lost soul hungry and alone out there, maybe you should go look for it? You could bring your own pet for a walk at the same time.</p>	<p>You found the missing pet! You decide to call the number in the missing pet post you found on social media... "Hello?" "Hi we found your pet!" "Mr. Snuggles!!!! OH MY GEE, you and your pet owner found mr. Snuggles. Thank you so much. Where are you two right now?" "We are at-" "OH MY GEEE WHAT A coincidence I'm literally just around the corner! I can see you now" *phone hangs up* "Mr Snuggles!!!" The owner really was around the corner and he picked up Mr. Snuggles before transferring you a convenient amount of money for the help.</p>
M2	<p>Good day pet owner. This is a message from the top secret super pet inspector bureau. Do you think you have an exceptional pet? Well we will be the judge of that. Tell you what: come meet us at the target location and we'll let you know what kind of rodent you're tagging along.</p>	<p>Money talks. At least that is what they said in that one movie. Or was it the cops? Anyways, the point is we think your pet is amazing. Terrific. And a pet of that caliber needs plenty of gold to live a top secret super pet lifestyle. I'd give you a ride back home, but uhh... no humans can get in our car. Until next time pet owner!</p>

Continuation of Table 18.1

Mission #	Mission Text	Reward Text
M3	Whilst reading the newspaper you saw an ad about an antique brass lamp for sale. It is not too far from here. Perhaps it is one of them magical lamps with a genie inside?	You found the person selling the lamp, and strangely he decides to give it to you for free. Upon touching it a genie pops out of the lamp. "I give you three wishes, what do you wish for pet owner?" Before you have time to say anything your pet has already wished for a bunch of coins. Three times. Oh well there goes your shot at eternal life and world peace. You guess you can spend some coins on food for your pet?
M4	There is a weird smell. You're not sure if you like it or not. However, Your pet is crazy about this smell, and is really trying to get you on a walk so you can trail it together.	So that's what money smells like! You just found a bunch of cash on the street. LOL.
M5	Your pet has a social media account and wants to add some friends. It insists on going outside to find someone to add.	Your pet not only found a new friend, but it found a wealthy friend. The new friend gave you a present of coins!
M6	Your pet has been offered a covid vaccine. You should bring it to the vaccination location.	As a reward for taking the vaccine and keeping society safe, your pet received a hefty sum of money.
M7	There is a sale on pet food. You should go to the store and stack up on some extra food for your pet!	Oh no. The store was sold out. As an apology they gave you money instead. That was strange.
M8	You and your pet are invited to a birthday party. Let's celebrate!	At the party your pet stole all the birthday presents. They were all envelopes full of money.

Continuation of Table 18.1		
Mission #	Mission Text	Reward Text
M9	There is a parade in the city. It is supposed to be at the target location. Plant a mission marker and find it.	Upon reaching the location you find out the parade was yesterday. But someone dropped their wallet, and you picked it up. It was full of money. Luckily the owner's ID was also present, so you can return the money. You decide not to return the money, because it is nice to have money instead.
M10	Some computer science student needs help beta testing his game. Want to help him out? Well you have his address, you could plant a marker and get there.	You reached the computer science student. After helping test his game for a few days he gives you a grand reward of coins. You can't help but think "if only this was real life..."
M11	You remember today is your pet's job interview. They are trying to land a job at the local airport as a wine taster. Would you like to accompany them?	Your pet got the job, and your pet decided to share part of their salary with you. How convenient.
Default	You were never supposed to see this mission text. This text is produced when the id for the missions does not match any saved mission text How did this happen? If you tell the developer he will probably be very frustrated that this happened in the first place.	That is weird. There is no reward text for this id. Maybe the developer made a mistake creating this game?

18.2 Mission Feature and Prensky's Design Principles

In the prestudy, design principles and elements that make games fun were highlighted. Among these are Prensky's design principles (see Section 9.1). When designing the mission feature, Prensky's elements were kept in mind. In this section, it will be made clear how the feature incorporates these elements.

The twelve elements are: fun, have rules, goals, outcomes, feedback, win states, challenge, problem-solving, interaction, representation, story, and play. The mission feature has **rules**. The player can only complete the mission by reaching the target location or walking the required steps. When completing the mission,

the player reaches a temporary **win-state**, and there is **feedback** telling the user that they have reached this win-state. There are **outcomes**, as the user will receive a reward when completing the mission. When clicking buttons to read text, planting mission markers, and walking to the target location, there is **interaction** with the game, even more so when **interacting** in multiplayer missions. Completing missions are **goals** in themselves. Finding the location is a **challenge** and counts as **problem-solving**, and walking for long distances can also be challenging. When completing multiplayer missions, the users have to enter a code, which represents problem-solving, although not very difficult. The **story** that surrounds missions involves the user's pet. This gives **representation** as the pet represents a real-life pet. The mission stories themselves match the story element.

According to Prensky, play is three different things, something one chooses to do, something intensely and utterly absorbing, and something that promotes the formation of social groupings. The mission feature is something that the player chooses to do [6]. It does promote the formation of social groupings since they require social grouping for completion. Multiplayer missions give greater rewards than single-player missions and thus also promote choosing them over single-player missions. Whether the mission feature is intensely and utterly absorbing remains to be seen after user testing.

18.3 Summary of BitPet Fantasy and Design Principles

This chapter has explained how mission texts of the mission feature were made to fit with the existing fantasy of BitPet. This was done by making the theme of the missions involve the pet in different scenarios. It has also highlighted how design principles were considered when coming up with the mission texts and the mission feature.

Chapter 19

Database, Server and Backend

This chapter briefly explains the PostgreSQL database used in BitPet at the project start and after my contributions to the database. It also presents my contributions to the server code.

19.1 The Server and Backend

This section covers how the server is running and my contribution to the server. Some details of how certain things such as missions are generated on the backend, is explained in greater detail in the sections related to them in Chapter 17. For an example, see Section 17.3.2.

19.1.1 My Contributions to the Server Code

Most of the server is identical to the server produced by the BitPet team mentioned in Section 15.3.1. I have made some contributions to this code. These contributions are:

- Database models for missions and multiplayer missions
- Endpoints in the API connecting to code for creating new missions and multiplayer missions
- Logic for suggesting, agreeing to, and declining meeting times for multiplayer missions
- Database models for log-in events, used to track the activity of users during the user-testing

- Database models for log-in streaks, as well as server code to calculate if a new log-in event should result in an increased streak counter or streak restart

19.1.2 Hosting on Heroku

For the user test the server was hosted on Heroku, a container-based cloud Platform as a Service [45]. I chose to run the server in Heroku’s european data center, with a *Hobby dyno* and a *Standard 0* PostgreSQL database. A Hobby dyno is the name of the type of container I rented from Heroku [60]. It had to select a dyno that would support around 30 user testers. I also chose the Standard 0 database plan which was the cheapest option that would let me have a database connection for each user at any given time and enough storage space and rows for the user test [61].

19.1.3 Updating Pet Stats Using the Heroku Scheduler

To update the stats of user’s pets, I used the same solution as the original team behind BitPet. I used the Heroku Scheduler. How this works is explained in Section 15.3.1. I originally configured the Heroku Scheduler to update the pet’s stats three times an hour but quickly changed it back to once an hour. When the stats updated three times an hour, a pet with as healthy stats as possible would diminish to 0 and die within one day without attention. Even if one logged in a couple of times a day, 10 hours of not logging in during the night would be enough to kill the pet. With the stats being updated once every hour, seeing the pet once every 24-36 hours is enough to make sure it survives.

19.2 Database at the Project Start

The database at the project start consisted of every table listed in Table 19.1 except tables 5, 6, 7, and 18. For a brief description of the purpose of each table, see Table 19.1.

19.3 My Contributions to the Database

When mentioning a table number in this section, it refers to the table number in Table 19.1. My contributions to the database consist of tables 5, 6, 7, and 18.

Table 5 was supposed to be used to keep track of when users logged in to the game. This ended up not being used in the experiment because I did not have time to implement the logic to identify a log-in scenario and store an entry in the database table. It was initially considered to be a fast process to implement this functionality, but BitPet’s backend uses sessions to handle log-ins. Once logged in, a user receives a session token, and it is used for logging in thereafter.

When using the token, the network calls do not go through the same endpoints in the server API as the ones responsible for logging in and receiving the session token in the first place. I was unable to uncover the inner workings of these endpoints in time for the experiment, as other more severe bugs had to be fixed.

Table 6 is used to store missions created for users and includes information such as reward, which fantasy story to present, owner of the mission, and time of creation.

Table 7 is used for the same purpose as table 6, except it is for multiplayer missions. This results in two foreign keys to the user table. In addition, it also has fields for the logic related to agreeing on a time to meet and codes for completing the multiplayer missions as described in Chapter 17.

Table 18 is very simple. It only holds a foreign key to the user who owns the streak and a counter that increases whenever the user logs in on consecutive days or resets when failing to do so.

For a full view of the information these tables contain, see Figure 19.2. See Figure 19.1 for a view of the entity-relationship diagram of the tables that hold relevant data for this project.

Table 19.1: Database Tables and their purposes. The "Used" column refers to whether the table is used in the experiment or not.

Table#	Table Name	Purpose Of Table	Used
#1	AR Internal Metadata	Stores metadata used for AR mode	Yes
#2	Failed Purchases	Stores data about failed currency purchases	No
#3	Food Types	Store every type of food that exists in BitPet	Yes
#4	Foods	Stores the food items every user has and how many of each they have	Yes
#5	Login Logs	Store an entry of each log-in a user makes to BitPet	No
#6	Missions	Stores every mission created in BitPet	Yes
#7	Multiplayer Missions	Stores every multiplayer mission created in BitPet	Yes
#8	Pet Steps	Stores every new amount of steps registered by a user's phone to their current selected pet	Yes
#9	Pet Types	Store every type of pet that exists in BitPet	Yes
#10	Pet Types Users	Unclear what purpose this table has	Yes
#11	Pets	Stores every pet created in BitPet as well as information about who owns the pet	Yes

Continuation of Table 19.1			
Table#	Table Name	Purpose Of Table	Used
#12	Purchase Types	Stores every type of real money transactions that can be made in BitPet such as purchasing in-game currency	No
#13	Purchases	Stores purchases of currencies in BitPet	No
#14	Rooms	Used to store meta-data about Unity Networking Rooms. These are used to sync multiplayer-data in the AR-mode	Yes
#15	Schema Migrations	Stores data about the Ruby on Rails Schema migrations	Yes
#16	Sessions	Stores data about user sessions. Used for authentication and log-in procedures of users	Yes
#17	Settings	Unclear what purpose this table has	No
#18	Streaks	Stores log-in streaks for users during the experiment	Yes
#19	Users	Stores account information for users such as username and password hash	Yes

19.4 Summary of Database, Server and Backend

This chapter has described the state of the server and backend at project start, as well as my contributions to the server and database. The entire backend supports the existence of users, pets, food, and coins, as well as the relations between them. My contributions include missions, multiplayer missions, and relations between them and users. I have also created the streaks table. In addition to the database tables, I have written server code necessary to support the logic of creation and completion of missions and streaks.

public
missions
id
title
missiontext
completed
longitude
latitude
coinreward
missiontype
created_at
updated_at
user_id
steps
steps_at_creation
mission_text_id

(a) Mission Table in the database.

public
multiplayer_missions
id
title
coinreward
missiontext
user_1_id
user_2_id
user_1_completed
user_2_completed
longitude
latitude
created_at
updated_at
user_1_code
user_2_code
user_1_suggested_time
user_2_suggested_time
agreed_time
completed
owner
user_1_reached_target
user_2_reached_target
code_completed
mission_text_id

(b) Mission Table in the database.

public
streaks
id
user_id
streak
last_day
created_at
updated_at

(c) Streaks Table in the database.

Figure 19.2: Three tables implemented for this project.

Chapter 20

Requirements & Testing

This chapter presents the requirements for the software that is developed during this project. It also describes the extent of testing that will be performed and how it will be done.

20.1 Functional & Non-Functional Requirements

After the idea brainstorming and planning phase, requirements were derived for the features to be developed. These requirements would serve as a checklist to make sure the most critical functionality had been achieved before user testing. tables 20.1 and 20.2 lists the functional and non-functional requirements for the features to be developed. These lists can be used as a checklist to help ensure the finished features have the intended functionality. For a detailed explanation of how the game works and thus where these requirements come from, see chapters 15 and 17. FR1-FR5, FR10, FR15, FR17-FR19, FR21-FR22 and FR33 are considered to be the most important functional requirements, as they are needed to support the existence of the mission feature. FR7-FR9 are second highest as it vastly improves the ease of completing multiplayer missions with strangers.

20.2 Testing

This section covers what type of testing was performed during the development phase of this project.

20.2.1 Testing Performed & Difficulties

During the development phase, I had to learn using a wide range of tools: Unity Engine, Ruby (the language), and the framework Ruby on Rails. As I

developed new parts of the features for BitPet I tested them on simulators on a computer. This came with some limitations, such as the GPS signal being simulated. Having BitPet understand the real-world location of the user is an integral part of the mission feature described in Chapter 17. Running BitPet in Unity worked, and the GPS signal could be simulated, but there was no way to know how well it would work in the real world. The Android device I was using for testing BitPet on a real device had a broken USB-C port during the first three months of development. The result was that I could not actually test BitPet and the mission feature on a real device until after many parts of the code were deemed to be finished. When I first got around to testing BitPet on my physical device after repairing the USB-C port, it turned out the code was not configured to receive the device's GPS signal properly. The problem was eventually solved, but it took a week of development time to identify the issue and resolve it. In the end, the buttons for previewing the mission location (see Section 17.3.1) ended up not working as well as intended, but they worked to an acceptable degree for a user test.

Testing the UI and loading of new scenes and server communication was easy to test manually with the simulators on the computer. Server requests were created in Postman [80] to efficiently test the server's endpoints and examine the responses generated.

Ruby on Rails does offer functionality for validating that data has the correct format for the database used. This type of validation is used by the team behind the version of BitPet this project started from. I did not allocate time to learn how to use this type of validation, nor how to write software tests for the server, database, or the C# code for the client in Unity.

In hindsight, I could have possibly saved time spent debugging if I had written more tests for the entire software stack, but with limited time for planning, learning the tools, and software development, it might not have been worth the time either. I would also have had to allocate time to actually writing the different tests.

To summarize, I tested every part that was developed before I moved on to the next part to develop the planned features. In the end, one or two weeks before the user testing was planned to start, I also went outside and actively tested the app by completing missions outside. This is a very time-consuming activity, as it requires the user to walk around to the location-missions target locations.

20.2.2 Lack of Extensive Testing

In an ideal scenario, one would carry out extensive testing of BitPet before initiating the user testing. In this project, there were two main reasons why extensive testing was not carried out. The first reason was that I did not have access to an iOS device, so I could not test BitPet on iOS prior to user testing. The other reason was limited time. I had to prioritize getting a working version of BitPet with the planned features over carrying out testing of an unfinished

feature.

As mentioned in Section 20.2.1, no software tests were written for this project, resulting in no automated set of tests that could be run at every incremental update to the code. This could have been used to detect bugs introduced by new code. This type of testing was not set up due to a small timeframe and lack of previous experience with automated testing.

20.3 Validation of Requirements

The user testing for this project is more of an experiment to gather data in order to answer the research questions listed in Chapter 3 than a user test to ensure the software developed is working as intended with regards to the functional requirements. Therefore there is no user testing to validate the functional requirements prior to the user testing. Validation of these functional requirements can still be done after the user-testing and interviews have been conducted. Prior to the experiment I still validated that the functional requirements were achieved on my own device before initiating the experiment with real users. This means I had not validation of the requirements for the iOS version of the game. For more information about why, see Section 20.2.2.

The non-functional requirements listed in Table 20.2 were harder to validate prior to the experiment, as I could not know how users without my knowledge of the system would perceive the UI and features. Because of this, NFR1, NFR5, and NFR7 were impossible to validate before having external testers use BitPet in the experiment. The wide range of devices that would be used for playing BitPet would also make NFR3 and NFR9 hard to validate. Lastly I could not stress the server too much on certain endpoints because of the limited credits for the Google API (see Section 17.3.5), which means I could not simulate huge workloads for the server. This resulted in NFR8 was hard to validate before the experiment.

NFR2, NFR4, NFR6 and NFR10 were all direct results of configuration in the code, so these were validated during development. The same applies to the functional requirements listed in Table 20.1.

20.4 Summary of Requirements & Testing

This chapter has described the requirements for the mission feature that will be developed for this project and how testing and validation will be performed. Due to a lack of experience with writing tests for the front-end and back-end technology used in this project and limited time for the project, writing tests have not been prioritized. The only testing performed was testing the software on an actual Android device during development and the experiment with participants.

FR#	Functional Requirement
FR1	The player must be able to receive missions
FR2	The player must be able to view their missions
FR3	The player must be able to make a location mission multiplayer
FR4	The player must be able to join multiplayer missions
FR5	The player must be able to leave multiplayer missions
FR6	The player must be able to suggest a time to meet other player in multiplayer missions
FR7	The player must be able to agree to a suggested time to meet the other player in multiplayer missions
FR8	The player must be able to suggest a new time to meet after a suggested time has been accepted or suggested
FR9	The player must be able to decline a suggested time to meet another player in multiplayer missions
FR10	The game must inform the player about mission completion
FR11	The game must have stories for the location missions
FR12	The game must provide a description of how a mission can be completed
FR13	The game must provide buttons that display helpful information across the game
FR14	The game must inform the player about the progress of multiplayer missions
FR15	The game must give both players rewards when one player enters the other player's multiplayer mission code
FR16	The game must update the selected pet's stats when a mission is completed
FR17	The play must be able to change between rendering a single-player and multiplayer directional arrow
FR18	The player must be able to to see the target location on the map
FR19	The player must be able to open a map and see their own location
FR20	The player must be able to cancel long dialogues of information
FR21	The player must be able to complete missions
FR22	The player must receive a reward when completing a mission
FR23	The player must be able to see their progress in a mission
FR24	The player must be able to see their daily log-in streak
FR25	The game must reset a player's daily log-in streak when they miss a day
FR26	The game must increment a player's daily log-in streak when they log in on consecutive days
FR27	The game must increase the required amount of steps for consecutive step-missions generated within the same day
FR28	The game must calculate rewards that scale with the distance required to walk in location missions and step-missions
FR29	The game must give better rewards for multiplayer missions than single-player missions
FR30	The player must be able to see the reward for missions before completion
FR31	The player must not receive the same daily mission too often and never twice in a row.
FR32	The target location must vary from day to day.
FR33	The game must be able to register the player's steps.

NFR#	Category	Non-Functional Requirement
NFR1	Usability	90% of players must be able to use the mission feature without failure after one try.
NFR2	Reliability	The mission feature must produce a new mission for the player every day.
NFR3	Reliability	Features must not make the app break.
NFR4	Data Integrity	If the app breaks, the streak must be preserved and displayed upon opening the app again.
NFR5	Usability	95% of players must be able to spot that multiplayer missions are more rewarding than single-player missions the first time they see a multiplayer mission.
NFR6	Usability	Players must not be required to play the game every day for pets not to die.
NFR7	Usability	90% of users must be able to use the UI without failing to perform the tasks that they want to perform, the first time they attempt to perform them.
NFR8	Availability	The server must respond to requests within 1 second so the app appears responsive.
NFR9	Performance	The client side must run with a FPS of at least 30 FPS.
NFR10	Performance	The client side must send requests to the server within 0.1 second of buttons being clicked.
NFR11	Usability	95% of players must notice any feedback produced by the application when being acted upon.
NFR12	Usability	95% of players must not report that they think feedback is missing from the application when interacting with it.

Table 20.2: Non-Functional Requirements

Part IV

Data Collection

This part explains how data was collected for this project through questionnaires and a user-testing experiment.

Chapter 21

Questionnaires

This chapter discusses the questionnaires used in the project. For a list of all the questions, see Appendices B, C, D, and E.

21.1 Purpose & Brief Description

The questionnaires were created to help answer the research questions in Chapter 3. Two questionnaires were created. One for the participants of the user test to answer before the two-week testing period of BitPet, and for the rest of the thesis, it will be referred to as *Questionnaire Pre*. The other questionnaire was for the participants to answer after the testing period. For the rest of the thesis, it will be referred to as *Questionnaire Post*. Questionnaire Pre is used to gather demographic data about the participants, such as age and gender. In addition, it inquires about previous experience with games and exergames. Lastly, it asks about habits around exercising and walking and feelings around socializing with friends and strangers. The last questions about exercise and socializing are repeated in Questionnaire Post to see if their views have changed after playing BitPet. For more details, see Section 21.2. For the questionnaire itself, see Appendix B for the questionnaire in Norwegian, and Appendix C for an English translation.

Questionnaire Post asks about different features in BitPet to uncover which parts of BitPet were motivating or demotivating, hard to understand, or easy to understand. It also asks users some questions regarding why they played the game they did. At the end of the questionnaire, it repeats the questions about exercise and socializing from questionnaire number one. For more details, see Section 21.2. For the questionnaire itself, see Appendix D for the questionnaire in Norwegian, and Appendix E for an English translation.

21.2 Questionnaire Design

The first designs of questionnaires had most questions asked twice, once in a positively loaded question and once in a negatively loaded question. An example of a positively loaded question would be "Do you enjoy walking outside?" while a negatively loaded question that equals the positive one could be "Do you dislike walking outside"?. Questionnaires tend to get lower quality responses when the length of the questionnaire increases [2] and therefore, I decided not to include both positive and negatively loaded questions of every question. Instead, I opted for presenting the respondents with statements. The respondents had to state how much they agreed with or disagreed with the statements. I also tried to reduce redundancy and ask questions or present statements that would cover an area as much as possible.

When provided a statement, the respondent could choose to respond with "completely disagree," "slightly disagree," "do not disagree nor agree," "slightly agree," and "strongly agree." I kept the number of options to 5 options. This will be sufficient for showing whether there is a bias towards negative or positive opinions on the questions. It also keeps the number of options to consider lower, possibly resulting in less time spent considering which option to pick for the respondent.

The questionnaires were created with Microsoft Forms [73]. The *shared settings* was set to open so that anyone with a link could answer the questions. Random users answering the questionnaire was not a problem. Participants in the user test were asked to enter their anonymous ID that was individually sent to each participant by email (see Section 22.3.1). Microsoft Forms allows for different *branches* in the questionnaire, which means users could receive follow-up questions to questions based on which options they picked on yes/no questions. It also allows for dividing the questionnaire into parts, so the answering process might seem less overwhelming. All answers can be directly exported to an Excel spreadsheet. Since users submit their personal anonymous ID, which is also the log-in username for the user test in BitPet, their answers to questions could be linked to their game data during the user test.

The questionnaires were written in Norwegian since all participants were Norwegian, and it would eliminate any possible problems related to lacking English skills. The complete list of questions includes a translation of the questions (see Appendices Appendices B, C, D, and E). For a glance at what the questionnaire looks like, see Figure 21.1.

Bitpet spørreundersøkelse

Dette er en spørreundersøkelse som skal besvares før testperioden av BitPet.

* Obligatorisk

Introduksjon og samtykke

Takk for at du har valgt å svare på denne spørreundersøkelsen.

I spørsmål 2 i denne delen av undersøkelsen viser jeg til informasjonsskrivet om innsamling og oppbevaring av data. Dette skrevet fikk du tilsendt i e-posten knyttet til din interesse om å delta i prosjektet. Dette skrevet ble også sendt ut i e-posten med lenken til denne spørreundersøkelsen. Du kan når som helst velge å avslutte å svare på denne undersøkelsen, og du kan når som helst i løpet av prosjektet gi beskjed om at du ønsker å trekke deg fra prosjektet. Da vil all data lagret om deg bli slettet.

1. Hvilken anonym ID (tall) fikk du tilsendt på e-post? *

Verdien må være et tall

2. Jeg har mottatt og forstått informasjon om prosjektet "BitPet" , og har fått anledning til å stille spørsmål. Jeg samtykker til: *

- å delta i spørreundersøkelser og brukertest
- å delta i intervju
- å delta i observasjon

Figure 21.1: Screenshot of the top part of page one of the first questionnaire.

Chapter 22

Experiment

This chapter explains how the user-testing experiment was planned and executed. It includes which data was going to be collected, the length of the experiment, and which information the users received before the experiment. It also discusses the goal of the experiment. The data gathered from the questionnaires are not considered in this chapter. This chapter is strictly for the two-week period where volunteers test BitPet.

22.1 Experiment Goal

The goal of the experiment is to gather data that could be helpful to answer the research questions in Chapter 3. Judging by what type of data will be gathered (see Section 22.2), the data will likely help to answer research questions:

RQ1: *How do people perceive playing exergames with strangers?*

RQ2: *Will playing exergames make people more comfortable interacting with strangers?*

RQ3: *When given a choice, are people more inclined to play exergames with people they know rather than strangers?*

RQ5: *Are people willing to overcome social anxiety to take care of their digital pet?*

22.2 Data to Be Gathered

During the experiment, data will be stored in the database tables described in Chapter 19. Most important for this project are the missions and the multiplayer missions, as these are the main features developed for BitPet. The data stored in the other tables are not as interesting, as much of the information related to those tables will come from the questionnaires and interviews. The mission

and multiplayer tables gather the information that tells us something about the pattern of how the players choose to play BitPet.

22.3 Experiment Details

This section discusses the details around the experiment, how it was carried out and how long it lasted.

22.3.1 Information Before the Experiment

The users received the following information before the user test experiment: Instructions on how to install BitPet on their device, a PDF with information about what data would be stored from their device during the experiment and how it would be treated until and after the project end (see Appendix F), a list of known issues or errors in BitPet and some temporary solutions or explanations to them, and some helpful instructions about how to play the game, log-in information for their account in BitPet. In addition to this information, the users were told that the experiment would last for two weeks, and they received a link to the first questionnaire.

The list of known problems that participants received was:

- *Error*: Sometimes, the game will repeatedly prompt you with a message saying, "Lost connection to the server, retry." **Explanation/fix**: This is not technically correct. A temporary fix is completely shut down the app and restart it.
- *Error*: No available missions. **Explanation/fix**: Missions are based on GPS-locations. Missions will only show up on your device if you are within a certain radius of the mission. In addition, you can only have X amount of single-player and multiplayer missions per day. If you move out of the radius of your current missions, and you have as many missions as you possibly can have, you will not be able to see any missions or receive a new mission until the next day.

The helpful instructions about how to play the game were simply telling the participants that the help button existed on the lobby screen and on the map screen.

I created unique log-in information for each participant, consisting of 6 digits with an eight-digit password. The same log-in ID was used by participants when answering the questionnaires.

22.3.2 Distribution of BitPet to Participants

BitPet was distributed to participants through TestFlight [96] for participants using iOS. Android users were given a link to Onedrive that let users download the Android APK file of the application.

22.3.3 Information During the Experiment

During the experiment, a tester asked for a place to report problems they faced during testing. Because of this, an e-mail was sent out to all participants to a Microsoft Forms document where participants could anonymously report issues faced during testing or choose to use their log-in ID to report issues.

22.3.4 Changes to the Backend During Experiment

During the first 24 hours of the experiment, participants reported that their pet had died already. This was not supposed to be able to happen within 24 hours. It turned out that I accidentally had added too many scheduled tasks for updating pets' stats on the Heroku Scheduler (see Section 19.1.3). I ended up turning down the difficulty to the supposed difficulty, which meant pets' stats would deplete at one-third of the rate it had at the beginning of the experiment.

Chapter 23

Interviews

This chapter describes why and how interviews will be conducted, including the questions that will be asked. For the results, see Chapter 24.

23.1 Purpose of Interviews

The interviews can uncover more in-depth information than what the participants answer in the questionnaires. The questionnaires are designed to be quick to answer to get as many people to answer them as possible. When interviewing participants, one can ask questions that are not strictly yes or no questions and understand why they answer the way they do. It also opens up the possibility of follow-up questions to answers the participants provide. The interviews might shed light on why participants have answered the way they have on the questionnaires, and can help in the discussion of the results.

23.2 Plan for the Interviews

The interview will be conducted over video-calling software. I will be asking the participants the questions listed below, and possibly ask other questions if I see fit. The calls will be recorded, and any questions that are asked spontaneously, as well as all questions and answers will be written down.

These are the planned questions for the interviews:

1. What was your impression of BitPet as a whole?
2. What do you think about the UI in BitPet?
3. Was there anything that was hard to understand or perform in the app?
4. How did BitPet run on your device? Did it run smoothly? Were there any issues?

5. Did you play multiplayer missions?
 - (a) Why/why not?
 - (b) If the user did not play multiplayer: Would you be more inclined to play multiplayer if it did not require direct contact such as speech or seeing the other person in real life? For instance, one could complete multiplayer missions by simply being in the same area as the other person and then interact on the screen or through AR?
 - (c) Would push notifications be an improvement?
6. Did you create any multiplayer missions?
7. Did covid play a part in avoiding multiplayer missions?
8. What do you think about the concept of having a pet to take care of?
 - (a) How often should one have to enter the app and pay attention to the pet?
 - (b) Would push-notifications about the state of the pet be helpful?
9. Did you feel like you had to actively walk to take care of them, or did it simply fit into your regular daily activities?
10. Can you think of a type of interaction one could have with other players that would not be intimidating or scary?
11. What do you think of push-notifications from games?
12. Do you think you started with too many coins in BitPet?
13. How did you perceive the fantasy surrounding missions? This means the mission text or story. Did it motivate you to complete missions?
14. Was there anything you missed in BitPet?
 - (a) What about missions where you received special rewards such as cosmetics for walking to the target location, would this be of interest?
15. Did it feel like working out when you were completing missions in BitPet?
16. How did you perceive the fantasy surrounding missions?
 - (a) Did it motivate you to complete missions?

Part V

Results and Discussion

This part presents the results from the user testing experiment, questionnaires and interviews, and a discussion of the results. In the results, the most relevant data for this research project is in focus. During the discussion, the qualitative and quantitative data are compared to point out differences in the two types of data. After discussing the results, the answers to the research questions and a conclusion for this project are presented. In the end, the future work needed for this project is described.

Chapter 24

Results

This chapter contains the results of the project and experiment. For a discussion about these results, see Chapter 25.

24.1 Participation

This section covers the data collected about participation in the experiment as well as some of the reasons for the results.

Out of 33 participants who signed up for the experiment, 25 answered Questionnaire Pre. Out of these 25 participants, 23 managed to log in to the game. Twenty-three participants answered Questionnaire Post after the experiment.

In Questionnaire Post, the respondents were asked if they had managed to test BitPet. They could answer: *yes*, *no*, *partly - but enough to have answer questions about my impression*, and *partly - but not enough to be able to answer questions about my impression*.

Figure 24.1 shows that only 13 participants tested BitPet enough to answer questions about their impressions of the game. Among these, nine were running BitPet on Android, and four were using iOS. Most participants did log in at least once during the experiment, but not all participants continued to test the game. More than half of the participants (12 out of 23) attempted to test BitPet on a device running iOS.

24.1.1 Problems Reported During The Experiment

Three users reported that their step-counter was not working with BitPet. All of these reports came from users running BitPet on iOS. A fourth user also owned an iPhone that was too old to run TestFlight, which was required to install BitPet. Four other participants with iOS reported no issues but still had not tested the app enough to answer questions. It is therefore unclear whether or not they suffered the same issues as the other iOS users. Two iOS users also

reported that the map would crash the app, making it impossible to complete missions. Only one Android user reported having the same issue with the map. Android users reported some other issues. One user could buy new pets, but they would not appear in the collection. One user could not receive new missions, and one user could not complete missions. One Android user could not connect to the game servers at all, and two android users reported that they sometimes randomly received messages about the app trying to reconnect to the servers.

In total, 15 users reported some minor or major issue with the application.

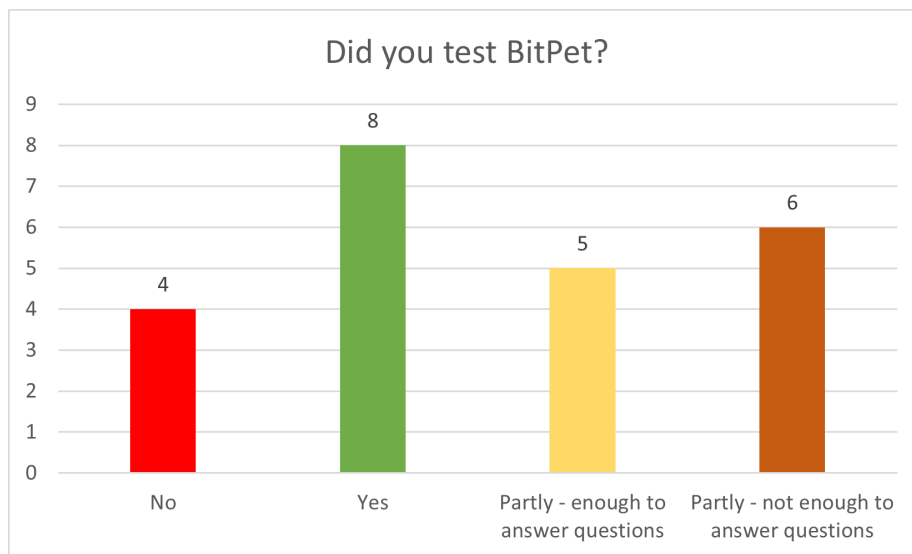


Figure 24.1: Amount of participants who tested BitPet enough to answer questions about their impressions.

24.2 Demographic

This section shows the demographic information about participants in the experiment and habits and traits belonging to the participants.

24.2.1 Demographic: Basic Information

Figure 24.2 shows the age distribution of participants, while Figure 24.3 shows the gender distribution. Most participants are young adults in the age group 18-24 years of age, and 64% of participants are male, with the remaining 36% being female.

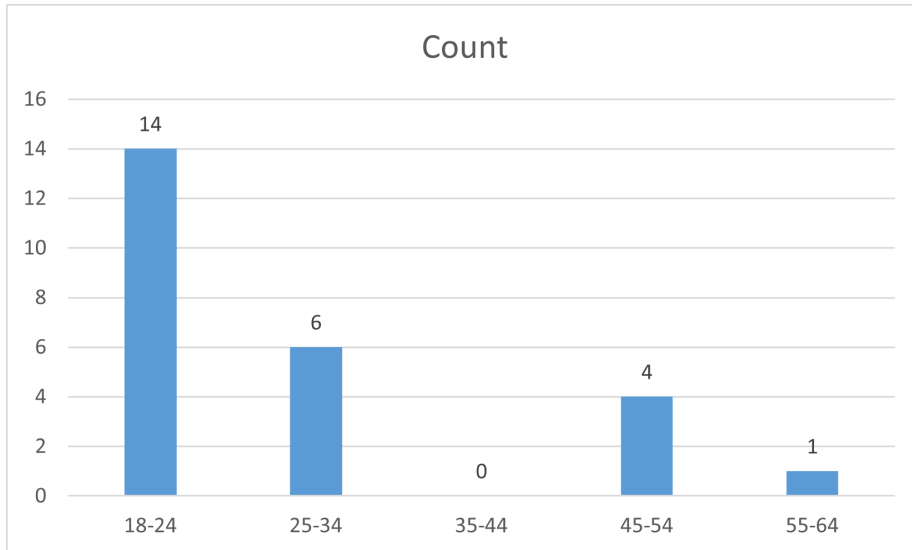


Figure 24.2: Age distribution of participants in experiment and questionnaires.

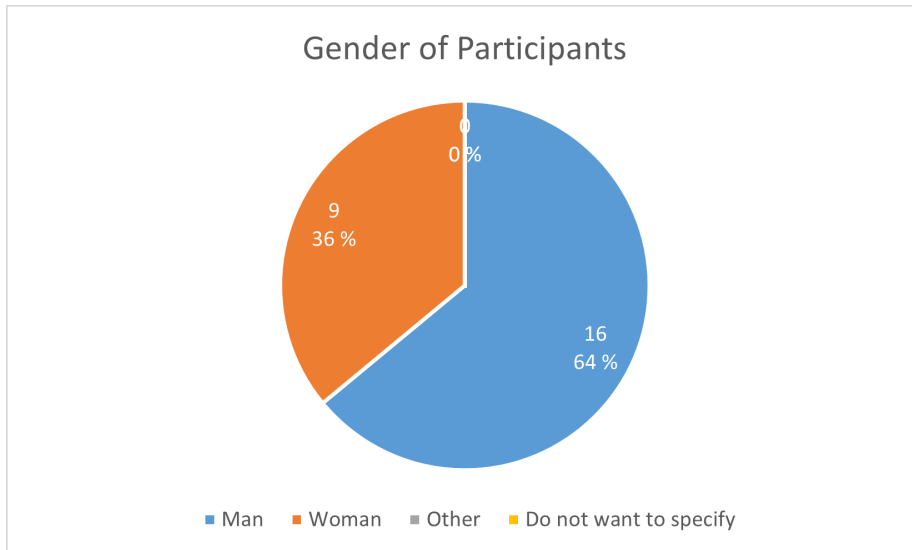


Figure 24.3: Gender distribution of participants in experiment and questionnaires.

24.2.2 Demographic: Relevant Habits and Traits

Out of the 25 participants, 8 were dog owners or took care of a dog at times (see Figure 24.4). Table 24.1 shows how frequently these participants took the dog out for walks of varying lengths, from less than 15-minute walks to longer than an hour.

Table 24.2 shows the participants' habits related to video games and physical activity in groups and alone during the last year. According to the questionnaire, around half of the participants often play video games. Around half of the participants engage in demanding physical activity in groups and alone every month or more frequently. All participants have been engaged in low-intensity physical activity with others monthly, while 68% engage in these activities weekly or more frequently. More participants have frequently engaged in demanding physical activity alone than with others. However, a higher number of participants never or very infrequently perform both demanding and low-intensity physical activity when alone. All participants engage in some form of low-intensity or demanding physical activity.

Table 24.3 shows the participants' self-assessed level of fitness during and before the pandemic. 16% of participants reported their fitness being very good before the pandemic, while only 4% (one participant) reported the same during the pandemic. The number of participants reporting a variation of bad level of fitness increased from 12% (3 participants) to 24% (6 participants). Neutral and good remained the same. This means 76% of participants reported themselves having a neutral or better level of fitness. Statements S1J and S1K in Table 24.4 show that almost all participants (92%) wish to improve their level of fitness, and 76% of participants wish to be more outdoors.

19 out of 25 participants say they go for walks to exercise, and 4 out of the remaining sometimes do. When going for walks to exercise, 23 out of 25 participants responded that they sometimes use music or podcasts to entertain themselves (see Figure 24.5). Notably, no participants use games for entertainment on these types of walks. When asked whether or not participants had a purpose for going on walks, 19 responded they sometimes do, while 4 participants responded yes, and only two rarely had a purpose.

24.2.3 Demographic: Experience With Exergames

Out of the 25 participants, only eight had previously tried exergames. Out of these, four participants no longer play, and the most frequently playing participant only plays monthly. Participants were asked about their experiences with Pokémon GO. Only 4 participants had never tried Pokémon GO before. Three participants out of the 19 who tried it still play, and they all play daily.

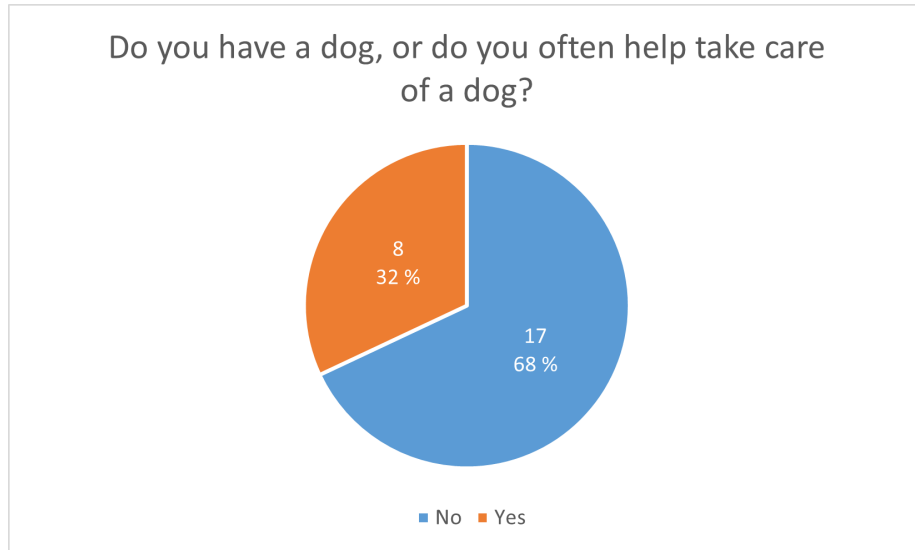


Figure 24.4: Distribution of dog owners or care-takers among participants in experiment and questionnaires.

The questions starting with Q22 ask the respondents "How often do you take the dog for these types of walks?"

ID	Question	N	HY	M	W	D
Q22a	Short walks (shorter than 15 minutes)?	12.5%	12.5%	37.5%	25%	12.5%
Q22a	Walks of around 15-60 minutes?	0%	0%	62.5%	37.5%	0%
Q22a	Walks longer than 60 minutes	0%	12.5%	75.0%	12.5%	0%

Table 24.1: Questions from Questionnaire Pre. N = Never, HY = Half-yearly, M = Monthly, W = Weekly, D = Daily.

24.2.4 Demographic: Interaction With Others

Both Questionnaire Pre and Questionnaire Post asked participants whether they agreed or disagreed with various statements about social interaction and whether they wished to improve their level of fitness or spend more time outdoors. Table 24.4 compares the responses to both questionnaires.

Only participants who had tested the app enough to answer questions about their experience with BitPet were given these statements in Questionnaire Post. Only 13 participants answered this part Questionnaire Post, down from 25 in Questionnaire Pre. This means that changes in how much participants agree or disagree could be due to which participants were missing in Questionnaire Post.

Table 24.2: Questions and answers from Questionnaire Pre about activity levels during the previous year. N = Never, HY = Half-yearly, M = Monthly, W = Weekly, MTW = Multiple Times a Week D = Daily

These questions ask you about your situation the last year.							
ID	Question	N	HY	M	W	MTW	D
Q6a	How often did you play video-games?	8.0%	32.0%	4.0%	16.0%	32.0%	8.0%
Q6b	How often have you been doing demanding physical activity in the shape of organized workouts or unorganized in the company of others (soccer, running, strength training etc.)?	24.0%	20.0%	12.0%	32.0%	12.0%	0%
Q6c	How often have you been in demanding physical activity alone?	12.0%	8.0%	24.0%	16.0%	40.0%	0%
Q6d	How often have you been doing low-intensity physical activity with others?	0%	0%	32.0%	40.0%	16.0%	12.0%
Q6e	How often have you been doing low-intensity physical activity alone?	4.0%	8.0%	4.0%	24.0%	36.0%	24.0%

Table 24.3: Questions from Questionnaire Pre about participants fitness level before and after the pandemic.

ID	Question	Bad	Slightly bad	Neutral	Good	Very good
Q7	How do you perceive your current level of fitness?	4.0%	20.0%	28.0%	44.0%	4.0%
Q9	How do you perceive your level of fitness prior to the pandemic?	4.0%	8.0%	28.0%	44.0%	16.0%

Some changes can be seen from Questionnaire Pre to Questionnaire Post. The first is that 10% less are positive towards being in physical activity with people they know (see statements S1c and S8c), and 10% more are positive towards being in physical activity with strangers (see Statements S1d and S8d). Secondly, statements S1f and S8f saw an increase in approval of talking with strangers from 36% to 61%. The last notable result is that 100% of the participants in Questionnaire Post wish to be more outdoors (S8K) up from 71% for Questionnaire Pre (S1k).

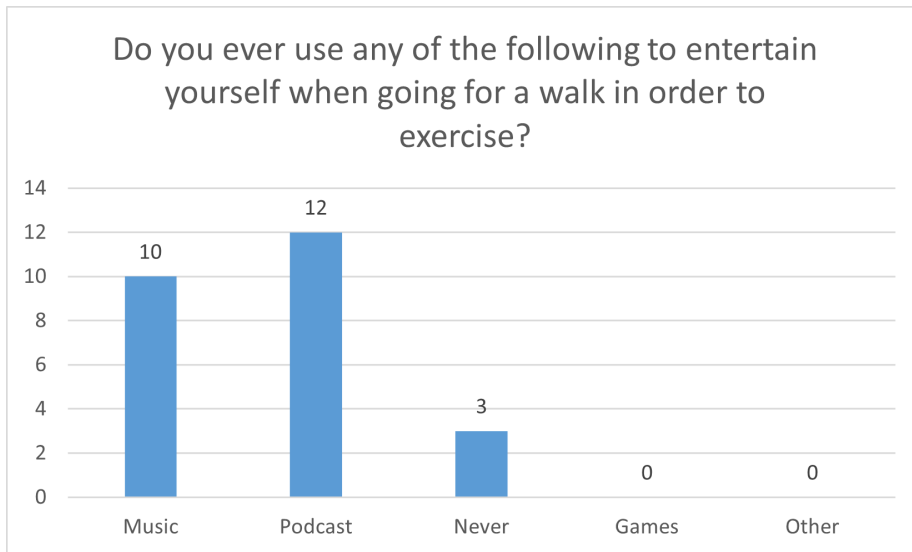


Figure 24.5: Respondents use these to entertain themselves when walking for exercise. The questionnaire accidentally had music listed twice.

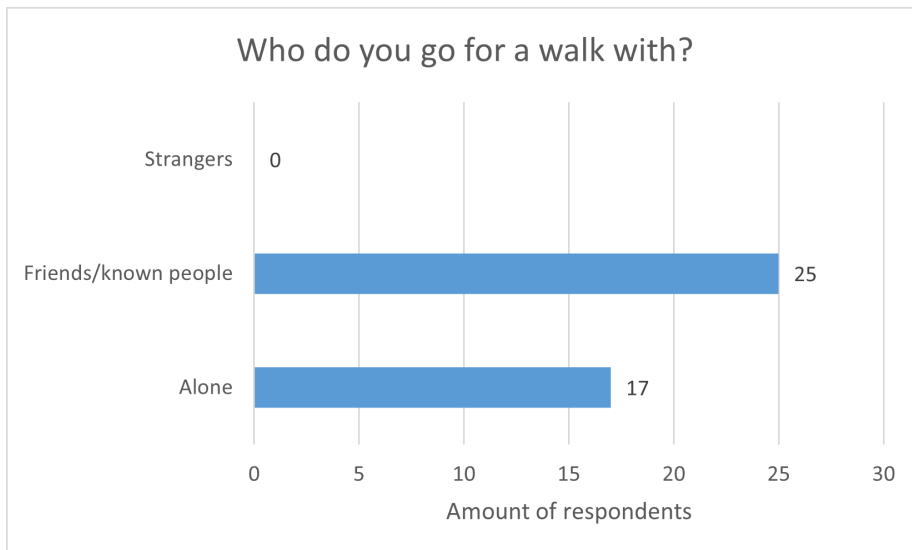


Figure 24.6: Shows who respondents go for a walk with. Respondents could choose multiple options.

Looking at the results that have stayed very much the same between the two questionnaires, one can see that the players are more positive towards interacting with friends than strangers. Even despite the drop that was mentioned from

Statement S1c to S8c.

It is also notable that half of the players would feel awkward playing a game like Pokemon GO (see Statement S1g) before the experiment and after the experiment. However, the neutral players changed to disagree with the statement in Questionnaire Post (see Statement S8g).

Table 24.4: Statements from both questionnaires compared. D = Disagree, N = Neutral, A = Agree.

ID	Statement	When	D	N	A
S1a	I like meeting people I know	Pre	4 %	0 %	96 %
S8a		Post	0 %	8 %	92 %
S1b	I like meeting people I don't know	Pre	28 %	24 %	48 %
S8b		Post	15 %	39 %	46 %
S1c	I like being in physical activity with friends or people I know	Pre	20 %	0 %	80 %
S8c		Post	8 %	23 %	69 %
S1d	I like being in physical activity with people I don't know	Pre	40 %	32 %	28 %
S8d		Post	46 %	15 %	39 %
S1e	I like to talk to people I know	Pre	4 %	0 %	96 %
S8e		Post	0 %	0 %	100 %
S1f	I like to talk to people I don't know	Pre	16 %	48 %	36 %
S8f		Post	8 %	31 %	61 %
S1g	If I played a mobile-phone game on the street, like Pokemon GO, I would feel strange/awkward	Pre	36 %	16 %	48 %
S8g		Post	54 %	0 %	46 %
S1h	I like to be social in big groups of people (such as concerts/festivals/markets)	Pre	12 %	32 %	56 %
S9h		Post	0 %	31 %	69 %
S1i	I like to be social in smaller groups of people (such as 1-5 people)	Pre	0 %	8 %	92 %
S8i		Post	0 %	0 %	100 %
S1j	I wish to improve my level of fitness	Pre	4 %	4 %	92 %
S8j		Post	8 %	0 %	92 %
S1k	I wish to be more outdoors	Pre	4 %	20 %	76 %
S8k		Post	0 %	0 %	100 %

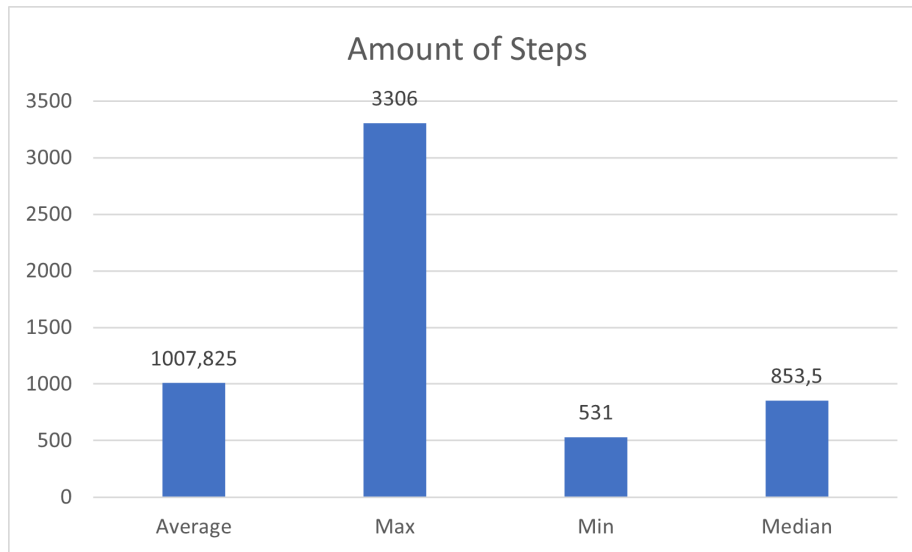


Figure 24.7: Amount of steps required for step-mission completion, the highest recorded (Max), lowest (Min), average, and median.

24.3 Missions

This section highlights the results gathered that are related to the mission feature in BitPet.

24.3.1 Experiment Data: Missions

This section highlights the data from the user testing experiment.

During the user testing experiment, 89 missions were created by users. Out of these, only 18 were completed. Out of the 89 missions created, 50 missions were location missions, and 39 were step-missions. The highest amount of steps required to complete a step-mission was 3306, the average was 1007.8, the lowest was 531, and the median was 853.5 (see Figure 24.7). Figure 24.8 displays all step-missions and their required steps for completion.

The game data showed that 18 unique users owned a mission, and five unique users completed a mission.

24.3.2 Questionnaire Post: Missions

Questionnaire Post shows that 7 participants tested the mission feature. This is different from the only 5 unique participants completed a mission (see Section 24.3.1).

Table 24.5 shows the statements and answers about missions from Questionnaire

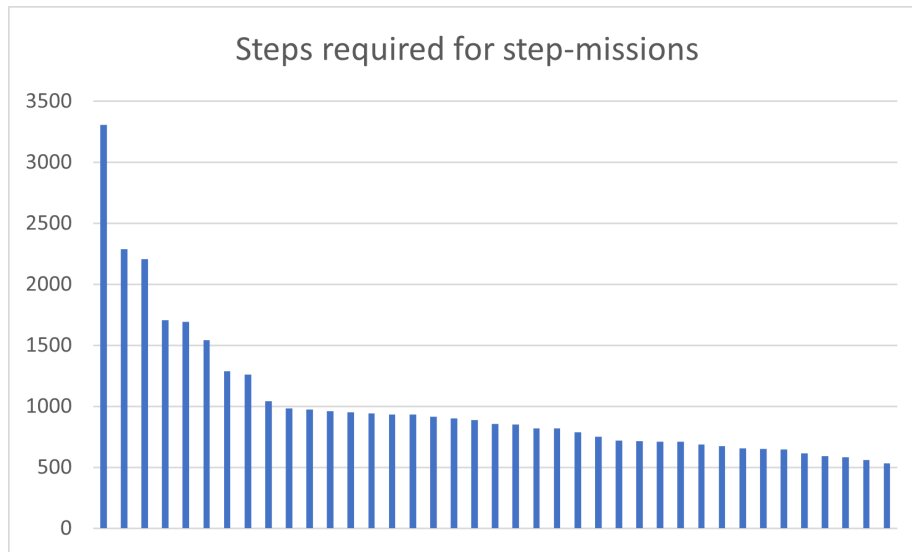


Figure 24.8: Amount of steps required for every created step mission, displayed from most to least. Every bar is one step-mission.

Post. Most players found the mission feature hard to understand. At the same time, players found the mission feature to be both fun and motivating to play BitPet. There was a slight preference for step-missions over location missions. Players were relatively pleased with the location of the mission destinations, and the rewards seemed to be perceived as balanced.

Only 4 participants out of 7 participants who tried the mission feature tested step missions. These four participants were given the statements seen in Table 24.6. The participants appeared to find the step-mission feature difficulty and reward very balanced.

24.3.3 Interviews: Missions

The interviews revealed some more information about what users thought about the mission feature. When asked if they felt like anything was missing in BitPet, one participant responded *“I missed having something to reach for. After covering the pets’ basic needs, I didn’t feel like there was anything to achieve. I would like to be able to get better stats for my pet or cosmetics after covering basic needs. That way, you could work a little extra to get a really cool pet. I think that would have motivated me to walk an extra trip. I like these features in Pokemon GO.”* Another responded *“I feel like there was not much to do in the game. Maybe I could have used the game in my hand when completing location missions, but I feel like there was not much to do when you only did step-missions. So maybe I didn’t get engaged with the game and thus found no interest in completing location-missions.”*

Table 24.5: Statements from Questionnaire Post about the mission feature. D = Disagree, N = Netural, A = Agree

ID	Statement	D	N	A
S4a	This mission feature was hard to understand	29%	0%	71%
S4b	This feature was fun	14%	29%	57%
S4c	This feature motivated me to play BitPet	14%	29%	57%
S4d	I was curious about what I would find at the target destination	57%	29%	14%
S4e	I liked the step-missions better than standard missions (location-missions)	14%	43%	43%
S4f	I liked the standard missions (location-missions) better than step-missions	43%	43%	14%
S4g	The locations I was supposed to walk to were boring places	43%	43%	14%
S4h	The locations I was supposed to walk to were unpractical	43%	29%	28%
S4i	I liked the destinations I was supposed to walk to	14%	43%	43%
S4j	The reward for standard missions (location) was too good	14%	71%	15%
S4k	The reward for standard-missions (location) was too poor	29%	71%	0%

Table 24.6: Statements from Questionnaire Post about the step-mission feature. D = Disagree, N = Netural, A = Agree

ID	Statement	D	N	A
S4a	Step-missions had too few steps in the beginning	50%	25%	25%
S4b	Step-missions had too many steps in the end	50%	50%	0%
S4c	Step-mission had a good progression in difficulty	0%	75%	25%
S4d	The reward for step-missions was too poor	25%	75%	0%
S4e	The reward for step-missions was too good	0%	100%	0%

The follow-up question *What about missions where you received special rewards such as cosmetics for walking to the target location, would this be of interest?* was responded with *“Yes, I did none of the location (standard) missions, I only did step-missions. They gave enough points. But if the location-missions gave other rewards such as cosmetics, I would have done them.”*

None of the interviewed participants had felt like working out when completing missions.

When asked if the mission texts were motivating, none of the interviewed participants responded that it was. At the same time, none of them said anything negative about the mission texts and the fantasy. Two were neutral and had

barely read them. While the last interviewed participant said *“If it was motivating me, I was not aware of it. I never did missions because of the text. But I liked the added “flavor” it gave to the game, they fit into the game and made sense in the game world.”*

One participant revealed that they might have felt like the mission feature was overwhelming as they responded with *“I actually had enough to do with the single-player mode. I was not afraid, but it was enough to do single-player and understand that.”* when asked why they had not played multiplayer missions. The same participant was asked if there was anything that was hard to understand in the game, to which they said *“At one point, I got a mission that only told me to walk, but I didn’t know there were two types of missions. It took a time before I understood this. I would have liked more information. I could have clicked help, but that is the last resort.”*, which might indicate that users have not understood the mission feature correctly.

24.4 Rewards

This section highlights the results related to rewards in BitPet.

24.4.1 Experiment Data: Rewards

Figure 24.9 shows the highest, lowest and average coin rewards for location missions. The highest was 82, the lowest 35, and the average was 64,7. Step-mission rewards can be seen in Figure 24.10. For step-missions, the highest reward was 21, lowest 7, and average 9,5.

24.4.2 Questionnaire Post: Rewards

Table 24.5 shows the participants responses to statements about the mission feature. From these players were very neutral to the statements S4j *The reward for standard missions (location) was too good* and S4k *The reward for standard-missions(location) was too poor*. Table 24.6 shows the responses to statements about step-missions. Statements S4d *The reward for step-missions was too poor* and S4e *The reward for step-missions was too good* both received very neutral responses. From the questionnaires, it seems players were not dissatisfied with the rewards.

24.4.3 Interviews: Rewards

No questions asked participants what they thought about the rewards, but some questions did uncover some opinions about them. When asking how hard it was to keep the pet alive, one participant responded with *“The steps I walked during a day was enough to give the pet enough stamina, and I received enough coins to buy a banana which was enough to keep the pet alive for the next day.”*, and another said *“I didn’t have to exert myself to keep them alive.”*

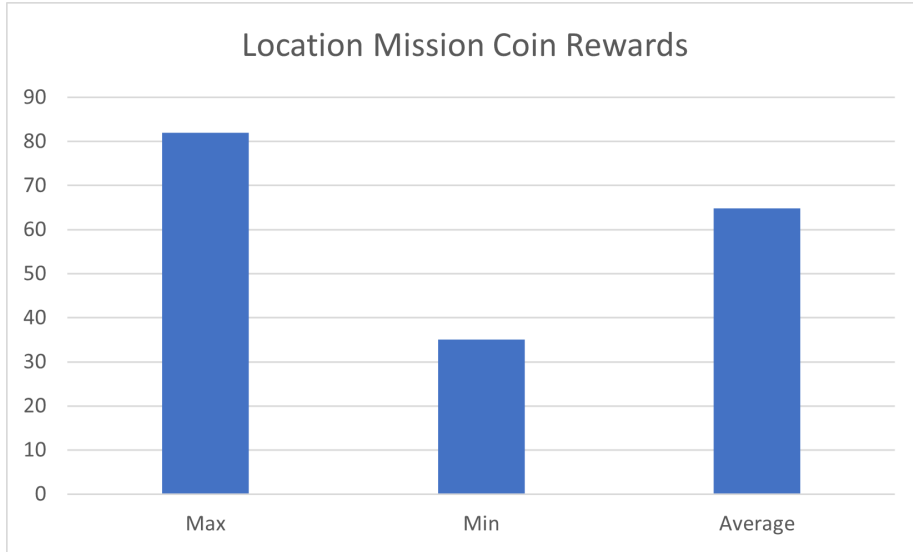


Figure 24.9: Highest (Max), lowest (Min) and average coin rewards for location missions.



Figure 24.10: Highest (Max), lowest (Min) and average coin rewards for step-missions.

When asked if the participants thought they started with too many coins, one said “*Yes. I could buy many pets in the beginning if I wanted to. I lost some motivation to play from the beginning.*”, and another said “*In the beginning, I think so. So yes, I would say yes. I bought the bear, and that used all my money. So after owning the bear, I didn’t have any coins. But I could have worked harder from the start to earn enough coins for buying the expensive pet.*”. The last interviewed participant said “*I never understood that. I just saw that I had many coins. If it was many or few, I had no reference of. Maybe I had a lot? I had no issues with coins.*”. The same participant had 302 000 coins, while all other participants had around 1000 coins, which was what players started with. The database showed the highest mission reward was 82 (see Section 24.4.1), which means there must have been a bug in the code that handles rewards. When asked how or when they received 302 000 coins, and if it was correct that they had that many coins, they responded “*I think so, it said that. But I don’t know how it appeared there.*”

One participant also suggested that cosmetic rewards could be a good reward and said the step-missions were good enough for coins: “*I did none of the location (standard) missions, I only did step-missions. They gave enough points. But if the location-missions gave other rewards such as cosmetics, I would have done them.*”

24.5 Pets

This section highlights the results gathered related to pets in BitPet.

24.5.1 Experiment Data: Pets

Figure 24.12 shows the distribution of pets and their status at the end of the experiment. In total, 48 pets were created in BitPet. At the end of the experiment, only six pets were alive. Figure 24.11 shows the pets’ cause of death. Twenty-one pets died of lack of happiness, three pets died from a lack of stamina, and only one pet died of hunger.

The 14 pets that had steps registered on them belonged to only eight owners.

24.5.2 Questionnaire Post: Pets

Out of the 13 participants who answered questions about their impression of the game, only three players managed to keep their pets alive the whole time. The players whose pets died were asked to agree or disagree with the statements in Table 24.7. Most players thought it was sad that their pet died, and almost everyone was either neutral or wanted to take better care of their next pet. Four out of the 10 participants lost some motivation to play BitPet when their pet died. No players were feeling helpless when their pet died.

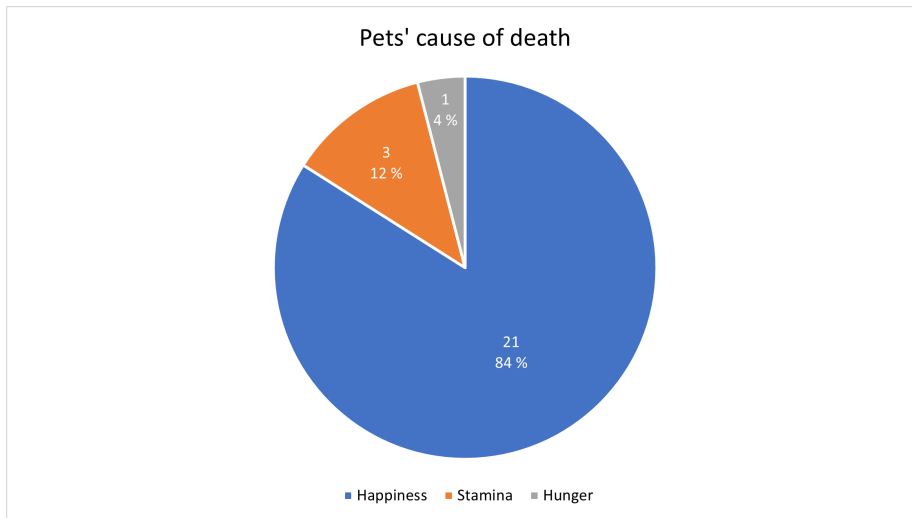


Figure 24.11: Pets' cause of death. 84% (21 pets) due to lack of happiness, 12% (3 pets), due to lack of stamina, and 4% (1 pet) due to hunger.

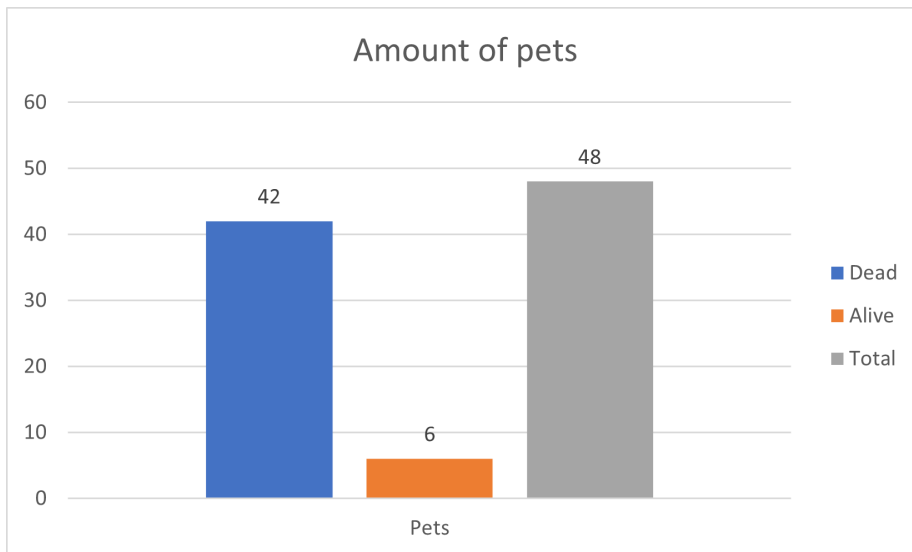


Figure 24.12: Amount of dead, alive and total pets at the end of the user testing experiment.

24.5.3 Interviews: Pets

Two of the interviewed participants were a little bit negative about the concept of pets. When asked what they thought of the concept, one said: *"It is not a*

Table 24.7: Statements from Questionnaire Post about pets. D = Disagree, N = Natural, A = Agree

ID	Statement	D	N	A
S3a	It was sad that my pet died	20%	20%	60%
S3b	When my pet died I it motivated me to take better care of my next pet	10%	20%	70%
S3c	When my pet died, it demotivated me to play BitPet	60%	0%	40%
S3d	When my pet died it made me feel helpless	50%	50%	0%

big point for me. It should have been taking care of myself. Now my cholesterol is increasing, and now I have worked out too little, now my fat percentage is increasing, etc. It would have been more exciting if I felt like I was taking care of myself. Having a pet was not very exciting.”, and another said: *“It has proven itself to work before with Tamagotchi and the likes, but I don’t think I am part of the target audience. You need a relationship with the pet, a bond, and I don’t feel like I had any bond with the pet since I just received it upon login. I felt no reason to try to keep it alive.”*. The last interviewed participant was not as negative, and actually found it a little bit interesting, but they pointed out that it was very easy to keep the pets alive: *“The minimum requirement to keep them alive was very easy. I didn’t have to exert myself to keep them alive.”*

The difficulty of keeping pets alive was revealed to be a problem for some users. Keeping the pet alive momentarily was very easy for all users, but one user said the game was too punishing when not being extremely consistent with the low effort needed in the first place. The same user suggested *“Now you have to log in once a day, or every other day, otherwise the pet will die. I think forgetting to visit the pet for a few days should not cause an irreversible consequence. It should rather hinder progress.”* Another user had the impression that the game was meant to be a pure exercise game, and as such, they thought three days of not visiting the app for exercise was adequate for punishing the user. This participant suggested goals for fitness and said *“If you didn’t reach such a goal three days in a row, then the sirens are calling. It has to be some regularity to the game; you just have to do something to support your health.”*. The last interviewed person thought logging in every day was completely fine, but they also said they were used to playing Pokémon GO daily.

All users thought push notifications for pets’ health status reaching critically low health would be a good improvement for the game.

24.6 Multiplayer Missions

This section highlights the collected data regarding multiplayer missions.

24.6.1 Experiment Data: Multiplayer Missions

During the experiment, only two multiplayer missions were created. Only one user was responsible for creating both of these missions. One other user joined one of these multiplayer missions. This means that in total, only two players were involved with multiplayer missions. The coin reward for these missions were 177 and 170 coins.

24.6.2 Questionnaire Post: Multiplayer Missions

Only one out of 13 participants who tested BitPet attempted to play multiplayer. Figure 24.13 shows what participants responded with when asked why they did not play multiplayer. The most common reason was *I found no one to play with*. A single participant chose *other* and also wrote the following when asked if they wanted to elaborate: *"I would have possibly played a multiplayer-mission if anyone I knew asked me to join one."*

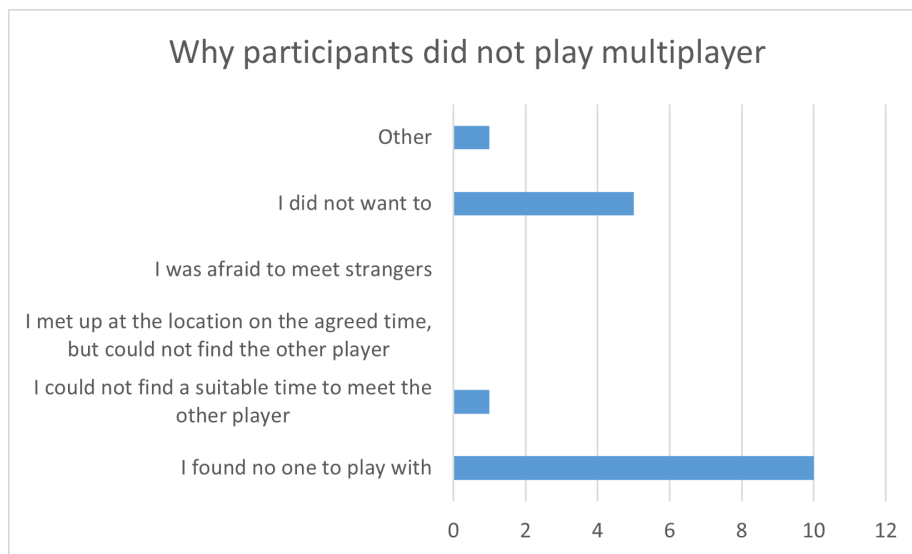


Figure 24.13: Reasons why players did not play multiplayer. Participants could pick multiple options. 13 participants answered in total.

24.6.3 Interviews: Multiplayer Missions

None of the interviewed participants had played multiplayer missions. When asked why one participant responded *"I didn't know whom to complete the missions with. I assume it is secret who the other user testers are, and I didn't think of a natural way to meet anyone."*. Another participant said *"I did not create any because I was afraid that something would automatically initiate a*

mission with someone else. I think I would have tried it if a friend asked me to try one. I didn't feel like trying out multiplayer missions alone, at least not after having played single-player missions.", while the last one said they had enough on their hands with the single-player missions.

All interviewed participants denied covid having any influence on their choice to avoid multiplayer missions.

When asked if a multiplayer mission that did not involve physically meeting other players, but perhaps simply be in the same area as them, would be more motivating to play, one response was that *"I don't think so. I think I would rather play with friends, or people around me."* A second response was *"Possibly, I don't really know how the multiplayer missions required in the first place. But after having heard you explain it now, I think I would not like to do that type of multiplayer. I would not like to physically meet the other player and talk to them. Maybe players could have to walk to the same location and interact with something on the location, but not with each other."*

One player suggested a this multiplayer feature for BitPet when asked if they could imagine a multiplayer feature they would have liked: *"Yes, perhaps if you walked past someone who also plays BitPet, then there could be some type of interaction between the pets. You could have a notification that told you that you met another player."* Another participant was asked if they would like this type of feature, to which the response was *"Yes that could have been fine."*

A different participant suggested adding a feature: *"You could have geo-caching, walking towards the same location, putting down an item for other players. Maybe you could put out food for other pets, and if other pets ate it, then you could also receive a reward or progress."*

All interviewed participants thought push notifications could be useful for multiplayer missions, such as being invited by a friend to complete a mission.

24.7 Log-in Streaks

This section highlights the results related to the log-in streak feature in BitPet.

24.7.1 Experiment Data: Log-in Streaks

During the experiment, the server was configured to overwrite current streaks whenever a streak was reset in BitPet. The result of this is that only players with a streak at the end of the experiment showed up with a streak at all in the database. Most players had a streak of 0 but could have possibly had a greater streak during the project. This poor configuration means there is only one result from the game data.

Figure 24.14 shows the number of players with a streak at the end of the project, which was 10. The highest streak recorded was four, and the lowest (non-zero) was 1. The average streak among all non-zero streaks was 2.3.

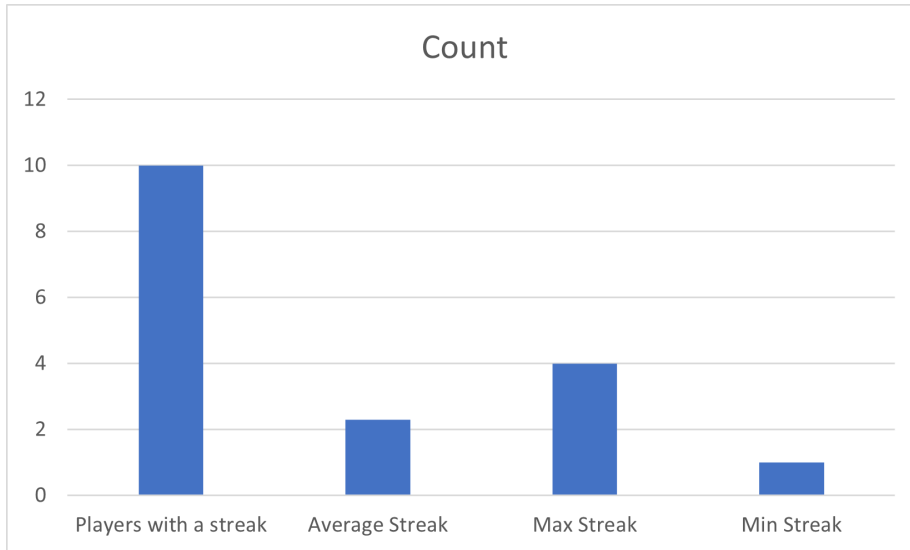


Figure 24.14: Amount of players with a streak (non-zero), and average, highest and lowest streak (of the non-zero streaks).

24.7.2 Questionnaire Post: Log-in Streaks

8 out of 13 players reported that they understood how the log-in streak worked. One player reported that it did not appear on their phone. Table 24.8 shows how the players perceived the log-in streak. Although almost all participants reported that they did not think much about the streak, a few (37%) were slightly motivated to keep playing BitPet because of the streak.

Table 24.8: Statements from Questionnaire Post about log-in streaks. D = Disagree, N = Netural, A = Agree

ID	Statement	D	N	A
S3a	Keeping the streak going was motivating me to play BitPet	63%	0%	37%
S3b	Keeping the streak going was stressful	75%	13%	13%
S3c	I did not really think much about the streak	0%	13%	87%

24.8 Steps

This section shows the step-data collected during the experiment. Since the logins of users were not tracked, the number of times steps were updated for users indicates how often the players logged into the game, as steps would only update when visiting the home screen.

Figure 24.15 shows how many times each user with steps recorded posted a step count to the database. The highest amount was 19 times, while the least was one time. Figure 24.16 shows how many steps were registered on each pet in the game. Most pets had zero steps recorded, but the highest amount of steps recorded was 150 984. This pet was created on day one and was alive at the end of the experiment.

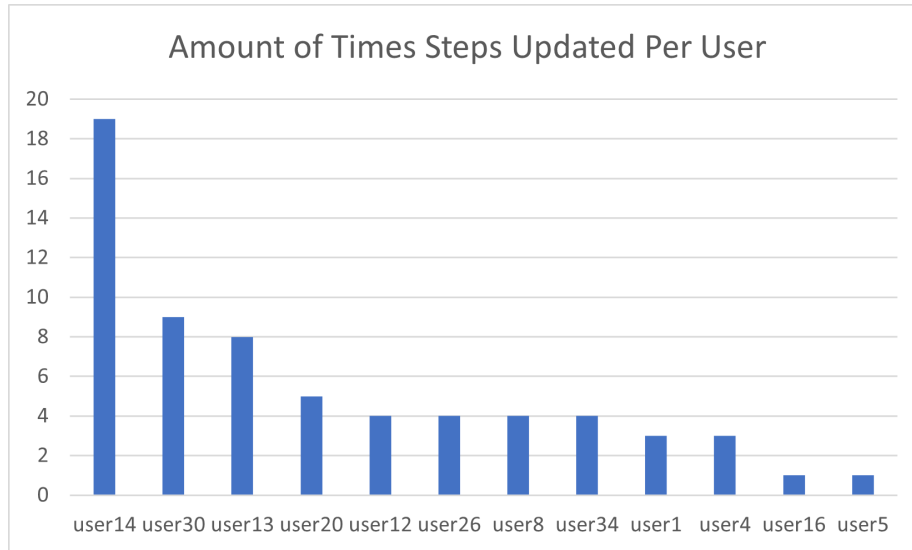


Figure 24.15: The amount of times steps walked was updated per user. Users with no updates are not included.

24.9 Questionnaire Post

This section presents the results from Questionnaire Post that has not yet been presented.

24.9.1 Questionnaire Post: Experiences from BitPet

Table 24.9 shows the participants' response to whether they agreed or disagreed with statements about their experience from playing BitPet. Some notable results are that only 30% of participants agreed with statement S2b *I was looking forward to going for a walk because I was going to play Bit-Pet*, 85% of participants disagreed with statement S2e *I wanted to go for a walk because I wanted to meet other players*, and 54% of the participants agreed to statement S2k *I cared about my pet* while 46% of the participants disagreed.

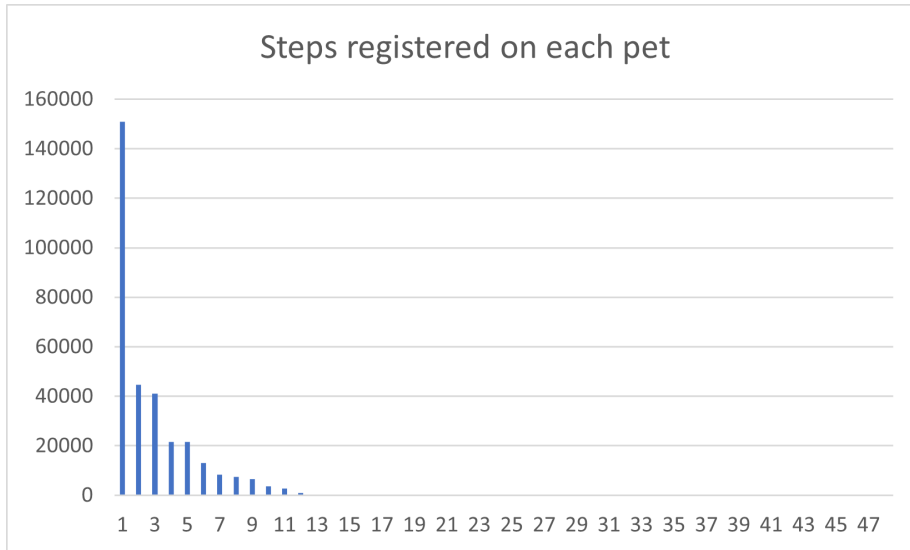


Figure 24.16: Amount of steps registered on each pet, 13 and out have zero steps. Numbers represent database ID of the pet.

Table 24.9: Statements from Questionnaire Post about experiences from BitPet. D = Disagree, N = Netural, A = Agree.

ID	Statement	D	N	A
S2a	Playing BitPet made me have fun	15%	39%	46%
S2b	I was looking forward to going for a walk because I was going to play BitPet	39%	31%	30%
S2c	I was looking forward to going for a walk because I was excited to discover what I would find in BitPet	39%	39%	22%
S2d	I wanted to go for a walk because my pet's well-being was important to me	31%	31%	38%
S2e	I wanted to go for a walk because I wanted to meet other players	85%	15%	0%
S2f	BitPet made me motivated to engage in physical activity	31%	39%	30%
S2g	BitPet made me go for more walks than I usually would	62%	15%	23%
S2h	BitPet made me go for walks for trips where I usually would have taken a car or public transport	77%	8%	15%
S2i	BitPet made me walk to areas I usually don't go to	38%	8%	54%

Continuation of Table 24.9				
ID	Statement	D	N	A
S2j	By playing BitPet I did not think about the fact that I was engaging in physical activity	15%	46%	39%
S2k	I cared about my pet	46%	0%	54%
S2l	I think it was awkward to play BitPet	69%	8%	23%
S2m	I think it was hard to play BitPet	46%	23%	31%
S2n	I think the walks in BitPet were too long	31%	62%	7%
S2o	I think the walks in BitPet were too short	8%	77%	15%
S2p	I got exhausted from playing BitPet	85%	15%	0%

24.10 Problems Reported

During the experiment, users could report issues. Three participants did report problems. Two of them had trouble with the step-counter. The final user reported that their app would crash whenever they opened the map. The same user reported that it worked when they were in one city but stopped working after moving to another city.

24.11 Feedback

Questionnaire Post had an open text answer where participants could give any comments about their experience of BitPet (see Table 24.10). Most participants left positive comments saying they believed the concept had good potential and that the design was nice. Some participants pointed out that they thought the goal was unclear and that the UI could be tricky to use. Participants seemed to miss a goal to strive for in the game.

24.12 Summary of Results

This chapter presented the game-data results from the experiment, the answers from Questionnaire Pre and Post, and the most relevant answers from the interviews. Notable results are that only a single player ever attempted to make a single-player mission into a multiplayer one. The participants prefer interaction, both physically and socially, with friends rather than strangers. 46%-48% of the players in questionnaires Pre and Post feel awkward playing exergames on smartphones on the street. The only significant change in the questionnaires from before the experiment to after was that players were more inclined to talk to strangers. However, the interviews and rest of the questionnaires and game data indicate that no such change in behavior has occurred. It is also important to note that the number of participants who answered Questionnaire Pre was 25, but only 13 participants tested the game enough to answer the questions about the game in Questionnaire Post.

Feedback #	Feedback
FB1	I had an impression that the game in itself was good, but it did not strike a chord with me and was not my type of game. Therefore I ended up playing very little, and I was not motivated to walk around just to achieve something in the game.
FB2	I experienced that I had to go outside to play. I opened the game, but I did not understand what I was supposed to do. So I thought I would look at it the next time I went for a walk, but I never did.
FB3	Would have been fun to try, but I felt a little silly with my phone more or less constantly up when out for a walk. I think it would be more motivating on days I didn't know where to walk. :)
FB4	Could become a good concept. Should be possible to use without always looking at the screen.
FB5	It was a cool concept, but it quickly became a little boring, and the mission UI was not optimal.
FB6	I got attached to the animals to some degree. I thought it was fun to have more than one animal, since I had to be a bit more active swapping pets. It was easy to keep the pets alive, so there could have been other bonuses to reach for (cosmetic items, stat boosts, etc.), in order to bother doing more than the bare minimum.
FB7	I wish one could get notifications so one was reminded to use the app and to take care of the pet.
FB8	I thought there was lacking motivation for me to join the game. I didn't really understand what the goal was in the game. Was it to have all the pets, and it was really easy to keep a single pet alive. It was really hard to keep many pets alive unless you played very actively.
FB9	Cool concept! I could not keep any pets alive, since I could not open the map, but the features I did test were cool (for instance being able to pet the pet).
FB10	I think it is a good idea, and it has potential. Some parts were hard to understand how worked.
FB11	I wish there was something like adventure sync and portrait mode.
FB12	I liked the design
FB13	I would have liked to play if the step-counter worked! Fun missions.
FB14	Nice/cute design on the characters.

Table 24.10: Feedback left by respondents of Questionnaire 2 when asked if they had any comments about their experience with BitPet.

Chapter 25

Discussion

This chapter discusses the results from Chapter 24.

25.1 BitPet as a Game

From the results it is clear that not all functional and non-functional requirements were fulfilled. Especially FR33 *The game must be able to register the player's steps.* and FR21 *The player must be able to complete missions* were not met for all players. It was mainly on iOS that these requirements were not met. No testing was performed on iOS prior to the experiment, so it did not come as a surprise that there would be some issues. NFR1 *The mission feature must be easy to understand* was not fulfilled for everyone. This is clear from the interviews and from the questionnaire were 71.4% of respondents agreed with the statement S4a *This mission feature was hard to understand.* NFR3 *Features must not make the app break* was also not met, as two players had the app repeatedly break whenever they opened the map. NFR6 *Players must not be required to play the game every day for pets not to die.* was not achieved on the first day of testing as the backend was configured in regards to how often pets' stats were depleted, but this was changed after the first day, and was achieved for the remaining 13 days of the experiment.

From the interviews and from the comments left at the end of Questionnaire Post, it is clear that many players lacked a clear goal. They said this made it less motivational to play the game, as they saw no point in playing. Everyone who was interviewed also felt that they started with too many coins, which might have contributed to the lack of clear goal, as it would be easy to keep the pet alive with food and minimal effort of walking. The participants did feel neutral about the rewards from the mission feature, which indicates that the balance of the rewards was good. The same applies for the difficulty of the missions in terms of distance required to walk.

Most participants were positive towards the concept of BitPet, this became clear

in the feedback left at the end of Questionnaire Post. In contrast, the interviews made it clear that not all of the participants actually think the concept of taking care of a pet is motivating to walk outdoors. Two of the three interviewed participants felt no attachment to the pet, but was more fixated on BitPet's potential as a tool for walking around outdoors and having missions or other features. Statement S2a in Questionnaire Post shows that 46.2% of the participants slightly agreed to having had fun when playing BitPet, while only 15.4% slightly disagreed. This might also be an indication that BitPet is a concept that has potential if the goal is made more clear, and the difficulty is more fine tuned, and bugs are fixed to make the game more reliable.

25.2 Interacting With Strangers

In Questionnaire Post, the most popular reason for not playing multiplayer missions was *I found no one to play with*. The second most popular reason (50% less popular) was *I did not want to*. Only one participant answered *Other* and *I could not find a suitable time to meet the other player*. From this it appears as though the main reason for players not playing multiplayer was the lack of having anyone to play with.

From the game data, it was revealed that only a single player ever decided to turn their single-player mission into a multiplayer mission. Albeit there was no explicit encouragement to actually make the missions multiplayer, it would be hard for players to not notice the options for multiplayer. This is because the UI consisted of two identical sets of buttons only differing in the colors, yellow and pink, and the words single-player and multiplayer. All players who played BitPet and was able to access the map screen without having BitPet crash, had checked out the single-player missions. The players also responded to the questionnaires that they had no one to play with, which indicates they did not know about the feature. From this it can be ruled out that the players were not unaware of the existence of multiplayer.

Only having one player trying to see what happens when one turns a single-player mission into a multiplayer mission could be a strong indication that there is a very high mental barrier preventing players from daring to risk being involved in meeting strangers for physical exergames. To support this theory, one of the interviewed participants also explicitly said that they were afraid creating a multiplayer mission would engage some sort of progress on a multiplayer mission with other players.

Questionnaire Pre and Questionnaire Post both asked players about their degree of agreement with statements about interacting with strangers and friends in the shape of talking and physical exercise (see Statements S8a to S8f, and S1a to S1f in Table 24.4). This table shows that the participants had a negative attitude towards being in physical activity with strangers, and it was considerably more negative than simply talking or meeting strangers. For physical activity with strangers 40% of the 25 participants in Questionnaire Pre were

either completely disagreeing or slightly disagreeing with statement S1d *I like to be in physical activity with people I don't know*, compared to only 16% for statement S1f *I like to talk to people I don't know*, and 28% for statement S1b *I like to meet people I don't know*.

The interviewed participants also said that they would prefer to play this type of game with friends, but had no interest in playing it with strangers, which supports the results from the statements in the questionnaires about interacting with others. Interestingly not a single participant among the 13 who tested BitPet chose the option *I was afraid to meet strangers* when asked why they did not play multiplayer. It could be that the participants did not want to admit to being afraid, as it could be seen as cowardly.

A very notable result from the same table mentioned above, Table 24.4, is the increase of players who agree with statements S1f and S8f. In Questionnaire Pre, only 36% of players agreed with the statement S1f *I like to talk to people I don't know*. After playing BitPet, this increased to 61% in Questionnaire Post's statement S8f. This data alone seems to indicate that BitPet has a positive effect on how players perceive talking with strangers. However, this seems very unlikely because no players interacted with other players in person during the entire experiment. The results are likely to come from the change in the number of respondents, or it could be coming from influence on the players' lives outside of the experiment.

25.3 BitPet's Effect on Players

Comparing the answers from Questionnaire Pre and Questionnaire Post, there is no significant difference between the players' opinions on interaction with strangers. The small changes that are recorded could simply be caused by the drastic drop in participation from Questionnaire Pre to Questionnaire Post. It dropped from 25 to only 13. When only seven participants tested the app thoroughly enough to have tried the mission feature it is hard to gauge how much of an effect it has had on the participants. Looking at the data collected from these 7 participants it appears that playing BitPet for a short period of time have had no effect.

25.4 Players' Perception of Digital Pets

Questionnaire Post asked players who's pet had died if it made them sad, if it motivated them to take better care of their next pet, and if it made them less motivated to play BitPet. 60% of participants who answered these questions agreed that it made them sad, and two participants were neutral. 7 players were motivated by their pet's death to take better care of the next pet. These results seem to indicate that the players did feel some connection with their digital pets. Having the pet die might have been a bit too harsh of a punishment, as four of the ten participants agreed that it made them less motivated to continue

playing. Questionnaire Post also asked players if they agreed with the statement S2k *I cared about my pet*, to which half of the participants agreed with the statement, and the other half disagreed. This indicates that the participants perception of the digital pets is very split. Interestingly no players had a neutral response to the statement. It should be kept in mind that the sample size of 10 participants is very small.

In the interviews two of the three interviewed participants had stated that they felt no connection with their pets what so ever, while the third did feel a connection. This could either mean that the two participants are simply not part of a potential target audience who could bond with a digital pet, or it could mean that the execution of how one takes care of the pets was not done correctly. One of the skeptical participants did admit that it could be possible that he would feel more attached to the pet if they were more involved in the creation of the pet, or making decisions on how it evolved.

If players don't feel any emotional connection to their digital pets it might be unlikely that they would be willing to step out of their comfort zone when it comes to engaging in social activity or physical activity in order to secure their pet's well-being.

The results from Questionnaire Post in regards to feeling sad when the pets died, half of the participants caring about the pet, and the excitement for the pets from the third and positive interviewed participant are still notable, and indicates that the concept of digital pets probably has merit.

25.5 Player's Feeling Awkward Playing Mobile Games on the Street

Half of the participants agreed with the statement S8l *I felt weird/awkward playing BitPet on the street*. This result is important as it shows that it could be BitPet's design that made players avoid playing multiplayer. Half of the players felt awkward walking around with their phone in public. If a player feels uncomfortable meeting a stranger in the first place, then there is a possibility the same player would be extra unlikely to voluntarily meet a stranger if they also had to play an exergame they felt awkward playing in the first place. This does not explain why the remaining half of players who either disagreed or strongly disagreed avoided multiplayer.

25.6 Summary of Discussion

In this chapter, the results from Chapter 24 were discussed. Participants in the experiment were positive towards BitPet as a game concept, but they felt it lacked purpose or a clear goal. The level of difficulty related to the physical activity was likely well balanced. However, having pets die when they have received too little care over a short period of time has proven to be too severe

of a punishment for some players. The combination of lacking a goal and too harsh punishment resulted in a game that was not motivating players to be more socially or physically active.

The players were very reluctant to engage in social interaction with strangers during the experiment. However, they expressed a wish to do so with friends, but the low number of participants made this impossible. Although the questionnaires seemed to indicate that players were more inclined to talk to strangers after playing BitPet, this is not very likely to result from playing BitPet. A longer experiment with more participants should be conducted to see if BitPet really is the cause.

Digital pets have motivated some players to play BitPet and to engage in both social and physical activity. Other players have seen no effect from these pets. The difference seems to come from the attachment players feel to their pets. More research on how to make players feel attached to their pets could be helpful for future experiments.

Chapter 26

Conclusion

The research goal for this project was defined as: *Investigate how a multiplayer exergame revolving around taking care of a digital pet can impact how players perceive socializing with friends and strangers, as well as how it can impact their physical activity.*

In Chapter 3 five research questions were presented.

RQ1: How do people perceive playing exergames with strangers?

With only a single participant choosing to try to make a mission multiplayer, and the questionnaire revealing that most players do not like engaging in physical activity with strangers, it seems prevalent that people do not want to or like playing exergames with strangers. The interviews supported these findings by revealing that they were only interested in playing with friends. Although the most popular answer, when asked why players did not play multiplayer, was "not finding anyone to play with," all other results from this study appear to point towards the players disliking physical activity and interaction with strangers.

RQ2: Will playing exergames make people more comfortable interacting with strangers?

Only two players in this study ever interacted with strangers, only by joining the same multiplayer mission. The two players never interacted beyond the act of joining the mission. Therefore, it is not possible to conclude whether or not playing exergames with strangers could make people more comfortable interacting with strangers. In this study, playing an exergame in single-player mode has not changed how the players perceive interacting with strangers. The study only lasted for two weeks and had very few participants. It is not possible to answer this question from this study.

RQ3: When given a choice, are people more inclined to play exergames with people they know rather than strangers?

The players participating in this study stated that they liked being in physical

activity with friends and disliked being in physical activity with strangers. The interviews revealed that some players would have enjoyed playing BitPet with friends, but they would not want to play it with strangers. Only a single player attempted to make a mission multiplayer, and only one player joined said multiplayer mission. Players are deemed to be much more likely to play exergames with people they know rather than strangers.

RQ4: Can taking care of a digital pet motivate people to be more physically active and socially active?

In order to motivate players to be more physically and socially active, there needs to be an emotional connection between the player and the pet. The questionnaires revealed that most players felt sad when their pets died, but the interviews also revealed that some players felt no connection with their pets. In addition to having a connection with the pet, it appears as though the players need another goal beyond simply taking care of the pet. In this study, the pet has not motivated players to be socially active at all. Players who did play actively kept revisiting the app and did walk enough steps to keep their pets alive. The same players reported that they had not increased their physical activity. Their already existing level of physical activity simply happened to be exactly what was needed to keep their pet alive. It cannot be said that the pet motivated players to be more physically active, but it does not rule out that it can be motivating if the required amount of physical activity is changed. To answer this question with greater certainty, a more extended testing period, with more participants and with a different level of difficulty, would be required. In addition, groups of friends should be recruited to investigate if the digital pet can increase the amount of social interaction players engage in with friends.

RQ5: Are people willing to overcome social anxiety to take care of their digital pet?

Players participating in this study reported in the questionnaire that they do not like engaging in physical activity with strangers. The same players were slightly more willing to talk with strangers but still not overly optimistic. No players ended up meeting other players in order to take care of their digital pet. Only one player created a multiplayer mission, and only one other player joined the same mission, but they never completed the mission or interacted with each other. The lack of emotional connection between players and their pets might be why players have not even considered engaging in multiplayer activities during this study. The questionnaire and interviews revealed that the degree of emotional connection varied from player to player. It is not clear from this study how much the strength of the emotional connection between the player and their pets matters to overcoming social anxiety. It must be noted that the experiment that was conducted during this study only lasted for two weeks and only had a few participants. An experiment that focuses on developing a stronger emotional bond between players and their pets could be necessary to answer this question.

BitPet with mission features for engaging in physical activity and social activity has received positive feedback. However, the game data and loss of interest among participants indicate that the version of BitPet developed for this study is not captivating enough to keep players motivated to play the game itself. In addition, this study has not found the game adequate to motivate players to engage in social interaction with strangers in any way, nor impact the way they perceive socializing with friends or strangers. It has shown that some players have very different bonds with their digital pets than others. With further development and research on developing stronger bonds between players and their pets, BitPet could unveil more of multiplayer exergames' potential for social and physical activity.

Chapter 27

Future Work

This chapter presents the further work that can be done on this project.

27.1 Changes to the Game

This section covers some changes that need to be done on the game before further research.

27.1.1 Bugfixes

With the lack of testing done before the experiment in this project, some serious bugs were existing in the code. The most prominent one was the step counter not working for most iOS users. Another bug was that some devices kept getting messages telling them the connection to BitPet had failed, even though it was working fine. This last bug was discovered during testing before the user test, but the cause was not found, and it was not very consistent.

27.1.2 A Clear Goal

From interviews, it was clear that users missed having a clear goal. This needs to be added to the game and is an integral part of game design principles. I suggest adding some information or a starting dialogue displayed for new users upon entering the game the first time. In addition, the goal should be surrounded by some fantasy that corresponds with the rest of BitPet. The goal should also explain why it needs to be achieved in the fantasy world and how it can be achieved by playing the game.

27.1.3 Difficulty and Rewards

The difficulty of the missions for the experiment during this project was not too difficult, which is good, but it could have been slightly harder to complete, as players reported that they did not have anything to reach for. I suggest adding

additional rewards besides the coins already existing. An example would be a cosmetic reward for the player's pet or achievements to unlock.

The difficulty of keeping the pets alive should also be looked into. I suggest making it easier to keep it alive and slowing down progress towards some bigger goal in BitPet whenever the pet's stats fall below a certain threshold.

27.1.4 Let Players Choose Locations

Players reported that some locations were less practical to walk to than others, and as such, would like to choose where their missions appeared. The current infrastructure using the Google Places API can easily be changed to support this type of feature. Instead of having the server select one location out of the list of around nine locations it receives from Google, it can present the list of locations to the player. The player could then select one location or even have the option of walking to any of the locations at any given time.

27.1.5 More Feedback

Players requested more feedback from interaction with the UI. I suggest adding small pop-up messages that inform the player of changes in the game state after interacting with the UI. A specific example that was requested is a feedback message after a mission marker has been planted. In addition, I suggest having the markers be planted automatically upon receiving missions.

27.1.6 Build a Stronger Emotional Bond between Players and Pets

Players reported not feeling any connection with their pets or that their pets did not matter to them. The same players suggested that taking part in creating the pet or having it develop more from one's own actions could help build a stronger bond with the pets.

I suggest adding a phase where the user shapes or forms the animal more, instead of just buying the animal to make a stronger bond with the pet. Perhaps players could even go looking for pets and catch them or tame them. Understanding how to build a bond between players and digital pets could even be a topic for a research project of its own.

27.2 Another Experiment with More Participants

This project's experiment had very few participants, and many lost interest during the experiment or experienced bugs that prevented them from taking part. I suggest running a new experiment with some of the suggested changes to the game from this chapter and recruiting more participants to test.

27.3 Scrapped Ideas

This section presents some ideas that were brainstormed for the mission feature but was not implemented due to lack of time for the project.

27.3.1 AR Interaction to Complete Missions

Initially, multiplayer missions were supposed to require the user to interact with other users within AR in order to complete missions. Lack of experience with 3D graphics and AR development caused this part of the mission feature to be scrapped as it would not be possible to develop within the project's timeframe.

27.3.2 Multistep-Missions

Multistep-missions were supposed to be missions that were gradually completed. In practice, it would be a series of GPS locations the user would have to reach, but they would only know about one location at a time. At every newly reached location, the following location would be revealed. The missions would be surrounded by fantasy to immerse the user in the BitPet world. This multistep mission was only scrapped due to a lack of development time.

27.3.3 Fantasy

This section presents some ideas that were considered to become a part of the game but did not make the cut due to restricted time for development.

In order to engage players, it is important to create a fantasy for the game. For this feature, three different fantasies are proposed: missing pet, traveling salesman, and mystical creature.

The **missing pet** fantasy is built around missing a pet in real life. In a typical scenario, someone will report their pet missing, either through social media or by posting a notice about it on noticeboards or in public places. This fantasy can be used in the game in a way where the mission to walk to a place is presented as a missing pet poster, where the pet was last seen on location X. The location will be shown on an actual map in the game, and the player can choose to walk there in real life and then find the pet in this location. By finding the pet, they can receive a reward that was stated on the missing poster. To further build on this fantasy, one can let one's own pet smell the area and find a trail of the missing pet that leads to a new location. This could then lead the player on a treasure trail until they finally find the missing pet for the final reward. To even further allow the player to feel engaged in this fantasy, it could be their own pet that is missing, and they have to go look for it.

The traveling salesman fantasy is based on temporary markets that show up in a city's marketplace. In this fantasy, the player will be notified about a market or a salesman that has set up shop on location X. If the player walks there, they will be given a free reward and the possibility of purchasing some items for a

special price, or some items that are only available at this special shop whenever it shows up.

The mystical creature feature is based on fairytales of special creatures. In this fantasy, the player is presented with a rumor about a mystical creature that has been spotted at location X. This could be in a newspaper article that shows up on the screen. If the player walks to this location, they can find the mystical creature and receive a reward, perhaps even capture the mystical creature or some reward that alters their pet's appearance.

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Appendices

Appendix A

Prestudy Appendix

A.1 Prensky Design Elements

1. Games are a form of fun	That gives us <i>enjoyment and pleasure</i>
2. Games are form of play	That gives us <i>intense and passionate involvement</i>
3. Games have rules	That gives us <i>structure</i>
4. Games have goals	That gives us <i>motivation</i>
5. Games are interactive	That gives us <i>doing</i>
6. Games are adaptive	That gives us <i>flow</i>
7. Games have outcomes and feedback	That gives us <i>learning</i>
8. Games have win states	That gives us <i>ego gratification</i>
9. Games have conflict / competition / challenge / opposition	That gives us <i>adrenaline</i>
10. Games have problem solving	That sparks our <i>creativity</i>
11. Games have interaction	That gives us <i>social groups</i>
12. Games have representation and story	That gives us <i>emotion</i>

Table A.1: Prensky's twelve elements important for making video games the most engaging pastime activity [6]

Six game design elements "found in every successful game throughout history" from magazine *Next Generation*

1. Good game design is balanced. Balance leaves the player feeling that the game is challenging but fair, and neither too hard nor too easy at any point.

2. Good game design is creative. Creative here is the opposite of formulaic. Good games are not merely clones of other games, but add something original.
3. Good game design is focused. Focus is figuring out what is fun about your game and giving the player as much of it as possible, without distraction.
4. Good game design has character. It's a game's depth and richness. Both the character and the characters in a game, if fully developed, are what is memorable.
5. Good game design has tension. Every good game does it in its own way. The classic way is to make the player care about the goal of the game, and then make it hard to achieve.
6. Good game design has energy. This comes from things like movement, momentum and pacing. The game's energy is what keeps you playing all night or rejuvenates you after a hard day.

Prensky highlights 11 game design elements by Falstein [6]. Here is a compressed version of them:

1. A Clear Overall Vision
2. A Constant Focus on the Player Experience
3. A Strong Structure
4. Highly adaptive - fun for a variety of players
5. Easy to learn, hard to master
6. Stays within the "flow state"
7. Provides frequent rewards, not penalties
8. Includes Exploration and Discovery
9. Provides mutual assistance - thing helps solve another
10. Has an interface that is very useful
11. Includes the ability to save progress

Prensky lists these elements as the language of video games, things one can expect to find in video games [6]:

1. All things can and should be clicked on (actually, this is more subtle, with what is or isn't clickable often indicated by very small design elements.)
2. You "build" things by clicking on a icon and dragging it to where you want it.

3. You move people by selecting them and clicking where you want them to go.
4. There are hidden combinations of keys that do interesting things.
5. There are hidden surprises, commonly known as “Easter Eggs,” for you to find.
6. There’s almost always more than one way to do something.
7. You many have to try something many times before it works.
8. There are almost always “cheats” or ways to get around something. These codes, which at the origin were ways for programmers and testers to get further ahead in the game, are coveted and passed from player to player and even reported in magazines.
9. Games can always be saved and reloaded later.
10. Games are “fair.” They don’t kill you off without giving you a chance and they don’t require resources you cannot get (although surviving or finding the resources may not be easy).

A.2 GameFlow

Table A.2: GameFlow Criteria for Player Enjoyment in Games - table from [9]

Element	Criteria
<p>Concentration Games should require concentration and the player should be able to concentrate on the game</p>	<ul style="list-style-type: none"> – games should provide a lot of stimuli from different sources – games must provide stimuli that are worth attending to – games should quickly grab the players’ attention and maintain their focus throughout the game – players shouldn’t be burdened with tasks that don’t feel important – games should have a high workload, while still being appropriate for the players’ perceptual, cognitive, and memory limits – players should not be distracted from tasks that they want or need to concentrate on

Continuation of Table A.2	
Element	Criteria
<p>Challenge Games should be sufficiently challenging and match the player's skill level</p>	<ul style="list-style-type: none"> - challenges in games must match the players' skill levels - games should provide different levels of challenge for different players - the level of challenge should increase as the player progresses through the game and increases their skill level - games should provide new challenges at an appropriate pace
<p>Player Skills Games must support player skill development and mastery</p>	<ul style="list-style-type: none"> - players should be able to start playing the game without reading the manual - learning the game should not be boring, but be part of the fun - games should include online help so players don't need to exit the game - players should be taught to play the game through tutorials or initial levels that feel like playing the game - games should increase the players' skills at an appropriate pace as they progress through the game - players should be rewarded appropriately for their effort and skill development - game interfaces and mechanics should be easy to learn and use

Continuation of Table A.2	
Element	Criteria
<p>Control Players should feel a sense of control over their actions in the game</p>	<ul style="list-style-type: none"> – players should feel a sense of control over their characters or units and their movements and interactions in the game world – players should feel a sense of control over the game interface and input devices – players should feel a sense of control over the game shell (starting, stopping, saving, etc.) – players should not be able to make errors that are detrimental to the game and should be supported in recovering from errors – players should feel a sense of control and impact onto the game world (like their actions matter and they are shaping the game world) – players should feel a sense of control over the actions that they take and the strategies that they use and that they are free to play the game the way that they want (not simply discovering actions and strategies planned by the game developers)
<p>Clear Goals Games should provide the player with clear goals at appropriate times</p>	<ul style="list-style-type: none"> – overriding goals should be clear and presented early – intermediate goals should be clear and presented at appropriate times
<p>Feedback Players must receive appropriate feedback at appropriate times</p>	<ul style="list-style-type: none"> – players should receive feedback on progress toward their goals – players should receive immediate feedback on their actions – players should always know their status or score

Continuation of Table A.2	
Element	Criteria
<p>Immersion Players should experience deep but effortless involvement in the game</p>	<ul style="list-style-type: none"> - players should become less aware of their surroundings - players should become less self-aware and less worried about everyday life or self - players should experience an altered sense of time - players should feel emotionally involved in the game - players should feel viscerally involved in the game
<p>Social Interaction Games should support and create opportunities for social interaction</p>	<ul style="list-style-type: none"> - games should support competition and cooperation between players - games should support social interaction between players (chat, etc.) - games should support social communities inside and outside the game

A.3 Reward systems

Eight reward systems proposed by Wang et al. [15].

1. Score systems - players gain points to keep score.
2. Experience point reward systems - often enhances the playable avatar, this makes it a facility type of reward. Rarely used for player ranking as it is often tied to amount of time invested rather than skill. It often locks content or gameplay until a high enough level needed to play the content is achieved.
3. Item granting systems - Virtual items that can be used by players or avatars. Encourages exploring and maintain interest during dull periods of play. Rare items can create a lot of interest among players.
4. Resources - can be collected and used to affect gameplay. Examples are life counts in Super Mario Bros, or gold in MMORPGs. Differs from items in that they are mainly for practical game use, no social comparison value or collection value.
5. Achievements - these systems usually consists of titles that can be bound to avatars upon competing tasks or clearly stated conditions. Classified as

glory, many players gain a sense of achievement by unlocking these type of rewards.

6. Feedback messages - instant rewards for successful actions. It can be a word flashing on the screen such as "perfect" when hitting a dance move perfectly in rhythm dance games. Pictures and sound effects can be used as well. They don't directly affect gameplay and disappear after a short time. Their value is the sense of praise they evoke. It can affect human emotions and behaviors. Immediate rewards are a central concern of flow theorists.
7. Plot animations and pictures - rewards after important events in video games to motivate further play. They are visually attractive and milestones that mark player achievements.
8. Unlocking mechanisms - this gives players access to game content. This is classified as access, and is often tied to the experience points system. It is thought to maintain player curiosity about what might be available in future play. It is a reinforcement for good performance but also an environment in support of an "ongoing learning principle".

A.4 Bartle's Specific Advice for Altering Player Balance

These lists are presented as found in [4]:

Ways to emphasise PLAYERS over WORLD:

- add more communication facilities
- add more player-on-player commands (eg. transitive ones like TICKLE or CONGRATULATE, or commands to form and maintain closed groups of personae)
- make communication facilities easy and intuitive
- decrease the size of the world
- increase the connectivity between rooms
- maximise the number of simultaneous players
- restrict building privileges to a select few
- cut down on the number of mobiles

Ways to emphasise WORLD over PLAYERS:

- have only basic communication facilities

- have few ways that players can do things to other players
- make building facilities easy and intuitive
- maximise the size of the world (ie. add breadth)
- use only "rational" room connections in most cases
- grant building privileges to many
- have lots of mobiles

Ways to emphasise INTERACTING over ACTING:

- make help facilities produce vague information
- produce cryptic hints when players appear stuck
- maximise the effects of commands (ie. add depth)
- lower the rewards for achievement
- have only a shallow level/class system
- produce amusing responses for amusing commands
- edit all room descriptions for consistent atmosphere
- limit the number of commands available in any one area
- have lots of small puzzles that can be solved easily
- allow builders to add completely new commands

Ways to emphasise ACTING over INTERACTING:

- provide a game manual
- include auto-map facilities
- include auto-log facilities
- raise the rewards for achievement
- have an extensive level/class system
- make commands be applicable wherever they might reasonably have meaning
- have large puzzles, that take over an hour to complete
- have many commands relating to fights
- only allow building by top-quality builders

Appendix B

Questionnaire Pre: Norwegian

Bitpet spørreundersøkelse

Dette er en spørreundersøkelse som skal besvares før testperioden av BitPet.

* Obligatorisk

Introduksjon og samtykke

Takk for at du har valgt å svare på denne spørreundersøkelsen.

I spørsmål 2 i denne delen av undersøkelsen viser jeg til informasjonsskrivet om innsamling og oppbevaring av data. Dette skrivet fikk du tilsendt i e-posten knyttet til din interesse om å delta i prosjektet. Dette skrivet ble også sendt ut i e-posten med lenken til denne spørreundersøkelsen. Du kan når som helst velge å avslutte å svare på denne undersøkelsen, og du kan når som helst i løpet av prosjektet gi beskjed om at du ønsker å trekke deg fra prosjektet. Da vil all data lagret om deg bli slettet.

1. Hvilken anonym ID (tall) fikk du tilsendt på e-post? *

Verdien må være et tall

2. Jeg har mottatt og forstått informasjon om prosjektet "BitPet" , og har fått anledning til å stille spørsmål. Jeg samtykker til: *

å delta i spørreundersøkelser og brukertest

å delta i intervju

å delta i observasjon

3. Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet *

Ja

Nei

Demografisk informasjon

4. Hvor gammel er du? *

Verdien må være et tall

5. Hvilket kjønn er du? *

- Mann
- Kvinne
- Annet
- Ønsker ikke å oppgi

Disse spørsmålene spør om situasjonen din det siste året.

Eksempler på rolig fysisk aktivitet: (gåtur/sykle rolig til jobb eller butikk etc., eller annen aktivitet hvor du ikke blir sliten eller andpusten).

Krevende fysisk aktivitet: Du blir sliten / svett / andpusten

6. Disse spørsmålene dreier seg om det siste året. *

	Aldri	Halvårlig	Månedlig	Ukentlig	Flere dager i uken	Hver dag
Hvor ofte har du spilt dataspill?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte har du vært i krevende fysisk aktivitet i form av organisert trening eller uorganisert sammen med andre (fotball, løpetrening, felles styrketrening etc.)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte har du vært i krevende fysisk aktivitet alene?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte har du vært i rolig fysisk aktivitet sammen med andre?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte har du vært i rolig fysisk aktivitet alene?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. Hvordan anser du din nåværende fysiske form? *

Dårlig	Litt dårlig	Nøytral	God	Veldig god
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Før pandemien

Her kommer de samme spørsmålene men de dreier seg om tiden før pandemien. Disse spørsmålene stilles fordi mange kan ha endret vanene sine under pandemien:

8. Disse spørsmålene dreier seg om FØR pandemien *

	Aldri	Halvårlig	Månedlig	Ukentlig	Flere dager i uken	Hver dag
Hvor ofte spilte du dataspill?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte var du i krevende fysisk aktivitet i form av organisert trening eller uorganisert sammen med andre (fotball, løpetrening, felles styrketrening etc.)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte var du i krevende fysisk aktivitet alene?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte var du i rolig fysisk aktivitet sammen med andre?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvor ofte var du i rolig fysisk aktivitet alene?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. Hvordan anser du din fysiske form slik den var før pandemien? *

Dårlig	Litt dårlig	Nøytral	God	Veldig god
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Påstander

Her kommer noen påstander hvor du skal svare hvor mye påstanden stemmer for deg eller ikke.

10. Disse påstandene handler om dine tanker og følelser rundt det å treffe andre mennesker *

	Helt uenig	litt uenig	verken eller	litt enig	helt enig
Jeg liker å møte mennesker jeg kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å møte mennesker jeg IKKE kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være i fysisk aktivitet sammen med venner / bekjente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være i fysisk aktivitet sammen med mennesker jeg IKKE kjenner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å snakke med mennesker jeg kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å snakke med mennesker jeg IKKE kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvis jeg hadde spilt et mobilspill på gaten som Pokemon Go ville jeg følt meg rar	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være sosial i store folkegrupper (f.eks. som ved konsert/festival/marked på torg)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være sosial med få personer av gangen (f.eks 1-5 personer)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg ønsker å bli i bedre form	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg ønsker å være mer utendørs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Her kommer noen spørsmål om Pokémon GO

11. Har du spilt Pokémon GO? *

Ja

Nei

12. Spiller du fortsatt Pokémon GO? *

Ja

Nei

13. Hvor ofte spiller du Pokémon GO? *

Halvårlig eller sjeldnere

Månedlig

Ukentlig

Daglig

Erfaringer

Her kommer noen spørsmål om noen av dine erfaringer og vaner rundt det å gå tur (i mark og rusletur i by).

14. Hvis du går tur, går du da alene eller med andre? *

- Alene
- Med venner/bekjente
- Med ukjente

15. Hvis du går tur pleier du å ha et formål med turen? *

- Ja
- Noen ganger
- Sjeldent
- Nei

16. Hender det at du går tur med det formål å være i fysisk aktivitet? *

- Ja
- Noen ganger
- Sjeldent
- Nei

17. Hvis du går tur med formål å være i fysisk aktivitet, underholder du deg på noen måte?

*

- musikk
- musikk
- podcast
- spill
- annet
- aldri

18. Vil du utdype "annet"?

19. Har du spilt treningsspill/exergames? *

- Ja
- Nei

20. Hvor ofte spiller du treningsspill/exergames? *

- Spiller ikke lengre
- Årlig
- Halvårlig
- Månedlig
- Ukentlig
- Daglig

21. Har du hund, eller hjelper du ofte noen å ta vare på en hund? *

Ja

Nei

22. Hvor ofte går du følgende turer med hunden? *

	Aldri	Halvårlig	Månedlig	Ukentlig	Daglig
korte turer (mindre enn 15 minutter)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
turet på mellom 15-60 minutter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
turet lengre enn 60 minutter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

23. Har du noen ytterligere kommentarer til undersøkelsen?

Appendix C

Questionnaire Pre: English

Table C.1: Questions from questionnaire 1 translated to English

Q# or S#	Type of Answer	Required	Question	Options
Q1	Enter text	Yes	Which anonymous ID (number) did you receive on e-mail?	None
Q2	Multiple Choice	Yes	I have received and understood the information about the "BitPet" project. I have had the opportunity to ask questions. I agree to:	<input type="checkbox"/> Participate in questionnaires and user test <input type="checkbox"/> Participate in interviews <input type="checkbox"/> Participate in observations
Q3	Radio Button / Single choice	Yes	I accept that my information will be kept and used until the end of the project.	<ul style="list-style-type: none"> • Yes • No
Q4	Enter text	Yes	How old are you?	None
Q5	Radio Button / Single choice	Yes	How old are you?	<ul style="list-style-type: none"> • Man • Woman • Other • Do not wish to answer

Continuation of Table C.1				
Q# or S#	Type of Answer	Required	Question	Options
Q6			The questions starting with Q6 ask about the respondents situation during the last year	All questions starting with Q6 have the following options: <ul style="list-style-type: none"> • Never • Once every half-year • Monthly • Weekly • Multiple days a week • Every day
Q6a	Radio Button / Single choice	Yes	How often have you played video-games?	See Q6
Q6b	Radio Button / Single choice	Yes	How often have you been doing demanding physical activity in the shape of organized workouts or unorganized in the company of others (soccer, running, strength training etc.)	See Q6
Q6c	Radio Button / Single choice	Yes	How often have you been in demanding physical activity alone?	See Q6
Q6d	Radio Button / Single choice	Yes	How often have you been doing low-intensity physical activity with others?	See Q6
Q6e	Radio Button / Single choice	Yes	How often have you been doing low-intensity physical activity alone?	See Q6

Continuation of Table C.1				
Q# or S#	Type of Answer	Required	Question	Options
Q7	Radio Button / Single choice	Yes	How do you perceive your current level of fitness?	<ul style="list-style-type: none"> • Poor • A little poor • Neutral • Good • Very good
Q8			The questions starting with Q8 ask about the respondents situation prior to the pandemic	<p>All questions starting with Q8 have the following options:</p> <ul style="list-style-type: none"> • Never • Once every half-year • Monthly • Weekly • Multiple days a week • Every day
Q8a	Radio Button / Single choice	Yes	How often have you played video-games?	See Q8
Q8b	Radio Button / Single choice	Yes	How often have you been doing demanding physical activity in the shape of organized workouts or unorganized in the company of others (soccer, running, strength training etc.)	See Q8
Q8c	Radio Button / Single choice	Yes	How often have you been in demanding physical activity alone?	See Q8

Continuation of Table C.1				
Q# or S#	Type of Answer	Required	Question	Options
Q8d	Radio Button / Single choice	Yes	How often have you been doing low-intensity physical activity with others?	See Q8
Q8e	Radio Button / Single choice	Yes	How often have you been doing low-intensity physical activity alone?	See Q8
Q9	Radio Button / Single choice	Yes	How do you perceive your level of fitness prior to the pandemic?	<ul style="list-style-type: none"> • Poor • A little poor • Neutral • Good • Very good
S1			The statements starting with S1 ask the respondents to answer to which degree they agree or disagree with the statement	<p>All statements starting with S1 have the following options:</p> <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree
S1a	Radio Button / Single choice	Yes	I like meeting people I know	See S1
S1b	Radio Button / Single choice	Yes	I like meeting people I don't know	See S1

Continuation of Table C.1				
Q# or S#	Type of Answer	Required	Question	Options
S1c	Radio Button / Single choice	Yes	I like being in physical activity with friends or people I know	See S1
S1d	Radio Button / Single choice	Yes	I like being in physical activity with people I don't know	See S1
S1e	Radio Button / Single choice	Yes	I like to talk to people I know	See S1
S1f	Radio Button / Single choice	Yes	I like to talk to people I don't know	See S1
S1g	Radio Button / Single choice	Yes	If I played a mobile-phone game on the street, like Pokemon GO, I would feel strange/awkward	See S1
S1h	Radio Button / Single choice	Yes	I like to be social in big groups of people (such as concerts/festivals/markets)	See S1
S1i	Radio Button / Single choice	Yes	I like to be social in smaller groups of people (such as 1-5 people)	See S1
S1j	Radio Button / Single choice	Yes	I wish to improve my level of fitness	See S1
S1k	Radio Button / Single choice	Yes	I wish to be more outdoors	See S1
Q10	Radio Button / Single choice	Yes	Have you played Pokemon GO?	<ul style="list-style-type: none"> • Yes • No
Q11	Radio Button / Single choice	Yes	Do you still play Pokemon GO?	<ul style="list-style-type: none"> • Yes • No

Continuation of Table C.1				
Q# or S#	Type of Answer	Required	Question	Options
Q12	Radio Button / Single choice	Yes	How often do you play Pokemon GO?	<ul style="list-style-type: none"> • Once every half year or rarer • Monthly • Weekly • Daily
Q13	Multiple Choice	Yes	If you go for a walk, do you usually walk alone or with others?	<input type="checkbox"/> Alone <input type="checkbox"/> With friends/people I know <input type="checkbox"/> With strangers
Q14	Radio Button / Single choice	Yes	If you go for a walk, do you usually have a specific reason for walking?	<ul style="list-style-type: none"> • Yes • Some times • Rarely • No
Q15	Radio Button / Single choice	Yes	Do you ever go for a walk in order to exercise?	<ul style="list-style-type: none"> • Yes • Some times • Rarely • No

Continuation of Table C.1				
Q# or S#	Type of Answer	Required	Question	Options
Q16	Radio Button / Single choice	Yes	Do you every use any of the following to entertain yourself when going for a walk in order to exercise?	<ul style="list-style-type: none"> • Music • Music • Podcast • Games • Other • Never
Q17	Enter text	No	Would you like to specify "other"?	None
Q18	Radio Button / Single choice	Yes	Have you every played exergames?	<ul style="list-style-type: none"> • Yes • No
Q19	Radio Button / Single choice	Yes	How often do you play exergames?	<ul style="list-style-type: none"> • Yearly • Every half year • Monthly • Weekly • Daily • I no longer play
Q20	Radio Button / Single choice	Yes	Do you have a dog, or do you often help take care of a dog?	<ul style="list-style-type: none"> • Yes • No

Continuation of Table C.1				
Q# or S#	Type of Answer	Required	Question	Options
Q21			The questions starting with Q22 ask the respondents "How often do you take the dog for these types of walks?"	All questions starting with Q22 have the following options: <ul style="list-style-type: none"> • Never • Every half year • Monthly • Weekly • Daily
Q21a	Radio Button / Single choice	Yes	Short walks (shorter than 15 minutes)	See Q22
Q21b	Radio Button / Single choice	Yes	Walks of around 15-60 minutes	See Q22
Q21c	Radio Button / Single choice	Yes	Walks longer than 60 minutes	See Q22
Q22	Enter Text	No	Do you have any comments about the questionnaire?	None

Appendix D

Questionnaire Post: Norwegian

BitPet spørreundersøkelse 2

Takk for at du har valgt å svare på denne spørreundersøkelsen.

Denne undersøkelsen inneholder maksimalt 25 spørsmål, hvor noen av dem er en samling påstander du må ta stilling til. Avhengig av hvilke svar du gir kan det hende du får færre enn 25 spørsmål.

Undersøkelsen vil ta trolig ta ca. ca 7-12 minutter å svare på.

Dette er spørreundersøkelse 2 som skal besvares etter brukertest av BitPet. Hvis du ikke har fått testet BitPet kan du likevel svare på denne brukerundersøkelsen. Det vil i så tilfelle gå veldig raskt ettersom du bare vil bli stilt noen få spørsmål.

* Obligatorisk

Del 1 av 11

Her samler jeg inn litt informasjon om selve gjennomføringen av testen

1

Hvilken anonym ID (tall) fikk du tilsendt på e-post? *

Verdien må være et tall

2

Testet du BitPet på iOS eller Android? *

iOS

Android

3

Hvilken telefon testet du BitPet på? (F.eks iPhone 8, eller Samsung A70) *

4

Fikk du testet BitPet? Noen brukere opplevde feil som gjorde at de ikke kunne spille BitPet. *

- Ja
- Delvis - nok til å svare på spørsmål om opplevelsen
- Nei
- Delvis - men ikke nok til å svare på spørsmål om opplevelsen

5

Hvor mange ganger trente du i løpet av testperioden? *

Verdien må være et tall

6

Hvor mange ganger gikk du på tur i løpet av testperioden? *

Verdien må være et tall

7

Hvor mange ganger gikk du på tur i løpet av testperioden for å sosialisere med noen? *

Verdien må være et tall

8

Hvor mange ganger gikk du på tur i løpet av testperioden fordi du ville spille BitPet? *

Verdien må være et tall

9

På hvor mange turer som du ville ha gjennomført til vanlig spilte du BitPet? (som f.eks handletur / transport til jobb/universitet) *

Verdien må være et tall

De neste spørsmålene handler om sosialisering med andre mennesker mens du spilte BitPet.

Del 2 av 11

10

Spilte du BitPet samtidig som du var sammen med noen du kjenner? *

- Ja
- Nei

11

Spilte du BitPet sammen med noen du ikke kjente fra før? (dette inkluderer å møte noen ute som spilte BitPet) *

- Ja
- Nei

12

*

Veldig ukomfortabel litt ukomfortabel verken eller komfortabel Veldig komfortabel

Hvor komfortabel var du med å snakke med og spille med personen?

13

Hvor mange ganger møtte du ukjente spillere? *

Verdien må være et tall

14

Var du mer komfortabel med å spille med en fremmed etter siste gang enn første gang? *

- Jeg var mer komfortabel med å møte en fremmed
- Uendret
- Jeg var mindre komfortabel med å møte en fremmed

De neste spørsmålene er påstander hvor du skal svare hvor mye påstanden stemmer eller ikke

Del 3 av 11

Hvor godt stemmer følgende påstander om BitPet for deg? *

	Helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
Å spille BitPet gjorde at jeg hadde det gøy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg så fram til å gå tur fordi jeg skulle spille BitPet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg så frem til å gå tur fordi jeg var spent på hva jeg kom til å finne i BitPet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg hadde lyst til å gå tur fordi jeg ville at dyret mitt skulle ha det bra	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg hadde lyst til å gå tur fordi jeg kunne møte andre spillere	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BitPet gjorde at jeg var motivert til å være i fysisk aktivitet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BitPet gjorde at jeg gikk flere turer enn jeg ville gjort til vanlig	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BitPet gjorde at jeg gikk turer hvor jeg til vanlig ville tatt bil eller kollektiv transport.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BitPet gjorde at jeg gikk til steder jeg ellers ikke pleier å gå.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ved å spille BitPet tenkte jeg ikke over at jeg var i fysisk aktivitet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
Jeg brydde meg om dyret mitt	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg syntes det var flaut å spille BitPet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg syntes det var vanskelig å spille BitPet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg syntes gåturene i BitPet ble for lange	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg syntes gåturene i BitPet var for korte	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg ble sliten av å spille BitPet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Daily streak (Del 4 / 11)

Denne delen handler om funksjonaliteten "Daily streak". Det er et aspekt i spillet hvor et tall øker for hver dag man logger på spillet på rad. Se bilde.



16

Forstod du at denne funksjonen fungerte ved at tallet gikk opp for hver dag du logget inn på rad? *

- Ja
- Nei
- Denne funksjonen var ikke tilgjengelig hos meg

Hvor godt stemmer følgende påstander? *

	Helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
Å holde streaken gående var motiverende til å spille BitPet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Å holde streaken gående var stressende	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg tenkte ikke noe særlig over streaken	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Oppdrag (Del 5 / 11)

De neste spørsmålene dreier seg om oppdragsfunksjonen i BitPet. I BitPet var det steps-missions og lokasjons-missions (Standard-missions). Steps Mission gikk ut på å gå x antall skritt for å klare oppdraget. Standardmissions /lokasjons-missions gikk ut på å gå til en gitt destinasjon.



18

Fikk du testet oppdrag (ikke flerspiller / multiplayer oppdrag)? *

- Ja
- Nei

Hvor godt stemmer følgende påstander? *

	Helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
Oppdragsfunksjonen var vanskelig å forstå	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Denne funksjonen var gøy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Denne funksjonen gjorde meg motivert til å spille BitPet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg var nysgjerrig på hva jeg kom til å finne ved måldestinasjonen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg likte steps mission bedre enn standard-missions (lokasjons-mission)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg likte standard-missions (lokasjon) bedre enn steps missions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lokasjonene jeg skulle gå til var på kjedelige steder	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lokasjonene jeg skulle gå til var på upraktiske steder	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg likte lokasjonene jeg skulle gå til	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Premien for standard-missions (lokasjon) var for bra	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Premien for standard-missions (lokasjon) var for dårlig	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Steps missions (Del 6/11)

Denne delen inneholder noen påstander om steps-missions. Steps missions fungerte slik at det første missionet på en gitt dag ville være et relativt lavt antall skritt. Deretter ville det stige ved hvert steps mission man fullførte.

20

Fikk du prøvd steps-missions? *

Ja

Nei

21

Hvor godt synes du følgende påstander stemmer om steps-missions? *

	helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
steps missions hadde for få skritt i starten	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
steps missions hadde for mange skritt i slutten	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
steps mission hadde en god progresjon i vanskelighetsgrad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
premien for steps-missions var for dårlig	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
premien for steps missions var for god	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Multiplayer Missions (Del 7/11)

Denne delen handler om multiplayer missions

22

Prøvde du å spille multiplayer missions? *

- Ja
- Nei

23

Gjennomførte du noen multiplayer missions? *

- Ja
- Nei

Hvor godt synes du følgende påstander stemmer om multiplayer missions? *

	helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
Multiplayer missions var skumle	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Multiplayer missions var vanskelig å forstå	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Multiplayer missions hadde gode premier	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Multiplayer missions hadde gode mål- destinasjoner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Multiplayer missions var gøy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg var spent på hva premien kom til å bli	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Hvorfor spilte du ikke, eller fullførte du ikke multiplayer missions? (Flere svar er tillatt)

*

- Jeg fant ingen å spille med
- Jeg klarte ikke å avtale et tidspunkt med noen
- Jeg møtte opp til avtalt tid, men jeg fant ikke den andre spilleren
- Jeg var redd for å møte ukjente spillere
- Jeg hadde ikke lyst
- Annet

Vil du utdype svaret over? (Frivillig)

Kjæledyr i BitPet (Del 8/11)

De neste spørsmålene handler om kjæledyret du hadde i BitPet

27

Døde et av kjæledyrene dine i BitPet? *

- Ja
- Nei

28

Hvordan passer følgende påstander for deg? *

	Helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
Det var trist at kjæledyret mitt døde	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At kjæledyret mitt døde gjorde meg motivert til å ta bedre vare på det neste kjæledyret	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At kjæledyret mitt døde gjorde meg mindre motivert til å spille BitPet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At kjæledyret mitt døde gav meg en følelse av hjelpeløshet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Å treffe andre mennesker (Del 9/11)

Nå kommer det noen påstander som du svarte på i spørreundersøkelse nummer 1. Her ønsker jeg å se om folks tanker har endret seg etter å ha spilt BitPet.

Disse påstandene handler om dine tanker og følelser rundt det å treffe andre mennesker: *

	Helt uenig	litt uenig	verken enig eller uenig	litt enig	helt enig
Jeg liker å møte mennesker jeg kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å møte mennesker jeg IKKE kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være i fysisk aktivitet sammen med venner / bekjente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være i fysisk aktivitet sammen med mennesker jeg IKKE kjenner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å snakke med mennesker jeg kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å snakke med mennesker jeg IKKE kjenner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hvis jeg spilte et mobilspill på gaten som Pokemon Go ville jeg følt meg rar	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være sosial i store folkegrupper (f.eks. som ved konsert/festival/marked på torg)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg liker å være sosial med få personer av gangen (f.eks 1-5 personer)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jeg ønsker å bli i bedre form	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Helt uenig

litt uenig

verken enig
eller uenig

litt enig

helt enig

Jeg ønsker å være mer
utendørs

Jeg følte meg rar når
jeg spilte BitPet på
gaten

Feil i BitPet (Del 10/11)

30

Opplvde du noen feil eller problemer under testingen av BitPet? (F.eks problemer med å klare oppdrag, eller at appen kræsjet, eller ikke oppførte seg som du forventet).



Kommentarer til BitPet og undersøkelsen (Del 11/11)

Helt på tampen, har du noe du vil tilføye? Ellers vil takke deg for tiden og for at du hjalp meg med mitt mastergradsprosjekt! Vennlig hilsen Tobias.

31

Har du noen ytterligere kommentarer om hvordan du opplevde å spille BitPet?
(Frivillig)

32

Har du noen ytterligere kommentarer til undersøkelsen? (Frivillig)

Appendix E

Questionnaire Post: English

Table E.1: Questions from questionnaire 1 translated to English

Q#	Type of Answer	Required	Question	Options
Q23	Enter text	Yes	Which anonymous ID (number) did you receive on e-mail?	None
Q24	Radio Button / Single choice	Yes	Did you test BitPet on iOS or Android?	<ul style="list-style-type: none"> • iOS • Android
Q25	Enter text	Yes	Which phone did you test BitPet on? (Example: iPhone 8, or Samsung A70)	None
Q26	Radio Button / Single choice	Yes	Did you get to test BitPet? (Some users experienced errors that made it impossible to play BitPet)	<ul style="list-style-type: none"> • Yes • Partly - enough to answer questions about the experience • No • Partly - but not enough to answer questions about the experience
Q27	Enter text choice	Yes	How many times did you train during the test period?	None
Q28	Enter text choice	Yes	How many times did you go for a walk during the test period?	None
Q29	Enter text choice	Yes	How many times did you go for a walk during the test period with the intention of socializing with someone?	None

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
Q30	Enter text choice	Yes	How many times did you go for a walk during the test period because you wanted to play BitPet?	None
Q31	Enter text choice	Yes	How many times did you go for a walk playing BitPet on walks you would have carried out usually as well (Example: shopping trip, transport to work or university)	None
Q32	Radio Button / Single choice	Yes	Did you play BitPet while being in company with anyone you know?	<ul style="list-style-type: none"> • Yes • No
Q33	Radio Button / Single choice	Yes	Did you play BitPet while being in company with someone you didn't already know (a stranger)? (This includes meeting someone playing BitPet)	<ul style="list-style-type: none"> • Yes • No
Q34	Radio Button / Single choice	Yes	How comfortable did you feel about talking and playing BitPet with the stranger?	<ul style="list-style-type: none"> • Very uncomfortable • Slightly uncomfortable • Neither comfortable nor uncomfortable • Comfortable • Very Comfortable

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
Q35	Enter text choice	Yes	How many times did you meet unknown players?	None
Q36	Radio Button / Single choice	Yes	Did you feel more comfortable playing with a stranger the last time you met a stranger than the first time you met a stranger?	<ul style="list-style-type: none"> • I was more comfortable meeting a stranger • Unchanged • I was less comfortable meeting a stranger
S2			The statements starting with S2 ask the respondents to answer to which degree they agree or disagree with the statement	<p>All statements starting with S2 have the following options:</p> <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree
S2a	Radio Button / Single choice	Yes	Playing BitPet made me have fun	See S2
S2b	Radio Button / Single choice	Yes	I was looking forward to going for a walk because I was going to play BitPet	See S2
S2c	Radio Button / Single choice	Yes	I was looking forward to going for a walk because I was excited to discover what I would find in BitPet	See S2

Continuation of Table E.1

Q#	Type of Answer	Required	Question	Options
S2d	Radio Button / Single choice	Yes	I wanted to go for a walk because my pet's well-being was important to me	See S2
S2e	Radio Button / Single choice	Yes	I wanted to go for a walk because I wanted to meet other players	See S2
S2f	Radio Button / Single choice	Yes	BitPet made me motivated to engage in physical activity	See S2
S2g	Radio Button / Single choice	Yes	BitPet made me go for more walks than I usually would	See S2
S2h	Radio Button / Single choice	Yes	BitPet made me go for walks for trips where I usually would have taken a car or public transport	See S2
S2i	Radio Button / Single choice	Yes	BitPet made me walk to areas I usually don't go to	See S2
S2j	Radio Button / Single choice	Yes	By playing BitPet I did not think about the fact that I was engaging in physical activity	See S2
S2k	Radio Button / Single choice	Yes	I cared about my pet	See S2
S2l	Radio Button / Single choice	Yes	I think it was awkward to play BitPet	See S2
S2m	Radio Button / Single choice	Yes	I think it was hard to play BitPet	See S2
S2n	Radio Button / Single choice	Yes	I think the walks in BitPet were too long	See S2
S2o	Radio Button / Single choice	Yes	I think the walks in BitPet were too short	See S2

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
S2p	Radio Button / Single choice	Yes	I got exhausted from playing BitPet	See S2
Q37	Radio Button / Single choice	Yes	Did you understand that this function worked by increasing the number every time you logged in on consecutive days?	<ul style="list-style-type: none"> • Yes • No • This function was not available for me
S3			The statements starting with S3 ask the respondents to answer to which degree they agree or disagree with the statement	<p>All statements starting with S3 have the following options:</p> <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree
S3a	Radio Button / Single choice	Yes	Keeping the streak going was motivating me to play BitPet	See S3
S3b	Radio Button / Single choice	Yes	Keeping the streak going was stressful	See S3
S3c	Radio Button / Single choice	Yes	I did not really think much about the streak	See S3
Q38	Radio Button / Single choice	Yes	Did you test the mission features (not multiplayer missions)?	<ul style="list-style-type: none"> • Yes • No

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
S4			The statements starting with S4 ask the respondents to answer to which degree they agree or disagree with the statement about mission features (standard-mission /location mission)	All statements starting with S4 have the following options: <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree
S4a	Radio Button / Single choice	Yes	This mission feature was hard to understand	See S4
S4b	Radio Button / Single choice	Yes	This feature was fun	See S4
S4c	Radio Button / Single choice	Yes	This feature motivated me to play BitPet	See S4
S4d	Radio Button / Single choice	Yes	I was curious about what I would find at the target destination	See S4
S4e	Radio Button / Single choice	Yes	I liked the step-missions better than standard missions (location-missions)	See S4
S4f	Radio Button / Single choice	Yes	I liked the standard missions (location-missions) better than step-missions	See S4
S4g	Radio Button / Single choice	Yes	The locations I was supposed to walk to were boring places	See S4
S4h	Radio Button / Single choice	Yes	The locations I was supposed to walk to were unpractical	See S4

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
S4i	Radio Button / Single choice	Yes	I liked the destinations I was supposed to walk to	See S4
S4j	Radio Button / Single choice	Yes	The reward for standard missions (location) was too good	See S4
S4k	Radio Button / Single choice	Yes	The reward for standard-missions (location) was too poor	See S4
Q39	Radio Button / Single choice	Yes	Did you get to try the step-mission feature?	<ul style="list-style-type: none"> • Yes • No
S5			The statements starting with S5 ask the respondents to answer to which degree they agree or disagree with the statement about step-mission feature	<p>All statements starting with S5 have the following options:</p> <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree
S5a	Radio Button / Single choice	Yes	step-missions had too few steps in the beginning	See S5
S5b	Radio Button / Single choice	Yes	step-missions had too many steps in the end	See S5
S5c	Radio Button / Single choice	Yes	step-mission had a good progression in difficulty	See S5
S5d	Radio Button / Single choice	Yes	the reward for step-missions was too poor	See S5

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
S5e	Radio Button / Single choice	Yes	the reward for step-missions was too good	See S5
Q40	Radio Button / Single choice	Yes	Did you try multiplayer missions?	<ul style="list-style-type: none"> • Yes • No
Q41	Radio Button / Single choice	Yes	Did you finish any multiplayer missions?	<ul style="list-style-type: none"> • Yes • No
S6			The statements starting with S6 ask the respondents to answer to which degree they agree or disagree with the statement about multiplayer-mission feature	<p>All statements starting with S6 have the following options:</p> <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree
S6a	Radio Button / Single choice	Yes	Multiplayer missions were scary	See S6
S6b	Radio Button / Single choice	Yes	Multiplayer missions were hard to understand	See S6
S6c	Radio Button / Single choice	Yes	Multiplayer missions had good rewards	See S6
S6d	Radio Button / Single choice	Yes	Multiplayer missions had good target locations	See S6

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
S6e	Radio Button / Single choice	Yes	Multiplayer missions were fun	See S6
S6f	Radio Button / Single choice	Yes	I was excited to know what the reward would be	See S6
Q42	Multiple Choice	Yes	Why did you not play, or complete any multiplayer missions?	<input type="checkbox"/> I did not find anyone to play with <input type="checkbox"/> I could not agree to a meeting time with anyone <input type="checkbox"/> I showed up at the agreed-upon time but I was unable to find the other player <input type="checkbox"/> I was afraid of meeting unknown players <input type="checkbox"/> I did not want to <input type="checkbox"/> Other
Q43	Enter text	No	Would you like to explain your answer above?	None
Q44	Radio Button / Single choice	Yes	Did any of your pets in BitPet die?	<ul style="list-style-type: none"> • Yes • No

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
S7			The statements starting with S7 ask the respondents to answer to which degree they agree or disagree with the statement	All statements starting with S7 have the following options: <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree
S7a	Radio Button / Single choice	Yes	It was sad that my pet died	See S7
S7b	Radio Button / Single choice	Yes	When my pet died I it motivated me to take better care of my next pet	See S7
S7c	Radio Button / Single choice	Yes	When my pet died, it demotivated me to play BitPet	See S7
S7d	Radio Button / Single choice	Yes	When my pet died it made me feel helpless	See S7
S8			The statements starting with S8 ask the respondents to answer to which degree they agree or disagree with the statement	All statements starting with S8 have the following options: <ul style="list-style-type: none"> • Completely disagree • Slightly disagree • Neither agree nor disagree • Slightly agree • Completely agree

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
S8a	Radio Button / Single choice	Yes	I like meeting people I know	See S8
S8b	Radio Button / Single choice	Yes	I like meeting people I don't know	See S8
S8c	Radio Button / Single choice	Yes	I like being in physical activity with friends or people I know	See S8
S8d	Radio Button / Single choice	Yes	I like being in physical activity with people I don't know	See S8
S8e	Radio Button / Single choice	Yes	I like to talk to people I know	See S8
S8f	Radio Button / Single choice	Yes	I like to talk to people I don't know	See S8
S8g	Radio Button / Single choice	Yes	If I played a mobile-phone game on the street, like Pokemon GO, I would feel strange/awkward	See S8
S8h	Radio Button / Single choice	Yes	I like to be social in big groups of people (such as concerts/festivals/markets)	See S8
S8i	Radio Button / Single choice	Yes	I like to be social in smaller groups of people (such as 1-5 people)	See S8
S8j	Radio Button / Single choice	Yes	I wish to improve my level of fitness	See S8
S8k	Radio Button / Single choice	Yes	I wish to be more outdoors	See S8
S8l	Radio Button / Single choice	Yes	I felt weird/awkward playing BitPet on the street	See S8

Continuation of Table E.1				
Q#	Type of Answer	Required	Question	Options
Q45	Enter text	No	Did you experience any errors or problems during the testing of BitPet? (For instance, issues with completing missions, the crashing or not behaving as expected)	None
Q46	Enter text	No	Do you have any comments about your experience playing BitPet?	None
Q47	Enter text	No	Do you have any comments about this questionnaire?	None

Appendix F

Information About Data Collection

Vil du delta i forskningsprosjektet

AR mobile game to promote physical and social activity

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å undersøke hvordan mobilspill med AR basert på fysisk aktivitet påvirker motivasjon til fysisk og sosial aktivitet. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Formålet med prosjektet er å undersøke hvordan et mobilspill som benytter AR teknologi og baserer seg på gåturer som fysisk aktivitet kan påvirke motivasjonen til å være i fysisk aktivitet samt hvordan det påvirker sosial aktivitet og holdninger knyttet til sosial aktivitet.

Prosjektet inngår i en masteroppgave ved NTNU, og spillet som brukes til prosjektet er et spill under utvikling som heter BitPet.

Etter prosjektet kan det hende at resultatene vil bli brukt til videre forskning, men all personidentifiserende data vil slettes etter dette prosjektet er over. Kun ikke-identifiserbare data vil bli tatt vare på.

Hvem er ansvarlig for forskningsprosjektet?

Institutt for datateknologi og informatikk er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?

Utvalget til dette prosjektet er ikke spesialisert. Hvem som helst kan få være med på prosjektet så lenge de er over 18 år og myndig. Du har blitt spurt om å delta fordi du enten kjenner noen som jobber med prosjektet, eller noen andre som deltar i prosjektet, eller fordi du har hørt om dette prosjektet på noen måte og selv tok kontakt med prosjektansvarlig for å delta.

Hva innebærer det for deg å delta?

Å delta innebærer i minste grad å svare på to spørreskjema og en brukertest av spillet som vil gå over to uker. Spørreskjemaene vil bli besvart elektronisk og vil kunne ta opp til 30-45 minutter å svare på. Spørsmålene vil dreie seg om vaner rundt fysisk og sosial aktivitet, samt hvordan du opplevde å bruke spillet.

Det kan hende du blir spurt om å stille til intervju eller observasjon i forbindelse med gjennomføringen av brukertesting, men det er ikke sikkert ettersom det ikke er nødvendig å intervju/observere alle deltakere. Det er frivillig å delta på intervju og observasjon. Et intervju og en observasjon vil bli utført for å oppdage tanker, følelser, problemer eller annet som oppstår rundt bruk av spillet og som ikke kommer frem på spørreundersøkelsene. Under intervju og observasjon vil det bli gjort lydopptak. Det kan også bli tatt bilder, men da vil det ikke bli tatt bilder av ansikter slik at det ikke blir personidentifiserende.

Under gjennomføring av brukertest vil det lagres informasjon om spillets tilstand (antall innlogginger, antall skritt gått, hvilke funksjoner i spillet som blir brukt) - for nærmere beskrivelse se "Ditt personvern - hvordan vi oppbevarer og bruker dine opplysninger".

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Det er bare studenten som gjennomfører prosjektet og ansvarlig veileder som vil ha tilgang til opplysninger under dette prosjektet.

Opplysninger vil bli oppbevart kryptert på institusjonens skylagring. Navnet og kontaktopplysningene dine vil jeg erstatte med en kode som lagres på egen navneliste adskilt fra øvrige data.

Deltakere vil ikke kunne gjenkjennes på noe som helst vis i publikasjoner knyttet til prosjektet.

Appen som blir brukt under prosjektet vil samle inn og lagre følgende data:

- Antall innlogginger du gjennomfører i løpet av testperioden og hvilken dag de forekommer
- Hvilke oppdrag du fullfører i løpet av testperioden.
 - Et oppdrag innebærer at du får beskjed om å gå til en GPS lokasjon og åpne appen din der. Da blir oppdraget fullført.
- Hvis du interagerer med en annen bruker, blir de anonymiserte id-ene deres lagret slik at det er mulig å se at de to id-ene har interagert.
- Appen sender inn GPS-posisjonene dine under bruk av appen, men disse blir ikke lagret med unntak av ett tilfelle.
 - Hvis du fullfører et oppdrag i appen, som innebærer å gå til en GPS posisjon, vil det bli lagret at oppdraget er fullført. I lagringen av oppdraget vil GPS posisjonen til oppdraget bli lagret samt din anonyme ID, og dermed vil det være lagret at du har vært på den gitte GPS posisjonen.
 - Resten av GPS-posisjonene som sendes inn vil bli brukt til å utregne logikk i spillet, men de vil ikke lagres. Det vil si at kun et fåtall av GPS-innsendingene i praksis blir lagret.
- Appen teller også antall skritt du går etter at appen har blitt åpnet. Dette kan skrues av ved å stoppe appen på telefonen. Antall skritt som blir sendt inn av appen, blir lagret på serveren.

Lagret data vil bli brukt til å se hvordan appen blir brukt, og sammenhengen mellom svar på spørreskjema og hvordan appen ble brukt.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er 11. juni 2021. Filen med navn og kode-kobling vil bli slettet ved prosjektslutt, og alle opplysninger vil være ikke-identifiserbare. Det vil ikke være mulig å vite hvem det er som har gitt de ikke-identifiserbare dataene som gjenstår etter prosjektslutt.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,

- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra NTNU har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- NTNU ved Alf Inge Wang (veileder, e-post: alf.inge.wang@ntnu.no, tlf: 73594485) eller Tobias Skjelvik (student, e-post: tobiassk@stud.ntnu.no, tlf: 911 45 233).
- Vårt personvernombud: Thomas Helgesen (e-post: thomas.helgesen@ntnu.no, tlf: 93079038)

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Alf Inge Wang
(Forsker/veileder)

Tobias Skjelvik
(Student)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *AR mobile game to promote physical and social activity*, og har fått anledning til å stille spørsmål. Jeg samtykker til:

- å delta i spørreundersøkelser og brukertest
- å delta i intervju
- å delta i observasjon

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

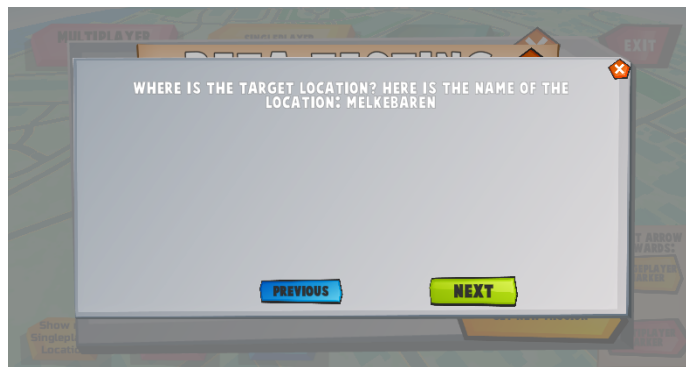
(Signert av prosjektdeltaker, dato)

Appendix G

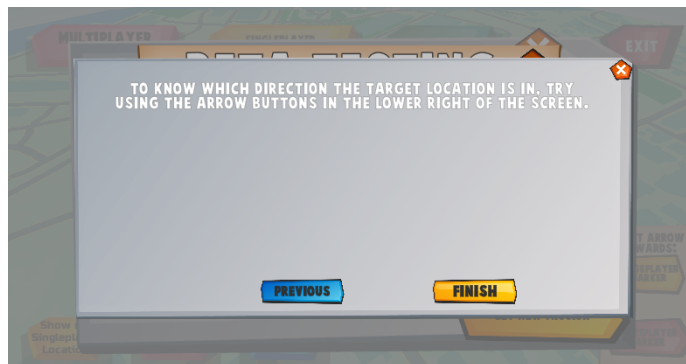
Images of My Contributions to BitPet



(a) Location mission help text is shown after clicking "NEED HELP?". Part 1 of 3.

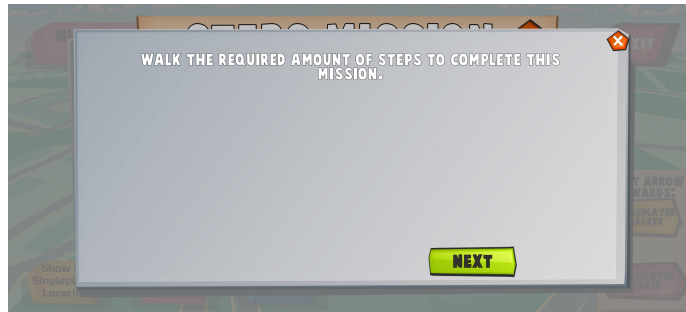


(b) Location mission help text is shown after clicking "NEED HELP?". Part 2 of 3.

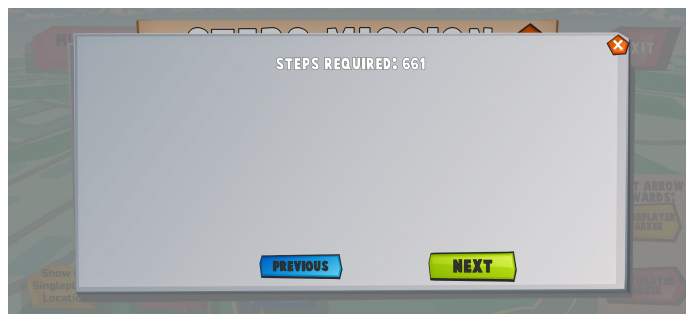


(c) Location mission help text is shown after clicking "NEED HELP?". Part 3 of 3.

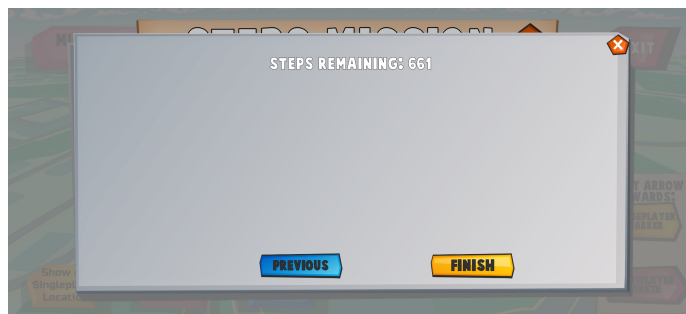
Figure G.1: The three part dialogue informing the user how to complete the location mission. It shows after clicking "NEED HELP" in the location-mission inspector.



(a) Step-mission text is shown after clicking "NEED HELP?". Part 1 of 3.

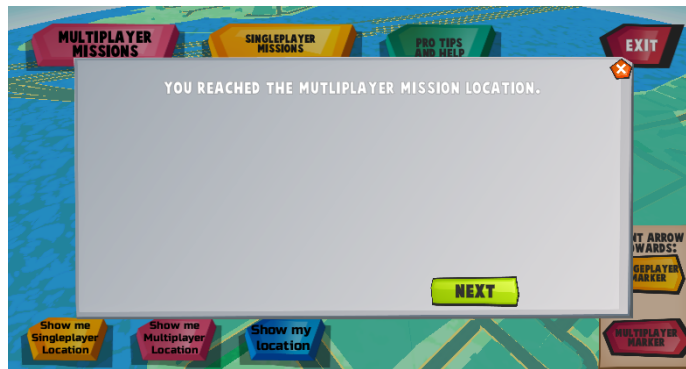


(b) Step-mission text is shown after clicking "NEED HELP?". Part 2 of 3.

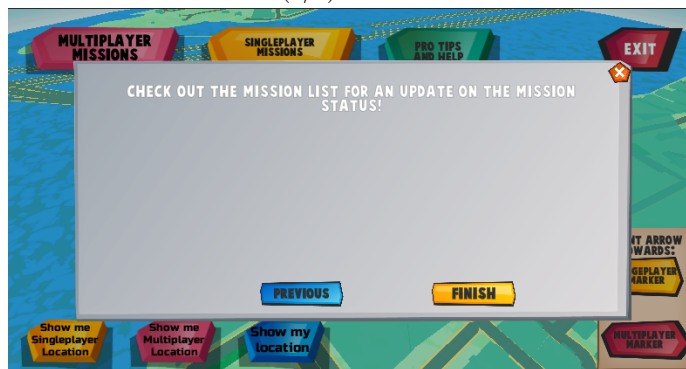


(c) Step-mission text is shown after clicking "NEED HELP?". Part 3 of 3.

Figure G.2: The three part dialogue informing the user about their step-mission progression. It shows after clicking "NEED HELP" in the step-mission inspector.

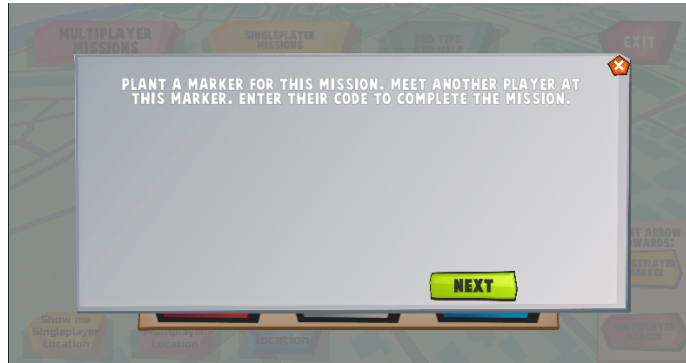


(a) A player has reached the multiplayer mission marker and receives feedback (1/2).

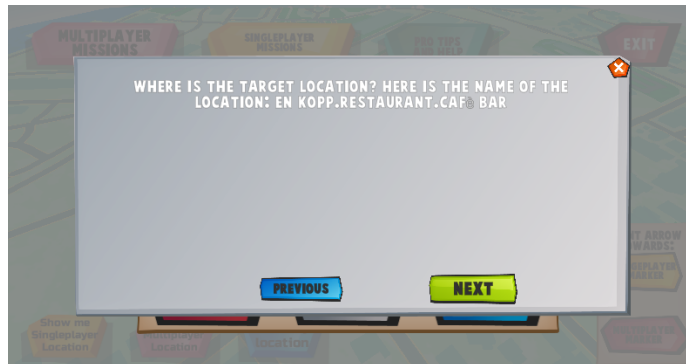


(b) A player has reached the multiplayer mission marker and receives feedback (2/2).

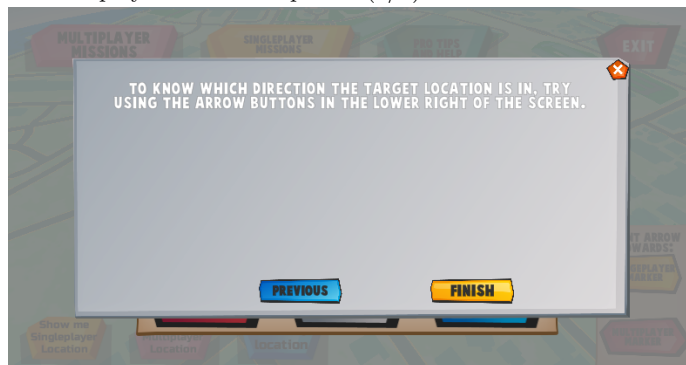
Figure G.3: Feedback dialogue for reaching multiplayer mission marker.



(a) A player has clicked the NEED HELP? button in the multiplayer mission inspector (1/3).



(b) A player has clicked the NEED HELP? button in the multiplayer mission inspector (2/3).

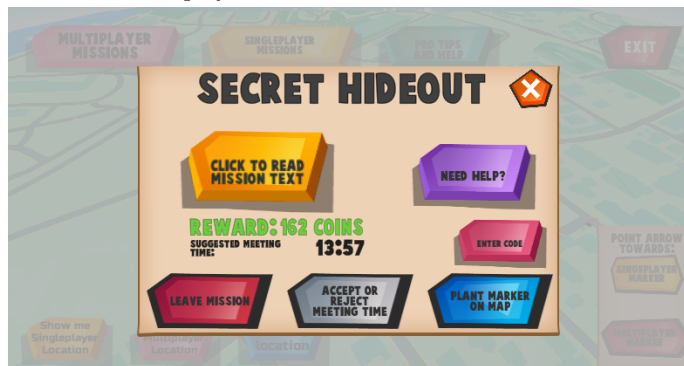


(c) A player has clicked the NEED HELP? button in the multiplayer mission inspector (3/3).

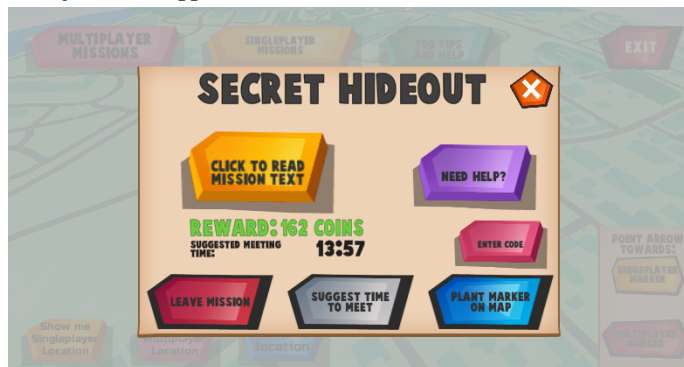
Figure G.4: Help dialogue that appears when a player has clicked the NEED HELP? button in the multiplayer mission inspector



(a) The mission inspector shows the agreed meeting time between two players.

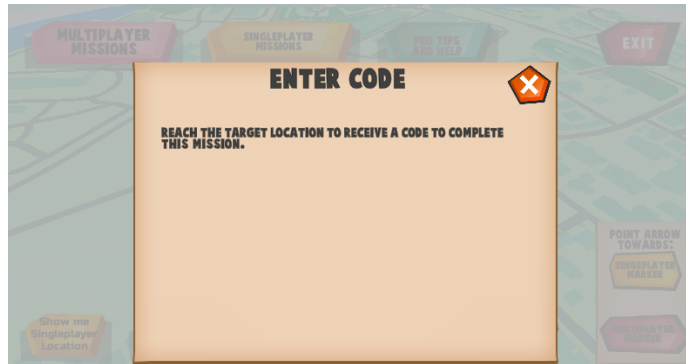


(b) Inspecting a multiplayer mission where the other player has suggested a meeting time. The player can accept or reject the suggested time.



(c) Inspecting a multiplayer mission after having suggested a time to meet. One can suggest a time to meet, but one cannot accept or reject the time, since one suggested it oneself.

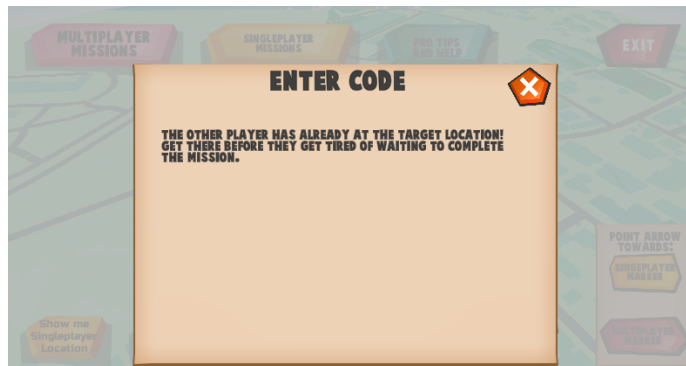
Figure G.5: Different states of the multiplayer mission inspector.



(a) Enter code screen. Appears after clicking the enter code button in multiplayer mission inspector. No players have reached the target location.



(b) Enter code screen after one has reached the target location, but the other player have not.



(c) Enter code screen when the other player is already at the target location, but one has not reached the location oneself.

Figure G.6: The different states of the *enter code* panel.