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Gamification of Chores

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Abstract

Today, a considerable portion of the population uses smartphones daily. The high diffusion of this technology and its application in different circumstances have become an attractive field for researchers. Particularly, gamification - the use of games for other purposes than mere entertainment. Additionally, statistics indicate a low motivation for housework, as opposed to the high motivation for phone usage. The latter of which this study attempts to use to motivate and encourage household members to do chores. We created an application by implementing several concepts deducted from an extensive background study of serious games, motivation, gamification, reward systems, and social interaction, in addition to a review of related work and existing applications.

The final test of the application involved 58 participants and lasted for two weeks. This test's primary focus was to examine users' perceptions of motivation, enjoyment, and engagement before and after using the application. These perceptions were evaluated by using a quantitative data generation method. Notable results found in the data show; (1) an indication of increased motivation and encouragement in doing chores by using the application, in fact, males had a statistically significant increase in motivation; (2) An implication that social interaction in terms of comparison coupled with rewards played a significant role in motivating users; and (3) differences in users' starting points seems to play a role in the motivational impact of the application.

Sammendrag

I dag bruker en betydelig del av befolkningen smarttelefoner på daglig basis. Spredningen av denne teknologien og dens anvendelse under forskjellige omstendigheter har blitt et attraktivt felt for forskere. Spesielt gamification - bruk av spill til andre formål enn bare underholdning. I tillegg indikerer statistikk en lav motivasjon for husarbeid, i motsetning til den høye motivasjonen for telefonbruk. Sistnevnte som dette studiet prøver å utnytte for å motivere og oppmuntre husholdningsmedlemmer til å gjøre husarbeid. Vi utviklet en applikasjon ved å implementere flere konsepter som ble trukket fra et omfattende bakgrunnsstudie av seriøse spill, motivasjon, gamification, belønningssystemer og sosial interaksjon, i tillegg til en gjennomgang av relatert arbeid og eksisterende applikasjoner.

Den endelige brukertesten av applikasjonen involverte 58 deltagere og varte i to uker. Denne testen sitt hovedfokus var å undersøke brukernes oppfatninger av motivasjon, glede og engasjement før og etter bruk av applikasjonen. Disse oppfatningene ble evaluert ved bruk av en kvantitativ datagenereringsmetode. Viktige resultater funnet i dataene viser; (1) en indikasjon på økt motivasjon og oppmuntring til å gjøre husarbeid ved å bruke applikasjonen, hvor menn hadde en statistisk signifikant økning i motivasjonen; (2) En implikasjon av at sosial interaksjon når det gjelder sammenligning kombinert med belønning spilte en betydelig rolle i å motivere brukere; og (3) forskjeller i brukernes utgangspunkt ser ut til å spille en rolle i den motiverende effekten av applikasjonen.

Preface

This Master's Thesis was written at the Norwegian University of Science and Technology. During the thesis several people aided us in making the thesis as successful as possible. Above all, we would like to extend our immense gratitude to our supervisor Alf Inge Wang, for providing invaluable guidance, and support for this thesis.

We would also like to praise co-students, Edvard Gjessing Bakken and Mathias Müller, who contributed with comprehensive feedback in the conceptualization, prototyping, and implementation of our application.

Additionally, we would like to extend our sincerest appreciation to each member of all families, couples, and collectives that participated in the final user test for providing precious feedback and results despite COVID-19's influence during the test period.

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Christoffer Almankaas, Fredrik Johannes Gillebo Sørmo

Trondheim, June 19, 2020

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Part I

Introduction and Research Methodology

The first part of the Master's Thesis, in addition to presenting the background motivation and a detailed description of the problem, also describes the project goals, research questions, the planned research methods and phases of the Master's Thesis.

Chapter 1

Motivation

In today's society, a considerable portion of the population use smartphones daily. According to Statista, in 2020, there are 3.5 billion smartphone users in the world [1]. Of these people, the average smartphone user unlocks their phone 150 times and spends 2 hours and 51 minutes on their phones every day [2]. The high diffusion of this technology and its application in different circumstances have become an attractive field for researchers [3, 4, 5, 6].

According to Business of Apps, the number one category for apps is games [7]. As Gee says, "since good games are highly motivating to a great many people, we can learn from them how motivation is created and sustained" [8]. Gamification is, in essence, how one can use such concepts from games in real life to motivate people to do tasks [9, 10, 11].

According to Common Sense Media, 35 percent of the times parents argue with their teens is about chores, and 31 percent is about phone usage [2]. This indicates a lack of motivation for doing chores, and a high motivation for phone usage. As we both have first hand experience in the the low motivation for doing chores in a household, we are additionally motivated to explore solutions utilizing phone usage to aid in the respective area.

This Master's Thesis will employ widespread phone usage in today's society to increase people's motivation, enjoyment, and engagement in doing chores. The results will be an application for iOS and Android that applies different game theory and gamification ideas to motivate various groups of people to fulfill chores, distribute chores, and urge each other to do chores.

At the end of the Master's Thesis, results will show whether or not the application

successfully improves motivation, enjoyment, and engagement for housework. We are highly motivated to see if this study's results will help solve some of the problems people living in groups encounter related to chores.

Chapter 2

Problem Description and Context

We will write this Master's Thesis over two semesters: autumn 2019, and spring 2020 as part of the Master's program in Informatics at the Department of Computer and Information Science (IDI) at the Norwegian University of Science and Technology (NTNU). The problem description in the Master's project: Gamification of Chores: Making chores a fun social activity with gamification, specifies that:

"The goal of this project is to research, design and implement an app for gamifying chores in a family. The goal is to make the planning, execution and rewards of doing chores (such as going out with the trash, cleaning, walking the dog etc). to a fun and social activity for a group or a family.

The project will include studying exciting concepts, evaluating these concepts, designing a new concept, implementing the concept and evaluating the concept with user."

To be able to test the tangible concept, two questionnaires will be provided to test perceived user perceptions of the application, before and after a final user test. By collecting data from all user interactions that occurs in the application during the test, it will be possible to validate assertions from the questionnaires. The questionnaires will only identify the testers generally perceived differences, while saving all user interactions that occurs in the application will contribute with granular data.

Chapter 3

Thesis Scope and Target Audience

This Master's Thesis will last from September 2019 to June 2020. The submission deadline is 22. June 2020. During this period, we will write the Thesis and implement and test a prototype. Alf Inge Wang will supervise the Thesis by providing feedback and support in the report, concept development, and implementation of the prototype. The targeted audience for our application is families, collectives and couples that live together.

Chapter 4

Report Outline

This Master's Thesis includes six parts, the introduction and research methodology, the preliminary study, the solution, the results and execution of an extensive user test, discussion of the results, research methodology, project, and application, and the conclusion which summarizes the thesis.

Up until now, **Part I** has introduced the thesis to the reader. The following chapters of part I will describe which research methodologies we plan to use throughout the project, as well as present the goals and research questions of the thesis.

In **Part II**, the preliminary study is presented, where serious games, motivation theory, gamification, reward systems, and social interaction are inspected. Related articles and papers are also reviewed. In addition to inspecting theory, several chore-related and popular applications are analyzed according to their functionality regarding reward systems.

Part III includes a description of the fully developed concept in addition to two discarded concepts. Furthermore, technologies used, the requirements of the final solution, the high fidelity prototype, and the final solution after implementation and prototyping of the proposed solution are included.

In **Part IV**, the reader is presented with a detailed description of the execution of the final user test. Also, the results of the final test are presented in context with the different data generation methods used.

Part V presents the discussion of the Master's Thesis, where the research methodology is evaluated. Additionally, an analysis of the results, as well as an evaluation

of the application and project, are described.

Finally, **Part VI** provides a conclusion of the project. It will also present future work and ideas that may improve the solution.

Chapter 5

Project Goals and Research Questions

This chapter presents the research goal and research questions for the Master's Thesis. Basili's Goal, Question, and Metrics research approach is the base for the Master's Thesis research approach [12]. The chapter will describe setting the research goal at a conceptual level, followed by a description of the research questions and the quantitative metrics used to evaluate them.

5.1 Research Goal

As described below, the goal of the research is comprehensive. The research questions described in Section 5.2 substantiate the research goal and further describe the research goal in detail. The definition of the research goal is:

Examine perceived user perceptions of an application created to motivate and encourage members of the household to execute chores.

The research goal includes the creation of a concept, a graphical user interface, and the implementation of an application that should include several gamification concepts. These concepts should motivate and encourage users to do chores. Testing the application in households for two weeks is then necessary to be able to examine the perceived user perceptions of these concepts.

5.2   Research Questions

The research questions defined below substantiate the research goal in detail. To be able to examine the research goal as a whole, it is necessary to examine the perceptions of enjoyment, engagement, motivation, and usability. Lastly, it is interesting to investigate how the distribution of chores is affected by using the application we will develop and how motivation diversifies for people with different starting points. The research questions are defined to examine gamification concepts that applied to an application potentially could make chores a fun, social activity. However, the results of the research questions may show inaccurately implemented concepts and functionality flaws that require further development. The research questions are:

RQ1: What kind of theories related to video games is most relevant to help our application increase a group's motivation for doing chores?
Understanding what concepts may help in increasing motivation for doing tasks is essential for the development of our application.

RQ2: What concepts from existing similar applications may work in our application?
Researching concepts from similar applications may help in developing and testing a better concept for our application.

RQ3: Which concepts implemented in our application seem to be the most effective form of motivation?
Investigating the effectiveness of the implemented concepts will result in useful information about each concept and its contribution to impacting motivation. Such information is valuable as to which concepts should be of focus in future development.

RQ4: How is the user's motivation for doing chores affected by our application?
This research question is of high importance due to its direct connection with what our application is attempting to accomplish. It will give a qualitative perception of how the application influences motivation in a practical setting.

RQ5: How does the user perceive the usability of our application?
The usability of our application may affect the user's motivation for doing chores. Therefore, it is crucial to investigate how users are navigating the application, how straightforward it is to learn the different concepts, and how the user perceives control.

RQ6: How does our application affect the group's enjoyment of doing chores?

With motivation in mind, it is essential to understand what makes our application fun to use. Therefore, it is relevant to research how the different concepts implemented in the application contribute enjoyment for users in a group. Also, it helps to know what concepts should be of focus in future development.

RQ7: How is the user's engagement towards chores affected by our application?

The user's engagement towards the application is vital as engagement creates personal involvement and a connection between the user and the application, which may increase the user's motivation.

RQ8: How is the distribution of chores within a group affected by our application?

An unbalanced distribution of chores may impact the motivation of doing chores. Therefore it is relevant to research if the application, even the distribution of chores.

RQ9: How does our application's effect vary on users with different starting points?

Our application may affect several people in different ways. Therefore, it is interesting to get an extensive understanding of how the motivation for people with various starting points is affected by the application. The starting points will include; (1) initial motivation for doing chores; (2) initial effort put into chores compared to others; (3) Initial frequency of doing chores; (4) Initial enjoyment for doing chores; and (5) The initial attitude towards chores. Researching the effect of the application on people with diverse starting points can help give an insight into the impact of the gamification concepts implemented.

Chapter 6

Research Method

This chapter presents the research method we will use to execute the preliminary study, the creation of prototypes, the implementation of a concept, and the development and testing of an iOS and Android application. Furthermore, the section presents the methods we plan to use for data generation. Figure 6.1 depicts the planned phases of the Master's Thesis.
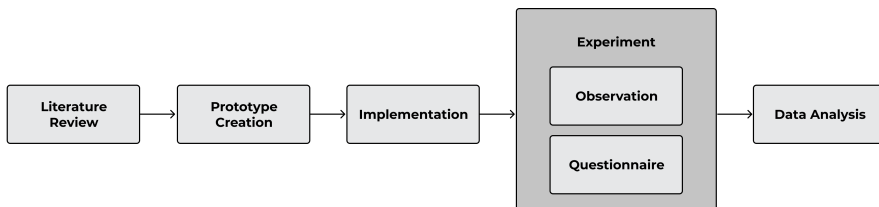
Figure 6.1: The planned phases of the Master's Thesis.

6.1 Literature Review

The literature review will consist of two phases; a review of existing literature, in addition to existing applications. During the examination of the existing literature, we will consider numerous research articles relevant to our thesis. These articles will consist of studies counseled by our supervisor, and articles found using the citation searching method, in addition to the snowball method [13, 14].

We will examine the totality of citations and the authors associated to prioritize and check articles' validity.

6.2   Development

The development phase will include two phases; prototyping and implementation. First, we will create a low fidelity prototype to translate high-level design concepts into physical and testable artifacts. The purpose of the low-fidelity prototype will be to test the concept's functionality quickly and inexpensively. We intend to test the prototype on several students, and in such a fashion, work until we have iteratively formed a high fidelity prototype. Before commencing development, we plan to clarify the application's visual design, interactivity, and content. Therefore, the high fidelity prototype must simulate the final solution as much as possible. By clarifying these decisions in advance, we will save time and resources during development. Besides, it will be easier to stay informed on the implementation decisions.

As for the implementation phase, we plan to use the Kanban method [15]. We will create suitable tasks by decomposing requirements and feedback received from testers. These tasks will be sorted into categories such as backlog, feedback, open tasks, in progress, needs testing, ready for deployment, and done.

6.3   Data Collection

The data generation methods we intend to use are observation and questionnaires. Since quantitative data can elucidate the research questions thoroughly, we consider a quantitative data generation method as most fitting [16]. For the quantitative data generation method, we plan to use questionnaires before and after conducting the final user test.

Furthermore, since we plan to triangulate data to validate results, qualitative data generation methods will be included; specifically, we will monitor user interactions in our application.

6.3.1   Observation

We plan to mostly observe users by accumulating user interactions happening in the application. This way, we will be empowered to follow a more considerable number of participants. Furthermore, since these observations will occur over the internet, users will not be disturbed as opposed to physical observation. That said, a physical observation may clarify other essential aspects in the usage of

the application; therefore, in order to observe users more physically, we plan on including our collectives in the testing of the application, separate from the final user test.

Since the functionality will be implemented in advance, and test users mostly will remain untouched by our observations, the observations can be clarified as covert and systematic [16]. By implementing this method of observation, we will be able to see accurate data of what test users do, rather than what they assert in the questionnaires.

6.3.2 Questionnaire

Two questionnaires will be provided to test participants; one before and another after the testing of the application. The questionnaires will collect quantitative data from test users by accumulating their feedback and thoughts. The questions used in the first questionnaire will be general questions concerning motivation, engagement, and enjoyment for doing chores. The second questionnaire will include the same questions as the first, in addition to questions linked to the concepts, functionality, and usability of the application.

To easily understand the collected data, the questionnaires will primarily consist of questions based on the Likert Scale [16]. The scale propose five different alternatives; "strongly disagree", "disagree", "neutral", "agree", "strongly agree". The rest of the questions will be of gender, age, and short and long answer questions where test users will have the opportunity to elaborate and express their thoughts in detail.

6.3.3 Data Analysis

In order to present data gathered from the final user test sensibly, we plan on using descriptive statistics. We will present data in an average manner and aim to highlight tendencies and statistical differences before and after using the application. Additionally, we plan on comparing statistics between different groups of participants. We plan to use the Mann-Whitney method when examining and comparing statistics. This will enable us to compare ordinal data produced when using a Likert scale in data generation methods [17].

6.3.4 Validity and Reliability

The Hawthorn Effect is generally an essential disadvantage of overt research because test users tend to modify their behavior when observed [16]. Because the observation will primarily not take place in the same physical space, a significantly reduced impact of the Hawthorn Effect is assumed.

The testing period will last for two weeks, which may indicate how the application performs in long term use. Testing the application on couples, families, and collectives will limit the results to the relevant audience. The results will ascertain if the various concepts implemented in the application are improving the test users' perceived motivation, engagement, and enjoyment for doing chores.

Part II

Preliminary Study

This preliminary study will present a detailed literature review of background theory with a focus on serious games, motivation theory and motivation related to games, and gamification, as well as pros and cons concerning the respective areas. The background study also includes reward systems and social interaction. Additionally, related work and reviews of both existing popular applications and applications that resemble our solution will be presented.

Chapter 7

Serious Games

This section will discuss what serious games are, their main functionalities, in what areas they are used, and how they affect different people in different groups.

7.1 What are Serious Games?

This section will mainly focus on the domain of serious games. However, there are related and sometimes overlapping domains, such as e-learning, edutainment, and game-based learning, that can conflict with serious games [18]. There are many different variations of how serious games are defined. To illuminate the concept of serious games, this section focus on three similar but somewhat different definitions and how they combine to create an overall understanding of serious games. Firstly, serious games are (digital) games used for purposes other than mere entertainment [18]. Secondly, "serious games are games that do not have entertainment, enjoyment, or fun as their primary purpose" [19]. Finally, Corti states that serious games "is all about leveraging the power of computer games to captivate and engage end-users for a specific purpose such as to develop new knowledge and skills" [20].

These definitions have some common denominators that help in producing an overall understanding of serious games. They all focus on the concept that serious games should, in some way, use the known positive effects of (digital) games to aid users in reaching some goal. This goal can vary based on what area the games focus on, for instance, in an educational setting, a serious game could help the user understand mathematics. Furthermore, we see that the definitions agree that serious games do not have entertainment nor enjoyment as their primary

focus. However, Michael and Chen underline that serious games can be both entertaining and enjoyable; it is just not their primary function [19].

Following these definitions, a serious game could be, for instance, a game with the intent to educate students in math, a game that could help soldiers to prepare for warfare, or in this case, a game that motivates people to do chores.

7.2   Areas of Use

Serious games can apply to a broad spectrum of areas, but usually, they are categorized in several different ways. Zyda states that serious games can apply to domains as diverse as healthcare, public policy, strategic communication, defense, training, and education [21]. Further, Michael and Chen provide a more market-oriented categorization where they organize serious games in different markets. The markets are military games, government games, educational games, corporate games, healthcare games, political, religious, and art games [19]. This section will focus on the categorization provided by Michael and Chen and aim to give a more profound description of the first four markets: Military, Government, Educational, and Corporate games.

7.3   Military Games

Among the oldest war games is the board game Chaturanga from India and the Chinese Wei Hei, both from about four thousand years ago [19]. These were simple games with simple rules. However, they proved to be an excellent tool for learning strategic planning. That said, today, the military uses way more advanced simulations and games to prepare for several different situations. Even though through the history, military simulations have been superior to the commercial option, it is now seen that commercial game technology, can work as an utmost cheaper alternative [19]. Examples of such commercial alternatives throughout the history are WarCraft, Doom, Close Combat, and Operation Flashpoint [19, 22].

7.4   Government Games

Terrorist attacks, disease outbreaks, biohazards, health care policy issues, city planning, traffic control, fire fighting, budget balancing, ethics training, and defensive driving are examples of the many challenges any government may potentially face [19, 23]. While some of these challenges might be more dangerous than others, it is safe to say that in all of the mentioned challenges, it can be

both cost-effective and comforting to be able to face such problems in a safe and free-of-consequence environment. That said, facing such challenges in a safe environment, lack of fear, and genuine emotions may interfere with decision-making and the simulations' results. However, being able to run the simulations repeatedly and in various environments provides the ability to prepare for countless different situations [18].

7.5 Educational Games

As mentioned earlier, serious games have related and sometimes overlapping domains. Edutainment is one such domain. It used to be the general term for games and other software developed for educational purposes [18]. However, as time passed, interest in the subject decreased due to both poor qualities of the games and software, and the growing interest in the Internet [19]. As Zyda said: "edutainment, an awkward combination of educational software lightly sprinkled with gamelike interfaces and cute dialog" [21]. Fortunately, today we see a more situational and constructionist approach as oppose to the old skill-and-drill interactive learning paradigm [24]. This means that edutainment has progressed towards the serious games domain. Furthermore, more and more games are gaining acceptance in education [19, 24]. Some games, designed using the same theory as our solution, have even changed classroom teaching globally, such as Kahoot! [25].

7.6 Corporate Games

Computer-assisted training was brought to corporations during the 1990s with multi-media PCs, first with CD-ROMs, and later the Internet [19]. This provided several advantages for businesses, especially in the case of cutting costs for different resources needed for training employees. However, the technology was new, and it did not propose any significant improvement in engagement and learning [18]. Today, the technology is more developed and therefore, the interest for such programs has increased.

7.7 Positive and Negative Effects

The field of serious gaming has many acclaimed benefits. However, there may be a lack of evidence to prove such advantages. As Squire et al. point out, "to date, we actually know relatively little about the consequences of game play on the cognition of those who play them" [26]. That being said, what we do know about serious games, is that they provide endless opportunities to experience different

situations and challenges in a safe environment [20, 23]. Besides, numerous analyses show that gaming promotes learning [27]. More specifically, Mitchell and Savill-Smith discuss a number of both negative and positive effects of gaming. Some adverse effects are health issues (headaches, fatigue, mood swings, and repetitive strain injuries), psycho-social issues (depression, social isolation, less positive behavior towards society in general, increased gambling, and substitute for social relationships). More positive effects are the development of analytical and spatial skills, strategic skills and insight, learning and recollection capabilities, psychomotor skills, visual selective attention [28]. Furthermore, another benefit is pointed out by Squire and Jenkins, who argue that games can be a powerful way of introducing new concepts and tie together different periods of history [23].

7.8   Summary

In this chapter, aspects of serious games have been discussed. Some aspects are discussed with a focus on concepts that can relate to Spot - the solution presented in this thesis. However, most of the aspects that are discussed are done so in a more general matter. This provides a better overall understanding of serious games and provides a better foundation for discussing the solution later on.

Chapter 8

Motivation through Games

In this chapter, intrinsic motivation is described, as well as numerous aspects of games' motivational elements. This chapter also discusses how these motivational elements can help improve a users' motivation within both games and real-life situations.

8.1   Intrinsic Motivation and Extrinsic Motivation

"Intrinsic motivation is innate to the human organism and begins as a basic, undifferentiated need for competence and self-determination" [29]. Thus, intrinsic motivation occurs when a person performs an activity for its own sake rather than the desire for some external reward [30]. While on the other hand, extrinsic motivation occurs when we are motivated to perform a behavior or engage in an activity to earn a reward or avoid punishment [31]. According to Sansone and Harackiewicz, the distinction between intrinsic and extrinsic motivation was controversial from the start. However, they found several studies showing that extrinsic rewards could undermine intrinsic motivation, especially in cases where the person would perform the activity either way. That way, illuminating a potential adverse side of extrinsically rewarding users for doing household work [32].

8.2   Malone's Framework for Intrinsic Motivation

Malone has developed a framework for intrinsic motivation. This framework discusses three essential aspects with intrinsic motivation; challenge, curiosity,

and fantasy, and combines these to present a framework for intrinsic motivation [33, 34]. This framework suggests specific extensions to games and how they might improve intrinsic motivation. This section will mainly focus on the overall description of the three main aspects. However, the entire framework is included in Appendix A.2.

8.2.1   Challenge

Several writers have noted that for an environment to be challenging, it must provide goals whose attainment is uncertain [35, 36]. According to Malone, what makes a good goal consists of numerous criteria. Firstly, a good goal is personally meaningful; secondly, a goal should be obvious or easily generated. Finally, a goal should provide direct feedback on performance.

Furthermore, Malone discusses that an environment is not challenging if the person is either sure to reach the goal or certain not to reach the goal. Thus, the challenge should be of some uncertainty to promote motivation.

Completing a challenge engages a person's self-esteem and makes people feel better about themselves. However, on the other hand, failing at a problem may reduce confidence and make people feel bad about themselves. Therefore, to maintain motivation, challenges should be presented at different difficulty levels to allow players to work in a range of their abilities.

8.2.2   Fantasy

According to Malone, an easy way to increase the fun of learning is to take an existing curriculum and overlay it with a game in which the player progresses towards some fantasy goal, or avoids some fantasy catastrophe. For example, Kahoot. It provides a fantasy goal of achieving points and beating classmates by answering curriculum-related questions. Malone describes these types of fantasies, where the fantasy relies on the practice of skill and not vice versa as extrinsic fantasies. Intrinsic fantasies, on the other hand, are fantasies where the fantasy depends on the skill, and the skill depends on the fantasy.

Malone also discusses the cognitive and emotional aspects of fantasy and describes certain advantages from both aspects. In terms of cognitive benefits, he mentions that metaphors or analogies of the kind provided by intrinsic fantasies can often help apply old knowledge in understanding new things. For instance, people playing angry birds already know somethings about the physics of objects, which may aid in learning the game.

In terms of emotional aspects, Malone discusses that emotions derived from fantasies may aid in motivating players to keep playing. For instance, fantasies like

war, destruction, and competition are likely to be more popular than other less emotional fantasies. However, people experience different emotions as a response to fantasies. Therefore it is essential to create numerous fantasies to create a more general appeal.

8.2.3 Curiosity

Malone states that to maintain a player's curiosity, one should keep an optimal level of informational complexity. This means that environments should determine complexity based on the players existing knowledge. Further, Malone separates curiosity into two main categories: sensory curiosity and cognitive curiosity. Sensory curiosity involves curiosity in terms of sensory values like light, sound, and visual effects in the environment. While cognitive curiosity is the player's desire to improve one's knowledge structures, with this in mind, Malone states that to engage learners' curiosity is to present just enough information to make their existing knowledge seem incomplete [33, 34]. For instance, a cliffhanger in a TV-series engages curiosity in the viewer.

8.3 Flow

Flow is a term coined by Csíkszentmihályi. According to Csíkszentmihályi, flow is a state of mind in which a person performing an activity is fully immersed in a feeling of energized focus [37]. It is something that is "so gratifying that people are willing to do it for its own sake, with little concern of what they will get out of it, even when it is difficult or dangerous. Csíkszentmihályi meant that by combining individual elements, one should be able to experience the flow experience. He specified eight essential elements: A task to be completed, the ability to concentrate on a task, the concentration is possible because the task has clear goals, that concentration is possible because the task provides immediate feedback, the ability to exercise a sense of control over actions, a deep and effortless involvement that removes awareness of the frustrations of everyday life, concerns for self disappears, but a sense of self emerges stronger afterward, and finally the sense of duration of time is altered. Concerning these eight elements, a more concise model is constructed for games in particular.

8.4 The Gameflow Model

Sweetser and Wyeth developed a gameflow model built on Csíkszentmihályi criteria for the flow experience and is oriented around games and the fact that games provide numerous flow experiences [38]. In a more summarized matter,

the gameflow model consists of eight elements: concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. Based on these elements, a game should engage the players in a way that intrigues their attention and enhances their concentration. Simultaneously, there should be a high workload and balanced challenges based on the players' perceived skill. Appropriate feedback should be given in terms of progress towards goals. On top of this, the game should, in some way, give the player an adequate amount of social interaction. A game that follows these guidelines should be able to provide a flow experience to players.

8.5   Skinner's Box

Skinner developed an approach to behavioral psychology based on his views on reinforcement, and several experiments measuring the effects on behavior based on reinforcement. These well-known experiments take place in an operant conditioning chamber known as Skinner's box [39, 40]. The box consisted of a lever connected to a food dispenser that would provide food to the animal on different schedules. Skinner separated these schedules in fixed and variable interval and ratio schedules. In a fixed interval schedule, the animal would receive food on given intervals regardless of lever actions. This was an ineffective motivator because reinforcement was independent of action. The same was to be said of variable-interval schedules. However, fixed ratio schedules demonstrated better results because the reinforcement was directly connected to the number of times the animal interacted with the lever. Nevertheless, the final reinforcement schedule provided the best result in terms of motivation. Since the animal could not predict how many times it had to interact with the lever before reinforcement, it ended up using the lever more consistently.

8.6   Self-Determination Theory

Self-determination, is a theory concerning different types of motivation. Self-determination ranges from intrinsic motivation (most self-determined) to amotivation (least self-determined) [41, 42]. Self-determination discusses three different kinds of psychological needs, autonomy, competence, and relatedness [42, 43, 44]. Autonomy is described as the ownership of one's behavior. Competence is being able to achieve goals and feeling mastery and effectiveness in doing so. Lastly, relatedness is feeling connected to others. According to self-determination, if these needs are satisfied, intrinsic motivation is increased. On the other hand, when these needs are not met, intrinsic motivation may be undermined by negative emotions [44].

Studies of self-determination show that by supporting intrinsic needs, more internalized learning is promoted [43]. Besides, additional studies show that by facilitating a feeling of autonomy, competence, and relatedness in games, the experience becomes more enjoyable [44, 45]. A game can promote a feeling of competence through feedback and rewards and build a feeling of relatedness through social interaction (competition and cooperation) [46].

8.7 Summary

In this chapter, different theories of motivation have been presented. In terms of Spot - the solution presented in this thesis - Malone's framework is highly relevant and will be applied in certain ways to improve the application's ability to motivate users to do housework. Furthermore, elements from Skinner's box are directly assessed in the solution, especially the implementation of a variable ratio reinforcement schedule. With regards to the gameflow model, this will be more of a measurement of results in how the implemented concepts affect the user. Lastly, concepts from Self-Determination are considered.

Chapter 9

Gamification

This chapter describes and defines gamification and investigates its connection with serious games. Furthermore, presenting benefits and issues by using gamification.

9.1 What is Gamification?

There are multiple definitions of gamification. Deterding defines gamification as "the use of game design elements in non-game contexts" [9]. Huotari and Hamari propose a definition that highlights the goal of gamification; "a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation" [10]. According to McGonigal, gamification can help motivate players to execute tasks in a serious game that they otherwise would not have executed [11].

Even though the term gamification has become increasingly popular the recent years, gamification has been around for a long time, used in non-game contexts. Bossomaier states that the fundamental game mechanics of gamification are points, leaderboards, badges, and levels and argues that these four fundamental points have been used already 3000 years ago in the Olympiads of Ancient Greece [47]. Since gamification has existed for a long time, gamification is, according to Anderson, "An overblown term for old-school marketing. Yes it works, No, it's no game changer (pun intended)" [48]. Levels frequently appear in loyalty programs for hotels and airlines, while badges formed Boy Scout and Girl Guide movements over a hundred years ago [47]. Many types of sports have incorporated the use of points and leaderboards.

9.2   Serious Games and Gamification

Deterding et al. describe the relationship between serious games and gamification and how they are different. Serious games are the use of games in non-game contexts where various parts of game elements create a whole full-fledged game [9]. In contrast, gamification is game design through game elements that are parts of the game [9]. Schreiber and Brathwaite define these parts as "Game Atoms," where games consist of "Game Design Atoms" [49].

Reeves and Read have identified ten elements that together can form a whole full-fledged game; levels, feedback, reputations, representation of self, three-dimensional environments, marketplaces and economies, ranks, teams, parallel communication systems, a competition where rules are well-defined and enforced, and time pressure [50]. These elements are not readily gamified when isolated, and may require proper implementation into a broader concept to be beneficial [50].

Deterding et al. argue that gamification can exist for training, health, news, and other application-areas and that the only thing that differs in a serious game is the exclusion of "game design elements as part of designing a game" [9]. They identified five levels of game design elements of varying levels of abstraction when surveying existing literature, as visualized in Table 9.1. Based on these findings they state that term "gamification" refers to "the use (rather than the extension) of, design (rather than game-based technology or other game-related practices), elements (rather than full-fledged games), characteristics for games (rather than play or playfulness), in non-game contexts (regardless of specific usage intentions, contexts, or media of implementation)".

9.3   Issues and Benefits

By creating a model to reason about user behavior in the presence of badges, Asthon et al. analyzed how badges could alter their behavior [51]. Specifically, the analysis of user behavior took place on Stack Overflow, collecting qualitative insight into optimizing the incentive effects of badges. The findings suggested increased participation, however questioning the quality of user actions.

Bossomaier suggests that increased participation is achievable through gamification because of the pervasiveness of online and multiplayer games [47]. Fitz-Walter et al. conducted a case study on 26 university students where the students were to use an application with achievements [52]. Being able to present orientation information in an engaging way to encourage the use of the application was considered the goal of the case study. The results from the case study indicate

Level	Description	Example
Game interface design patterns	Common, successful interaction design components and design solutions for a known problem in a context, including prototypical implementations	Badge, leaderboard, level
Game design patterns and mechanics	Commonly reoccurring parts of the design of a game that concern gameplay	Time constraint, limited resources, turns
Game design principles and heuristics	Evaluative guidelines to approach a design problem or analyze a given design solution	Enduring play, clear goals, variety of game styles
Game models	Conceptual models of the components of games or game experience	MDA; challenge, fantasy, curiosity; game design atoms; CEGE
Game design methods	Game design-specific practices and processes	Playtesting, playcentric design, value conscious game design

Table 9.1: Five game design elements of varying abstraction, taken from [9].

that value was created by adding game elements. However, there were some usability challenges with achievements that required numerical input because they allowed the students to complete them by trial and error. Fitz-Walter et al. emphasize the importance of balancing usability and enjoyment in the conclusion of their case study.

An online learning environment application with achievement badges was implemented by Hakulinen et al. to study the effect of achievement badges [53]. Being divided into two groups, with and without achievement badges, 281 students tested the application. The results show that achievement badges had some students motivated to pursue them. However, the achievement badges did not affect the course grading and Hakulinen et al. conclude that applied methods should be carefully selected to be able to benefit from the full potential of engaging elements.

In education, MathLand, a math application with levels, leaderboard, and avatars, improved student performance by 22% in a math class in Canton after three years [54]. Attendance increased by 13% during the two first years. The application allowed students to gain points when completing math levels, which moved their avatar on a leaderboard visible for all students. However, there was no case-control study; thus, the results may not be reliable.

Bogost criticized a simple point collection system, the lowest level of gamifica-

tion, affirming that gamification should be more meaningful [55, 56]. According to Bogost, meaningful use of gamification can involve dynamics like mechanisms which enable customizable goals. Using gamification for precise tasks and contexts where motivation and attendance are low gives a powerful effect, according to Bossomaier [47].

9.4   Summary

This chapter brings forward different definitions of gamification, describes a few connections with serious games and elaborates on issues and benefits of the use of gamification. The most important takeaway is to avoid pitfalls when creating a concept using gamification. A pitfall can be using the lowest level of gamification, and being unable to balance usability and enjoyment [52, 55, 56]. The final concept should consider using the ten elements described by Reeves and Read [50]. Lastly, by making sure that elements are connected, the effects that occurred in Hakulinen et al.'s study should be avoided [53].

Chapter 10

Reward Systems

This section will present reward systems and their use. Furthermore, presenting various reward types.

10.1 How are Reward Systems Used?

Players are given rewards upon completing tasks within a game. Rewards contribute by encouraging players to continue playing. Rewards can provide social meaning by displaying completed rewards outside of the game itself, according to Reeves and Read and Salen and Zimmerman [50, 57]. Wang and Sun researched game reward systems and how they provide gaming experiences and social meanings to players [58]. Their studies concluded with game reward systems being able to "establish status, attract attention and build social connections with other players, or motivate players to collaborate when searching for secret information or hidden items" [58]. Also, reward mechanisms may cause other game mechanisms to be further enjoyable by setting goals for players, and these reward mechanisms provide curiosity, which contributes to players having more fun [58].

Salen and Zimmerman suggests that successful game design is dependent on creating meaningful play [57]. The relationship between player actions, its outcome, and purpose may provide meaning to players. Reward systems build relationships from player actions being recognized by providing immediate feedback.

Playing a new game, players must learn how the game works. Learning can be enhanced by rewarding players an equal amount as the effort they have invested in learning the game [59, 60]. Providing representational feedback of progress

towards goals and tasks is crucial [60]. Such feedback is essential as it encourages mastery of the game [61].

Wang and Sun proposes categories for the utilization of various reward types [58]. They visualized the reward usage classifications in a dual-axis, as seen in Figure 10.1. The horizontal axis represents personal and community enjoyment, while the vertical axis represents the seriousness of the player activities ranging from casual to progress.

The advancement category represents players that are using rewards to progress in the game—for instance, building strength so that players gain the feeling of increased skill and power, being able to fight stronger enemies. Wang and Sun argues that players "feel a greater sense of fun if they believe that their skills are improving" [58]. The review category represents players that, for example, enjoy looking at their achievement collections or have their avatar wear powerful equipment. Wang and Sun believes that such rewards provide entertainment by providing players with a sense of accomplishment and memories connecting rewards with special game events [58]. Review rewards, therefore, provide entertainment that embraces the feeling of accomplishment [62]. The sociality category represents players that use rewards as social tools to show off accomplishments and information to establish status. For single-player games, game companies create reward systems that elaborate accomplishments even outside of the game, commonly in online forums [58]. The cooperate/compete category represents players that enjoy cooperation and competition. These players are often required to share resources and are usually encouraged by the game design to interact with others [58].
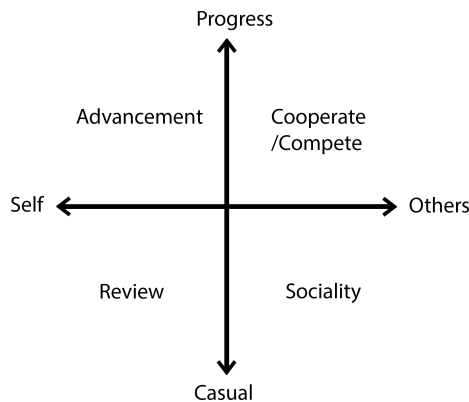
Figure 10.1: Reward type classifications, retrieved from [58].

10.2 Reward types

The following section describes the various reward types explained by Wang and Sun [58].

10.2.1 Score System

Commonly used in sports and games, score systems provide an evaluation of player performance. Thus, the scoring system does not affect the gameplay directly but is instead used to compare players and their performance. Such a score system may provide a positive game experience by matchmaking players of equal skill, or contribute to rewarding players with glory. Chess, World of Warcraft, and Apex Legends are examples of games with implemented scoring systems, see Figure 10.2. Furthermore, a scoring system may collect a score from multiple player actions and accumulate a total score over time.
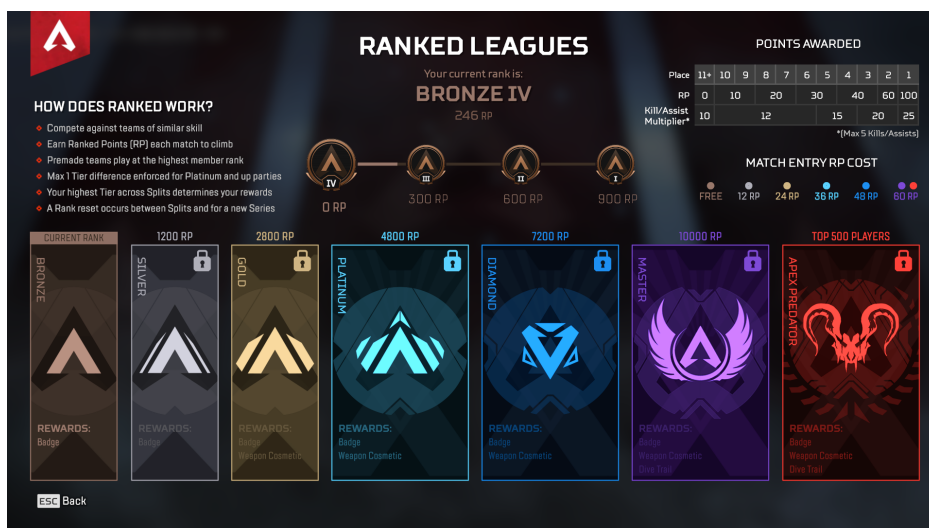
Figure 10.2: Score system in Apex Legends.

10.2.2 Experience

Role-playing games commonly consist of avatars being able to grow in strength by leveling up using experience point reward systems. To be able to level up, players must accumulate experience points up to a specific number. Avatars earn

experience points from multiple actions completed in the gameplay. Different from scoring systems, experience points are: bound to a specific avatar rather than single gameplays; rarely used for player ranking as experience points do not reflect skill, but rather time and effort; directly affecting gameplay by making various tasks easier to accomplish.

10.2.3   Items

Widely used in role-playing games and massively multiplayer online role-playing games, system rewards grants virtual items that can be equipped by avatars, see Figure 10.3. Items may vary in strength, and how they affect gameplay. Item granting mechanisms may encourage players to explore the game world to collect the best items, which may produce social value.

Figure 10.3: Screenshot of legendary items found in Borderlands 3.

10.2.4   Resources

Players are in various games required to collect resources to be able to, for example, produce buildings, units, and items. In Age of Empires III, players must gather virtual wood and stone to progress. Different from items, resources are mostly used for practical game use or sharing.

10.2.5 Achievements

"From the perspective of a single game, an achievement appears as an optional challenge provided by a meta-game that is independent of a single game session and yields possible reward(s)" [63]. Achievement systems encourage players to play games in challenging, creative, and explorative ways. Achievements serve as meta goals and usually provide multiple goals to the gameplay. Being able to show off completed achievements may produce glory through social interaction with other players, and produce meaning. In World of Warcraft, players can complete thousands of achievements. Blizzard Entertainment, the creator of World of Warcraft, made the first player that completed all achievements a celebrity in gaming circles.

10.2.6 Feedback Messages

Feedback messages provide instant rewards by creating positive emotions. Such feedback is usually a response to successful actions. For example, in a game based on timing, players may receive textual feedback like "perfect" when the action performed was perfectly executed. Reeves and Nass and Bracken et al. prove that positive feedback is affecting player emotion and behavior [64, 65].

10.2.7 Animation/Cinematic

Animations and cinematics motivate players by providing a sense of fun. The animations and pictures can be visually attractive and immerse the player further into the plot, while they can also act as milestones following completion of major events such as defeating an incredibly strong enemy. Usually, the cinematics consists of higher quality than in the gameplay, and Blizzard Entertainment is known for their astonishingly detailed cinematics in World of Warcraft, see Figure 10.4.

10.2.8 Unlocking Mechanisms

Unlocking mechanisms provide players with access to new game content when the player fulfills specific requirements. Hallford and Hallford classifies unlocking mechanism rewards as access [67]. The player's curiosity is maintained by initially hiding and then gradually exposing game content as the player progresses. Malone argues that providing incomplete information leads to intrinsically motivating environments [33].

Figure 10.4: Screenshot of World of Warcraft Legion trailer, taken from [66].

10.3   Summary

This chapter brings forward examples of a variety of reward systems and their use. In the implementation of a reward system, player actions should provide immediate feedback. To enhance learning, players should continuously receive representational feedback of progress towards goals and tasks. Combining multiple reward types should be carefully executed to reduce unnecessary complexity, which affects the rest of the application. In order to facilitate motivation in terms of social interaction and extrinsic rewards, scoring systems, items, and feedback messages are relevant rewards system for our application.

Chapter 11

Social Interaction

Most new games today include multiplayer modes or some form of social interaction. In fact, some new games are solely created for multiplayer gaming only. That said, the gameflow model emphasizes the importance of social interaction in games, see Chapter 8. This chapter describes social interaction with a focus on social gaming and physiological linkage.

11.1   Social Gaming

Today, the fact that social interaction acts as a motivator for games is widely accepted in the academic community [68]. As Ekman et al. say, "Contemporary gaming is often a highly social activity." See Figure 11.1. Several studies show that playing with a friend facilitates more positive emotions than playing alone [69]. This section describes the game session, social presence, and physiological linkage.
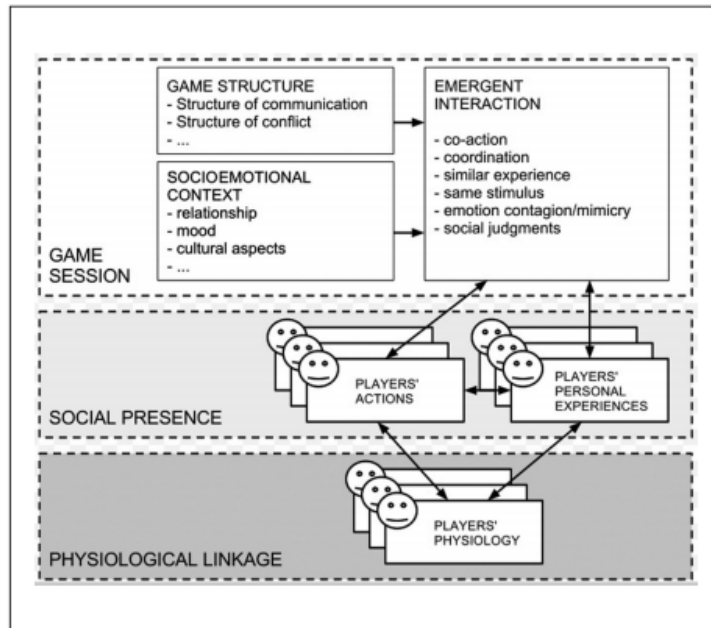
Figure 11.1: The connection between the game session, social presence, and physiological linkage [70].

11.2 The Game Session

According to Ekman et al., the game session is a shared situation between players and spectators. Players and spectators form the situation based on their different social backgrounds. Zimmerman describes two different game situations; cooperative is a game where players win or lose together, while competitive is a game where the players cannot all win [71]. A structure of communication should be implemented to elevate the social interaction within a game session. In many games, communication is implemented within the game. However, today, many third-party applications provide excellent Voice over Internet Protocol (VoIP) communication possibilities [70]. For instance, Discord is a highly popular application for communication in social gaming [72]. Furthermore, an important aspect that helps form the game session is the socioemotional context - players' existing relationships, personalities, current moods, and cultural differences. A game session where players have prior knowledge of one another often proves different than a game session comprised of strangers [70].

11.3 Social Presence

According to Biocca et al., social presence consists of three dimensions: copresence, psychological involvement, and behavioral involvement [73]. Firstly, Biocca describes copresence as a sense of being in touch with another human being. It can both be a sensory representation and a mental representation of the other person. For instance, a player can experience copresence when seeing a person, but also when imagining a person's existence. Secondly, psychological involvement refers to the emotional and mental connectedness between people. For example, psychological involvement happens when a person responds to how another person feels. Finally, behavioral involvement is the relationship between two or more peoples' actions. For instance, if a person performs some action in response to another person's actions, that would be behavioral involvement. Since physiological linkage taps into all these dimensions, it acts as a useful tool for evaluating social presence within a game session [70, 73].

11.4 Physiological Linkage

"Physiological linkage refers to joint changes in the physiological activity of two or more people" [74, 75]. There are several arguments as to why physiological linkage is an excellent tool for measuring people's physiological responses to social gaming. Firstly, As Hatfield et al. said, "Physiological linkage emerges when people are intensively interacting with each other" [76]. As of today, many mul-

tiplayer games comprises of highly intensive interactions between players. For instance, in Call of Duty, one of the main interactions happening between players is shooting at one another. Secondly, the physiological linkage is not confined to any particular media. Thus, it can be used in both digital games and physical games [74, 77]. Furthermore, physiological linkage occurs in many different social interactions ranging from close collaboration to hostile encounters. Finally, as already mentioned, physiological linkage taps into all three dimensions of the social presence that occurs in a game session [70].

11.5   Motivation from Physiological Linkage

The social presence within a game session is known to motivate players, and even in some cases, make players play the game solely for the social interaction, even if they do not like the game [78]. Further, by including the three dimensions of social presence, our solution may benefit from the physiological linkage between the players. The physiological linkage to other people may, for some people, act as a sole motivator for completing housework.

11.6   Summary

Social interaction is a good motivator for games. By specifying the game session occurring in the solution this thesis provides. The physiological linkage can be used as a means to evaluate the social presence happening while using the application. The data is mainly collected from two questionnaires, and hopefully, this can be used to illustrate how the social aspect of our solution impacts motivation.

Chapter 12

Related Work

This chapter, in a concise manner, will present several similar works, more precisely two Master's Theses, two papers, in addition to one book concerning two articles on gamification. In addition to this, this chapter will highlight similarities and differences between our Master's Thesis and the examined work.

12.1 Gamification and Family Housework Applications

Bjering et al. explore how gamification is utilized in applications that target family housework [79]. During the study, an extensive analysis of several so-called chore apps are made. The analyses are based on a classification framework for educational apps and concepts of game design elements. The applications where evaluated on several parameters, see Figure 12.1 and Figure 12.2. An important point made in Bjering et al.'s study is that a gamified approach towards housework can influence family interaction in both positive and negative ways. With that in mind, the study highlight three essential findings:

- that existing apps tend to be mostly instructive and partly manipulable

- that they tend to focus on external rather than intrinsic motivation

- that they target family members individually, rather than the family as a whole

In addition to these findings, the study did an extensive background study where theories such as self-determination, behaviorism, social cognitive theory, and flow

Figure 12.1: The parameters the applications in Bjering et al.'s study were evaluated on, taken from [79].

Figure 12.2: An example of an application evaluation in Bjering et al.'s study, taken from [79].

were discussed. During the background study, several essential points were made concerning motivation. Some of these points were:

- Pavlov and Skinner saw extrinsic motivation as the best way to encourage people to do activities.

- Self-determination states that people have a strong internal desire for growth inherently, but that the surroundings must support this; if they do not, the internal desire might die.

- Intrinsic motivation, as explained by Deci and Ryan, correlates well with Csikszentmihalyi's concept of flow: whatever produces flow becomes its own reward.

- Deci and Ryan also point out that rewards might have adverse effects if they are poorly implemented.

- Building upon self-determination, in order for a task to be motivating; (1) The task must be meaningful; (2) The task must give a personal responsibility so that one can plan and do the task the way one thinks is best; and (3) One need feedback on the task.

Furthermore, the background study included a thorough analysis of gamification. One exciting quote highlighted in the study is that of Robertson, where she says, "What we're currently terming gamification is in fact the process of taking the thing that is least essential to games and representing it as the core of the experience. Points and badges have no closer a relationship to games than they do to websites and fitness apps and loyalty cards. (...) They are the least important bit of a game, the bit that has the least to do with all of the rich cognitive, emotional and social drivers which gamifiers are intending to connect with" [80]. Bjering et al. agree with this criticism. However, they claim that by moving past the superficial application of mere points, gamification can encourage immersion and engagement by considering the wide range of game design elements.

The study results are discussed from a motivation perspective by drawing attention to three concepts that relate to intrinsic motivation: Competence, autonomy, and relatedness. The results include a list of suggestions for future chore app development. This list includes focusing on autonomy, competence, and relatedness, to use limited extrinsic rewards, to focus on collaboration rather than the individual, and to explore the constructive and more open field of play.

12.2 Improving User Experience with Gamification and Reward Systems

Kartevoll tries to take advantage of the continuously increasing use of smartphones and tablets in order to motivate children to assist in housework using gamification [81]. Kartevoll states that gamification features are often implemented poorly and might have a reversed effect on motivation. Consequently, Kartevoll's study explores ways of implementing a reward model to improve such poor use of gamification, see Figure 12.3. In order to implement this reward model, Kartevoll explores several theories and mechanics concerning gamification, as well as motivation theory related to games, reward systems, and social interaction.
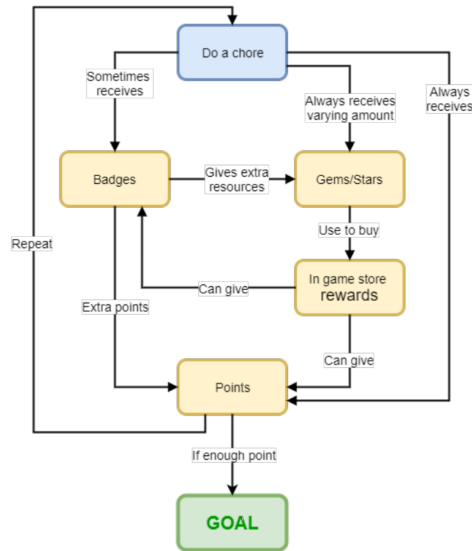
Figure 12.3: Kartevoll's proposed reward model for his solution, taken from [81].

The findings of these studies serve as a foundation for Kartevoll's proposed solution. Key points that Kartevoll found in his studies were:

- By rewarding often and in various forms, rewards can become powerful motivators.

- Greed should never be underestimated as a motivator.

- Using different gems of various worth when rewarding users for doing chores may trigger curiosity due to the uncertainty it facilitates.

- The use of triangularity is one of the most interesting and exciting choices humans make.

Based on these critical points, in addition to other findings, Kartevoll implements the reward model in a mobile application, which he created with Unity. This application intends to enhance children's motivation, engagement, and enjoyment in doing chores.

To test the quality of these perceptions, Kartevoll conducted an experiment where 22 children participated. The results of this experiment suggest that the application positively affects every category of the perceptions examined. However, the experiment also revealed several flaws and improvements to increase the affected

perceptions even further. Most of these improvements were specific to the application's implementation and consisted of minor ideas on how to improve single features. However, one crucial statement Kartevoll makes is that a reward model can not single handily contribute to making a task's motivation intrinsic as it does not necessarily have a direct impact on its execution.

12.3 Gamification and Web-based Homework

Goehle demonstrates how video game mechanics can be used to help improve student engagement with online mathematics homework [82]. He does this by integrating two standard video game systems, levels and achievements. He implements these systems with the online homework program WeBWorK.

In order to get more familiar with the video game systems and how to apply it in an application, Goehle does a background study on gamification. Here, he finds that levels should be implemented in such a way that granting levels become more challenging when achieving higher levels. Further, he separates achievements in three types, achievements earned in the ordinary course of gameplay, achievements requiring extra effort, but still earned by performing regular in-game activities, and achievements requiring players to accomplish a goal mainly unrelated to the standard gameplay.

Goehle chose WeBWorK due to its open-source nature, meaning it was easy to modify. The system rewarded students with five XP for every homework problem answered correctly. A new level was reached whenever a student's accumulated XP passed a given threshold, see Table 12.1. Furthermore, the system implemented a script that monitored secondary conditions in order to verify achievements. These achievements consisted of hidden and visible goals. The system made sure to give students immediate feedback on both level progression and earned achievements. Finally, to increase the weight, the achievements and levels carried with the students, a feature where students could share their progress on their Facebook wall, was implemented.

The system was tested in two sections of a standard 16-week Calculus I course. The sections consisted of a total of 60 students, of which 29 students responded to a questionnaire concerning the system. 93% said they kept track of their level and achievements, and 89% said they actively tried to earn achievements. However, the students' performance remained the same as in courses without the system. That said, the gamification of the course seemed to increase the students' engagement in doing homework.

Level	XP	Name
1	0	Calculus Initiate
2	100	Calculus Novice
3	210	Calculus Apprentice
4	330	Calculus Journeyman
5	460	Calculus Fellowcraft
6	600	Calculus Adept
7	760	Calculus Craftsman
8	940	Calculus Artisan
9	1140	Calculus Specialist
10	1360	Calculus Professor

Table 12.1: The increasing thresholds for achieving new levels in Goehle's homework system. Taken from [82].

12.4   Studying Gamification: The Effect of Rewards and Incentives on Motivation

Richter et al. try to form theoretical principles for gamification in practice [83]. They offer a framework for building feedback mechanisms based on the role of rewards on intrinsic and extrinsic motivation. They do this by examining gamification and serious games, in addition to introducing three components: a model of motivation in games (see Figure 12.4), a classification of game achievements according to their characteristics, and future research directions.
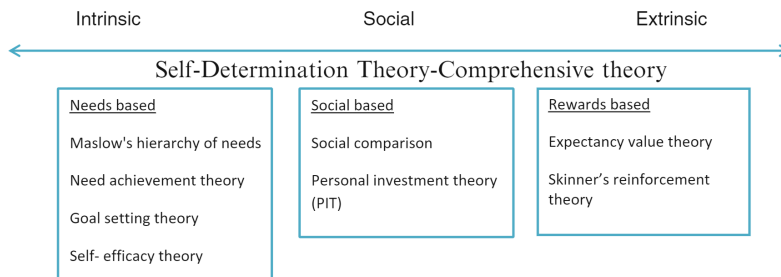
Figure 12.4: A model of motivation in games, taken from [83].

They find that serious games and gamification are sometimes distinct but often interchangeable. Serious games' primary purpose is to train, investigate, or advertise, whereas gamification is the application of game elements for purposes other than their expected use for entertainment. They examine a spectrum of motivation theories to deepen their understanding of the role of rewards and interpretation of players' motivations for engaging and playing. Here they find several vital points concerning motivation in games. Some of these points are:

- Competition, social interaction, or cooperation may influence player behavior.

- Human behaviors are driven by the desire to satisfy physical and psychological needs.

- People aim toward a more approving position than others they are compared with.

- Occasional reinforcement of behaviors leads to a greater persistence to extinction than continuous reinforcement.

Richter et al.'s study on the effect of rewards and incentives on motivation concludes that even though the goal of gamification is to create and maintain intrinsic motivation, it does so by applying extrinsic motivators, see Table 12.2. Further, the conclusion states the importance of understanding human drivers, beliefs, and emotions in order to design effective rewards systems.

12.5 The Gamification as a Resourceful Tool to Improve Work Performance

This study focuses more on a technological view of how gaming solutions are implemented in work situations to improve work performance. Chen also studies cases of practices in applying gamification in businesses [84].

Chen, similar to the other studies, does a study on how gamification works. One interesting point that he finds is that the acceptance for gamification is higher when the rewards are associated with business objectives, and when feedback is instant. Further, he discusses technological limitations concerning the implementation of gamification. He finds that even though there are few limits from a technological perspective, there are constraints that should be considered. For instance, data collection may be a limitation in cases where the game strategy relies on data that is not being tracked.

Additionally, the study evaluates how gamification aids in solving business problems. One essential problem addressed is the ever-increasing problem that the

Motivation theory	Incentives/rewards	Role
Self efficacy	Audio/verbal/visual/music/ sounds effect	Feedback
	Progress bar	Feedback, achievements
Self-efficacy, goal-setting, PIT, expectancy value, need achievement	Points/bonus/divident	Feedback, reward, status, achievements, competition, progression, ownership
	Mini games/challenges/quests	Reward, status, competition, achievements
Self-efficacy, goal-setting, PIT, expectancy value, social comparison	Badges	Status and reputation, achievements and past accomplishments, collection, competition, ownership
	Virtual goods	Reward, social, status, achievements, ownership, self-expression
	Leaderboard	Status and reputation, achievements, competition
	Rewards-choosing colors, power	Achievements
Self-efficacy, goal-setting, PIT, expectancy value, need achievement, social comparison	Achievements	Collection, status, competition, discovering, progression
	Levels	Feedback, status and reputation, achievements, competition, moderate challenge
Social comparison, personal investment theory, expectancy value	Avatar	Social, self-expression, ownership

Table 12.2: The theoretical base of incentives and rewards, taken from [83].

workers are not engaged at work. He states that implementing layers of gaming methodologies on top of HR's current systems can lead to a more desired employee performance. Furthermore, by using gamification, HR can focus more on individual skill levels, and thereby train employees to become great resources to the company.

Chen also discusses the limitations of gamification. He finds that:

1. Gamification shall not present any challenges originating from confusion.

2. Training and experiments must be conducted to eliminate glitches and problems that could obstruct the system.

3. Employees must be given an appropriate amount of time to learn the game mechanics.

4. A meaning to the user must be provided in the game.

Furthermore, the process of implementing gamification can be expensive. Thus companies with inadequate funds may be incapable of keeping up with competitors as they can not afford the implementation of these systems.

Chen concludes that gamification is based on the fact that individuals prefer to play rather than work. He also finds that the mind processes stimuli much faster in a gaming environment. That said, he also states that effectiveness depends on how the system is used. For instance, experiments have shown that participants in teams put more effort into the game than participants who played alone. Finally, the conclusion states that tech stakeholders and analysts believe game mechanics, feedback loops, and rewards will become more embedded in daily life.

12.6 Mandatory Fun: Consent, Gamification and the Impact of Games at Work

This study examines whether gamification is a tool that encourages the benefits highlighted by prior studies, or if gamification in a work setting is more of a "mandatory fun" for employees. They explore the relationship between consent and the effect of gamification [85].

They present three hypotheses that they explore in an experiment conducted in a startup company. These hypotheses are:

1. "Consent moderates the relationship between gamification and employee positive affect such that (a) for those who consent to the game, gamification improves employee positive affect and (b) for those who do not consent to the game, gamification decreases employee positive affect" [85].

2. "Consent moderates the relationship between gamification and performance such that (a) for those who consent to the game, gamification improves employee performance and (b) for those who do not consent to the game, gamification decreases employee performance" [85].

3. "Greater gameplay outside of work increases the likelihood that employees will consent to games at work" [85].

During the experiment, 242 salespeople answered both pre- and post-treatment surveys. The experiment involved a basketball-themed game, where employees were rewarded whenever they completed a sale. The reward afforded the employees points and played different basketball-related animations on large screens throughout the office. The experiment lasted 18 days.

Results from the experiment showed that consent played a vital role in the game's impact; Increased degrees of consent correlated with increased positive effect within the game condition, see Figure 12.5. Furthermore, they found a clear connection between multiplayer gameplay outside of work and consent to game

at the workplace. Hence, games can have a strong positive or negative effect, depending on the employee's underlying consent.
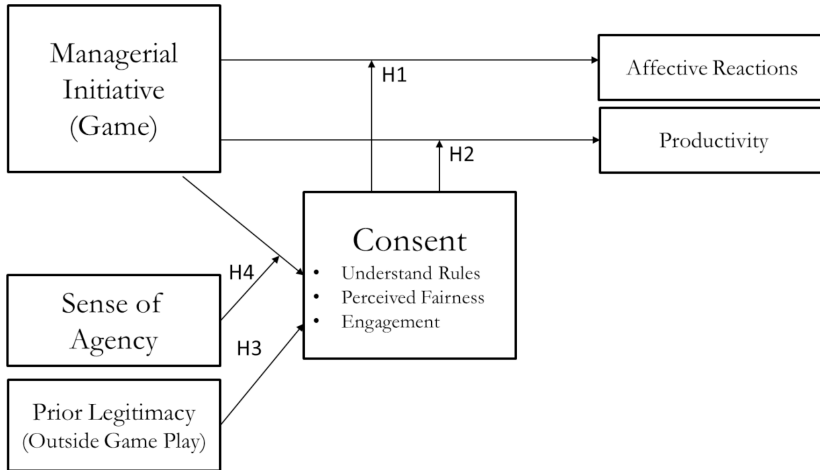
Figure 12.5: How the three hypotheses, H1, H2, and H3 support the effect of the implemented game, taken from [85].

12.7   Similarities and Differences

This section presents the similarities and differences between our work and the presented related work. The section is organized such that each work is examined with similarities and differences in mind. They are presented in the order they were reviewed.

12.7.1   Gamification and Family Housework Applications

The main difference between our work and Bering et al.'s work is that their study focuses more on analyzing existing applications and the effect of gamification in those applications, whereas we focus more on implementing gamification in an actual application.

Furthermore, in terms of the background study, they focus more on self-determination and intrinsic motivation, and how that can be achieved by using gamification elements. On the other hand, we focus on directly rewarding the completion of tasks and putting more focus on extrinsic motivation. Furthermore, Bjering et al. discuss their result from a motivation perspective by drawing attention to

competence, autonomy, and relatedness. At the same time, we focus more on general motivation, enjoyment, and engagement in chores. However, similarly to their study, we focus on collaboration instead of the individual, and we agree on the fact that it is critical to move past the superficial application of mere points in order to use gamification to encourage immersion and engagement.

12.7.2 Improving User Experience with Gamification and Reward Systems

Kartevolls study is more similar to our study. He has an immense focus on rewards to promote motivation, enjoyment, and engagement in doing chores. However, Kartevoll is more focused on children, whereas we focus more generally on groups of families, collectives, and couples.

12.7.3 Gamification and Web-based Homework

Goehle focuses on another domain than ours, in which he tries to implement gamification mechanics in a homework system. Furthermore, Goehle has a more specialized focus, where he mainly focuses on levels and achievements, whereas we focus more on gamification in general. However, Goehle presents many similarities to us in the way he implements feedback and social interaction. He focuses on immediate feedback, and he implements a social media sharing feature to strengthen the effect of the gamification elements implemented.

12.7.4 Studying Gamification: The Effect of Rewards and Incentives on Motivation

Richter et al. have a more theoretical take on the study. They tried to create a framework for building feedback mechanisms based on the role of rewards instead of implementing an application that utilizes gamification. However, they present many similar motivation theories, especially in terms of social interaction and occasional reinforcement.

12.7.5 The Gamification as a Resourceful Tool to Improve Work Performance

This study focuses more on gamification in a work-related scenario and addresses more business-related problems. Additionally, Chen focuses more on the technological limits concerning the implementation of gamification. On the other hand, we focus on the possibilities provided by gamification. Nevertheless, Chen

highlights some interesting points that agree with our implementations; that individuals prefer to play rather than work, and that participants in groups put more effort into the game than participants playing alone.

12.7.6   Mandatory Fun: Consent, Gamification and the Impact of Games at Work

Opposing to our study, this study concerns itself more with the impact of gamification concerning users' consent. Interestingly, they found that users with prior gaming experience often showed more consent; this is not something we have actively considered but should consider in the future development of our solution.

12.8   Summary

This chapter has reviewed two related Master's Theses and four related articles. These reviews show many highlights and key points that relate to our study. Additionally, similarities and differences between our study and the reviewed work are presented in an organized manner. The review of the related work act as a foundation for validating that our methods correspond with already tested standards, as well as elaborating on our theoretical background in a way the aids in further improvement of our final solution.

Chapter 13

Application Review

This chapter will review successful applications and chore-related applications in terms of how they use rewards and how they motivate users. The chapter will end with a discussion of the different reward types and how they can be implemented in the final solution.

13.1 Non-Chore Related Examples

This section will review different successful non-chore related applications.

13.1.1 Archero

Archero is a fast-paced mobile action game. The gameplay consists of various stages iterated by one character controlled by the player. Each stage consists of several enemies, and the goal is for the player to complete as many stages as possible before dying. The player accumulates different types of currency when playing the stages. These currencies can be used to upgrade the character, buy new supporters, and even upgrade different items.

The game has a playful design and uses 3d objects and characters with an orthographic camera angle to create beautiful gameplay. In addition to this, the game has an impressive menu with tons of extra features. For instance, the game promotes a battle pass, which lets the user earn rewards by playing and leveling, it lets the player open chests in which the player can win items of different rarities, and it offers limited edition playing modes that change with time, see Figure 13.1.

Reward types	Motivation
Coins, Gems, and Sapphire as Currency	Buy and upgrade gear
Items	Improve player
Scrolls as resources	Acquire new characters
Completion of levels	Reach new levels
Experience points	Experiment with new weapons
Battle pass	Level up the player
Hidden rewards in unlockable chests	Get higher score then other players
Visuals and Sound	Curiosity on new content
Animations	

Table 13.1: Rewards and Motivation in Archero.

As seen in Table 13.1, the game offers plenty of reward types and motivating elements. One reward type that plays a particularly important role in this game is new items. This may facilitate curiosity in the user by the introduction of new hidden items and the impact these items have on the gameplay. The importance of curiosity in motivation is outlined in Malone's framework (Chapter 8).

Figure 13.1: Screenshots of the mobile game Archero.

13.1.2 Fortnite

Fortnite is a highly successful online third-person sandbox shooter; it comes with many game modes, where the most popular is the battle royale mode. The battle royale mode consists of 100 players that skydive and lands on different locations. The goal is to be the last one to survive. In order to survive, the player has to kill other players, gather resources to build protection, scavenge for gear, weapons, and consumables to gain the advantage, and avoid the continually shrinking dome that forces all players closer to the center, see Figure 13.2.

Figure 13.2: Screenshot of the game Fortnite.

The game targets a wide variety of players. It has a playful low-poly game design that focuses on fun characters, emotes, and even dancing. This game, similar to Archero, offers a vast amount of features outside of the game session. Players can buy cosmetics, emotes, and dances to customize their characters. Fortnite motivates players to play in many different ways, especially by using rewards of different kinds, see Table 13.2.

Epic Games, the creators of Fortnite, has created a game to facilitate game flow. It implements all the elements described by Sweetser and Wyeth (Chapter 8) to achieve game flow. Seeing that the game in August 2018 recorded 78.3 million monthly active players [86], it is safe to say that the game provides excellent incentives for players to play.

Reward types	Motivation
Items and Gear	Social Interaction Competition
Experience points	Challenge
Score	Curiosity of new items and gear
Hidden rewards	Curiosity of new emotes and dances
Cosmetics	A clear goal of surviving
Emotes and Dances	Feedback on performance trough kills
Character skins	Feedback on performance by placement
Instant feedback	
Penalties	
Visuals and Sound	
Animations	

Table 13.2: Rewards and Motivation in Fortnite.

13.2   Chore-Related Examples

The following section presents different chore-related solutions and the rewards and strategies they use to motivate users.

13.2.1   Sambo

Sambo is a mobile application that focuses on chore-related tasks within a collective. The application states that it helps collectives fulfill their household tasks by distributing tasks through a todo-list. Also, by making users able to see if other users complete their distributed tasks, they claim to help motivate users to do tasks. Furthermore, it offers features that let players "burn" other players that avoid doing household work, see Table 13.3.

The application is easily manageable, and all players can add tasks to the todo-list. The application automatically distributes these tasks. The app also lets the user decide on time intervals for how often tasks should be completed. The app has a simplistic design and uses fun icons to help categorize tasks, see Figure 13.3.
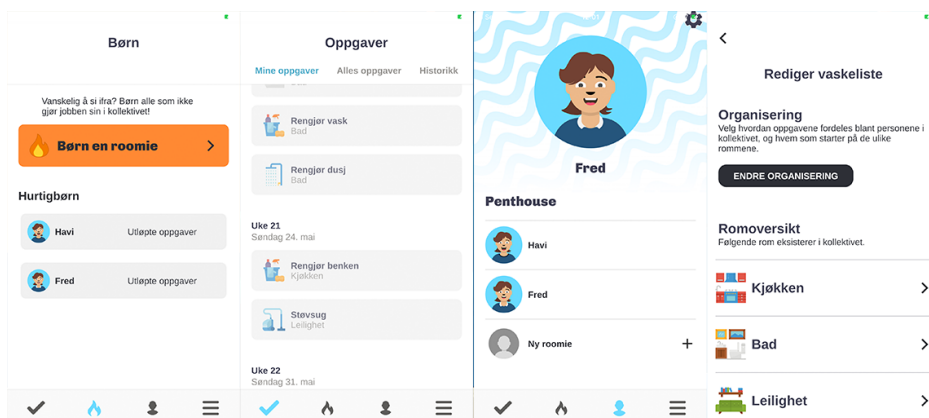
Figure 13.3: Screenshots of the mobile app Sambo.

Reward types	Motivation
Feedback	Overview of completed tasks
Penalties	Get burned by others if lazy
Visuals	Deadlines
	Clear tasks

Table 13.3: Rewards and Motivation in Sambo.

13.2.2 Homey

Similar to Sambo, Homey is a mobile application that focuses on chores. However, Homey is oriented around families and offers features more applicable in families. Such features are the distribution of allowance, from parents to kids, as a reward for single tasks, organizing responsibilities for both parents and kids, photo-proof for validating the completion of tasks, and role separation for administrating the app on various levels, see Table 13.4.

Homey also implement a simplistic yet fun design and uses icons to classify tasks in a fun way. However, the usability of Homey is a bit more comprehensive and requires more effort at first, see Figure 13.4.

Reward types	Motivation
Feedback	Overview of completed tasks
Allowance	Clear tasks
Visuals	Fulfill responsibilities
Score points	Social interaction, compare statistics
	Social interaction, validate others

Table 13.4: Rewards and Motivation in Homey.
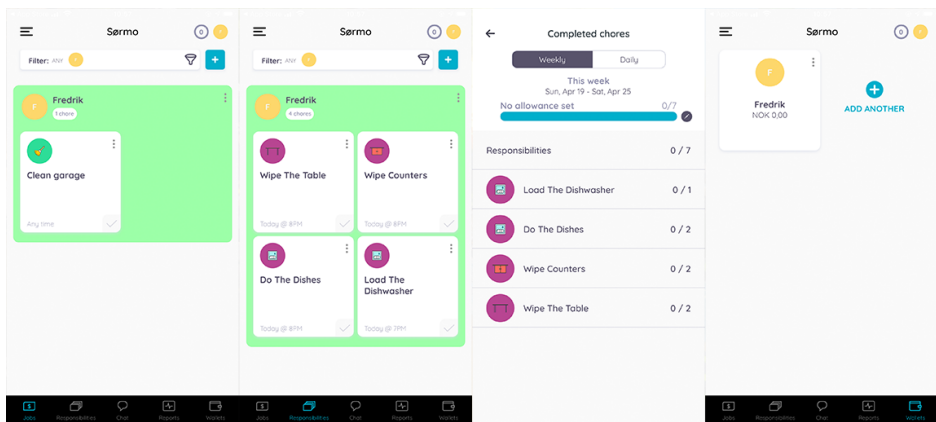
Figure 13.4: Screenshots of the mobile app Homey.

13.2.3   OurHome

OurHome bears many similarities to both Homey and Sambo. However, OurHome does not directly target families nor collectives. It implements a more general organizing of tasks and rewards that targets both groups. It uses a more customizable reward system where any user can add rewards and define the cost and criteria of such rewards, see Table 13.5.

OurHome has a more professional look in general, yet similar to Homey and Sambo; it also uses fun icons as a way to categorize tasks. In terms of tasks and responsibilities, OurHome uses a more todo oriented illustration. Hence, tasks are more similar to Sambo then Homey, see Figure 13.5.
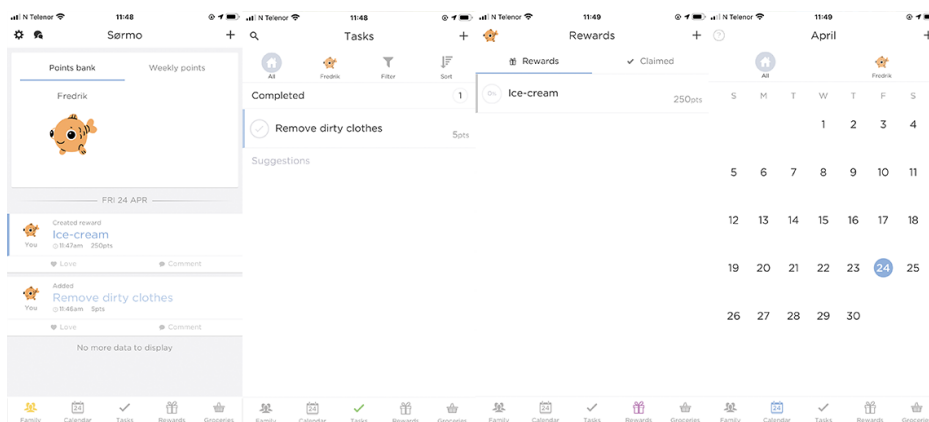
Figure 13.5: Screenshots of the mobile app OurHome.

Reward types	Motivation
Feedback	Overview of completed tasks
Rewards	Clear tasks
Visuals	Fulfill responsibilities
Score points	Social interaction, validate others

Table 13.5: Rewards and Motivation in OurHome.

13.3 Discussion

This section discusses the analysis of the applications with a focus on reward types, motivational elements, and the difference between chore-related applications and general games.

13.3.1 Reward Types

The chore-related applications all used rewards to some extent. These rewards mostly consisted of points and scores; that, in some ways, could be converted to real-life rewards. Compared to other popular games, this seemed a bit boring and flat. However, it can be discussed that the motivation for playing popular games is originated in the enjoyment itself. Simultaneously, chore-related applications are more focused on motivating users to do something that, for many, is

seen as boring. Thus, directly rewarding the completion of tasks, may be more relevant then rewarding the usage of the application with rewards such as visuals, animations, and sound.

13.3.2 Motivation

In the analyzed applications, most of the motivation seemed to come directly from rewarding the completion of tasks. However, social interaction occurred to some extent. Statistics on how many completed tasks a user did seemed to aid in facilitating competition between the users. Additionally, Homey and OurHome, implemented features that let users validate other people's tasks. Finally, Sambo implemented a feature that lets users burn other users for not doing tasks. According to the flow model, social interaction is one of the eight elements that help facilitate flow [37].

According to Malone, challenge, fantasy, and curiosity are essential for intrinsically motivating people [33, 34]. In all the analyzed chore-related applications, challenge comprised of doing the chores themselves, whereas curiosity relied more on the specific types of rewards, and the introduction of new rewards. Fantasy was only implemented to some extent; thus, the usage of the applications themselves felt somewhat flat. However, as stated, these applications focus more on the task at hand than the usage of the applications.

Part III

The Prototype: Spot

This part presents Spot, an iOS and Android application, the result of working iteratively to create a fun, motivating, and engaging application for doing chores. First, elaborating three different concepts outlined iteratively. Furthermore, presenting the technologies, proposed solution, requirements, low and high fidelity prototypes, architecture, and testing of the application.

Chapter 14

Concept

This section presents the fully developed concept in addition to two prototyped concepts. The concepts described are a result of working iteratively, where concepts evolved. The first two concepts were conceptualized, prototyped, partially developed, and evaluated. The evaluation led to the final concept, Spot, which was also conceptualized and prototyped in addition to being fully developed and tested.

14.1   First Concept: Chorify

As a result of multiple workshops, and brainstorming, a paper prototype of the first concept was formed. The entire paper prototype is included in Appendix C. By testing the paper prototype on several people, and building a conceptual design, the establishment of Chorify took place. The logo and login view is illustrated in Figure 14.1. The core concept of Chorify is to be a fun and motivating game-like tool wrapped around doing chores in a household. Being a tool, Chorify tries to give players freedom by enforcing as few rules as possible. Tightly coupled into the core concept, Chorify enables users to distribute, execute, and get rewarded for doing chores. Collaboration and individual effort are embraced by including both collective and individual rewards in the core concept. Rewards are real rewards, decided, added, and provided by members of the household itself. Players are required to evaluate the chores completed by others in the household to facilitate learning and teamwork.

The concept combines an idle game concept with a reward system based on doing chores. A typical idle game rewards players with a virtual currency over

time, even if the player is not playing the game. The specific amount rewarded is calculated by the number of upgrades the player has bought. The price of buying upgrades increases proportionally with increased income, however giving the player a feeling of progression through better looking visual elements.
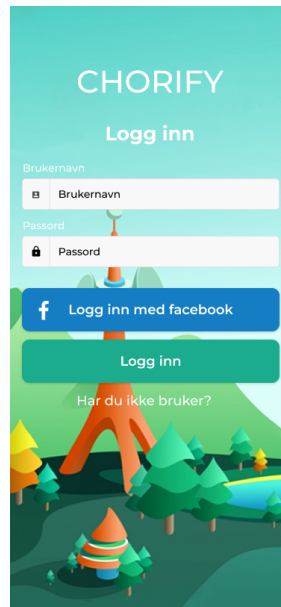
Figure 14.1: Chorify: Logo and log in screen.

14.1.1   Functionality and Interfaces

The screens most commonly used are illustrated in Figure 14.2 and Figure 14.3. In Chorify, there are two virtual currencies: "SUPERPENGER" is acquired by doing the first three chores of the week, and "MINIPENGER" from every chore completed after those three. Each individual in the household can upgrade a single piece of "SUPERPAPPA" with SUPERPENGER to increase his speed towards a collective reward. The collective reward is a reward the household decides to reward themselves with when they reach the goal. Eating out at a restaurant and going out bowling are examples of possible rewards. MINIPENGER is used to buy individual rewards. Weekly wages, choosing what to have for dinner, choosing a movie for the next movie evening in the household are examples of possible rewards.

Chores are divided into two groups, responsibility areas, and rarely done chores.

Responsibility areas are chores that must be done several times during the week, for example, going out with the trash. To avoid having the same responsibility area every week, each member of the household receives a random area each week. Rarely done chores happen every other week, for example, cleaning the bathroom. However, the completion of any chore requires an evaluation from another member of the household. The evaluation determines the amount of virtual currency rewarded to the household member who completed it.
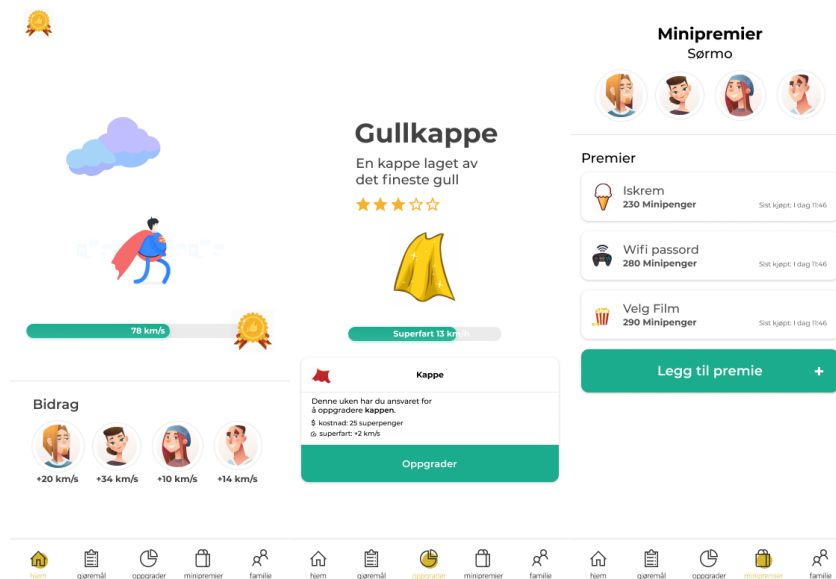
Figure 14.2: Chorify: Left: Collective progress and member contribution. Middle: Individual upgradeable piece. Right: Individual rewards.

14.1.2 Evaluation

Several flaws were found when converting the Chorify concept from theory to a practical concept during the development. First of all, the visual elements and effects would be crucial to give members of the household a feeling of progression. With a lack of experience within graphic design, the concept would not reach its potential. The second most crucial flaw discovered was that upgrading only a single element would be boring and become a usability issue. The evaluation concluded that the upgrade should be automatically executed when receiving a reward.
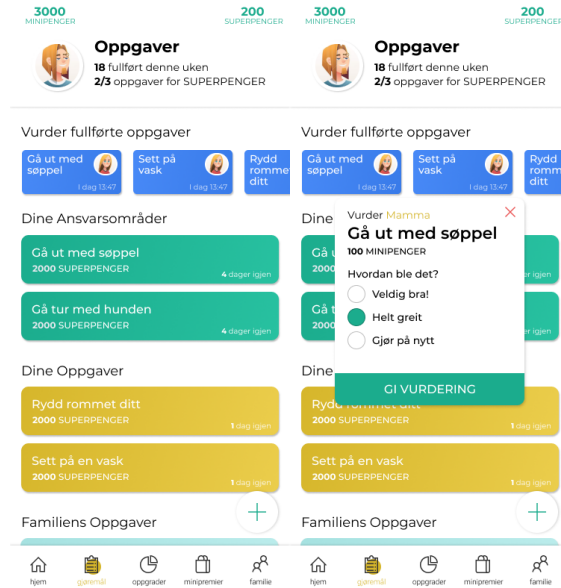
Figure 14.3: Chorify: Left: Main view, displaying active and completed chores. Right: Evaluating another household member's chore.

14.2   Second Concept: Chorify-Boat

To solve the flaws discovered when evaluating the Chorify concept, the establishment of Chorify-Boat took place. By changing the theme from a family-centered super dad to a boat theme allowed for multiple upgradeable elements for boats. A fleet of boats illustrated in Figure 14.4, where each household member represents each boat, determined the progression towards a collective reward. Each individual could unlock new boats, with a variety of upgrade boosts illustrated in Figure 14.5. A considerable amount of time was spent on the graphical design and the implementation of a new high-fidelity prototype.
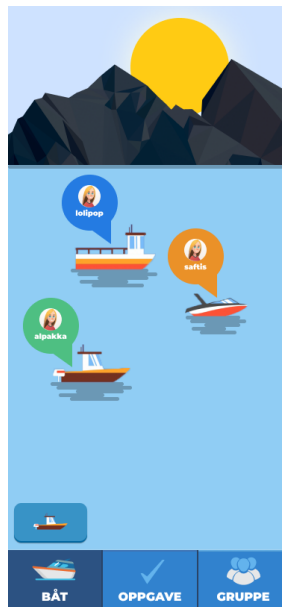
Figure 14.4: Chorify-boat: Each household member represented by their boat.
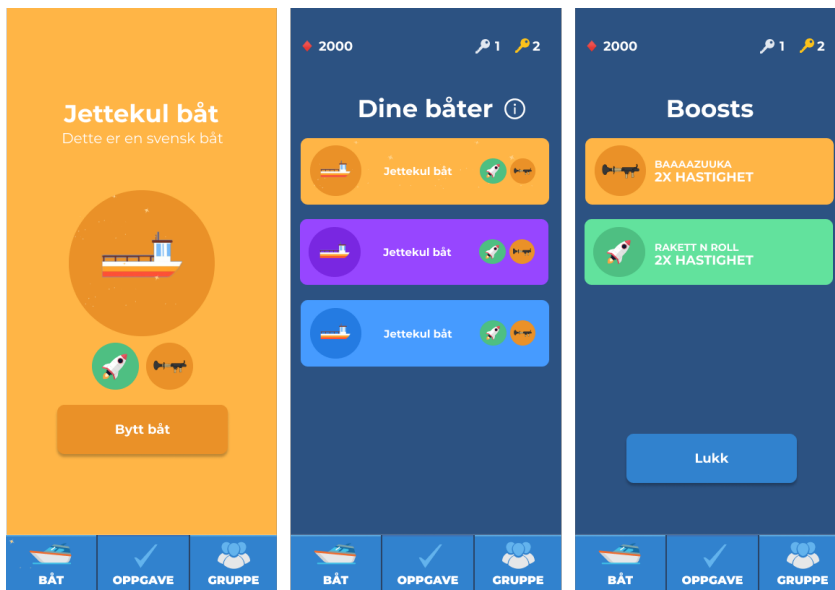
Figure 14.5: Chorify-boat: Left: Your selected boat. Middle: Your boats. Right: Boat's selected boosts.

Chorify-Boat uses the same core concept as described in Section 14.1 concerning the distribution, execution, and reward system for doing chores. A few new elements were introduced to compare each member's effort with the other members of the household, as illustrated in Figure 14.6. The effort for the last seven days displays a sum of the rating the member has received from their evaluated chores. Such a leaderboard aims to engage household members into doing chores by clearly displaying the difference of each member's effort. The emoji-bar places household members into a ranked system based on effort, trying to engage members by providing a goal.

Figure 14.6: Chorify-boat: The main view, displaying a comparison of effort, functionality to add new chores, and completed chores to evaluate.

The reward system was revamped, adding a wheel a fortune to spin after completing a chore, as illustrated in Figure 14.7. Spinning the wheel provides a random reward. The reward types are new boats of different rarity, boosts for boats, and diamonds. Purchasing individual rewards requires diamonds, a virtual currency. Individual rewards are rewards that focus on having other members of the household do things, rather than focusing on materialistic rewards that must be bought—for example, choosing another household member to make dinner, breakfast, or give a massage. Default individual rewards would be chosen

according to the type of the household, family, collective, or couple. Only three rewards can be bought weekly. However, active rewards that can be bought are randomly selected weekly. A bought reward cannot be bought by any other person that week.
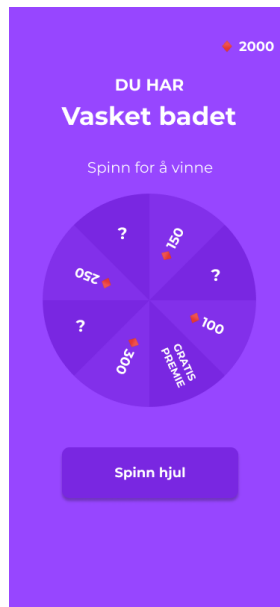
Figure 14.7: Chorify-boat: The wheel of fortune providing a random reward.

14.2.1 Evaluation

When evaluating the themed boat concept, a couple of crucial questions arose. Thinking long term, will users get bored of receiving new boats, and being able to upgrade them? Is the concept tightly coupled together? A thorough discussion revealed that the concept consisted of two poorly coupled concepts that are not suited for an application classified as a tool. There are too many actions that are enforced on the household members. The concept should be simplified and, to a greater extent, tightly coupled.

14.3 Final Concept: Spot

Spot is the final concept that was fully developed and tested in households. All elements related to boats and boosts were removed to simplify the concept. The theme was generalized to be applied to multiple types of households like collectives, families, and partners efficiently. Focusing on the execution, and rewarding of doing chores, Spot embraces individual rewarding for members that contribute to their household by doing chores. By inspiring and engaging members to do chores, Spot tries to motivate and encourage members of the household to execute chores. The concept needed to allow for a fast and straightforward way for members to add completed chores. Failing to do so, members would hesitate to use Spot as doing chores would be even more time consuming than it already is. However, the use of Spot requires further effort than only just doing a chore. It is, therefore, crucial that the members feel that the additional time invested in using Spot pays off by having a motivating and engaging reward system. Instead of rewarding members with materialistic rewards, Spot tries to engage members of the household to reward each other with actions that make each member's contribution seen and appreciated. The development of Spot will be described more in detail in the following chapters.

Chapter 15

Potential and Chosen Technologies for the Solution

This chapter presents the technologies used to develop the solution and what factors were taken into consideration when deciding on the technologies. We will not mention all the considered technologies.

15.1 Figma

Figma is a sophisticated graphical design application running in the browser. It is excellent for both collaborative and solo graphical design jobs; it comes with a lot of industry-standard tools and assets that make it less complicated to design complex user interfaces [87]. Figma was mostly used for conceptualizing and designing the different scenes for the concepts. As mentioned in Chapter 14, we considered several concepts, and Figma proved to be very useful in helping us visualize and prototype those concepts.

15.2 Unity

Unity is a game development framework that lets the user develop both 2d, 2.5d, and 3d games. The documentation on the engine is excellent, and it makes it possible for anyone to learn Unity regardless of prior knowledge. However, programming in Unity is done in C#; hence general knowledge of C or other classical programming languages provides an advantage when learning Unity [88].

15.3   React Native

React Native is the mobile version of React. It lets users develop cross-platform mobile applications by using JavaScript. React Native, similar to Unity, is incredibly well documented, and anyone can get familiar with the framework. React Native is an open-source framework and has a vast amount of active users. Hence, the framework continually updates, and it aims to be compliant with most modern tools.

Furthermore, React Native comes with a lot of user-created libraries and tools that aid in developing complex applications. React Native is excellent for many application types due to the variety of tools and libraries, especially heavy UI reliant HTTP applications. However, opposite to Unity, React Native is not particularly useful for game development nor game-oriented applications [89].

15.4   Unity or React Native

The exploration of multiple concepts naturally resulted in difficulties when deciding on what technologies to use for development. For instance, the first concept focused more on the game part of the solution. Hence a discussion of whether Unity was a better choice then React arose. However, as we evaluated the concepts and moved on to a more housework focused solution, the decision on the technologies became more evident. Unity is an excellent tool for game-oriented applications; it is not, however, as great for heavy UI reliant applications. Thus due to its compliance with cumbersome UI and Firebase, the decision landed on React Native for the final concept.

15.5   Expo

React Native is, as mentioned, an excellent tool for developing cross-platform applications. However, when it comes to deployment and publishing of such applications, the process can be complicated and time-consuming. Expo is a platform that helps in solving these problems by being able to quickly build and deploy React Native applications [90]. However, since Expo is an independent platform that supports React Native, it is not always in sync with the latest updates of React Native. Thus it can not be expected to support all the newest functionality provided in React Native. That said, the advantage of being able to build and deploy quickly, in our case, outweighs the fact that some new features might be missing.

15.6 Firebase

Firebase provides several web services for developers to use both when developing and deploying applications. Some of these services are Firestore, a document-oriented live database, and cloud functions, server functions triggered by events or user requests [91]. Due to React Natives compliance with Firebase, Firebase was a natural choice for hosting and managing the backend for the solution.

15.7 Amplitude

Amplitude is a web service that provides developers with tools to register user-events and organize them in ways that aid in analyzing user behavior in the application [92]. Amplitude is compliant with Expo and proved to be an excellent tool to collect data on how the users behaved in the solution. Hence, aiding in the analysis validation of the user behavior in the final user test.

15.8 Summary

This chapter has presented some of the key technologies used in the developed solution. Furthermore, it has presented decisions that were made with regards to technology and conflicts that occurred due to the frequent iteration of concepts in the beginning.

Chapter 16

Proposed Solution

This chapter will present the first iteration of the proposed final solution.

16.1 User Flow

This section will describe the main user flow within the proposed application. Only the most repetitive, and core actions for the usage of the proposed solution are included, see Figure 16.2.

16.1.1 Duel

Whenever the question of which user should do a specific chore raises. The users can challenge one another using the duel feature. The duel feature is a simple game that tests users' reflexes in different ways. The user that loses the duel has to complete the chore. The duel feature engages users in the application and aims to facilitate social interaction in terms of competition. Furthermore, the duel also provides a way of implementing fantasies within the application. For instance, the duel could be that the users have to dodge chores falling from the sky, or that the users have to shoot one another in a classical cowboy duel. As Malone states, fantasies like war, destruction, and competition are likely to be more popular than other less emotional fantasies [33, 34].

16.1.2 Chore

The user finishes a chore and adds it as completed within the application. All chores are displayed together in a chore-list and await evaluation by other users.

However, before the evaluation is done, the user that completed the chores is instantly rewarded with a wheel of fortune.

16.1.3   Wheel of Fortune

Whenever a user completes a chore, the application presents the user with a wheel of fortune. This wheel displays various potential rewards that the user may obtain. In the proposed solution, there are three different rewards, a varying amount of coins, an unknown price that reveals with the evaluation of the chore, and a free real-life reward. Some rewards are less likely to be won than others. For instance, acquiring a small number of coins will happen more frequently than winning a free real-life reward. As Roger says, rewards can become powerful motivators by rewarding often and in varying amounts [93].

16.1.4   Reward Ladder

Whenever a reward is won, the application presents the user with a reward ladder. This ladder illustrates what kind of impact the evaluation will have on the reward. Let us say, for instance, the user wins a reward of 300 diamonds. These diamonds, however, might be reduced in the case of receiving a bad evaluation. This provides an incentive for the user to not only complete chores, but also be thorough in the execution of doing chores, see Figure 16.1.

16.1.5   Evaluation

The evaluation comprises two factors: how well the user did the task and the effort the task required. The solution aim to facilitate social interaction through competition by letting users evaluate each other. As stated in Chapter 11, social interaction is known to be a powerful motivator, and that playing with a friend produces more positive emotions than playing alone [69]. Also, a game can promote a feeling of relatedness through social interaction (competition and cooperation). As stated by self-determination theory, by facilitating a feeling of relatedness in games, the experience becomes more enjoyable [44, 45].

16.1.6   Sharing

Whenever an evaluation is complete, the evaluating user is prompted to share the event on social media. This is a way of raising interest in the application, and it is a decent way to encourage competition between separate families and groups.
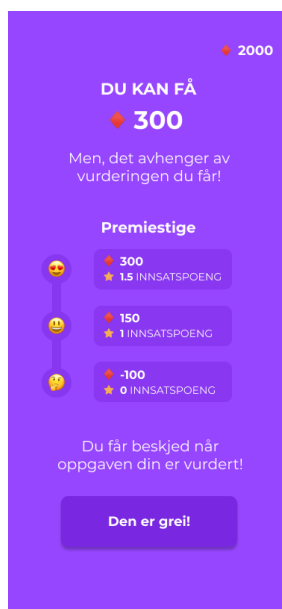
Figure 16.1: Screenshot of the reward ladder within the proposed final solution.

16.1.7   Diamonds

Diamonds are solely gathered by doing chores. The primary purpose of these diamonds is to act as a currency within the application. Currently, the proposed solution implements only one way to use this currency, the in-game store. However, with future development in mind, diamonds can act as a global currency for multiple functionalities; for instance, one feature discussed is the possibility to pay each other for doing chores. Furthermore, the metaphor of saving diamonds to achieve some reward may aid younger users in familiarizing themselves with fundamental, economic concepts.

16.1.8   Store

The in-game store distributes different real-life rewards. These rewards can both be user-generated or default rewards that come with the application. The default rewards vary based on the users living situation. For instance, the store presents users living in a collective with different rewards than users living in a family. The prices for the rewards vary based on the impact of the reward on the real-life situation. The store cycles the rewards each week. This means that new

rewards are presented at the start of each week, whereas the old rewards get unavailable. As Malone states, to engage learners' curiosity is to present just enough information to make their existing knowledge seem incomplete. Thus, the cycling of rewards facilitates curiosity in the user and motivates the user to both exploring and buying new rewards [33, 34].

16.1.9 Real-Life Rewards

The real-life rewards are mostly a way of facilitating social interaction. The rewards themselves enables users to interact on different matters. For instance, one reward could be that another user should cook dinner. This may create social interaction on two layers. Firstly, the result of the reward can trigger emotional responses in both users. The user that has to cook dinner might feel angry, frustrated, and engaged, and the user that gets the dinner might feel a sense of victory and achievement. Secondly, the user that has to cook dinner might feel a need for revenge and therefore gather diamonds more quickly to achieve vengeance. As stated by Anderson et al., revenge motivation correlates positively with anger [94]. Also, self-determination theory underlines that rewards can aid in increasing competence, and thereby increase the enjoyment of the game [44, 45].
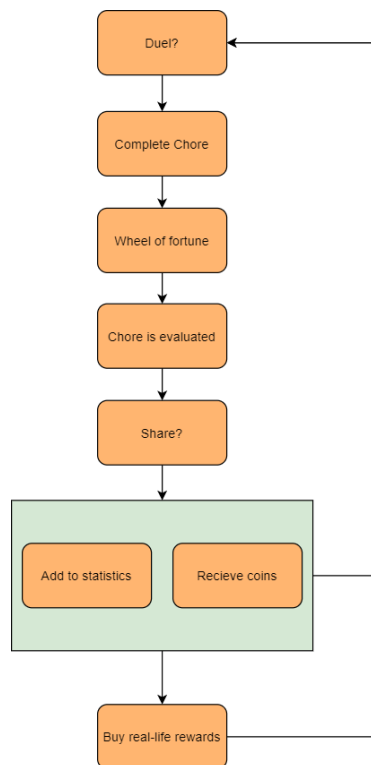
Figure 16.2: The main flow of doing chores using the proposed solution.

16.2   Statistics

Whenever a user logs a completed task, statistics within the group are updated. The application bases these statistics on the effort put into chores, the number of chores, and the evaluation of the completed chores in the last seven days. The statistics are presented in numerous ways, see Figure 16.3. Firstly, the user with the best effort, the overall average, and the user's score are presented together. This follows the theory presented by Sharot, where she says that the need for being better than the average often contemplates laziness [95]. Secondly, a smiley bar that shows overall effort compared to others is presented on the task screen. Thirdly, a screen showing a log of all completed tasks with their evaluation in the last seven days, is implemented. Finally, each user's total statistics are presented on their profile page. The competition that these statistics promote may increase motivation. As said in Chapter 11, the fact that social interaction acts as a motivator for games is widely accepted in the academic community [68].
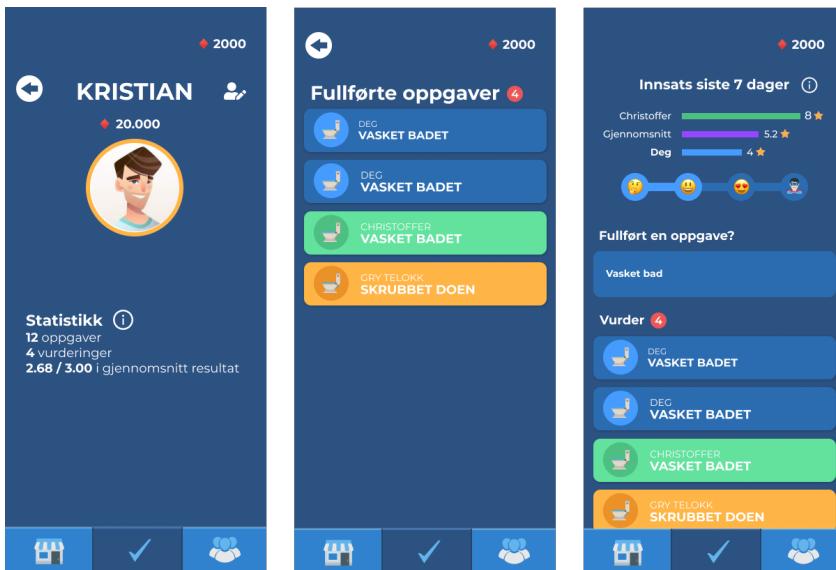
Figure 16.3: Left: Profile statistics. Middle: Completed tasks. Right: Comparison between the user, the average, and the best performing user.

16.3 Randomized Elements

The proposed solution implements randomness in several ways. Firstly, the wheel of fortune distributes different rewards every time; secondly, the store cycles new random rewards each week. Finally, the label that each user gets when entering a group changes randomly over time.

Skinner found that by not having a direct link between the interaction and the level of reinforcement, there was a higher incentive for the subject to do the interaction [39]. Thus the randomness in the amount of currency the user receives for doing chores may create a higher incentive to do chores. Furthermore, the randomness aids in varying the information presented within the solution. Hence, following Malone's framework, maintaining the user's curiosity.

16.4 Data Collection

In order to balance the solution and develop it further, the proposed final solution implements data collection. This is done by using Amplitude to log certain user events within the application. Some examples of these events are presented in Table 16.1, the rest of the events are illustrated in Appendix B.1.

Events	Properties
create task	taskName
create custom reward	reward
create group	groupId
update group	groupId

Table 16.1: Examples of user events that are recorded in the application.

16.5 Customization

To further elevate the user's curiosity, the proposed application implements, to some extent, the possibility for customization. There are three ways to customize the solution; the user can change the avatar, nickname, and group name. These are small changes, but may to some degree, aid in keeping the user interested in the application. The social aspect of presenting the user in different ways may aid in creating a mental representation of the user and thereby elevating the copresence in the solution [73].

16.6   Feedback

According to Sweetser and Wyeth's gameflow model, clear feedback on progress towards goals is essential to achieve gameflow [38]. Additionally, self-determination theory contemplates feedback as an essential element in increasing competence, which again increases the enjoyment of the application [44, 45]. With this in mind, the solution clearly states how many diamonds the user has collected. Also, how many diamonds are needed to be able to buy rewards. Likewise, it is clearly illustrated through statistics how the user performs compared to others. Although the proposed solution provides transparent feedback on progression towards goals, it does not provide much feedback in terms of visuals and sound. That being said, as the primary focus of this application is to motivate users to do housework and not use the application itself, feedback in terms of visuals and sounds are not prioritized.

Chapter 17

Requirements

This chapter presents the requirements for the final solution. These requirements were initially created based on the preliminary study, concept- and prototype phase, in addition to the iterative evolution of the implemented solution.

17.1 Functional Requirements

This section presents the functional requirements implemented in the final and tested version of Spot, see Table 17.1. The priority is defined such that high means it must be implemented, medium means it should be implemented, and low means it is nice to have.

ID	Description	Priority
F1	The user should be able to register a user with a avatar and a nickname	High
F2	The user should be able to log in	High
F3	The user should be able to log out	Low
F4	The user should be able to reset the password	Medium
F5	The user should be able to change the avatar and nickname	Low
F6	The user should be able to create a group	High

F7	The user should be able to invite other users to a group	High
F8	The user should be able to view group invitations	High
F9	The user should be able to ignore a group invite	Low
F10	The user should be able to accept a group invite	High
F11	The user should be able to leave a group	Low
F12	The user should be able to receive a notification when invited to a group	Medium
F13	The user should be able to view other members of the group	High
F14	The user should be able to view statistics of each user in a group	Medium
F15	The user should be able to change the name of a group	Low
F16	The user should be able to view an emoji-bar of each group member's effort ranging between four different emojis	Medium
F17	The user should be able to add a completed chore	High
F18	The user should be able to receive suggestions based on their input when adding a completed chore	High
F19	The user should be able to view chores that are ready for evaluation	High
F20	The user should be able to evaluate the completed chore of others	High
F21	The user should be able to view a reward ladder immediately after adding a completed chore	Medium

F22	The user should be able to receive a reward after their completed chore has been evaluated	High
F23	The user should be able to view the reward ladder for their own completed chores that has not yet been evaluated	High
F24	The user should be able to share an evaluated chore on social media	Low
F25	The user should be able to see an comparison of the group members effort for the last seven days	High
F26	The user should be able to view a history of evaluated chores	Low
F27	The user should be able to collect the reward from multiple chores at the same time	Medium
F28	The user should be able to receive a notification when others add completed chores	High
F29	The user should be able to receive a notification when someone evaluated their completed chores	High
F30	The user should be able to view available rewards to buy in the shop	High
F31	The user should be able to buy available rewards in the shop	High
F32	The user should be able to view all rewards	High
F33	The user should be able to add custom rewards	High
F34	The user should be able to delete custom rewards	Low
F35	The user should be able to deactivate default rewards	High
F36	Default rewards should be added to the reward pool when a user sets the group type	High
F37	The user should be able to select group type before opening the shop	Medium

F38	The user should be able to change group type	Low
F39	New rewards for purchase should be randomly picked each week	Low
F40	The user should be able to view a history of bought rewards	Medium
F41	The user should be able to receive a notification when new rewards are available to buy	High
F42	The user should be able to choose another member to execute the reward when buying a reward	Medium
F43	The user should be able to view a pop up with additional information about specific features	Low
F44	The application should automatically capture and store all user interactions in the application	Medium
F45	The application should display visual feedback to the user	High

Table 17.1: The functional requirements in the application.

17.2   Non-Functional Requirements

This section presents the non-functional requirements for the final and tested version of Spot, see Table 17.2.

ID	Category	Description
NF1	U1	It should take no longer than 5 minutes to register
NF2	U2	It should take no longer than 30 seconds to add a completed chore
NF3	U3	It should take no longer than 5 minutes to learn how to use the application
NF4	A1	The application should work as intended with no errors during run-time

NF5	A2	The cloud functions should be available 99% of the time
NF6	A3	The database should be available 99% of the time
NF7	M1	Should be able to add new rewards and display them in the shop within 2 hours.
NF8	M1	Should be able to add new task suggestions and display them as suggestions to users creating tasks within 2 hours.
NF9	M1	Should be able to add new reward ladders and display them to users being rewarded within 2 hours.

Table 17.2: The non-functional requirements in the application.

Chapter 18

High Fidelity Prototype and Functionality of Spot

This chapter presents the high fidelity prototype and the functionality of Spot. Firstly, presenting the various views and functionality in the high fidelity prototype. Further, describing the testing of the prototype and elaborating on the results and changes that were necessary.

18.1   High Fidelity Prototype

The high fidelity prototype was created based on the proposed solution presented in Chapter 16. The following sections describe each view of the high fidelity prototype in detail.

18.1.1   Login and Registration

For the sake of usability, everyone that wants to use the application is required to create a user connected to their email. The login and registration views are illustrated in Figure 18.1. By using their email, users can easily invite each other to groups and restore their account on other devices. However, the user stays logged in on a device and is not required to log in again unless the user manually logs out.
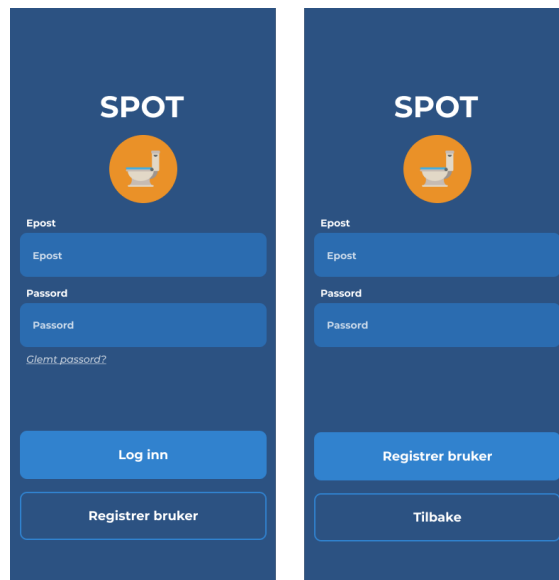
Figure 18.1: Left: Log in view. Right: Registration view.

18.1.2 Selecting Avatar and Nickname

Upon registration, the user is prompted to choose an avatar and a nickname, as shown in Figure 18.2. The chosen avatar is a visual representation of a user that is commonly displayed throughout the application, together with the user's nickname. It is possible to change the avatar and the nickname later.
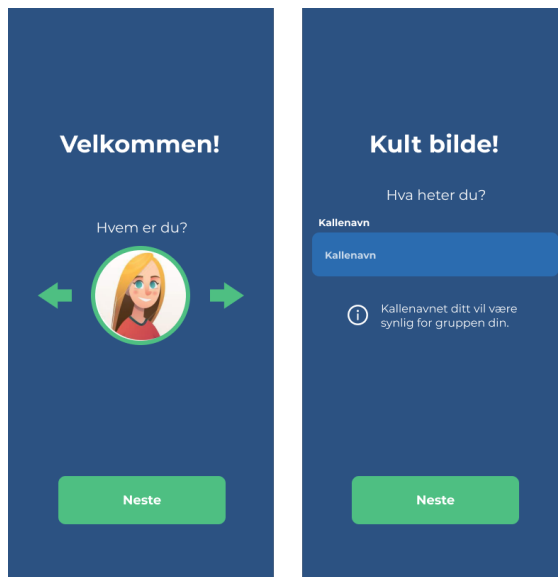
Figure 18.2: Left: Selecting an avatar. Right: Choosing a nickname.

18.1.3 Creating a Group

If the user is not already in a group, a view illustrated on the left in Figure 18.3 presents two options; Join a group or create one. When creating a group in the middle of Figure 18.3, the user must come up with a group name. When successfully creating a group, the user is sent to the group view, as illustrated on the right in Figure 18.3. This view enables a navigation bar, which enables navigation to the shop and the task view. The group may be edited by clicking the settings icon in the upper right. Users can be invited by clicking the invite button at the bottom of the view. The statistics related to each group member can be seen by clicking the member bar. The member bar contains the avatar, nickname, and a random positive sentence.
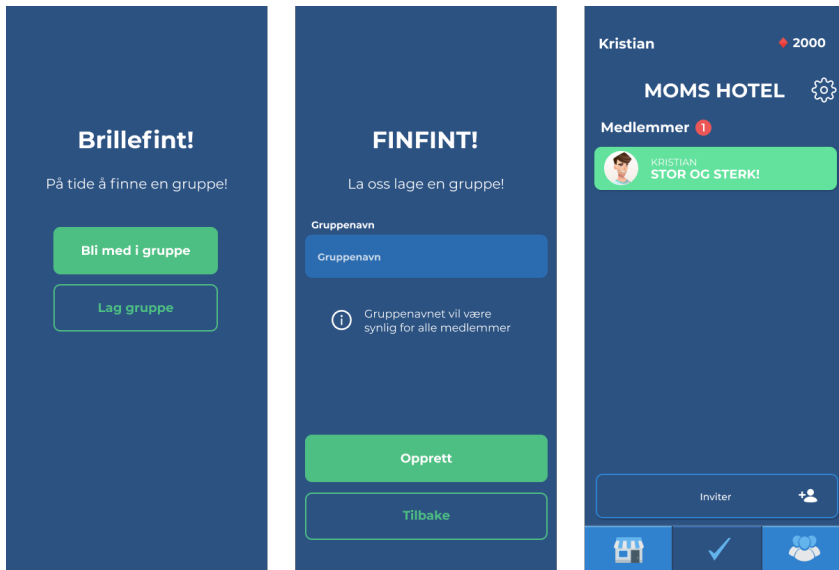
Figure 18.3: Left: Join or create group. Middle: Create a group. Right: Overview of the group.

18.1.4 Inviting a User to a Group

Inviting a user to the group is done in the invite user view illustrated in Figure 18.4. A user can be invited in two different ways. The first alternative requires that the email of the user to invite is known and inputted. Lastly, a click on the copy link button will insert an invitation link to the users' clipboard, which can be pasted and sent to users that are to be invited.
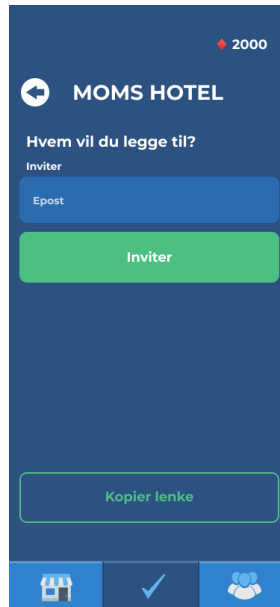
Figure 18.4: Inviting a user to the group.

18.1.5 Joining a Group

To be able to join a group, the user must be invited by any member of the group. A list of invitations is displayed, as shown in Figure 18.5. The list of invitations can be viewed after clicking the button "bli med i gruppe" illustrated in Figure 18.4. Each invitation is clickable, which then displays the avatar, name, and a random positive sentence for each member in the group. The user can either join or go back.
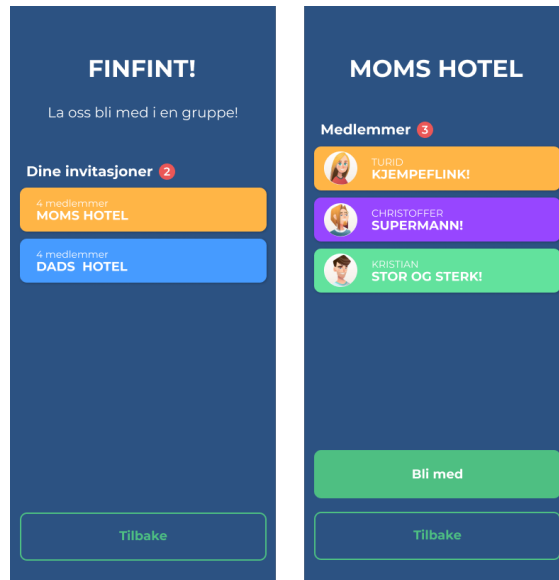
Figure 18.5: Left: Your invitations. Right: Members of an inviting group.

18.1.6 Settings

Any group member may change the group name by navigating from the overview of the group to the group setting view illustrated to the right in Figure 18.6. By clicking on the member bar that represents the current user in the overview of the group, the profile view shows up, as illustrated in Figure 18.6 to the left. The profile view allows users to change their nickname and avatar and log out of the user.
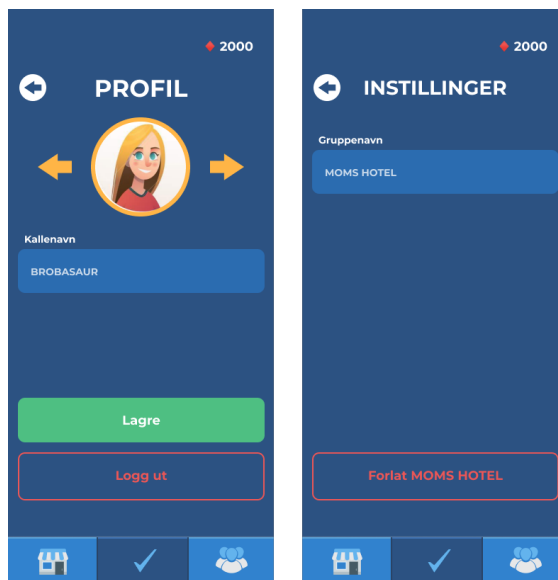
Figure 18.6: Left: User settings. Right: Group settings.

18.1.7 Group Member Profile

Clicking a group member in the group view navigates the user to the profile of that member, as illustrated in Figure 18.7. The group member profile view displays statistics such as the number of chores completed, number of evaluations, and the average rating received on chores.
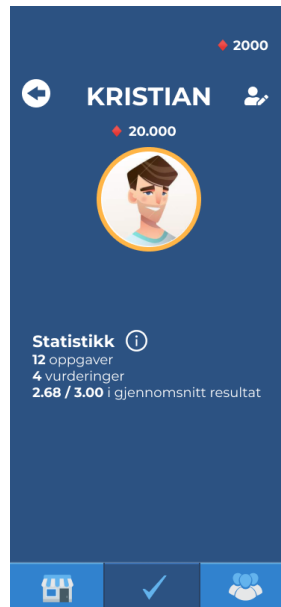
Figure 18.7: Group member profile.

18.1.8 Adding Completed Chores

When a member of a group has completed a chore, the member must click the input field below the text "Fullført en oppgave?" as illustrated in Figure 18.8. A list of clickable elements retrieved from previously entered chores matching the text in the input field appears to simplify adding chores. Clicking the plus sign or an element in the list navigates the user to the view illustrated in the middle of Figure 18.8. The chore can then be discarded by going back, complete adding the chore, or change the name of the chore that has been completed.
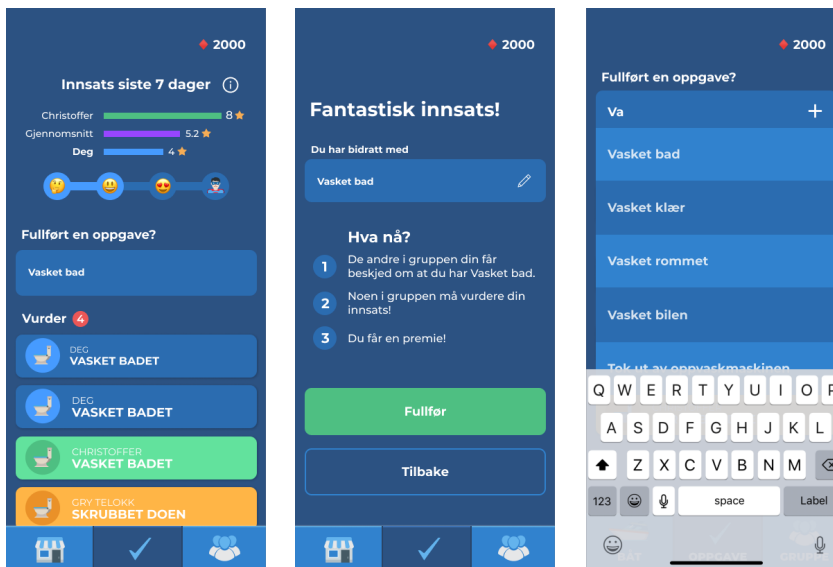
Figure 18.8: Left: Task screen. Middle: Add a chore screen. Right: Choose chore name based on suggestions.

When submitting the chore, a wheel of fortune is presented, as illustrated to the left in Figure 18.9. Spinning the wheel of fortune provides a reward ladder, with the prize selected being the top tier reward as illustrated to the right in Figure 18.9. The evaluation received from another group member determines which reward ladder tier that is rewarded. When a reward ladder is selected, all other members of the group receive a notification saying a chore needs to be evaluated.
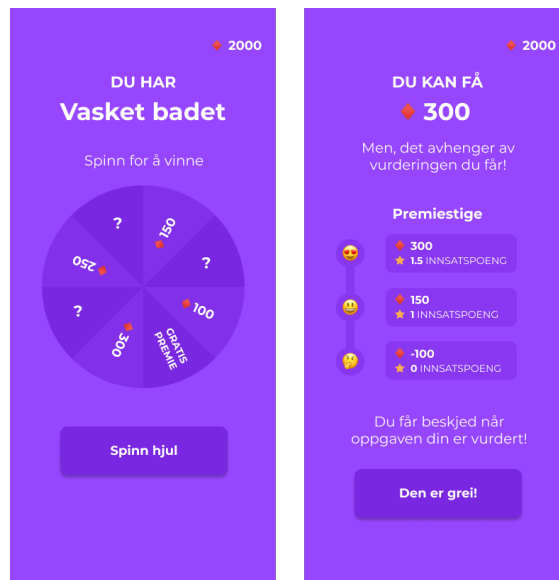
Figure 18.9: Left: Wheel of fortune. Right: Reward ladder showing potential reward.

18.1.9   Evaluating a Chore

Chores that need evaluation are listed on the task view, as illustrated to the left in Figure 18.8. When evaluating a chore, the evaluator is presented with emojis representing three various feelings, as illustrated in Figure 18.10. The evaluator must then pick the most appropriate emoji based on the result and effort required for the chore. After evaluating the chore, the evaluation and the name of the chore are shareable on social media. The group member that completed the chore will now receive a notification that a reward is claimable.
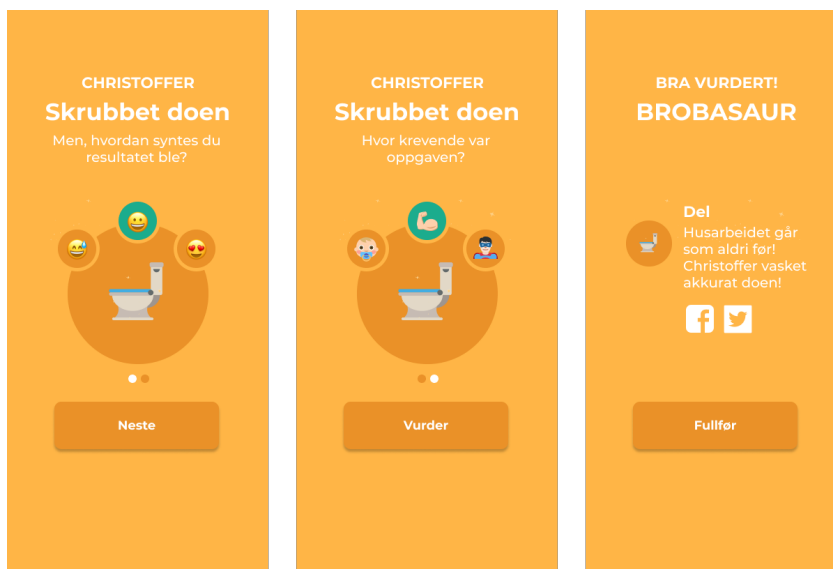
Figure 18.10: Left: Evaluate the result of a fulfilled chore. Middle: State the effort of a fulfilled chore. Right: Share the evaluation on social media.

18.1.10   Shop Setup

Before group members may buy rewards using the diamonds they have accumulated from doing chores, the store must be setup. As illustrated to the left in Figure 18.11, the group type must be set. The group types available are family, collective, and partner. However, the partner option is not displayed in the illustration for simplicity purposes during the design of the prototype. When a group type is selected, a default set of rewards for that type may be reviewed. Each week, four rewards are chosen randomly for the group members to buy. However, members are allowed to deactivate rewards that are not of interest, as illustrated

to the right in Figure 18.11.
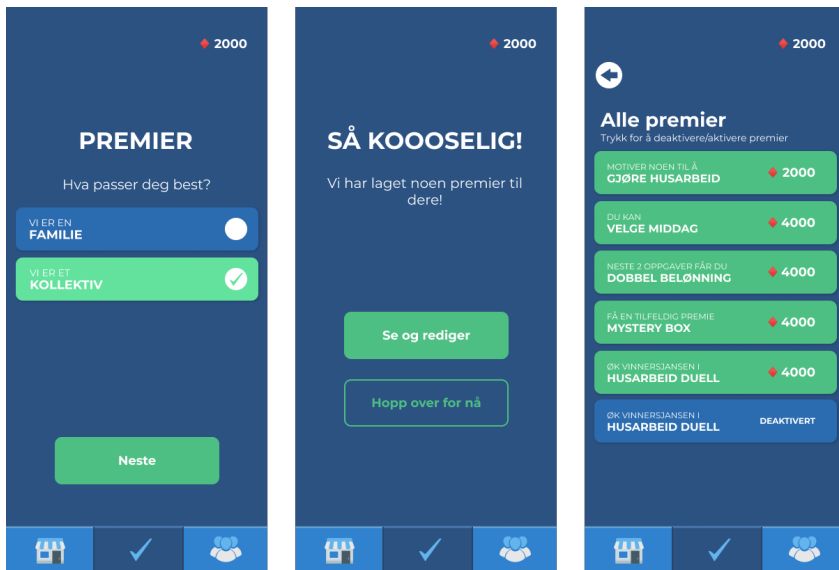
Figure 18.11: Left: Choose household type. Middle: Information on rewards for the specific household type. Right: All rewards available for the specific household type.

18.1.11 Shop

The shop icon in the navigation bar navigates the user to the shop view illustrated to the left in Figure 18.12. The shop-view displays the randomly selected buyable rewards for that week. The name and avatar of the buyer are displayed if bought. Buying rewards may require the user to select another member of the group to execute the reward- For example, by motivating another member to do a chore by increasing the possible reward from doing that specific chore, or selecting a group member to make dinner. It is also possible to view the previously bought rewards in the group.
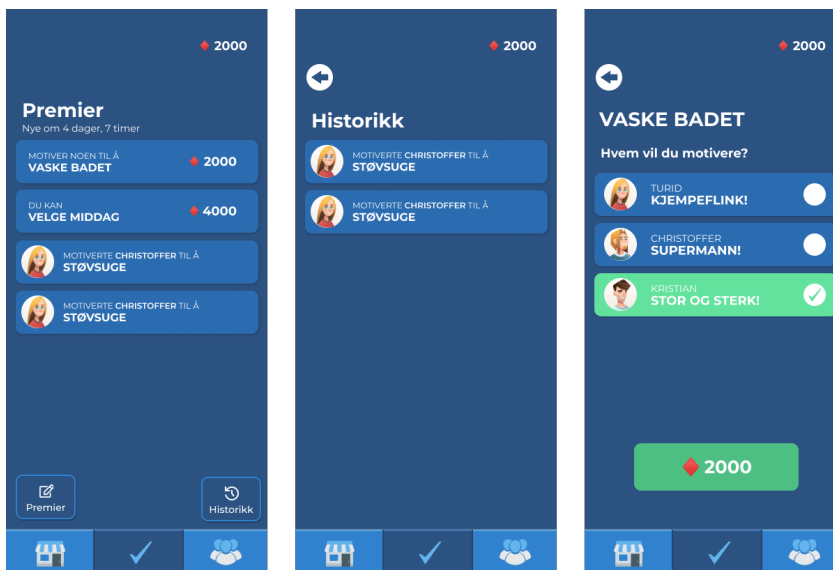
Figure 18.12: Left: Available, and bought rewards this week. Middle: History on all bought rewards. Right: Buying a reward.

18.1.12 The Effort Last Seven Days

The chart displayed at the top of the left image in Figure 18.8 visualize the effort in the group from the last seven days. The number of chores completed and their evaluated rating help determine the effort rating of each member in the group. The emoji-bar below the chart determines the current users' effort compared to the group member with the highest effort.

18.2   Testing of High Fidelity Prototype

This section describes the testing phase of the high fidelity prototype and the modified improvements to the prototype after evaluating the feedback. The most critical element to test was the understanding of the user interface. Four people tested the prototype, while a more significant number of people gave feedback through the process of creating the prototype. A Quick Response Code containing a link to the high fidelity prototype hosted with Figma allowed for realistic testing on the testers' phones.

18.2.1   Execution

Testers' were presented with a quick intro of the Master's Thesis after opening the prototype on their phones. Furthermore, elaborating on the purpose of the test and the concept of the application. The testers' were told to think out loud so that their thought process could be understood. The limitations of the prototype were elaborated, and the testers' were informed that they could quit at any time. The test was conducted using the following questions:

1. Go ahead and create an account

2. Create a group

3. Invite a member with the email "tester@tester.tester"

4. Locate and set up the shop

5. Deactivate an active reward

6. Which rewards are active for the current week?

7. Locate and add a chore

8. Locate and evaluate a chore done by another group member

9. Buy a reward from the shop

After the completion of the tasks in the list above, testers' were asked for feedback on the application.

18.2.2   Results and Improvements

In general, the testing of the prototype revealed that the main concepts were working as intended. The testers believed that using such an application would motivate them to do chores and that the functionality was easy to understand.

Setup
Testers had no problems registering a user by selecting an avatar, and choosing a nickname. Additionally, no problems transpired when creating a group and inviting other users. One tester asked if it was possible to change his nickname, and struggled to locate the view containing that functionality. The tester suggested that an icon representing a user profile could be added to the group view.

Chores
When adding a new chore, one tester mentioned that it was weird that the input field in the chore view acted as a button, redirecting the user to the add chore view. Another tester mentioned his uncertainty about the meaning of the emoji-bar and how the reasoning behind the effort for the last seven days. However, after some time, the tester discovered the information popup describing the functionality after clicking the icon used as a metaphor for information. The information was somewhat explanatory, and the tester commented that the text could need adjustments to clarify the various concepts more quickly.

One tester mentioned that the wheel of fortune was fun, but having to spin it every time doing a chore would probably just feel like a hassle.

Shop
The shop was working as intended. However, two testers mentioned that they would have liked functionality that made it possible for them to add custom rewards.

Chapter 19

Final Solution

This chapter presents the final solution after implementing and prototyping the proposed solution. This chapter does not present the solution as a whole. Instead, it presents the changes made from the proposed solution and thereby shows the current final solution. The first section describes the changes done to the user flow, the second section describes minor changes concerning the overall application, the third section present changes made to the statistics, and finally, the last section will present additions to the solution.

19.1 Changes to the User Flow

As seen in Figure 19.1, there where two significant changes in the user flow. Both the duel and the wheel of fortune features where deprecated. The duel feature was down prioritized due to lack of time and its voluntary participation in the user flow. The wheel of fortune, on the other hand, was implemented and tested on several users. Interestingly, the time it took for the whole reward process to be completed had a negative effect on the user's motivation. This negative effect contemplated the motivation gained from the excitement and curiosity the wheel promoted. To eliminate the time it took for users to see their reward, the wheel of fortune was obliterated. However, the rewards given to the users are still random and illustrated by a reward ladder.
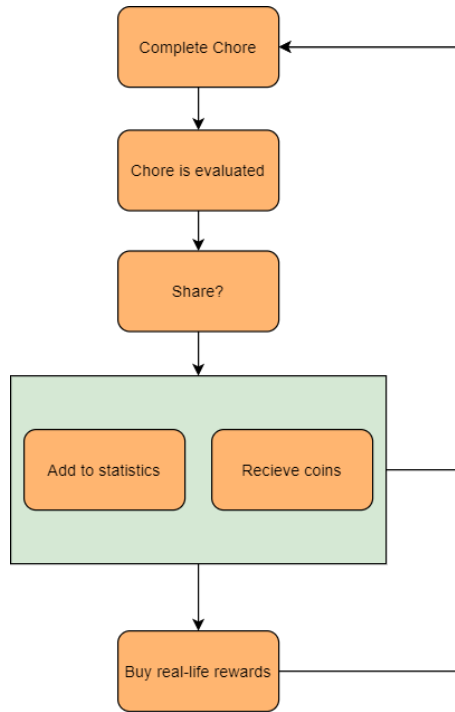
Figure 19.1: The main flow of doing chores using the final solution.

19.2   Minor Changes

During the implementation phase, some minor user tests were made. As a result
of these tests, the solution implemented changes. The tests showed that users
struggled with separating their completed tasks from other users' tasks. Hence,
a division of the tasks was implemented such that the user's tasks were isolated
from other tasks, see Figure 19.2.

In addition to this, minor user tests also showed that the unknown rewards took
away the concept of instant feedback. Malone, Csíkszentmihályi, and Sweetser
and Wyeth all, in their way, state the importance of direct feedback on per-
formance [33, 34, 37, 38]. Hence the unknown prices were removed from the
solution.

Figure 19.2: The front page of the final solution.

19.3   Changes to the Statistics

There were two significant changes made to the statistics in the solution. The first change concerned the emoji-bar presented with the other statistics on the front page of the application. During the implementation phase, it became clear that this emoji-bar was redundant and presented statistics that were already displayed in another way. Presenting information in different ways is not necessarily bad. The variety it provides keeps the user interested in the application. However, presenting the same information in several ways in the same place seems unnecessary. Hence, the emoji-bar was removed from the front page and added to the profile page instead, see Figure 19.2 and Figure 19.3.

Furthermore, the log that displayed all completed tasks the last seven days was lacking information. In the proposed solution, the log only showed the name of the tasks done in the last seven days. This gave the users limited flexibility when examining the completed work. Hence, the evaluation of the task, the evaluating user, date of completion, and the reward given was added, see Figure 19.4.
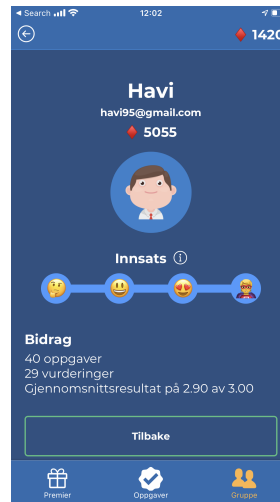
Figure 19.3: The profile page of the final solution.

19.4   Additions to the Solution

This section presents additions added to the proposed solution. These additions primarily concern balancing the rewards given to the users and the possibility of adding customized rewards.

19.4.1   Balancing

Seeing that the number of diamonds achieved by fulfilling chores was, to a certain degree, random, a question of whether this made the distribution of rewards feel unfair and uncertain for the users raised. For instance, if a user cleans the entire apartment, he might be rewarded with 100 diamonds, while someone that empties the dishwasher might, if lucky, be rewarded with 200 diamonds. As Csíkszentmihályi mentions, it is essential to give the user a sense of control to achieve flow. Hence the uncertainty concerning rewards might negatively impact the flow experience in the solution [37]. Also, in terms of Malone's framework, not reaching a goal, or getting inconsistent feedback on performance may result in a lessening of confidence [33, 34].

In order to balance this, the final solution implements a bonus feature. This feature rewards the user with an extra amount of diamonds based on the effort it requires to complete the task. In this case, the user that cleans the apartment gets a more substantial bonus than the user that empties the dishwasher. However,
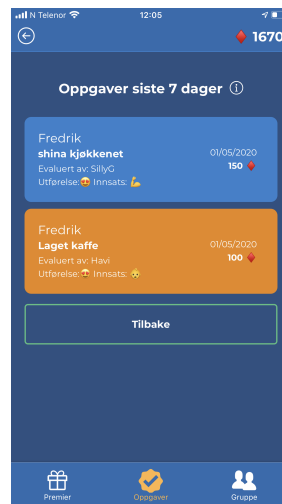
Figure 19.4: The log of the final solution.

accurately balancing this bonus is still challenging; therefore, the collection of data on the matter helps in adjusting the bonus multipliers.

19.4.2 Customized Rewards

In the proposed solution, rewards were predefined in the application; This gives more control in terms of managing the application's use. However, we found that it obstructed freedom in how the users used the application. Hence, the application became more of a dominating platform, instead of being a tool, as first planned. With that in mind, the final solution implements a way for users to create custom rewards. Thus giving the user more control in how the application rewards housework.

Chapter 20

Software Architecture

This chapter will present the general architecture of the final solution. The figures presented will not include all files and components implemented in the solution. Only the most influential components and structures will be described. However, Appendix A.1 includes an illustration of the complete file structure of our solution.

20.1 Architecture Overview

The architecture overview is illustrated in Figure 20.1. More detailed information on the technologies can be found in Chapter 15. The architecture of the solution consists of a client-side and a back end side, in addition to a third-party data collection framework called Amplitude. The client-side consists of a React Native application running on Expo and the back end consist of a document-oriented database called Firestore, in addition to a Firebase service called cloud functions. The client communicates with the database in two ways, both directly and indirectly. Direct communication happens on an HTTPS-based library for Expo called Firebase. Indirect communication happens in the same library; however, it happens by triggering cloud functions that communicate with the database. The application was implemented by writing 12 349 lines of code, excluding auto-generated code produced by the various technologies used.
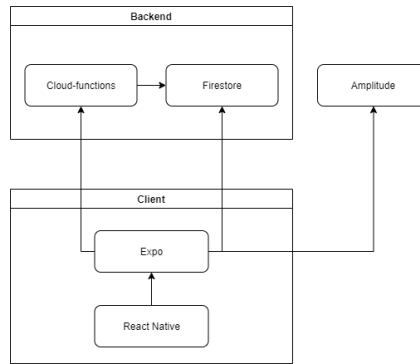
Figure 20.1: The general architecture of the solution.

20.2   Database

The collections and relations in the document-oriented database are illustrated in Figure 20.2. As this is a document-oriented database, it does not follow the same limitations and rules as a relational database. That said, an entity-relationship diagram is still a proper way of illustrating relationships in the database. The relationships illustrated does not directly translate to the relations occurring in the database, but it acts as a foundation for understanding the overall setup of the database.
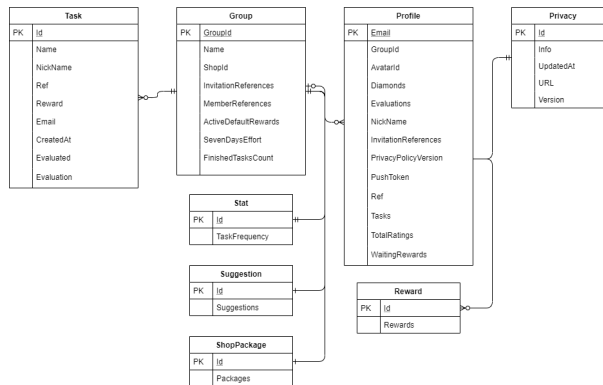
Figure 20.2: The collections and their relationships in the document-oriented database.

The most important relationships happening in the database are those concerning profiles, groups, and tasks. These relationships are responsible for connecting the data generated in the most fundamental functionality in our solution. A group keeps track of members, and tasks completed, whereas profiles keep track of which group they belong to, and invitations gotten from groups. Like profiles, tasks keep track of which group they belong to, who completed the task, who evaluated the task, and the evaluation that was given. The remaining collections, stats, suggestions, shopPackages, rewards, and privacy, keeps track of data such as different kind of rewards available, suggestions in terms of task names, different shop packages, and the newest privacy policy.

20.3   React Native

This section describes how the client app is organized in terms of components and hooks.

20.3.1   Components

The React Native app running in the client consists of several components. An illustration of how the components are structured is shown in Figure 20.3. The components in the application are primarily organized in two bulks, one bulk for modules and one bulk for shared components. A module primarily consists of one or more screens, and specific components used to form those screens. On the other side, the components in the shared bulk are components that can be used between different modules. The shared components consist of regular components and brokers. Brokers are components that extend React Native standard components, for instance, a text component, and enables centralized modification that impacts all usages of that specific broker.
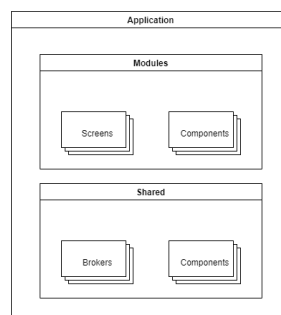
Figure 20.3: The structure of the components in the React Native application.

The modules and shared components implemented in the application are shown in Figure 20.4. These are the top-level components in the application, and most of them consist of several additional sub-components. The application, in total, implements 57 components.
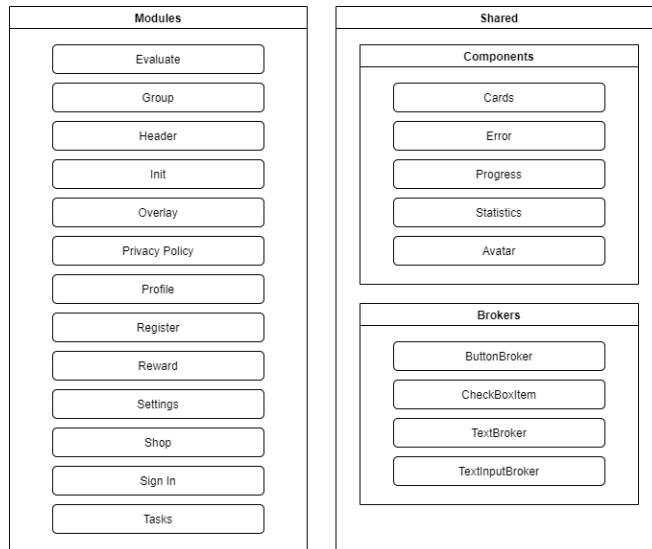
Figure 20.4: The modules and shared components in the application.

20.3.2   Hooks

Hooks enable developers to reuse stateful logic between components, without needing to change the component hierarchy [96]. Our application implements several hooks that allow stateful logic in the implemented components. These hooks mostly implement logic that concerns communicating with services such as Firestore and cloud-functions. The different categories of the custom hooks implemented in our solution are shown in Figure 20.5. Each category consists of several hooks that are used throughout the application. The application, in total, implements 30 custom hooks.
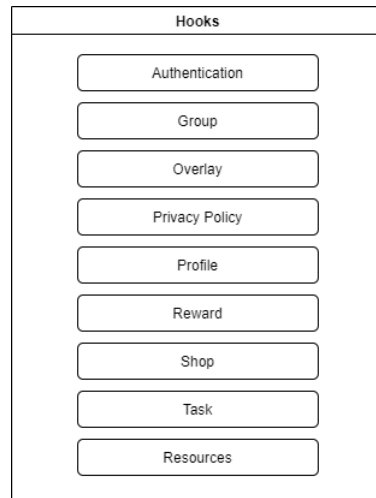
Figure 20.5: The different categories of hooks implemented in the application.

Chapter 21

Testing and Validation of Requirements

This chapter will describe the method used to test the implementation of functional requirements in the application. Furthermore, a short evaluation of the non-functional requirements and how they were tested are included.

21.1   Approach

The functional requirements of the application consisted of 45 requirements. During the application's development, these requirements were separated into smaller tasks and distributed on a Kanban board. The tasks where tested and approved on an iterative basis, meaning that whenever a task was completed, it was moved to the "testing" bulk on the kanban board, and if not approved, it was moved back into the workflow. However, not all tasks were tested before starting development on the next task. Instead, new tasks were tested several at the time in a complete test of the application; this made the development more productive. It was simpler to reveal bugs and flaws on a global scale, opposing a local test where only the task at hand was examined.

Whenever we conducted such a test of the application, we focused on the tasks chosen to be examined. First, we considered their natural function in the application before we actively tried to break their functionality. After we tested the tasks, we sometimes tested the application on others in order to reveal unthought-of pitfalls and bugs potentially. When bugs and flaws were found, we created new

tasks to fix the problems. Although we thoroughly tested the implemented tasks, some new flaws where revealed in the final user test.

21.2   Validation of Requirements

A functional requirement was validated and completed when all the tasks originated in the requirement was tested and approved. As mentioned in the previous section, the application consists of 45 functional requirements; all functional requirements were completed to a satisfactory level. The quality assurance of the requirements was done so that we evaluated each other's implemented tasks and requirements. This enabled us to objectively examine the requirements and give constructive feedback based on the completion of the requirement. The fulfillment of the functional requirements is illustrated in Table 21.1.

The non-functional requirements mostly concern the usability of the application. Therefore, in order to be able to evaluate the fulfillment of the non-functional requirements, we included several questions regarding usability in the final questionnaire of the final user test. Here we found that 96% of the participants agreed that the application was easy to use, indicating that NF1 to NF4 was fulfilled. Additionally, by monitoring Firebase, we validated NF5 and NF6. Since Firestore lets us add entries to collections, we managed to almost instantly add new reward ladders, shop rewards, and suggestions. Hence, we fulfilled NF7 to NF9. The non-functional requirements are shown in Table 17.2.

ID	Description	Completion	Comments
F1	The user should be able to register a user with an avatar and a nickname	Complete	Several screens taking the user through the registration process.
F2	The user should be able to log in	Complete	A screen enabling the user to log in with credentials authenticated in Firebase.
F3	The user should be able to log out	Complete	A button in the profile page letting the user sign out.
F4	The user should be able to reset the password	Complete	A feature that emails the user a reset password link.

F5	The user should be able to change the avatar and nickname	Complete	A settings screen that lets the user make changes to the profile.
F6	The user should be able to create a group	Complete	A screen that lets the user create a group.
F7	The user should be able to invite other users to a group	Complete	A screen that lets user invite others by using their email address.
F8	The user should be able to view group invitations	Complete	A screen that presents the invitations the user has gotten.
F9	The user should be able to ignore a group invite	Complete	The invites are displayed on a separate screen that does not interfere with the usage of the application.
F10	The user should be able to accept a group invite	Complete	A screen that displays information about the respective group, and lets the user join.
F11	The user should be able to leave a group	Complete	The profile settings enables the user to leave the current group.
F12	The user should be able to receive a notification when invited to a group	Complete	Using Expo push notification library to send notifications to the invited user.
F13	The user should be able to view other members of the group	Complete	A screen showing all members in the group.

F14	The user should be able to view statistics of each user in a group	Complete	Each user can review other users' profiles, showing both nickname, avatar, statistics, and diamonds.
F15	The user should be able to change the name of a group	Complete	A group settings screen that enables users in the group to change the group name.
F16	The user should be able to view an emoji-bar of each group member's effort ranging between four different emojis	Complete	The emoji-bar is displayed on each users profile page.
F17	The user should be able to add a completed chore	Complete	Two separate screens enabling the user to add a completed chore.
F18	The user should be able to receive suggestions based on their input when adding a completed chore	Complete	A feature that stores the frequency of the completion of different tasks and suggests tasks ordered on its popularity in the group.
F19	The user should be able to view chores that are ready for evaluation	Complete	A screen that lists all completed tasks that can be evaluated.
F20	The user should be able to evaluate the completed chore of others	Complete	A screen that lets users evaluate a chore based on effort and result.

F21	The user should be able to view a reward ladder immediately after adding a completed chore	Complete	A screen that shows the potential rewards that can be given depending on the evaluation.
F22	The user should be able to receive a reward after their completed chore has been evaluated	Complete	A screen that prompts the user with rewards ready to be claimed.
F23	The user should be able to view the reward ladder for their own completed chores that have not yet been evaluated	Complete	The user can review their potential rewards screen by clicking their listed task in the tasks screen.
F24	The user should be able to share an evaluated chore on social media	Complete	The evaluation screen lets users optionally press a share button that opens the user's device standard for sharing.
F25	The user should be able to compare the group members effort for the last seven days	Complete	Three bars showing the best performing user, the average performance of the users, and the user's performance, also effort can be reviewed on profile pages.
F26	The user should be able to view a history of evaluated chores	Complete	A separate screen showing all evaluated chores the last seven days.
F27	The user should be able to collect the reward from multiple chores at the same time	Complete	The prompt that shows the rewards ready to be claimed accumulates all the rewards and lets the user claim all at once.

F28	The user should be able to receive a notification when others add completed chores	Complete	Using the Expo push notification library, the application sends a notification to all users in the group when a user adds a completed chore.
F29	The user should be able to receive a notification when someone evaluated their completed chores	Complete	Notifications are sent to the evaluated user when the chore is evaluated.
F30	The user should be able to view available rewards to buy in the shop	Complete	A screen that lets the users see rewards available to be bought.
F31	The user should be able to buy available rewards in the shop	Complete	A screen that lets users browse and buy available rewards.
F32	The user should be able to view all rewards	Complete	A screen that lets the user see all rewards available in the group.
F33	The user should be able to add custom rewards	Complete	A screen that takes the user through the creation of a reward.
F34	The user should be able to delete custom rewards	Complete	An edit reward screen that lets the user delete custom rewards
F35	The user should be able to deactivate default rewards	Complete	A screen that lets users manage the rewards in a group.
F36	Default rewards should be added to the reward pool when a user sets the group type	Complete	All default rewards stored in Firestore are added to the group rewards when the user sets the group type.

F37	The user should be able to select group type before opening the shop	Complete	The application prompts the user to select a group type before showing the shop.
F38	The user should be able to change the group type	Complete	The screen that lets users manage rewards also lets users change group type.
F39	New rewards for purchase should be randomly picked each week	Complete	The application schedules a new random pick of available rewards every seven days.
F40	The user should be able to view a history of bought rewards	Complete	A screen that lists the bought rewards.
F41	The user should be able to receive a notification when new rewards are available to buy	Complete	The application sends a push notification to all users in the group when new rewards become available.
F42	The user should be able to choose another member to execute the reward when buying a reward	Complete	A setting enables the user to choose another user to execute the reward when buying rewards.
F43	The user should be able to view a pop up with additional information about specific features	Complete	An overlay that displays additional information about features in the application.
F44	The application should automatically capture and store all user interactions in the application	Complete	All fundamental user interactions are sent and stored in Amplitude.

| F45 | The application should display visual feedback to the user | Complete | Visual feedback is given for every user interaction, for instance pressing a button executes a press animation. |

Table 21.1: The fulfillment of the functional requirements.

Part IV

Execution and Results

This part will describe the execution and results of the final test. Firstly, the different data generation methods, the research context, and the participants in the test will be described. Secondly, the results from observations and questionnaires made during the test will be elaborated.

Chapter 22

Execution

This chapter will provide a detailed explanation of the execution. A description of the research context, the participants, and the performance of the data generation methods will also be given.

22.1 Research Context and Participants

One primary goal of this Master's Thesis was to test our application in several real-life situations. This meant implementing a fully working solution that could easily be distributed to testers. In order to simulate a real-life situation, our application was distributed through Apple and Google's platforms. Hence, in theory, anyone with an Android or iOS device could be invited to test our solution. However, to manage the testing and maintain control of the data generation methods, test invites were not distributed massively. Instead, 58 test subjects of different gender and age were invited to test the solution in their current living situation.

In addition to having an Android or iOS device, there were three essential criteria that participants had to fulfill. Firstly, they had to live in a collective, family, or domestic partnership. Secondly, everyone in the household had to participate in the test. Finally, in order to be COPPA compliant, children under 13 years of age were discouraged from participating. To eliminate familiarity bias, which often occurs in a Master's Thesis test, several unfamiliar test subjects were included.

The test started 9th of March 2020 and lasted two weeks before ending on the 24th of March. The testing did not occur in a face to face manner, and therefore some

challenges in ensuring consistent feedback and fulfillment of test criteria occurred. However, by encouraging participants to provide any feedback by mail, phone, or through messenger, and thoroughly checking that all participants fulfilled the criteria, we were able to move past these challenges.

Unfortunately, during the final test, the spread of COVID-19 impacted Norway. In addition to the lockdown, several other measures that were made may have had an impact on our test results. However, by being understanding when addressing our test participants, and consistently asking for feedback, consistent data were generated under the circumstances.

22.2   Questionnaires

The final test consisted of two questionnaires, one at the beginning of the test and one at the end of the test. These questionnaires were made to compare motivation, enjoyment, and engagement in household work before and after the use of the application. Further, the final questionnaire also gathered information about the usability of the application. Both questionnaires gave information on the privacy policy that protects the participants' data.

22.2.1   Likert Scale

In order to capture the participants' attitudes and feelings toward statements of motivation, enjoyment, and engagement concerning the application, the questionnaires use a 5 point Likert scale, see Figure 22.1. This scale measures direction by agree/disagree and intensity by strongly/not. According to Albaum, "A Likert-type item, because it requires a person to rate extent of agreement, may encourage the retrieval and integration of more detailed information from memory than do items calling for a simple evaluation" [97]. Hence, enabling the users to answer using a 5 point Likert scale promotes a more genuine response from prior experience, or memory, instead of a new evaluation. Nevertheless, the questionnaire still has some questions that require the participant to give a more direct answer. For instance, one question concerns the number of tasks a user accomplishes during the week.

22.2.2   Questionnaire before Final Test

In order to gather precise data, the first questionnaire needed to be answered before the application was introduced to the participants. The questionnaire consisted of 17 questions. The first seven questions were meant to gather information on the participants themselves, see Table 22.1. The primary reason for

I am motivated to do chores *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure 22.1: Example statement from questionnaire.

gathering this information on the participants was to be able to separate participants in different segments and correlate that with the results gathered from the test. Hence, addressing RQ9, see Section 5.2.

ID	Questions
1	Email Address
2	Firstname
3	Surname
4	Gender
5	Age
6	How do you live?
7	How many people live in your household?

Table 22.1: The questions regarding information on the participants in the first questionnaire.

Furthermore, the remaining ten questions concerned the motivation, enjoyment, and engagement in doing chores before using the application. This part consisted of 6 statements, see Table 22.2. The primary reason for including these statements was to capture the participants' motivation, enjoyment, and engagement for chores before using the application.

Additionally, this part consisted of four single answer questions. The first focused on a quantitative evaluation of how many tasks a user completes during a week. The second and third focused on direct feedback concerning challenges and how to surpass such challenges concerning housework. The final question was if the participants had any additional comments, see Table 22.3.

ID	Questions
8	I am motivated to do chores
9	I put more effort into chores compared to others in my household
10	I do chores often
12	I enjoy doing chores
13	I think it is important to do chores
14	I think it is important to do chores thoroughly

Table 22.2: The statements regarding motivation, enjoyment, and engagement in the first questionnaire.

ID	Questions
11	On average, how many chores do you complete weekly (for instance last week)?
15	Can you describe any challenges you have experienced concerning housework in your home?
16	If so, do you have any suggestions on what could help overcome those challenges?
17	Do you have any additional comments?

Table 22.3: The questions relying on direct answers in the first questionnaire.

22.2.3   Questionnaire after Final Test

The questionnaire after the final test consisted of 30 questions. The first three questions focused on identifying the participants so that comparing the data with the first questionnaire would be more straightforward. In order to compare data with the first questionnaire, the next section consisted of the same statements concerning users' perceptions as the first questionnaire, see Table 22.2. The final questionnaire, in addition to these statements, also gathered more data on the motivation, enjoyment, and engagement in using the application in different ways, see Table 22.4.

Primarily, the statements on users' perceptions were chosen based on Malone's framework for motivation, gameflow, and social interaction described in Chapter

8 and Chapter 11. [33, 34, 38, 70]. For instance, statement 20 addresses the participant's curiosity generated from social interaction, and statement 23 directly measures whether a participant became less aware of the surroundings, see Table 22.4.

ID	Questions
11	I was motivated to do chores by using the application
12	I was motivated to buy rewards in the application
13	I was motivated to use the application so that other members of my household could see what I did
14	I thought the application was fun to use
15	I thought it was fun to earn points by doing chores
16	I thought it was fun to see my contribution compared with others in my household
17	I thought it was fun to buy rewards
18	I thought it was fun to add my own custom rewards
19	I thought it was exciting to evaluate the chores done by others in my household
20	I was curious of how others evaluated the chores i did
21	I thought it was exciting to buy a reward
22	I was curious of what rewards others would buy
23	I was so engaged in the application, that I became less aware of my surroundings

Table 22.4: The additional statements regarding motivation, enjoyment, and engagement in the final questionnaire.

Furthermore, the final questionnaire gathered data on the usability of the application. The statements concerning usability were based on a framework for measuring usability in an application. Some statements regarding the usability of the essential functionality were included, see Table 22.5.

Lastly, the last section of the final questionnaire gathered some general information regarding the further use of the application and additional comments on the

ID	Questions
24	I thought the application was easy to use
25	I felt in control of what I was doing in the application
26	It was easy to add chores that I had done
27	It was easy to add custom rewards
28	I thought the application was easier to understand after using it for a while

Table 22.5: The statements regarding usability in the final questionnaire.

final test.

22.3   Observation

Due to COVID-19 and restrictions on social distancing, physical observations of participants was not possible during the final test. However, our plan was always to conduct most of the observations through the Internet by collecting data on user behavior. Hence, observing the participants' behavior was still possible trough user events, the user events that were observed are illustrated in Appendix B.1.

22.3.1   Validation

The collected data was used to validate further the answers given in the questionnaires. For instance, in the questionnaire, the participants were asked how frequently they did chores; this answer was easily validated by checking the collected data. see Figure 22.2.

22.3.2   Behaviour

Furthermore, the events gathered enabled us to monitor the different efforts of users within a group. This enabled us to see if specific behavior in other users in the group aided in increasing the number of chores a user performed. Hence, in many ways, we could see the effects of social interaction, see Figure 22.3. Furthermore, it enabled us to see whether the application contributed to an increase in the number of completed tasks, see Figure 22.4.
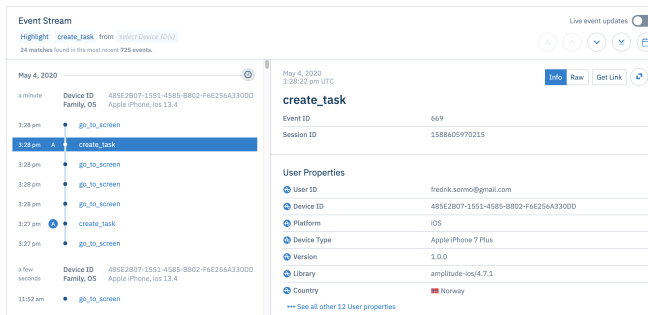
Figure 22.2: Example of user events gathered from participant.
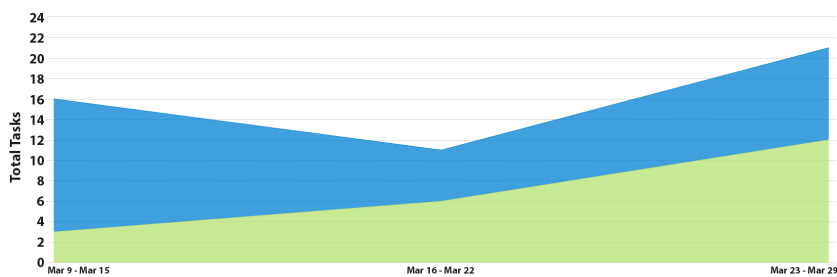
Figure 22.3: Example of comparison between the amount of chores two partici-
pants completed weekly in the same group.

22.4   Physical Observation

As mentioned in our research method, see Section 6.3.1, we planned to, separately
from the final user test, include our collectives in the testing of the application.
This gave us the possibility to more physically observe the application's usage.
However, as the people involved in the observations were friends and partners,
the familiarity bias effect was increased. That said, these observations were used
more as a feedback loop for improving single features in the application than
examining users' perceptions of motivation, enjoyment, and engagement in doing
chores.
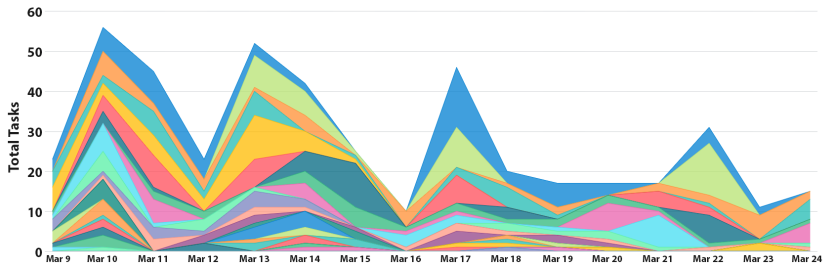
Figure 22.4: Graph segmented in groups showing chores added to the application on a daily basis during the test period.

Chapter 23

Results

This chapter presents descriptive statistics from the data generation methods used in the final testing of the application. Firstly, starting with a presentation of the results from both questionnaires, followed by presenting the results collected by observing user interactions in the application. Since results from the physical observation of our collectives were separate from the final test and more concerned with improving the application than examining users' perceptions, we see no point in including these results in this chapter.

Most of the statistics are summarized in tables with a three-point Likert Scale, reduced from the original five-point Likert Scale in the questionnaires. Most tables consist of a question id (Q), statement (Statement), group type (Group), the number of respondents (n), those that disagreed (D), those that were neutral (N), and those that agreed (A). In some tables where the probability of a difference between two groups exists, probability values (P-Value) are added to enlighten the probability of the observed result, assuming the null hypothesis is true. The significance level for the p-value is set to 5%, in which p-values below 0,05 are determined as statistically significant and therefore highlighted in bold. As most of the data is ordinal, we use the Mann-Whitney method to calculate the probability values [17].

23.1   Participants

A total of 58 people aged between 15 and 67 answered the first questionnaire and thereby voluntarily signed up for the final user test of Spot. However, as seen in Figure 23.1, data collected from Amplitude shows that only 50 of the participants registered in the application. Of these people, 28 managed to answer the last questionnaire. The number of people that did not go through with the whole experiment represents people that were interested in testing the application but failed to persuade the rest of the household. Additionally, one tester informed us that she had been infected with COVID-19 and was unable to complete the experiment. The results presented in this thesis will primarily be based upon the data gathered from the 28 participants that completed both questionnaires. However, answers from all 58 participants in the first questionnaire are presented in Appendix B.2.

The distribution of gender, type of household, and age for participants that completed the whole experiment are presented in Figure 23.2. Since only three participants living in collectives managed to complete the experiment, data from collectives became lacking; therefore, we decided to neglect collectives from the results comparing household types.
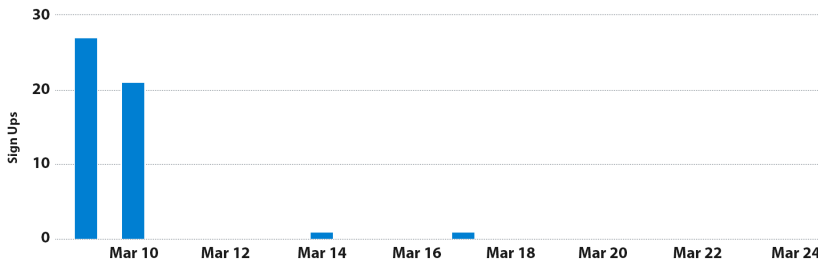
Figure 23.1: Data from Amplitude showing user sign ups between 9th of Mars and 24th of Mars.
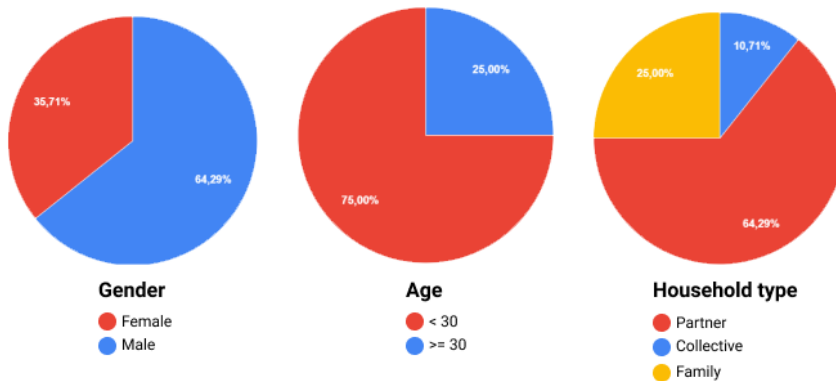
Figure 23.2: Left: Distribution of gender. Middle: Distribution of age. Right: Distribution of household type.

23.2 General Results from Questionnaires

This section presents the overall results from the questionnaires, giving the reader an overview of all participants' responses.

23.2.1 General Motivation

Table 23.1 presents and compares the general motivation answers from both questionnaires. The statistics may indicate an increase in motivation to do chores after the testing period. Interpreting the answers to statement two may indicate that the distribution of chores has become further equal in households. As the statistics suggest, more participants are neutral, while disagreeing and agreeing less after the testing period compared to before. Participants state they are doing chores more often, as indicated by the results for statement three. The statistics reveal an increase of 14% of participants that agree to enjoy doing chores, which may indicate a slight boost in enjoyment towards doing chores. The importance of doing chores is unchanged according to the participant's opinions, while extra participants may believe that it is important that chores should be done thoroughly after the testing period compared to before.

Q	Statement	Group	n	D	N	A	P(BA)
1	I am motivated to do chores	Before	28	14%	39%	46%	0,11
		After	28	7%	29%	64%	
2	I put more effort into chores compared to others in my household	Before	28	21%	32%	46%	0,79
		After	28	7%	50%	43%	
3	I do chores often	Before	28	18%	21%	61%	0,66
		After	28	4%	29%	68%	
4	I enjoy doing chores	Before	28	36%	46%	18%	0,19
		After	28	25%	43%	32%	
5	I think it is important to do chores	Before	28	0%	4%	96%	0,83
		After	28	0%	4%	96%	
6	I think it is important to do chores thoroughly	Before	28	4%	11%	86%	0,61
		After	28	4%	0%	96%	

Table 23.1: Answers from both questionnaires. The P-Value comparing before and after is represented by P(BA).

23.2.2   Motivation by using Application

Table 23.2 presents the results related to motivation and the use of the application. The results show that 50% of the participants agree that the application motivated them to do chores, while 21% disagree. Participants found having other members of the household see the chores they did, be further motivating than buying rewards. Further, 64% of the participants would like to continue using the application.

Q	Statement	n	D	N	A
7	I was motivated to do chores by using the application	28	21%	29%	50%
8	I was motivated to buy rewards in the application	28	36%	25%	39%
9	I was motivated to use the application so that other members of my household could see what I did	28	14%	14%	71%
25	If possible, I would continue to use the application	28	25%	11%	64%

Table 23.2: Answers related to motivation and the use of the application.

23.2.3 Enjoyment

Table 23.3 presents the results related to enjoyment and the use of the application. The statistics show that most participants think the application was fun to use, with only 4% disagreeing, as shown in the responses to statement 10. Of the participants, 75% thought earning points for doing chores was fun, while only 46% thought it was fun to buy rewards. In comparison, interestingly enough, 50% thought it was fun to add custom rewards. Furthermore, 57% stated they thought it was fun to see their contribution compared to others in the household.

Q	Statement	n	D	N	A
10	I thought the application was fun to use	28	4%	14%	82%
11	I thought it was fun to earn points by doing chores	28	7%	18%	75%
12	I thought it was fun to see my contribution compared with others in my household	28	18%	25%	57%
13	I thought it was fun to buy rewards	28	21%	32%	46%
14	I thought it was fun to add my own custom rewards	28	14%	36%	50%

Table 23.3: Answers to enjoyment questions in the last questionnaire.

23.2.4 Engagement

Table 23.4 presents the results related to engagement and the use of the application. The statistics show that 54% of the participants thought to evaluate others was exciting. Furthermore, 68% was curious about how others evaluated the chores they had done. Of the participants, 46% agreed that it was exciting to buy a reward and were curious about what rewards others would buy. Lastly, only 7% agree to be so engaged in the application that they became less aware of their surroundings.

Q	Statement	n	D	N	A
15	I thought it was exciting to evaluate the chores done by others in my household	28	29%	18%	54%
16	I was curious of how others evaluated the chores i did	28	14%	18%	68%
17	I thought it was exciting to buy a reward	28	21%	32%	46%
18	I was curious of what rewards others would buy	28	14%	39%	46%
19	I was so engaged in the application, that I became less aware of my surroundings	28	79%	14%	7%

Table 23.4: Answers to engagement questions in the last questionnaire.

23.2.5   Usability

Table 23.5 presents the results related to the usability of the application. The statistics indicate that 96% thought that the application was easy to use and that 86% found the application easier to use after using it for a while. Going forward, 89% of participants felt in control of what they were doing in the application, while 100% found it easy to add chores they had done. Only 71% of the participants found it easy to add custom rewards.

Q	Statement	n	D	N	A
20	I thought the application was easy to use	28	0%	4%	96%
21	I felt in control of what I was doing in the application	28	4%	7%	89%
22	It was easy to add chores that I had done	28	0%	0%	100%
23	It was easy to add custom rewards	28	0%	29%	71%
24	I thought the application was easier to understand after using it for a while	28	4%	11%	86%

Table 23.5: Answers to usability questions in the last questionnaire.

23.2.6   Different Starting Points

Table 23.6 presents the results related to the starting points of the participants, grouping results from before the testing period to see how they have been affected by using the application. The statistics show that most of the participants that previously disagreed, did in the last questionnaire choose neutral or agree. 50% of the participants that disagreed with being motivated to do chores changed their opinion to agree after using the application. Furthermore, of those who enjoyed doing chores before using the application, 20% disagreed after.

Q	Statement	Starting Point	n	D	N	A
1	I am motivated to do chores	Agreed	13	8%	15%	77%
		Neutral	11	0%	45%	55%
		Disagreed	4	25%	25%	50%
2	I put more effort into chores compared to others in my household	Agreed	13	0%	31%	69%
		Neutral	9	0%	78%	22%
		Disagreed	6	33%	50%	17%
3	I do chores often	Agreed	17	0%	18%	82%
		Neutral	6	0%	33%	67%
		Disagreed	5	20%	60%	20%
4	I enjoy doing chores	Agreed	5	20%	20%	60%
		Neutral	13	31%	46%	23%
		Disagreed	10	20%	50%	30%
5	I think it is important to do chores	Agreed	27	0%	0%	100%
		Neutral	1	0%	100%	0%
		Disagreed	0	0%	0%	0%
6	I think it is important to do chores thoroughly	Agreed	24	0%	0%	100%
		Neutral	3	0%	0%	100%
		Disagreed	1	100%	0%	0%

Table 23.6: Answers from the last questionnaire grouped by answers in the first questionnaire.

23.3   Results from Questionnaires: Gender

This section presents the results from the questionnaires, giving the reader an overview of the statistics related to genders.

23.3.1   General Motivation

Table 23.7 presents the results related to the general motivation of the participants grouped by gender, before and after testing the application. The results show a statistically significant difference between the genders before using the application, where females are more motivated to do chores. However, males' motivation to do chores have statistically significantly increased during the use of the application. A higher percentage of both genders responded to being neutral when asked if they put more effort into chores than others in the household after the testing period than before. For males, the statistics may indicate a tendency where the perception of doing chores often leads to increased perception of putting more effort into chores than others.

23.3.2   Motivation by using Application

Table 23.8 presents the results related to motivation and the use of the application grouped by genders. The statistics may indicate that females are slightly more motivated by using the application than males. Responses to statement 8, "I was motivated to buy rewards in the application", show a higher percentage of females being neutral than males. However, males have a higher percentage of agrees. Females seem to agree more than males when it comes to being motivated by using the application so that other members of the household could see what they did. Also, females seem to be slightly more interested in the continued use of the application, as interpreted from responses to statement 25.

Q	Statement	Group	n	D	N	A	P(G)
7	I was motivated to do chores by using the application	Male	18	28%	28%	44%	0,73
		Female	10	10%	30%	60%	
8	I was motivated to buy rewards in the application	Male	18	39%	17%	44%	0,67
		Female	10	30%	40%	30%	
9	I was motivated to use the application so that other members of my household could see what I did	Male	18	17%	22%	61%	0,33
		Female	10	10%	0%	90%	
25	If possible, I would continue to use the application	Male	18	28%	11%	61%	0,89
		Female	10	20%	10%	70%	

Table 23.8: Answers related to motivation and the use of the application grouped by gender.

Q	Statement	Gender	Group	n	D	N	A	P(BA)	P(GB)	P(GA)
1	I am motivated to do chores	Male	Before	18	50%	28%	22%	0,03	0,01	0,77
			After	18	10%	20%	70%			
		Female	Before	10	0%	20%	80%	0,94		
			After	10	0%	40%	60%			
2	I put more effort into chores compared to others in my household	Male	Before	18	33%	39%	28%	0,31	0	0,08
			After	18	11%	56%	33%			
		Female	Before	10	0%	20%	80%	0,52		
			After	10	0%	40%	60%			
3	I do chores often	Male	Before	18	28%	28%	44%	0,35	0,01	0,04
			After	18	5%	39%	56%			
		Female	Before	10	0%	10%	90%	0,76		
			After	10	0%	10%	90%			
4	I enjoy doing chores	Male	Before	18	50%	28%	22%	0,14	0,37	0,72
			After	18	28%	33%	39%			
		Female	Before	10	10%	80%	10%	0,97		
			After	10	20%	60%	20%			
5	I think it is important to do chores	Male	Before	18	0%	6%	94%	0,8	0,4	0,55
			After	18	0%	6%	94%			
		Female	Before	10	0%	0%	100%	0,97		
			After	10	0%	0%	100%			
6	I think it is important to do chores thoroughly	Male	Before	18	5%	17%	78%	0,5	0,11	0,25
			After	18	6%	0%	94%			
		Female	Before	10	0%	0%	100%	0,97		
			After	10	0%	0%	100%			

Table 23.7: Answers from participants that answered both questionnaires grouped by gender, before and after the test period. The P-Values are comparing: before and after P(BA), gender before P(GB), and gender after P(GA).

23.3.3 Enjoyment

Table 23.9 presents the results related to enjoyment and the use of the application grouped by gender. Generally, both genders responded with no significant differences. However, the statistics may indicate a tiny difference between the genders, with females thinking the app was more fun to use than what males thought. The trend of females being slightly more agreeing than males is also visible in statements 11, 12, and 13. Lastly, the results may indicate that males perceive adding custom rewards as more fun than females.

Q	Statement	Group	n	D	N	A	P(G)
10	I thought the application was fun to use	Male	18	0%	22%	78%	0,41
		Female	10	10%	0%	90%	
11	I thought it was fun to earn points by doing chores	Male	18	6%	22%	72%	0,47
		Female	10	10%	10%	80%	
12	I thought it was fun to see my contribution compared with others in my household	Male	18	17%	33%	50%	0,46
		Female	10	20%	10%	70%	
13	I thought it was fun to buy rewards	Male	18	17%	39%	44%	0,73
		Female	10	30%	20%	50%	
14	I thought it was fun to add my own custom rewards	Male	18	6%	39%	56%	0,27
		Female	10	30%	30%	40%	

Table 23.9: Answers to enjoyment questions in the last questionnaire grouped by gender.

23.3.4   Engagement

Table 23.10 presents the results related to engagement and the use of the application grouped by gender. There is no significant difference between the genders in statement 15 and 19. However, in statement 16, "I was curious of how others evaluated the chores I did." far more females disagree than males. Likewise, the same trend with females being far more disagreeing than males can be seen in statement 17 and 18. A statistically significant difference is detected in responses to statement 18, "I was curious of what rewards others would buy".

Q	Statement	Group	n	D	N	A	P(G)
15	I thought it was exciting to evaluate the chores done by others in my household	Male	18	28%	17%	56%	0,90
		Female	10	30%	20%	50%	
16	I was curious of how others evaluated the chores i did	Male	18	0%	28%	72%	0,35
		Female	10	40%	0%	60%	
17	I thought it was exciting to buy a reward	Male	18	11%	44%	44%	0,65
		Female	10	40%	10%	50%	
18	I was curious of what rewards others would buy	Male	18	0%	39%	61%	**0,02**
		Female	10	40%	40%	20%	
19	I was so engaged in the application, that I became less aware of my surroundings	Male	18	83%	11%	6%	0,43
		Female	10	70%	20%	10%	

Table 23.10: Answers to engagement questions in the last questionnaire grouped by gender.

23.3.5 Usability

Table 23.11 presents the results related to the usability of the application grouped by gender. Generally, the results indicate an almost equal response to the usability statements. However, the results may suggest that females thought they were less in control of what they were doing in the application than what males are stating.

Q	Statement	Group	n	D	N	A	P(G)
20	I thought the application was easy to use	Male	18	0%	6%	94%	0,79
		Female	10	0%	0%	100%	
21	I felt in control of what I was doing in the application	Male	18	6%	0%	94%	0,29
		Female	10	0%	20%	80%	
22	It was easy to add chores that I had done	Male	18	0%	0%	100%	0,72
		Female	10	0%	0%	100%	
23	It was easy to add custom rewards	Male	18	0%	22%	78%	0,90
		Female	10	0%	40%	60%	
24	I thought the application was easier to understand after using it for a while	Male	18	6%	11%	83%	0,76
		Female	10	0%	10%	90%	

Table 23.11: Answers to usability questions in the last questionnaire grouped by gender.

23.4 Results from Questionnaires: Age

This section presents the results from the questionnaires, giving the reader an overview of the statistics related to age.

23.4.1 General Motivation

Table 23.12 presents the results related to the general motivation of the participants by age, comparing results from before, and after testing the application. None of the results indicate a statistically significant difference between the two age groups. However, there is a tendency in statement one, two, three, and five where the p-value has decreased.

Q	Statement	Age	Group	n	D	N	A	P(BA)	P(AB)	P(AA)
1	I am motivated to do chores	Age >= 30	Before	7	14%	43%	43%	0,48	0,71	0,58
			After	7	0%	43%	57%			
		Age < 30	Before	21	14%	38%	48%	0,16		
			After	21	9%	24%	67%			
2	I put more effort into chores compared to others in my household	Age >= 30	Before	7	14%	43%	43%	0,44	0,49	0,19
			After	7	0%	29%	71%			
		Age < 30	Before	21	19%	38%	43%	0,81		
			After	21	10%	57%	33%			
3	I do chores often	Age >= 30	Before	7	0%	29%	71%	0,95	0,68	0,24
			After	7	0%	14%	86%			
		Age < 30	Before	21	24%	19%	57%	0,56		
			After	21	5%	33%	62%			
4	I enjoy doing chores	Age >= 30	Before	7	29%	43%	28%	0,79	0,67	0,81
			After	7	14%	57%	29%			
		Age < 30	Before	21	38%	48%	14%	0,19		
			After	21	29%	38%	33%			
5	I think it is important to do chores	Age >= 30	Before	7	0%	0%	100%	0,95	0,83	0,58
			After	7	0%	0%	100%			
		Age < 30	Before	21	0%	5%	95%	0,81		
			After	21	0%	5%	95%			
6	I think it is important to do chores thoroughly	Age >= 30	Before	7	0%	0%	100%	0,7	0,19	0,34
			After	7	0%	0%	100%			
		Age < 30	Before	21	5%	14%	81%	0,74		
			After	21	5%	0%	95%			

Table 23.12:   Answers from participants that answered both questionnaires grouped by age, before and after the test period. The P-Values are comparing: before and after P(BA), age before P(AB), and age after P(AA).

23.4.2   Motivation by using Application

Table 23.13 presents the results related to motivation and the use of the application grouped by age. Motivation to do chores by using the application is somewhat equal between the two age groups. However, those above the age of 30 may be slightly more agreeing than those below. Responses to statement 8 may indicate that participants above 30 were more motivated to buy rewards in the application than those below. The older group may be extra motivated to use the application so that other members of the household can see what they did than the younger group.

Q	Statement	Group	n	D	N	A	P(A)
7	I was motivated to do chores by using the application	Age >= 30	7	14%	29%	57%	0,44
		Age < 30	21	24%	29%	48%	
8	I was motivated to buy rewards in the application	Age >= 30	7	14%	29%	57%	0,60
		Age < 30	21	43%	24%	33%	
9	I was motivated to use the application so that other members of my household could see what I did	Age >= 30	7	0%	14%	86%	0,14
		Age < 30	21	19%	14%	67%	
25	If possible, I would continue to use the application	Age >= 30	7	14%	0%	86%	0,73
		Age < 30	21	29%	14%	57%	

Table 23.13: Answers related to motivation and the use of the application questions grouped by age.

23.4.3   Enjoyment

Table 23.14 presents the results related to enjoyment and the use of the application grouped by age. No significant differences are detected between the two age groups when analyzing responses to statement 10 and 11. However, in statement 12, "I thought it was fun to see my contribution compared with others in my household", the statistics may indicate that those above the age of 30 are more agreeing than those below. Furthermore, the trend of participants above 30 being more agreeing than those below may also be the case in responses to statement 13 and 14.

Q	Statement	Group	n	D	N	A	P(A)
10	I thought the application was fun to use	Age >= 30	7	0%	14%	86%	1,00
		Age < 30	21	5%	14%	81%	
11	I thought it was fun to earn points by doing chores	Age >= 30	7	14%	14%	71%	0,87
		Age < 30	21	5%	19%	76%	
12	I thought it was fun to see my contribution compared with others in my household	Age >= 30	7	14%	14%	71%	0,33
		Age < 30	21	19%	29%	52%	
13	I thought it was fun to buy rewards	Age >= 30	7	0%	29%	71%	0,75
		Age < 30	21	29%	33%	38%	
14	I thought it was fun to add my own custom rewards	Age >= 30	7	0%	29%	71%	0,73
		Age < 30	21	19%	38%	43%	

Table 23.14: Answers to enjoyment questions in the last questionnaire grouped by age.

23.4.4 Engagement

Table 23.15 presents the results related to engagement and the use of the application grouped by age. The statistics may indicate that participants above the age of 30 agree more than those below in being excited to evaluate the chores completed by others in the household. Although not statistically significant, the same tendency with participants above 30 agreeing more than those below is visible through all of the remaining statement responses related to engagement.

Q	Statement	Group	n	D	N	A	P(A)
15	I thought it was exciting to evaluate the chores done by others in my household	Age >= 30	7	0%	29%	71%	0,56
		Age < 30	21	38%	14%	48%	
16	I was curious of how others evaluated the chores i did	Age >= 30	7	0%	0%	100%	0,98
		Age < 30	21	19%	24%	57%	
17	I thought it was exciting to buy a reward	Age >= 30	7	0%	29%	71%	0,85
		Age < 30	21	29%	33%	38%	
18	I was curious of what rewards others would buy	Age >= 30	7	0%	43%	57%	0,10
		Age < 30	21	19%	38%	43%	
19	I was so engaged in the application, that I became less aware of my surroundings	Age >= 30	7	43%	43%	14%	0,16
		Age < 30	21	90%	5%	5%	

Table 23.15: Answers to engagement questions in the last questionnaire grouped by age.

23.4.5 Usability

Table 23.16 presents the results related to the usability of the application grouped by age. The results show no significant difference between the two age groups. However, participants above the age of 30 seem to feel less in control of what they were doing in the application than those below.

Q	Statement	Group	n	D	N	A	P(A)
20	I thought the application was easy to use	Age >= 30	7	0%	0%	100%	0,67
		Age < 30	21	0%	5%	95%	
21	I felt in control of what I was doing in the application	Age >= 30	7	0%	29%	71%	0,63
		Age < 30	21	5%	0%	95%	
22	It was easy to add chores that I had done	Age >= 30	7	0%	0%	100%	0,37
		Age < 30	21	0%	0%	100%	
23	It was easy to add custom rewards	Age >= 30	7	0%	14%	86%	0,58
		Age < 30	21	0%	33%	67%	
24	I thought the application was easier to understand after using it for a while	Age >= 30	7	0%	14%	86%	0,90
		Age < 30	21	5%	10%	86%	

Table 23.16: Answers to usability questions in the last questionnaire grouped by age.

23.5 Results from Questionnaires: Household

This section presents the results from the questionnaires, giving the reader an overview of the statistics related to household type.

23.5.1 General Motivation

Table 23.17 presents the results related to the general motivation of the participants by household type, comparing results from before, and after testing the application. Before the test period, the statistics may indicate a small difference between families and partners in their perception of putting more effort into chores than others in the household. However, after the testing period, there is a statistically significant difference between them, with families being much more agreeing than partners.

Q	Statement	Household	Group	n	D	N	A	P(BA)	P(HB)	P(HA)
1	I am motivated to do chores	Partner	Before	18	11%	39%	50%	0,36	0,95	0,76
			After	18	11%	28%	61%			
		Family	Before	7	14%	43%	43%	0,48		
			After	7	0%	43%	57%			
2	I put more effort into chores compared to others in my household	Partner	Before	18	22%	39%	39%	0,7	0,76	**0,03**
			After	18	11%	67%	22%			
		Family	Before	7	29%	14%	57%	0,44		
			After	7	0	29%	71%			
3	I do chores often	Partner	Before	18	17%	22%	61%	0,98	0,2	0,16
			After	18	6%	33%	61%			
		Family	Before	7	0%	29%	71%	0,95		
			After	7	0%	14%	86%			
4	I enjoy doing chores	Partner	Before	18	39%	44%	17%	0,35	0,48	0,74
			After	18	33%	33%	34%			
		Family	Before	7	28%	43%	29%	0,79		
			After	7	14%	57%	29%			
5	I think it is important to do chores	Partner	Before	18	0%	6%	94%	0,98	0,83	0,83
			After	18	0%	6%	94%			
		Family	Before	7	0%	0%	100%	0,95		
			After	7	0%	0%	100%			
6	I think it is important to do chores thoroughly	Partner	Before	18	0%	17%	83%	0,68	0,95	0,81
			After	18	0%	0%	100%			
		Family	Before	7	0%	0%	100%	0,7		
			After	7	0%	0%	100%			

Table 23.17: Answers from participants that answered both questionnaires grouped by household type, before and after the test period. The P-Values are comparing: before and after P(BA), household type before P(HB), and household type after P(HA).

23.5.2 Motivation by using Application

Table 23.18 presents the results related to motivation and the use of the application grouped by household types. As indicated by the statistics for statement 7, families may be more motivated to do chores by using the application than partners. Similarly, the trend of families agreeing stronger than partners is visible in the responses to the remaining statements.

Q	Statement	Group	n	D	N	A	P(H)
7	I was motivated to do chores by using the application	Partner	18	22%	28%	50%	0,54
		Family	7	14%	29%	57%	
8	I was motivated to buy rewards in the application	Partner	18	39%	28%	33%	0,18
		Family	7	14%	29%	57%	
9	I was motivated to use the application so that other members of my household could see what I did	Partner	18	22%	17%	61%	0,11
		Family	7	0%	14%	86%	
25	If possible, I would continue to use the application	Partner	18	28%	17%	56%	0,19
		Family	7	14%	0%	86%	

Table 23.18: Answers related to motivation and the use of the application questions grouped by household types.

23.5.3 Enjoyment

Table 23.19 presents the results related to enjoyment and the use of the application grouped by household types. Families may slightly more agree than partners to statement 10, "I thought the application was fun to use." The statistics may indicate that partners thought it was slightly more fun to earn points by doing chores than what families perceived. Furthermore, families may be more agreeing than partners in that seeing their contribution compared to others was fun. In responses to statement 13, "I thought it was fun to buy rewards," 71% of families agree, while only 33% of partners agree. The same trend is shown in statement 14, "I thought it was fun to add my own custom rewards," where 71% of families agree, while 39% of partners agree.

Q	Statement	Group	n	D	N	A	P(H)
10	I thought the application was fun to use	Partner	18	6%	17%	78%	0,28
		Family	7	0%	14%	86%	
11	I thought it was fun to earn points by doing chores	Partner	18	6%	22%	72%	0,70
		Family	7	14%	14%	71%	
12	I thought it was fun to see my contribution compared with others in my household	Partner	18	17%	33%	50%	0,35
		Family	7	14%	14%	71%	
13	I thought it was fun to buy rewards	Partner	18	28%	39%	33%	**0,05**
		Family	7	0%	29%	71%	
14	I thought it was fun to add my own custom rewards	Partner	18	17%	44%	39%	0,14
		Family	7	0%	29%	71%	

Table 23.19: Answers to enjoyment questions in the last questionnaire grouped by household types.

23.5.4   Engagement

Table 23.20 presents the results related to engagement and the use of the application grouped by household type. The results from the engagement-related statements may indicate a trend where families generally agree more than partners. The statistics may show that families think its more exciting to evaluate chores done by others, buy rewards, and be curious about how others evaluate the chores they have done, and what rewards others would buy. Lastly, families were statistically significantly more agreeing in being so engaged in the application that they became less aware of their surroundings.

Q	Statement	Group	n	D	N	A	P(H)
15	I thought it was exciting to evaluate the chores done by others in my household	Partner	18	28%	17%	56%	0,14
		Family	7	0%	29%	71%	
16	I was curious of how others evaluated the chores i did	Partner	18	17%	22%	61%	0,14
		Family	7	0%	0%	100%	
17	I thought it was exciting to buy a reward	Partner	18	28%	39%	33%	0,15
		Family	7	0%	29%	71%	
18	I was curious of what rewards others would buy	Partner	18	17%	44%	39%	0,36
		Family	7	0%	43%	57%	
19	I was so engaged in the application, that I became less aware of my surroundings	Partner	18	89%	6%	6%	**0,04**
		Family	7	43%	43%	14%	

Table 23.20: Answers to engagement questions in the last questionnaire grouped by household types.

23.5.5   Usability

Table 23.21 presents the results related to the usability of the application grouped by household type. The statistics indicate no significant difference between the various household types. However, families seem to feel less in control of what they were doing compared to partners. Furthermore, families seem to think it was easier to add custom rewards than what partners conceive.

Q	Statement	Group	n	D	N	A	P(H)
20	I thought the application was easy to use	Partner	18	0%	6%	94%	0,90
		Family	7	0%	0%	100%	
21	I felt in control of what I was doing in the application	Partner	18	6%	0%	94%	0,33
		Family	7	0%	29%	71%	
22	It was easy to add chores that I had done	Partner	18	0%	0%	100%	0,74
		Family	7	0%	0%	100%	
23	It was easy to add custom rewards	Partner	18	0%	39%	61%	0,32
		Family	7	0%	14%	86%	
24	I thought the application was easier to understand after using it for a while	Partner	18	6%	6%	89%	0,16
		Family	7	0%	14%	86%	

Table 23.21: Answers to usability questions in the last questionnaire grouped by household type.

23.6   Results from Observations

This section presents results from observing user interactions in Amplitude. The results are presented in a way that compares the average amount of tasks and evaluations done, and rewards bought, between gender, household, and age. These results are mainly used to assess the validity of the results gained from the questionnaires.

23.6.1   Gender

As seen in Figure 23.3, females did more tasks, fewer evaluations, and bought more rewards than males. This contemplates the results from the questionnaires that indicates that females, in general, contribute more to housework than males. Additionally, the fact that females bought more rewards than males supports the results from the questionnaires indicating that more females than males thought it was fun to buy rewards.
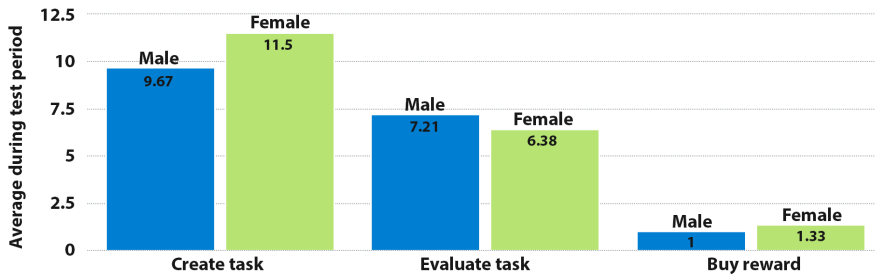
Figure 23.3: The average amount of tasks done, evaluations done, and rewards bought by females and males during the test period.

23.6.2   Age

Figure 23.4 shows that participants above age 30 did more tasks, more evaluations, and bought more rewards that those under 30. This supports the results from the questionnaires indicating that those above 30 were more motivated to do chores using the application than those under. Furthermore, seeing that those above 30 bought more rewards than those under, may imply that they slightly more enjoyed the application.
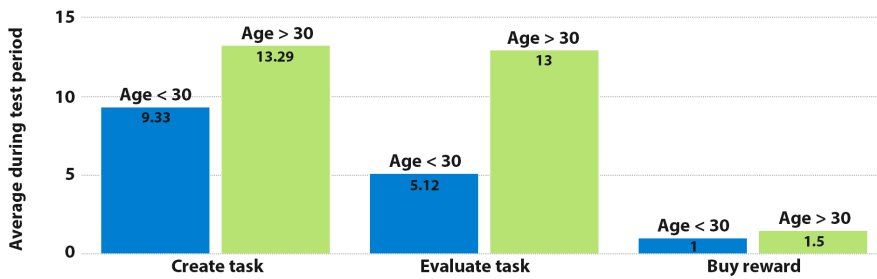
Figure 23.4: The average amount of tasks done, evaluations done, and rewards bought by participants above and under 30 years of age during the test period.

23.6.3 Household

Figure 23.5 is similar to Figure 23.4. This indicates that most of the participants above 30 registered as family members, whereas those under 30 mostly consisted of partners. However, there are some minor differences. The gap in the number of chores, evaluations, and bought rewards are somewhat smaller.
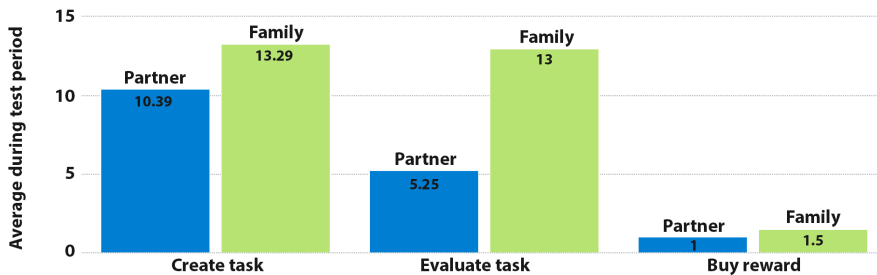
Figure 23.5: The average amount of tasks done, evaluations done, and rewards bought by families and partners during the test period.

Part V

Discussion

The following chapters present an evaluation of the research methodology, an analysis of the results, evaluation of the application, and the project.

Chapter 24

Research Methodology Evaluation

This chapter discusses the research methodologies used. Furthermore, discussing the threats to validity.

24.1 Methods

Several methods have been used in the research of the Master's Thesis, as explained earlier in Chapter 6. This section examines the methods used.

24.1.1 Questionnaire

As a way of gathering quantitative data from participants, two questionnaires were given before and after testing the application for two weeks. Questionnaires are quick and easy for testers to complete. However, questionnaires may present several disadvantages, such as testers misreading questions, fail to understand, and be affected by other opinions. Testers may also fail to receive the questionnaires on email if marked as spam. When we were sending out questionnaires to testers that signed up for testing, several testers responded days later, stating that the email was marked as spam. Significant effort was put into having testers respond to both questionnaires; however, we were unable to reach testers who did not respond to the last questionnaire as we did not have any other contact information.

24.1.2   Observation

The use of a systematic observation discovers what people do, rather than what they say they do. The data collected may be more detailed and precise compared to methods where the participants say what they do [16]. Observing testers using the application proved to be difficult as observing someone at home for two weeks was not doable in our case. However, tracking tester's interactions with the application proved efficient in precisely tracking what the testers did. The consequence of the disadvantage caused by The Hawthorn Effect was minimized as the observation did not take place in the same physical space. However, the learning curve and functionality that enabled the acquisition of every user interaction took a considerable amount of time to implement into the application. Performing analysis on the collected data required a substantial amount of time and effort. Even though observing the tester's interactions with the application provided precise and detailed data, choosing such an approach should be carefully evaluated due to the time that needs to be invested in the implementation and analysis.

24.2   Threats to Validity

Halfway into the testing period of two weeks, COVID-19 precipitated a national lockdown. The lockdown may have enforced the most serious nationwide restrictions since world war two. It is reasonable to believe that voluntary participation in testing our app may have been down prioritized. As a consequence, the validity of the test results may not be precise. Performing the test period without the impact of COVID-19 would have been a more realistic scenario.

The application was tested in testers' households. The opinion of the individuals in the households might have affected the others if their opinion was different, causing them not to state their honest opinion in the questionnaires.

Using questionnaires requires a significant number of responses so that the results can be seen as valid. However, our experiment was tested by 28 people, whereas only three lived in collective households. The responses from these three participants may suggest the general thought of people living in collective households, but the findings for this particular household type can, in no circumstance, be generalized to the whole population.

Chapter 25

Result Analysis

This chapter discusses and analyzes the results presented in Chapter 23. The analysis of the results is split into the diverse categories: general, gender, age, and household type to correspond more easily with the results presented, and the research questions described in Section 5.2. Lastly, a summary of the result analysis presents the essential particulars found upon analyzing the results.

25.1   General

The questionnaires suggest an increase in motivation to do chores. However, the increase may be a result of directly or indirectly use of the application. In statement one, "I am motivated to do chores", 46% agreed in the first questionnaire, while 64% agreed in the last questionnaire. The P-Value found is 11%, only six percent higher than the threshold we have set to determine a finding as statistically significant. The perceived enjoyment of doing chores may have increased some, which may indicate a tendency of increased motivation to do chores as a result of increased enjoyment.

The statistics indicate that the most impactful element in increasing motivation to do chores is the concept where users could observe what other household members had done, contemplating the widely accepted fact that social interaction acts as a motivator for games [68]. Furthermore, interpreted from the results, the reward system may be the most impactful element in increasing enjoyment; this supports Wang and Sun's theory of reward systems' ability to provide curiosity and contribute to users having more fun [58]. Additionally, 50% thought the application motivated them to do chores, while 82% thought the application was

fun to use. Most participants enjoyed earning points for doing chores and being able to compare themselves with others. Few participants stated that buying rewards was fun. However, the observation proves that most participants only bought one reward during the testing period. The number of chores that need to be finished for participants to buy rewards may have been too high, as buying rewards more often could have been more fun. Also, letting participants choose among all rewards could have been more fun than the implemented functionality of selecting a reward from a weekly pool of three rewards.

Several participants found the application engaging, with chores being evaluated by others being a successful concept in generating curiosity. The latter of which Malone highlights as an essential element in increasing intrinsic motivation [33, 34]. As evaluating chores is tightly coupled with elements like adding chores and earning points for doing chores, we successfully avoided the effects that occurred in Hakulinen et al. 's study [53]. Few participants found the application so engaging that they became less aware of their surroundings. That said, our application is created to tightly couple reality with technology, with realistic input in the form of doing chores and realistic output in the form of executing rewards for others in the household. The intent was not to immerse the participants into using the application itself for an extended period but instead couple the application with the reality of doing chores. Therefore, it is still reasonable to suggest that our application was working as intended.

The application needed to balance usability and enjoyment to be able to fulfill its potential, according to Fitz-Walter et al. [52]. Happily, 96% of the participants found the application easy to use, and 86% found it easier to understand after using it for a while. 100% agreed that the most basic functionality, being able to add chores, was easy. This outcome may be a result of the extensive development of the high fidelity prototype. Finally, 64% of participants would like to continue to use the application.

25.1.1   Different Starting Points

In terms of different starting points, the results addressed all five starting points defined in RQ9, see Section 5.2. This was done in order to more easily be able to give a direct answer to the particular research question. Off all users that stated they had low motivation to do chores before using the application, we saw that only 25% still asserted low motivation in the final questionnaire; this may indicate that elements in the application were effective in motivating unmotivated users. On the other hand, of those that were initially motivated to do chores, 8% stated they lacked motivation after the test. This supports Sansone and Harackiewicz's findings, stating that extrinsic rewards could undermine intrinsic

motivation, especially in cases where the person would perform the activity either way [32]. That said, most of the initially motivated participants seem to have remained motivated after the final test.

Furthermore, although not statistically significant, the results indicate that participants that agreed, and the participants that disagreed in putting more effort into chores than others have become more neutral to the particular statement after using the application. Additionally, users that agreed and users that disagreed in doing chores often before using the application may have also become more neutral to that respective statement after using the application. Altogether, these results may indicate a better distribution of chores, which might result from participants seeing household statistics on the effort put into chores, and the number of chores completed. Lastly, it may also imply that our application facilities a cooperative platform for doing chores. Hence, facilitating physiological linkage between participants [71].

Of users not enjoying doing chores before the testing period, the statistics show that only 20% still did not enjoy doing chores after completing the testing period indicating successful facilitation of autonomy, competence, and relatedness through rewards, feedback, and social interaction in the application. As studies show, by facilitating a feeling of autonomy, competence, and relatedness in games, the experience becomes more enjoyable [44, 45]. That said, the statistics indicate that only 60% of those that were already enjoying doing chores still enjoyed doing chores after the use of the application. These results may suggest that those that enjoy doing chores believe using an application requires unnecessary effort.

The only change seen in the different starting points regarding the attitude towards chores was that all users being neutral to the statement "I think it is important to do chores thoroughly" agreed to the statement after using the application. This may indicate that users with a neutral attitude towards chores may become more aware of how housework is conducted in their homes.

25.2 Gender

In motivation to do chores, males had a statistically significantly motivational increase, which females did not, with 33% and -10%, respectively. The negative trend of females' motivation may indicate that the application was too much of a hassle to be used as they were already quite motivated to do chores as the results from the first questionnaire indicates. However, the results indicate a much more similar motivation among the genders after using the application than prior.

Both genders seem to believe they are putting more effort into doing chores than others in their households. However, after the testing period, females' perception

of putting more effort into chores than others may have decreased while males increased, suggesting that the distribution of doing chores has become more even between the two genders. A statistical difference is found between the genders, with females' being the most agreeing in their perception of doing chores often, before and after using the application. The results from the observation support the results from the questionnaires, where females are doing more housework than males. The results may indicate that males think its more important to do chores thoroughly after the testing period than before. These statistics may indicate that evaluating chores done by males may have led to them doing chores more thoroughly.

By using the application, females seem to be further motivated by using the application so that others in the household can see what they did, compared to males. However, most of the participants were partners, and observations show that females did more chores than males. That may suggest that motivation for showing others what has been done in terms of housework, increases with the number of chores fulfilled.

The use of the application may suggest increased motivation as a result of chores being more fun. The first questionnaire, statement four, "I enjoy doing chores", indicates a difference between males and females, with respectively 50% and 10% being disagreeing. However, the results from the last questionnaire show a decrease in the percentage for males, with only 28% who disagree after the testing period. Although not statistically significant, the decrease may indicate increased enjoyment for males when doing chores.

According to the statistics, males are more agreeing than females in their perception of being curious about what rewards other members would buy. According to observations made, females bought more rewards than males; this may suggest a tendency that males, as a result of females buying more rewards, have become more curious toward what rewards females would buy.

25.3   Age

Participants below the age of 30 may have had a more considerable increase in their perception of enjoying to do chores than participants below the age of 30. The increase has led to both groups being approximately equal in their perception of enjoying chores after the testing period.

There seems to be a difference between the two age groups, in which participants above 30 extra agree to increased motivation by showing others what they had done. The statistics indicate that participants above 30 are more likely to be curious about what rewards others would buy. Furthermore, observations show

that participants above 30 bought more rewards than participants below, which may be the reason why participants above 30 may be extra curious.

25.4 Household

A statistically significant difference was found in the last questionnaire between partners and families in their perception of putting more effort into chores than others in the household. The statistics show that families considerably more agree than partners. Children were not obligated to answer the questionnaires due to the general laws concerning privacy for children. As a consequence, most of the data collected from families may be from parents; this may be why the distribution of housework has become more uneven for families as parents realized they were doing more chores than before the test period.

The results indicate that families were more agreeing than partners in being motivated to use the application so that others in the household could see what they did. It is reasonable to propose that families usually consist of more than two people; this may support the assertion that an increased number of people in a household strengthens the motivation gained from showing others what they have done.

For families, buying rewards seem to be the most fun concept, while most partners seem to enjoy being able to earn points. In terms of buying rewards, families are statistically significantly more agreeing in their responses than partners. The concept of having rewards may be further appropriate for a family, as rewards may already be a known concept incorporated in the process of doing chores in a family. Therefore, the reward concept may be more readily transferred and applied in the application, compared to partners.

Families seem to be more curious than partners in how others evaluate the chores they have done. A similar trend with families being more agreeing is seen in the excitement towards evaluating others' chores, buying rewards, and evaluating others. In terms of being so engaged in the application that they became less aware of their surroundings, families are statistically significantly more agreeing than partners.

25.5 Summary

After using the application for two weeks, 64% indicate that they are interested in continuing the use of the application. However, families seem to be standing out, with 86% being interested. Exactly why families seem more interested in using the application is hard to decipher from the statistics. However, the statistics may

allude that families thought using the application was more enjoyable, created more engagement, and generated more motivation than partners. For families, engagement, and enjoyment towards doing chores may make the doing of chores more persevering.

Generally, the motivation to do chores seem to have increased, and particularly for males, with a statistically significant increase. The most impactful element seems to be the social concept coupled with the reward system, where participants were able to see each other's efforts. An indication of increased equal distribution of chores throughout households can be seen by interpreting the results from the questionnaires. However, the observation shows that females are doing chores more often than males.

Chapter 26

Project and Application Evaluation

This chapter presents a brief evaluation of the process, graphical design, architecture, and functionality of the application.

26.1 Evaluation of Process

Most of the process worked seamlessly. Since we worked in the same physical space most of the time, there were few communication problems. Additionally, we were able to validate quickly and give feedback on each other's work, and the fact that we were able to work together when conceptualizing and prototyping saved time in decision making and testing. The organizing of tasks was done by using Kanban, which worked flawlessly. We found that by using a tool named Trello [98], we were able to maintain the project tasks online. This played an important role when working separately. The latter of which, we had to do in the last period of the thesis due to COVID-19. When working separately, we communicated by using discord, email, and messenger. During the start of these times, work was not as quickly validated, and we became less efficient. However, as time passed, we got used to the circumstances, and we were able to resume our healthy work habits online.

26.2   Evaluation of Design

A big-hearted number of hours went into the graphical design of the application during the creation of the high fidelity prototype. Although we had little experience in graphical design, we managed to come up with a design that received great feedback. We believe that reading up on graphic design literature helped us create an application that was likable by most testers. However, we believe that having expert knowledge of graphical design on the team could have reduced the time invested significantly and allowed for further iterations of work towards the development of the application.

26.3   Evaluation of Architecture

The technologies chosen for the application laid the foundation for the architecture. Most of the architecture worked as planned. However, there where some minor struggles that we had to solve during the development.

The React Native application implemented several components and hooks, and the relations between components and hooks became somewhat complicated. However, by strictly following the structural rules we set for ourselves, we managed to maintain control of the codebase. That said, we experienced some problems in validating that the JavaScript data-objects used throughout the client maintained the same structure. However, we managed to solve this by implementing models as interfaces for how the data-objects should appear.

Cloud functions proved to be a great way to outsource logic from the client, meaning that we created cloud functions to relieve the client from massive operations. That said, cloud-functions sometimes responded slowly, and thereby the point of outsourcing logic became obsolete. However, this only happened a few times before the cloud-functions were scaled to be more efficient.

26.4   Evaluation of Functionality

Most of the functionality implemented into the application was working as intended. However, there were some issues concerning Over The Air updates, referred to as OTA. The application was configured to deploy the newest version directly to testers' phones without the need for the tedious process of releasing an updated version through Apple and Google. The deployment occurred automatically as part of a pipeline running when new code was pushed to the master branch of the GitHub repository. However, when testers' installed the application from the Play Store and App Store, the application failed to load the newest

build. Consequently, an outdated build with bugs was introduced to the testers' during the first time they were using the application. However, the second time the testers' opened the application, the newest build was installed and initiated correctly. The functionality with bugs that impacted testers was an unintended change of their avatar in addition to groups being able to open the shop before completing ten chores. Although OTA updates seemed like an effective means of constantly pushing new code to production, generating a new build and releasing it through the Play Store and App Store would have been a more trustworthy solution.

Part VI

Conclusion and Future Work

The final part will present the conclusion of the project, and end
with a chapter presenting future work that can be done to potentially
improve the solution.

Chapter 27

Conclusion

In this project, a preliminary study concerning serious games, motivation, gamification, reward systems, and social interaction has been conducted. Additionally, the review of two related Master's Theses, two papers, and a book concerning gamification, followed by a review of other popular applications, in addition to similar applications, has provided a foundation for conceptualizing solutions concerning housework applications.

Three concepts were explored and prototyped before landing on the proposed solution. Several changes were made during the development of the proposed solution before the solution was finalized. The solution consists of 45 functional requirements and nine non-functional requirements. The functional requirements were validated before the application was published on Apple and Google's testing platforms.

With the solution fully developed and ready for testing, an extensive user test that included 58 participants, and lasted two weeks were conducted.

Weaknesses and strengths regarding the application's ability to raise the users' motivation, enjoyment, and engagement in doing housework were observed. Additionally, the usability of the application was measured. The results showed that by implementing gamified elements in the process of doing chores, Spot, the solution created in this project, confirmed that chores, depending on users' starting points, gender, age, and household type, can be motivating, enjoying, and engaging.

RQ1: What kind of theories related to video games is most relevant to help our application increase a group's motivation for doing chores?
A preliminary study was conducted as described in Part II to be able to find relevant concepts and methods to motivate users to do chores. The preliminary study involved reviewing existing related work and reading related literature and theory. The findings from the preliminary study concluded that the application could benefit from using elements from Malone's framework, behavioral psychology, a reward system, self-determination theory, and social interaction [33, 34, 39, 44, 45, 58, 68, 70, 78].

That said, our application did not implement all examined theories. Instead, a set of elements that we found most relevant were implemented. These elements consisted of challenge and curiosity from Malone's framework, randomly scheduled rewards from behavioral psychology, scoring systems, items, and feedback messages from a reward system, and finally existing relationships, competitiveness, copresence, physiological involvement, and behavioral involvement from social interaction.

RQ2: What concepts from existing similar applications may work in our application?
A study of similar applications was done in Chapter 13. During this study, an extensive analysis of reward types and how they affected the user's motivation for doing chores were done. Findings from this study exposed three concepts that were relevant to our solution.

Firstly, making users able to see if other users completed their tasks seemed to affect social interaction. Secondly, the concept of evaluating others seemed to elaborate even further on social interaction. Thirdly, custom rewards showed success in one of the similar applications.

71% of the participants in the final test agreed that they were motivated to use the application so that others could see what they did. 57% thought it was fun to see their contribution compared to others. 54% thought it was exciting to evaluate others. 68% were curious about how others evaluated their chores. 50% thought it was fun to add custom rewards. These numbers indicate that all three concepts showed success in our application.

RQ3: Which concepts implemented in our application seem to be the most effective form of motivation?
The results indicate that the concept that enabled individuals to showcase the chores they had concluded was the most effective concept towards motivation. To be able to showcase concluded chores, the application implemented a reward system where users earned points from doing chores. These points were then used to present a comparison of individuals in the household.

RQ4: How is the user's motivation for doing chores affected by our application?

An extensive user test producing results concerning the motivational effect of the application was conducted as described in Part IV. The test involved two questionnaires, one to be answered before the test, and one to be answered at the end of the test. These questionnaires presented several identical questions in order to be able to compare the participants' motivation before and after using the application.

The results from the experiment, although not statistically significant, indicate that, in general, users' motivation for doing chores increased by using the application. In fact, males had a statistically significant increase. Lastly, 50% of the users agreed that they were motivated to do chores by using the application.

RQ5: How does the user perceive the usability of our application?

The results from the last questionnaire prove that the users' perception of the usability of the application is excellent, as 96% of the users' agreed to the statement of the application being easy to use. The results indicate that users of older age felt less in control of what they were doing in the application than younger users. However, statistics indicate that older users perceived the application to be easier to use after using it for a while. Furthermore, The application would have struggled to fulfill its purpose without users' ability to add chores - the most basic functionality of the application. Fortunately, 100% of the users' agreed that adding chores was easy.

RQ6: How does our application affect the group's enjoyment of doing chores?

Results from the final user test denote that the application affected groups' enjoyment of doing chores positively. The statistics from the two questionnaires indicate an increase of 14% in users that agrees to enjoy doing chores. Also, 82% of the participants thought it was fun to use the application. Lastly, families may enjoy the application slightly more than partners; however, statistics suggest that couples have a more notable increase in the general enjoyment of doing chores.

RQ7: How is the user's engagement towards chores affected by our application?

Although not statistically significant, results from the final user test denote that users' engagement towards chores was positively affected by our application, especially for those above ages of 30, families, and males. However, as the statistics suggest, the most impactful concept in increasing engagement was evaluating the completed chores of others. Families seem to be more engaged by the curiosity generated from others evaluating their completed chores than partners. That said, results denote that males, on the other hand, were more curious about what

rewards others would buy rather than being excited by the rewards they would buy themselves.

RQ8: How is the distribution of chores within a group affected by our application?

Results from the final questionnaire showed that 50% of the participants were neutral to the statement, "I put more effort into chores than others in my household." Seeing that in the first questionnaire, only 32% were neutral, an increase of 18% indicates that the application has aided in a more neutral distribution of chores.

RQ9: How does our application's effect vary on users with different starting points?

Off all users that stated they had low motivation to do chores before using the application, we saw that only 25% still asserted low motivation in the final questionnaire. On the other hand, of those that were initially motivated to do chores, 8% stated they lacked motivation after the test. Still, most of the initially motivated participants, according to the statistics, remained motivated after the final test.

Furthermore, the statistics indicate that participants that agreed, and participants that disagreed in putting more effort into chores than others became more neutral to the particular statement after using the application. Additionally, results indicate that users that agreed and users that disagreed in doing chores often before using the application also became more neutral to that respective statement after using the application. This denotes that the application affected both sides of participants in a way that facilitated a better distribution of chores.

Of participants not enjoying doing chores before the testing period, only 20% still stated they did not enjoy doing chores after completing the testing period. That said, only 60% of those that were already enjoying doing chores still stated they enjoyed doing chores after the use of the application. These results may suggest that those that enjoy doing chores believe using an application requires unnecessary effort.

Fulfillment of the Research Goal

The research goal of the Master's Thesis was to "Examine perceived user perceptions of an application created to motivate and encourage members of the household to execute chores." The research goal was split into research questions, as discussed priorly. The testing of the application revealed statistics that indicate increased users' perceptions of motivation, engagement, and enjoyment in doing chores. The impact of these perceptions varied based on users' starting points, gender, age, and household type. The research goal is concluded accomplished as a result of the research questions being answered.

Chapter 28

Future Work

This chapter exhibits future work concerning the implementation of the application, new ideas, and further testing. The future work is based upon feedback, the results obtained from the final user test.

28.1   Implementation

The final user test revealed several defects concerning the implementation of the application. Generally, most of the defects were minor bugs, writing mistakes, and misplacement of content. However, in some cases, users experienced errors that genuinely impacted the usage of the application. Although none of the flaws where system-breaking, fixing them all together would undoubtedly improve the usage of the application. For this purpose, this section will explain most of these errors.

Table 28.1 illustrates most of the minor flaws, their priority, and the estimated effort it takes to resolve them. In terms of priority, low means it does not impact the overall use, medium means it has an impact on the use of the application and should be fixed, and high means it has a critical effect on the use of the application, and it must be fixed. Additionally, concerning the effort to fix flaws, low means it should be straightforward to find and fix, medium means it should be easy to fix, but it might take time to locate, and high means it is challenging to both fix and locate.

As seen in Table 28.1, three flaws have a high priority. First, the critical flaw concerning the inconsistent delivery of new application builds. Admittedly, this

Flaw	Priority	Effort to fix
Inconsistent delivery of new application builds	High	Medium
Push notifications for Android fails to deliver	High	Medium
Bought rewards display the wrong avatars	High	Medium
Can not use parentheses or plus signs when creating task	Medium	Low
Bought rewards display the wrong avatars	High	Medium
The next time trying to register after exiting the application before creating a nickname the abort button throws an error	Low	Medium
Emojis does not show on Android 8	Low	Low
To much content in the information popup exceed small screens	Low	Low
The keyboard does not minimize when scrolling	Low	Low
The length on task names is to restricted	Low	Low

Table 28.1: Flaws reported during the final user test.

is more of a mistake in the configuration of the build delivery system than an error. To fix this, we must reconfigure the build system implemented by Expo and make sure that new builds are forced to the client. Secondly, by not being able to deliver push notifications on Android, much of the information flow in the application may be obstructed. We suspect that in order to support push notifications for Android, one must provide additional configurations in the Android build. Finally, the fact that avatars are misplaced in the bought rewards might confuse users in whom the reward applies. We suspect that this error originates in inconsistent indexing of Avatar files.

28.2   Ideas for the Application

Feedback gotten from the user test showed that the aspect of comparing effort with others highly motivated users to do chores. With this in mind, the idea of implementing a more sophisticated leaderboard that lets users compare additional parameters arose. Such a leaderboard could include, top three users based on

effort last seven days, last month, last year, and all time.

Furthermore, some of the feedback indicate that users would be more likely to buy rewards if they could choose whatever reward they wanted. Therefore, another idea is to remove the randomness of the available rewards and make all rewards available at all times.

Some users wanted to set task-specific goals with appropriate rewards within the application. Therefore, implementing a feature that lets users create specific goals consisting of certain tasks that should be completed in order to get a specific reward became an exciting idea.

Finally, the last idea concerns the possibility of rewarding users with real-life coupons providing discounts on stores, cinemas, and training centers. This can be implemented by negotiating agreements with businesses so that coupons could be rewarded in the application.

28.3   Further Testing of the Application

To start, another similar user test as the one conducted in this thesis should be conducted. However, seeing that our test only included three participants from collectives, this test should focus more on collectives as opposed to families and couples. This test should include the same questionnaires before and after, in order to be able to compare results with families and couples further.

Furthermore, in terms of extended research, another more extensive experiment should be conducted. This experiment should last for a more extended period and include a vast amount of randomly selected participants. Such an experiment would provide more valid results, as an extended amount of time would reduce validity problems. Also, more randomly selected participants would further reduce the familiarity bias effect often occurring in a Master's Thesis. Moreover, in order to further evaluate the effectiveness of our application, this sort of experiment could compare user perceptions in our app against other existing similar applications. This experiment exceeds our scope but is certainly something that could produce impressive results.

Since most of the testing that has been done is connected to research, more specifically, users' perceptions of motivation, enjoyment, and engagement in doing chores, one should conduct another test concerning itself more with the implementation, development, and usability of the application. That way, one could get more comprehensive feedback, which could aid in further improving the application.

Lastly, we saw that by testing our solution, we uncovered several mistakes and

new ideas on how to improve the application. With that in mind, for future work, one should test more frequently to save time and resources in further developing the application; this would also contribute to a more iterative development process.

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Appendices

A Figures

A.1 The File-Structure of the Application


```
SPOT                              +---hooks                              |   |     JoinGroupScreen.js          |   \---tasks
|   .eslintrc                     |   |   Collections.js                 |   |     MyGroupScreen.js            |         CreateTaskScreen.js
|   .gitignore                    |   |   resources.js                   |   |     NoGroupScreen.js            |         TaskLogScreen.js
|   .watchmanconfig               |   |                                  |   |                                 |         TaskScreen.js
|   App.js                        |   +---authentication                |   +---header                       |
|   app.json                      |   |     auth.js                      |   |     header.js                   |   \---components
|   babel.config.js               |   |                                  |   |                                 |         AutoComplete.js
|   google-services.json          |   +---group                         |   +---init                         |         AutoCompleteCard.js
|   jsconfig.json                 |   |     group.js                     |   |     InitScreen.js               |         DisplayTasks.js
|   Navigation.js                 |   |                                  |   |                                 |         TasksHeader.js
|   package.json                  |   +---overlay                       |   +---overlay                      |
|   yarn.lock                     |   |     overlayHook.js               |   |     Overlay.js                  +---services
|                                 |   |                                  |   |                                 |     AsyncStorageService.js
+---.expo-shared                  |   +---privacy_policy                 |   +---privacy_policy                |     ErrorService.js
|     assets.json                 |   |     privacy_policy.js            |   |     PrivacyPolicyScreen.js      |     RegisterService.js
|                                 |   |                                  |   |                                 |
+---assets                        |   +---profile                       |   +---profile                      +---shared
|   |   icon.png                  |   |     profile.js                   |   |     ProfileScreen.js            |   |   InformationList.js
|   |   splash.png                |   |                                  |   |                                 |   |   Logo.js
|   |   spot_logo.png             |   +---reward                        |   +---register                     |   |
|   |                             |   |     reward.js                    |   |     RegisterAvatarScreen.js     |   +---avatar
|   +---avatars                   |   |                                  |   |     RegisterProfileScreen.js    |   |     AvatarSelector.js
|   |     avatar-1.png            |   +---shop                          |   |     RegisterScreen.js           |   |
|   |     avatar-10.png           |   |     shop.js                      |   |                                 |   +---brokers
|   |     avatar-11.png           |   |                                  |   +---reward                        |   |     ButtonBroker.js
|   |     avatar-12.png           |   \---task                          |   |     RewardClaimScreen.js        |   |     CheckboxItem.js
|   |     avatar-13.png           |         task.js                      |   |     RewardScreen.js             |   |     TextBroker.js
|   |     avatar-2.png            |                                      |   |     RewardShareScreen.js        |   |     TextInputBroker.js
|   |     avatar-3.png            +---models                             |   |                                 |   |
|   |     avatar-4.png            |   |   Group.js                       |   +---settings                      |   +---cards
|   |     avatar-5.png            |   |   Log.js                         |   |     SettingsScreen.js           |   |     DefaultCard.js
|   |     avatar-6.png            |   |   Profile.js                     |   |                                 |   |
|   |     avatar-7.png            |   |   ShopReward.js                  |   +---shop                          |   +---error
|   |     avatar-8.png            |   |   Stats.js                       |   |   |   ShopAllRewards.js         |   |     ErrorMessage.js
|   |     avatar-9.png            |   |   Task.js                        |   |   |   ShopChooseGroupTypeScreen.js|   |
|   |                             |   |                                  |   |   |   ShopCreateOrEditRewardScreen.js| +---progress
|   +---fonts                     +---modules                            |   |   |   ShopHistoryScreen.js      |   |     ProgressBar.js
|   |     Montserrat-Bold.ttf     |   |   ErrorScreen.js                 |   |   |   ShopReward.js            |   |
|   |     Montserrat-Regular.ttf  |   |                                  |   |   |   ShopScreen.js            |   \---statistics
|   |                             |   +---evaluate                       |   |   |                             |         BarStats.js
|   \---images                    |   |   |   EvaluateScreen.js          |   |   \---components                |         EmojiStats.js
|         knoob.png               |   |   |                              |   |         ShopActiveRewards.js    |         EmojiStatsVertical.js
|         toilet.png              |   |   \---components                |   |         ShopCard.js             |
|                                 |   |         EvaluateCircleButton.js  |   |         ShopGetStarted.js       \---utils
+---config                        |   |                                  |   |         ShopTimeUntilRefresh.js       Analytics.js
|     amplitude.js                |   +---group                         |   |                                       AvatarService.js
|     firebase.js                 |   |     CreateGroupScreen.js         |   +---signin                             Colors.js
|                                 |   |     GroupSettingsScreen.js       |   |     ForgottenPasswordScreen.js        PositiveWords.js
+---context                       |   |     InvitationsScreen.js         |   |     SignInScreen.js                   PushNotifications.js
|     GlobalContext.js            |   |     InviteMemberScreen.js        |   |                                       SentryCrashService.js
                                                                                                                          stats.js
                                                                                                                          statsOld.js
```

Figure A1: The file-structure of the application.

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A.2 Malone's Framework for Intrinsic Motivation

Framework for a Theory of Intrinsically Motivating Instruction

I. Challenge
 A. Goal
  1. Personally meaningful goals
  2. Obvious or easily generated goals
  3. Performance feedback
 B. Uncertain outcome
  1. Variable difficulty level
   a. determined automatically
   b. chosen by learner
   c. determined by opponent's skill
  2. Multiple level goals
   a. score-keeping
   b. speeded responses
  3. Hidden information
  4. Randomness
 C. Toys vs. tools
 D. Self-esteem

II. Fantasy
 A. Intrinsic and extrinsic fantasies
 B. Cognitive aspects of fantasies
 C. Emotional aspects of fantasies

III. Curiosity
 Optimal level of informational complexity
 A. Sensory curiosity
  audio and visual effects
 B. Cognitive curiosity
  1. "Good form" in knowledge structures
   a. complete
   b. consistent
   c. parsimonious
  2. Informative feedback
   a. surprising
   b. constructive

Figure A2: Malone's framework for intrinsic motivation, taken from [33].

A.3 Questionnaire before Final User Test

Figure A3: Segment 1 from the questionnaire before the final user test.

Figure A4: Segment 2 from the questionnaire before the final user test.

Figure A5: Segment 3 from the questionnaire before the final user test.

:::

I enjoy doing chores *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I think it is important to do chores *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I think it is important to do chores thoroughly *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Can you describe any challenges you have experienced concerning housework in your home?

Long-answer text

If so, do you have any suggestions on what could help overcome those challenges?

Long-answer text
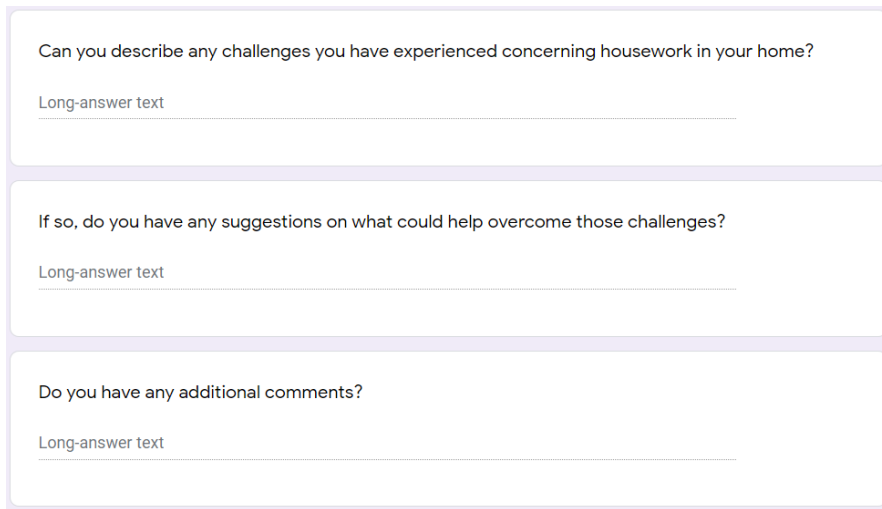
Figure A6: Segment 4 from the questionnaire before the final user test.

Figure A7: Segment 5 from the questionnaire before the final user test.

Can you describe any challenges you have experienced concerning housework in your home?

Long-answer text

If so, do you have any suggestions on what could help overcome those challenges?

Long-answer text

Do you have any additional comments?

Long-answer text

Figure A8: Segment 6 from the questionnaire before the final user test.

A.4 Questionnaire after Final User Test

Figure A9: Segment 1 from the questionnaire after the final user test.

Figure A10: Segment 2 from the questionnaire after the final user test.

Figure A11: Segment 3 from the questionnaire after the final user test.

Figure A12: Segment 4 from the questionnaire after the final user test.

Figure A13: Segment 5 from the questionnaire after the final user test.

Figure A14: Segment 6 from the questionnaire after the final user test.

Figure A15: Segment 7 from the questionnaire after the final user test.

I was curious of what rewards others would buy *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I was so engaged in the application, that I became less aware of my surroundings *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure A16: Segment 8 from the questionnaire after the final user test.

Figure A17: Segment 9 from the questionnaire after the final user test.

It was easy to add custom rewards *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I thought the application was easier to understand after using it for a while *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure A18: Segment 10 from the questionnaire after the final user test.

Section 7 of 7

General

Description (optional)

If possible, I would continue to use the application *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Do you have any additional comments?

Long-answer text

Figure A19: Segment 11 from the questionnaire after the final user test.

B   Tables

B.1   User Events Recorded in the Application

Events	Properties
create task	taskName
create custom reward	reward
create group	groupId
update group	groupId
create profile	email
sign in	method
sign out	
sign up	method
evaluate task	taskName, effort, result, creatorOfTask
join group	groupId
go to screen	screen
activate shop	
select shop	shopId
update profile	
edit active rewards	rewards
delete custom reward	reward
edit custom reward	reward
leave group	groupId
invite member	email
spend virtual currency	type, item, virtual currency name, value
claim virtual currency	virtual currency name, value
rewards to be claimed	rewards

Table A1: User events that are recorded in the application.

B.2   First Questionnaire: Results from all Participants

The statistics are summarized in tables with a three-point Likert Scale, reduced from the original five-point Likert Scale in the questionnaires. The tables consist of a question id (Q), statement (Statement), group type (Group), the number of respondents (n), those that disagreed (D), those that were neutral (N), and those that agreed (A). In some tables where the probability of a difference between two groups exists, probability values (P(group type)) are added to enlighten the probability of the observed result, assuming the null hypothesis is true. The significance level for the p-value is set to 5%, in which p-values below 0,05 are determined as statistically significant and therefore highlighted in bold.

Q	Statement	n	D	N	A
1	I am motivated to do chores	58	17%	38%	45%
2	I put more effort into chores compared to others in my household	58	22%	36%	41%
3	I do chores often	58	19%	33%	48%
4	I enjoy doing chores	58	40%	43%	17%
5	I think it is important to do chores	58	0%	3%	97%
6	I think it is important to do chores thoroughly	58	2%	17%	81%

Table A2: Answers from all participants that answered the first questionnaire.

Q	Statement	Group	n	D	N	A	P(G)
1	I am motivated to do chores	Male	28	21%	43%	36%	0,2
		Female	30	13%	33%	53%	
2	I put more effort into chores compared to others in my household	Male	28	32%	39%	29%	**0,05**
		Female	30	13%	33%	53%	
3	I do chores often	Male	28	32%	25%	43%	0,13
		Female	30	7%	40%	53%	
4	I enjoy doing chores	Male	28	46%	29%	25%	0,88
		Female	30	33%	57%	10%	
5	I think it is important to do chores	Male	28	0%	4%	96%	0,88
		Female	30	0%	3%	97%	
6	I think it is important to do chores thoroughly	Male	28	4%	18%	79%	0,7
		Female	30	4%	18%	79%	

Table A3: Answers from all participants that answered the first questionnaire grouped in genders.

Q	Statement	Group	n	D	N	A	P(G)
1	I am motivated to do chores	Age >= 30	13	8%	46%	46%	0,98
		Age < 30	45	20%	36%	44%	
2	I put more effort into chores compared to others in my household	Age >= 30	13	15%	23%	62%	0,54
		Age < 30	45	24%	40%	36%	
3	I do chores often	Age >= 30	13	0%	31%	69%	0,26
		Age < 30	45	24%	33%	42%	
4	I enjoy doing chores	Age >= 30	13	31%	38%	31%	0,34
		Age < 30	45	42%	44%	13%	
5	I think it is important to do chores	Age >= 30	13	0%	8%	92%	0,4
		Age < 30	45	0%	2%	98%	
6	I think it is important to do chores thoroughly	Age >= 30	13	0%	31%	69%	**0,04**
		Age < 30	45	2%	13%	84%	

Table A4: Answers from all participants that answered the first questionnaire grouped in age.

Q	Statement	Group	n	D	N	A	P(H)
1	I am motivated to do chores	Partner	29	14%	29%	58%	0,79
		Family	15	13%	38%	49%	
2	I put more effort into chores compared to others in my household	Partner	29	28%	34%	38%	0,59
		Family	15	27%	27%	47%	
3	I do chores often	Partner	29	21%	31%	48%	0,24
		Family	15	7%	40%	53%	
4	I enjoy doing chores	Partner	29	45%	41%	14%	0,19
		Family	15	27%	47%	27%	
5	I think it is important to do chores	Partner	29	0%	3%	97%	0,87
		Family	15	0%	7%	93%	
6	I think it is important to do chores thoroughly	Partner	29	0%	14%	86%	0,7
		Family	15	0%	20%	80%	

Table A5: Answers from all participants that answered the first questionnaire grouped in household.

C Paper Prototype

This section outlines the several hand-drawn screens for the paper prototype of the first concept Chorify. These screens were used in a low fidelity prototype, and aided in evaluating the different features of the concept.
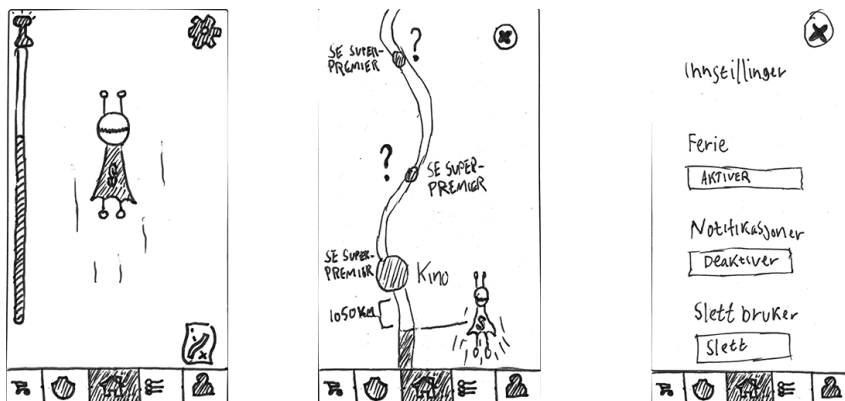
C.1 Paper Prototype: Home Screen

Figure A20: Left: Home screen, middle: Map screen, right: Settings screen.

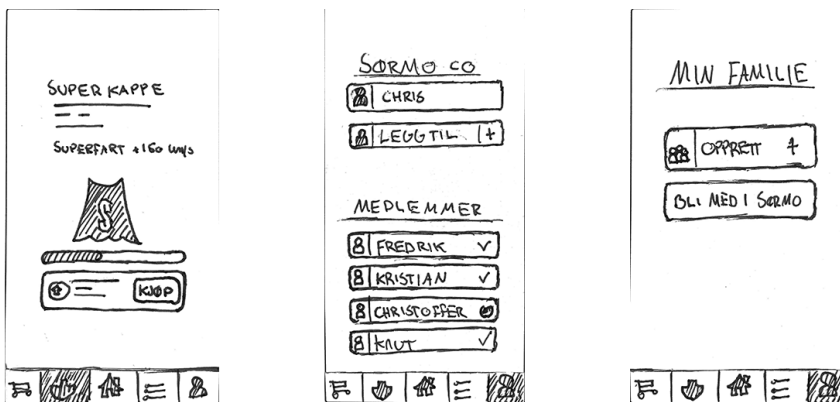## C.2 Paper Prototype: Upgrades and Family

Figure A21: Left: Upgrade screen, middle: Family overview screen, right: Create/Join family screen.

C.3 Paper Prototype: Super Reward, and Super Reward Managing

Figure A22: Left: Super rewards screen, middle: New super reward, right: Edit super reward.

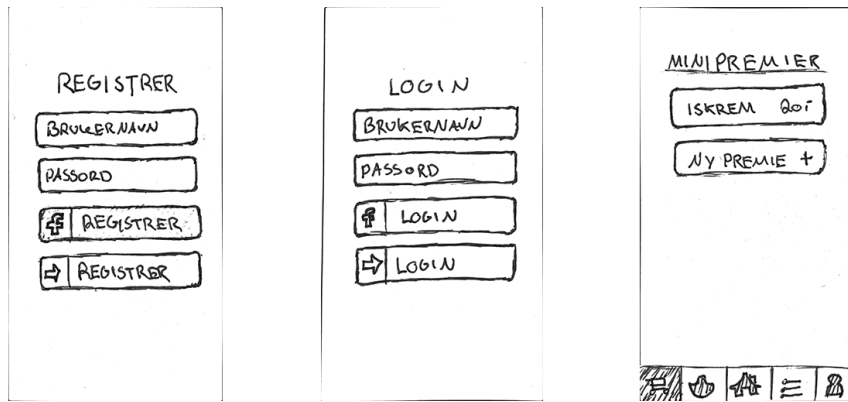## C.4   Paper Prototype: Register, Login and Small Rewards

Figure A23: Left: Register user, middle: Login screen, right: Small rewards

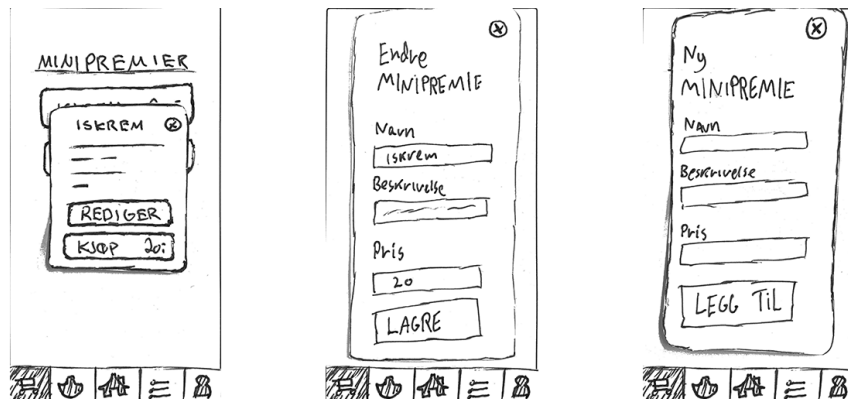## C.5   Paper Prototype: Managing Small Rewards

Figure A24: Left: See small reward, middle: Edit small reward, right: New small reward.

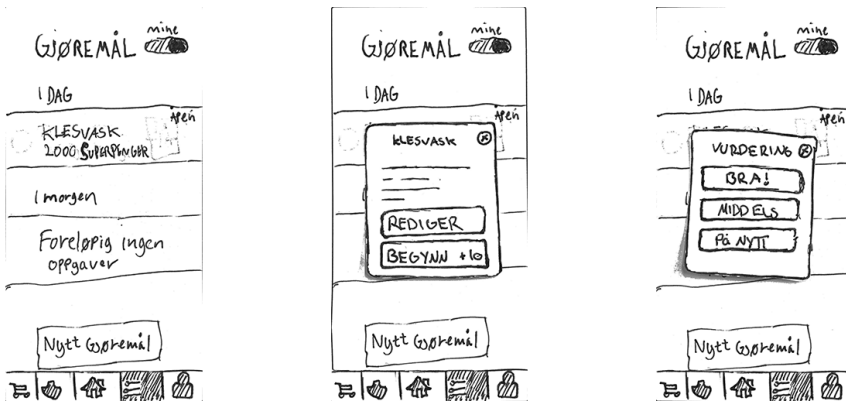## C.6 Paper Prototype: Tasks, and Task Management

Figure A25: Left: Task screen, middle: See task, right: Evaluate task.
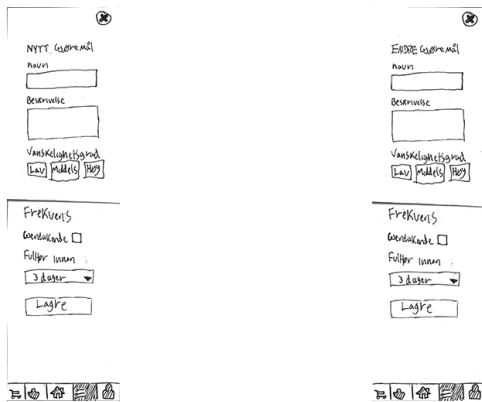
C.7 Paper Prototype: Further Task Management

Figure A26: Left: New task, right: Edit task.

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Gamification of Chores

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