Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Computer Science

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# Gamification of Chores

Master's thesis in Informatics
Supervisor: Alf Inge Wang
May 2021

NTNU
Kunnskap for en bedre verden

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# Abstract

In today's society, the number of people owning smartphones increases daily. Games are one of the most popular types of mobile applications. In addition to the high usage of smartphone gaming, people tend to take on a minimal share of total household work. This suggests that they have a high motivation for using their phones but lack motivation for doing chores.

We decided to take advantage of this situation. With the high popularity of smartphone gaming, its elements could beneficially be used in non-game contexts. We developed a mobile application where several elements were applied from a comprehensive preliminary study on serious games, motivation, gamification, reward systems, social interaction, and several related works and applications.

Through brainstorming sessions and iterations of concept and prototyping development, we ended up with the mobile application Tidy, a tool for planning, organizing, and performing chores in the household.

*"something that is tidy is neat and is arranged in an organized way." [1]*

Tidy is space-themed and lets household members compete about racing their rockets to the moon in time-limited competitions. At the start of each competition, chores get distributed through fun mini-games. Users can progress their rockets towards the moon by completing or evaluating chores. This also earns them TidyCoins to purchase in-game cosmetics or their own customized real-life rewards. Users also earn encouraging achievements for their hard work. Competition winners receive a boost in the upcoming competition, and their flag is planted on the moon to symbolize their victory.

After developing the application, we conducted an experiment where 50 participants tested it for two weeks. We wanted to investigate whether the application could affect users' motivation, engagement, and enjoyment of performing chores, their perception of chores kin the household, and how they perceived the application's usability. The quantitative data generation method results showed increased motivation, especially for partners, females, and participants aged 25 or older. It also showed an increase in both engagement and enjoyment for all participants. Users experienced slight usability problems while learning to use the application, but eventually found it easier to use. The perception of chores changed positively, especially for partners, who also reported the most positive usability feedback.

# Preface

This Master's thesis was written at the Norwegian University of Science and Technology (NTNU), Faculty of Information Technology and Electrical Engineering, Department of Computer Science. Throughout the project we have received invaluable support, guidance, and input from our supervisor Alf Inge Wang, and would like to extend our sincere appreciation for the facilitation provided by him.

We would also like to thank our families, cohabitants, and fellow students who gave us valuable help by testing and providing feedback on our concept, prototypes, and the report itself, in multiple iterations.

Lastly, this thesis would have no result without the 50 participants in the experiment. We would therefore also like to thank all friends, families, fellow students, friends of friends, and everyone else who tested our application and provided important feedback despite the COVID-19 situation.

Jonas Jevnaker Aas, Svenn Grønbeck
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# Table of Contents

**Abstract** i

**Preface** ii

**Abbreviations** 1

**I Introduction** 2

**1 Motivation** 3

**2 Problem Description and Context** 4

**3 Reader's Guide** 5

**II Research Methodology** 6

**4 Research Goal and Research Questions** 7
4.1 Research Goal . . . 7
4.2 Research Questions . . . 7

**5 Research Method** 9
5.1 Literature Review . . . 10
5.2 Design & Creation . . . 10
5.2.1 Concept creation . . . 10
5.2.2 Prototyping . . . 10
5.2.3 Implementation . . . 10
5.2.4 User Testing . . . 11
5.3 Experiment . . . 11
5.3.1 Observations . . . 11
5.3.2 Questionnaires . . . 11
5.3.3 Validity and Reliability . . . 12
5.4 Data Analysis . . . 12
5.4.1 Quantitative . . . 12
5.4.2 Qualitative . . . 12

**III Preliminary Study** **13**

**6 Serious Games** **14**
6.1 What Are Serious Games? . . . 14
6.2 Use Cases . . . 14
6.2.1 Exergames . . . 15
6.2.2 Education . . . 15
6.2.3 Healthcare . . . 16
6.2.4 Training . . . 16
6.3 Benefits and Challenges . . . 17
6.4 Summary . . . 17

**7 Theories on Motivation** **18**
7.1 Intrinsic and Extrinsic Motivation . . . 18
7.2 Skinner's Box . . . 18
7.3 Self-determination Theory . . . 19
7.4 Flow . . . 19
7.5 The Gameflow Model . . . 20
7.6 Malone's Framework for Intrinsic Motivation . . . 20
7.6.1 Challenge . . . 20
7.6.2 Fantasy . . . 21
7.6.3 Curiosity . . . 21
7.7 Summary . . . 21

**8 Gamification** **23**
8.1 What is Gamification? . . . 23
8.2 History of Gamification . . . 23
8.3 Serious Games and Gamification . . . 24
8.4 Benefits and Issues . . . 24
8.5 Summary . . . 26

**9 Reward Systems** **27**
9.1 What are Reward Systems? . . . 27
9.2 Reward Characteristics . . . 28
9.3 Utilizing Rewards . . . 28
9.4 Reward Types . . . 29
9.4.1 Score Systems . . . 29
9.4.2 Experience Points . . . 30
9.4.3 Items . . . 30
9.4.4 Resources . . . 30
9.4.5 Achievements . . . 31
9.4.6 Feedback Messages . . . 31
9.4.7 Animations / Cinematic Scenes . . . 32
9.4.8 Unlocking Mechanisms . . . 32
9.4.9 Summary . . . 32

**10 Social Interaction** **34**
10.1 Social Gaming and Motivation . . . . . 34
10.2 Interaction Through Teams . . . . . 34
10.3 The Game Session . . . . . 35
10.4 Examples of Social Interaction in Games . . . . . 35
10.5 Summary . . . . . 36

**11 Related Work on Gamification** **37**
11.1 The Effect of Points and Audio on Concentration, Engagement, Enjoyment, Learning, Motivation, and Classroom Dynamic Using Kahoot! . . . 37
11.2 Does Educational Gamification Improve Students' Motivation? If So, Which Game Elements Work Best? . . . . . 38
11.3 Gamification and Web-based Homework . . . . . 39
11.4 Gamification and Family Housework Applications . . . . . 40
11.5 Improving User Experience with Gamification and Reward Systems . . . 41
11.6 Gamification of Chores . . . . . 42
11.7 Similarities and differences . . . . . 43
11.7.1 The Effect of Points and Audio on Concentration, Engagement, Enjoyment, Learning, Motivation, and Classroom Dynamic Using Kahoot! . . . . . 43
11.7.2 Does Educational Gamification Improve Students' Motivation? If So, Which Game Elements Work Best? . . . . . 43
11.7.3 Gamification and Web-based Homework . . . . . 43
11.7.4 Gamification and Family Housework Applications . . . . . 44
11.7.5 Improving User Experience with Gamification and Reward Systems 44
11.7.6 Gamification of Chores . . . . . 44
11.8 Summary . . . . . 44

**12 Application Reviews** **45**
12.1 Non-chore Related . . . . . 45
12.1.1 Duolingo . . . . . 45
12.1.2 Hold . . . . . 46
12.1.3 Summary . . . . . 48
12.2 Chore Related . . . . . 48
12.2.1 Nipto . . . . . 48
12.2.2 OurHome . . . . . 49
12.2.3 Summary . . . . . 50
12.3 Discussion . . . . . 50
12.3.1 Reward Types . . . . . 51
12.3.2 Motivation . . . . . 51
12.4 Summary . . . . . 51

**IV Prototype** **52**

**13 Concept** **53**

13.1 Iteration 1 . . . 53
13.1.1 Interfaces and Functionality . . . 54
13.1.2 User testing . . . 61
13.1.3 Evaluation . . . 62
13.2 Iteration 2 . . . 62
13.2.1 Changes from the Previous Version . . . 62
13.2.2 New functionality . . . 65
13.2.3 Evaluation . . . 66

**14 Potential and Chosen Technologies for the Proposed Solution 67**
14.1 Design . . . 67
14.1.1 Figma . . . 67
14.2 Framework . . . 67
14.2.1 Unity . . . 68
14.2.2 React Native . . . 68
14.2.3 Expo . . . 68
14.3 Firebase . . . 68
14.3.1 Realtime database . . . 69
14.3.2 Firebase Analytics . . . 69

**15 Proposed Solution 70**
15.1 User Flow in the Proposed Solution . . . 70
15.1.1 Planning . . . 70
15.1.2 Chores and evaluations . . . 70
15.1.3 Achievements . . . 71
15.1.4 TidyCoins and XP . . . 71
15.1.5 Store . . . 71
15.1.6 Weekly competition . . . 72
15.2 Firebase Analytics . . . 72
15.3 Customization . . . 72
15.4 Feedback . . . 73

**16 Requirements 75**
16.1 Functional Requirements . . . 75
16.2 Non-functional requirements . . . 78

**17 High-Fidelity Prototype of the Proposed Solution 79**
17.1 High-Fidelity Prototype . . . 79
17.1.1 Start screen, Login, and Registration . . . 79
17.1.2 Creating a group . . . 81
17.1.3 Joining an existing group . . . 82
17.1.4 Home . . . 82
17.1.5 Settings . . . 83
17.1.6 Planning . . . 86
17.1.7 Chores . . . 89
17.1.8 Achievements . . . 91

17.1.9 Store . . . 91
17.1.10 Profile . . . 92
17.1.11 Weekly Podium . . . 93
17.2 High-Fidelity Prototype Testing . . . 94
17.2.1 Execution of the test . . . 94
17.2.2 Results . . . 94

**18 Final solution** **96**
18.1 Changes to the solution . . . 96
18.1.1 Rewards . . . 96
18.1.2 Deciding competition length . . . 96
18.1.3 Colors . . . 97
18.2 Additions to the solution . . . 97
18.2.1 Amount of Group Requests Indicator . . . 97
18.2.2 Onboarding . . . 97
18.2.3 Flag on the moon . . . 98
18.2.4 Statistic page . . . 99
18.2.5 In-game rewards . . . 99
18.2.6 Rocket Flame Color . . . 100
18.2.7 Repeating chores . . . 100

**19 Software Architecture** **101**
19.1 Architecture Overview . . . 101
19.2 Database . . . 102
19.3 React Native . . . 103
19.3.1 Components . . . 104
19.3.2 Screens . . . 104
19.3.3 Global state . . . 104
19.3.4 Services . . . 104
19.3.5 Utils . . . 104

**20 Testing and Validation of Requirements** **105**
20.1 Approach . . . 105
20.2 Validation of Functional Requirements . . . 105
20.3 Validation of Non-Functional Requirements . . . 109

**V Execution and results** **110**

**21 Execution** **111**
21.1 NSD Form . . . 111
21.2 Research Context and Participants . . . 111
21.3 Questionnaires . . . 112
21.3.1 Likert Scale . . . 112
21.3.2 First questionnaire . . . 112
21.3.3 Final questionnaire . . . 113

21.4 Observations . . . 114
21.4.1 User Behaviour . . . 114
21.4.2 Realtime tracking . . . 114

**22 Results** **116**
22.1 Participants . . . 116
22.2 Results from Questionnaires . . . 117
22.2.1 Results from both Questionnaires Compared . . . 118
22.2.2 Results on Application Usage from the Final Questionnaire . . . 120
22.3 Results from Observations . . . 126
22.3.1 Comparison between completed chores and evaluated chores . . . 127
22.3.2 Comparison between hat games and rocket chores played . . . 128
22.3.3 Comparison between real-life and in-game rewards purchased . . . 128

**VI Discussion** **130**

**23 Result Analysis** **131**
23.1 How Results align with Theory . . . 131
23.1.1 Reward Systems . . . 131
23.1.2 Social Interaction . . . 132
23.1.3 Motivation . . . 133
23.2 Result Analysis by Groups . . . 133
23.2.1 All participants . . . 133
23.2.2 Gender . . . 134
23.2.3 Age . . . 134
23.2.4 Household . . . 135
23.2.5 Usability . . . 135
23.3 Summary . . . 135

**24 Evaluation of Project and Application** **137**
24.1 Project Evaluation . . . 137
24.2 Application Evaluation . . . 137
24.2.1 Evaluation of Design . . . 137
24.2.2 Evaluation of Functionality . . . 138
24.2.3 Evaluation of Architecture . . . 138

**25 Evaluation of Research Methodology** **140**
25.1 Methods . . . 140
25.1.1 Questionnaires . . . 140
25.1.2 Observations . . . 141
25.2 Threats to validity . . . 141

**VII Conclusion and future work** **142**

**26 Conclusion** **143**

26.1 Fulfillment of the Research Questions . . . . . 144
26.1.1 RQ1: What theories and concepts used in previous relevant applications work well for motivating chores? . . . . . 144
26.1.2 RQ2: How is the user's motivation for doing chores affected by our application? . . . . . 144
26.1.3 RQ3: How is the user's engagement with chores affected by our application? . . . . . 144
26.1.4 RQ4: How does the user perceive the usability of our application? 144
26.1.5 RQ5: How is the user's enjoyment towards doing chores affected by our application? . . . . . 145
26.1.6 RQ6: To which extend does the use of our application affect the household's perception of chores? . . . . . 145
26.1.7 RQ7: How is the group dynamic of the household affected by using our application? . . . . . 145
26.2 Fulfillment of the Research Goal . . . . . 146

**27 Future Work** **147**
27.1 Application Flaws During the Experiment . . . . . 147
27.2 New Ideas for the Application . . . . . 148
27.2.1 Make the Application Family-friendly . . . . . 150
27.3 Further Research and Testing . . . . . 150

**Appendices** **158**

**A Tables** **159**

**B Figures** **160**

**C Questionnaires** **161**

# List of Tables


8.1 Levels of Game Design Elements of Various Abstraction [42] . . . . . 25

12.1 Rewards and motivation in Duolingo . . . . . 46
12.2 Rewards and motivation in Hold . . . . . 47
12.3 Rewards and motivation in Nipto . . . . . 49
12.4 Rewards and motivation in OurHome . . . . . 50

13.1 Tasks in concept prototype user testing . . . . . 61

15.1 A selection of user events . . . . . 72

16.1 Functional requirements . . . . . 77
16.2 Non-functional requirements . . . . . 78

17.1 Tasks in high-fidelity prototype user testing . . . . . 94

20.1 Validation of Functional requirements . . . . . 108
20.2 Validation of Non-Functional requirements . . . . . 109

21.1 Information questions in the first questionnaire . . . . . 113
21.2 Comparable questions in the first questionnaire . . . . . 113
21.3 Selection of questions and statements in the final questionnaire . . . . . 114

22.1 Results comparing before and after. . . . . 118
22.2 Results comparing before and after grouped by gender including results from Mann-Whitney test comparing before and after. . . . . 119
22.3 Results comparing before and after grouped by age including results from Mann-Whitney test comparing before and after. . . . . 119
22.4 Results comparing before and after grouped by household including results from Mann-Whitney test comparing before and after. . . . . 120
22.5 Answers from final questionnaire on motivation from using the application 121
22.6 Answers from final questionnaire on engagement from using the application 121
22.7 Answers from final questionnaire on enjoyment from using the application 122
22.8 Answers from final questionnaire on usability from using the application . 122
22.9 Answers from final questionnaire on general from using the application . . 123
22.10 Results from using the application grouped by gender, including results from Mann-Whitney test comparing male and female. . . . . 123

22.11 Results from using the application grouped by age, including results from Mann-Whitney test comparing age groups. . . . . 124
22.12 Results on motivation from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 124
22.13 Results on engagement from using the application grouped by household, including results from Mann-Whitney test comparing households . . . . . 125
22.14 Results on enjoyment from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 125
22.15 Results on usability from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 126
22.16 Results on general from using the application grouped by household, including results from Mann-Whitney test comparing households . . . . . 126

27.1 Reported bugs during the final test . . . . . 148
27.2 Improvements and ideas based on feedback . . . . . 149

A.1 All user events gathered in Firebase Analytics . . . . . 159

C.1 Results from the first questionnaire . . . . . 176
C.2 Results from the first questionnaire grouped by gender . . . . . 176
C.3 Results from the first questionnaire grouped by age over and under 25 . . . 177
C.4 Results from the first questionnaire grouped by household . . . . . 177
C.5 Results comparing before and after including results from Mann-Whitney test comparing before and after. . . . . 178
C.6 Results comparing before and after grouped by gender including results from Mann-Whitney test comparing before and after. . . . . 179
C.7 Results comparing before and after grouped by age including results from Mann-Whitney test comparing before and after. . . . . 180
C.8 Results comparing before and after grouped by household including results from Mann-Whitney test comparing before and after. . . . . 181
C.9 Results on motivation from using the application. . . . . 182
C.10 Results on engagement from using the application. . . . . 182
C.11 Results on enjoyment from using the application. . . . . 183
C.12 Results on usability from using the application. . . . . 183
C.13 Results on general from using the application. . . . . 183
C.14 Results on motivation from using the application grouped by gender, including results from Mann-Whitney test comparing male and female. . . . 184
C.15 Results on engagement from using the application grouped by gender, including results from Mann-Whitney test comparing male and female. . . . 184
C.16 Results on enjoyment from using the application grouped by gender, including results from Mann-Whitney test comparing male and female. . . . 185
C.17 Results on usability from using the application grouped by gender, including results from Mann-Whitney test comparing male and female. . . . . 185
C.18 Results on general from using the application grouped by gender, including results from Mann-Whitney test comparing male and female. . . . . 185

C.19 Results on motivation from using the application grouped by age, including results from Mann-Whitney test comparing age groups. . . . . 186
C.20 Results on engagement from using the application grouped by age, including results from Mann-Whitney test comparing age groups. . . . . 186
C.21 Results on enjoyment from using the application grouped by age, including results from Mann-Whitney test comparing age groups. . . . . 187
C.22 Results on usability from using the application grouped by age, including results from Mann-Whitney test comparing age groups. . . . . 187
C.23 Results on general from using the application grouped by age, including results from Mann-Whitney test comparing age groups. . . . . 187
C.24 Results on motivation from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 188
C.25 Results on engagement from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 188
C.26 Results on enjoyment from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 189
C.27 Results on usability from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 189
C.28 Results on general from using the application grouped by household, including results from Mann-Whitney test comparing households. . . . . 189

# List of Figures


5.1 Research method - Phases of the Master's thesis . . . . . 9

6.1 Screenshots from VRun [21] . . . . . 15
6.2 Screenshots from Kahoot! . . . . . 16

9.1 Reward usage classification [58] . . . . . 28
9.2 Score system in Fifa Ultimate Team Weekend League . . . . . 29
9.3 Resources in Minecraft . . . . . 30
9.4 Master Hunter achievements from Red Dead Redemption 2 . . . . . 31
9.5 Feedback in Pokémon Go . . . . . 31
9.6 Cinematic scene from Red Dead Redemption 2 . . . . . 32

10.1 Screenshot from A Way Out [73] . . . . . 35

11.1 How the experiment was carried out in Wang and Lieberoth's study [75] . 38
11.2 A partial schreenshot of an achievement and level notification - Taken from [77] . . . . . 40
11.3 An example of Bjering et al.'s evaluation of chore applications. [78] . . . . 40
11.4 Screenshots from Spot . . . . . 42

12.1 Screenshots from Duolingo . . . . . 46
12.2 Screenshots from Hold . . . . . 47
12.3 Screenshots from Nipto . . . . . 49
12.4 Screenshots from OurHome . . . . . 50

13.1 Login . . . . . 54
13.2 Change rocket . . . . . 54
13.3 Create/join group . . . . . 55
13.4 Rules . . . . . 55
13.5 Invite . . . . . 55
13.6 Home . . . . . 56
13.7 Planning chores . . . . . 56
13.8 *The Hat Game* . . . . . 57
13.9 *Flying chores* . . . . . 57
13.10 Chores overview . . . . . 58
13.11 Completing a chore . . . . . 58

13.12 Evaluation overview . . . 59
13.13 Evaluating a chore . . . 59
13.14 Achievements . . . 59
13.15 Store overview . . . 60
13.16 *Bought reward* . . . 60
13.17 Edit rocket . . . 61
13.18 Prototype user test . . . 62
13.19 Changes to flying chores . . . 63
13.20 Changes to the Hat Game . . . 63
13.21 Changes to Evaluation . . . 64
13.22 Changes to Achievements . . . 64
13.23 Changes to the Store . . . 65
13.24 Information about another user . . . 65

15.1 Different scores give different rewards . . . 71
15.2 Feedback when completing a chore . . . 73
15.3 User flow in the Proposed Solution . . . 74

17.1 Login view . . . 80
17.2 Register view . . . 80
17.3 Choosing user name . . . 80
17.4 Selecting rocket color . . . 80
17.5 Joining or creating a group . . . 81
17.6 Group name . . . 81
17.7 Competition length . . . 81
17.8 Group overview . . . 81
17.9 Group code . . . 82
17.10 Waiting screen . . . 82
17.11 Home . . . 83
17.12 User details . . . 83
17.13 Settings . . . 83
17.14 Edit chores . . . 84
17.15 Chore Editor . . . 84
17.16 Edit chores . . . 85
17.17 Chore Editor . . . 85
17.18 Group requests . . . 85
17.19 Group request . . . 85
17.20 Pre-planning . . . 86
17.21 Planning options . . . 86
17.22 Pre-planning . . . 87
17.23 Planning options . . . 87
17.24 Pressing the magical hat . . . 87
17.25 Viewing given chores . . . 87
17.26 Pressing the magical hat . . . 88
17.27 Pressing the magical hat . . . 88
17.28 Chore overview . . . 88

17.29 My chores . . . 89
17.30 Completing a chore . . . 89
17.31 Chores available for evaluating . . . 90
17.32 Evaluating a chore . . . 90
17.33 Chore is evaluated . . . 90
17.34 Viewing an evaluated chore . . . 90
17.35 New achievement . . . 91
17.36 Achievements overview . . . 91
17.37 Store . . . 92
17.38 Real life reward . . . 92
17.39 Mark bought item as used . . . 92
17.40 Profile . . . 93
17.41 Real life reward . . . 93
17.42 Weekly podium . . . 93
17.43 Coin boost . . . 93

18.1 Group request indicator . . . 97
18.2 Group request indicator . . . 97
18.3 Onboarding . . . 98
18.4 Onboarding - Menus and Keyboard . . . 98
18.5 Group request indicator . . . 98
18.6 Statistic page . . . 99
18.7 In-game rewards . . . 99
18.8 Adjusting rocket flame . . . 100
18.9 Repeating chores . . . 100

19.1 Architecture overview . . . 102
19.2 Firebase Realtime Database Entity Relationship Model . . . 103
19.3 React Native architecture overview . . . 103

21.1 Likert Scale Example . . . 112
21.2 Firebase Analytics Realtime tracking example . . . 115

22.1 Application registrations during the experiment . . . 116
22.2 Gender, age and household distribution for the final questionnaire . . . 117
22.3 Number of times rocket was pressed . . . 127
22.4 Completed chores compared with evaluated chores . . . 127
22.5 Hat game compared with rocket chores . . . 128
22.6 Real life rewards compared with in-game rewards . . . 129

B.1 Overview of React Native components . . . 160

C.1 First questionnaire - Part 1 . . . 161
C.2 First questionnaire - Part 2 . . . 162
C.3 First questionnaire - Part 3 . . . 163
C.4 First questionnaire - Part 4 . . . 164

C.5 Final questionnaire - Part 1 . . . . . 165
C.6 Final questionnaire - Part 1 . . . . . 166
C.7 Final questionnaire - Part 2 . . . . . 167
C.8 Final questionnaire - Part 3 . . . . . 168
C.9 Final questionnaire - Part 4 . . . . . 169
C.10 Final questionnaire - Part 5 . . . . . 170
C.11 Final questionnaire - Part 6 . . . . . 171
C.12 Final questionnaire - Part 7 . . . . . 172
C.13 Final questionnaire - Part 8 . . . . . 173
C.14 Final questionnaire - Part 9 . . . . . 174
C.15 Final questionnaire - Part 10 . . . . . 175

# Abbreviations

GQM = Goal, Question, and Metric

HTTPS = Hypertext Transfer Protocol Secure

MMORPG = Massive Multiplayer Online Role-Playing Game

NTNU = Norwegian University of Science and Technology

OS = Operative System

RPG = Role-Playing Game

SDT = Self-Determination Theory

SRSs = Student Response Systems

XP = Experience Points

# Part I

# Introduction

The first part of the Master's Thesis describes the motivation for the task at hand, a definite description of the problem and context, and a reader's guide that provides an overview of what readers can expect to find in the thesis.

Chapter 1

# Motivation

Today, more and more people own a smartphone. Many people are dependent on their phones in their everyday lives. The total number of smartphone users globally has reached 3.8 billion, which results in a worldwide smartphone penetration of 48.33% [2]. This means that almost half of the world's population owns a smartphone.

Amongst these people, the average user spends 171 minutes on their phones daily and clicks it 2617 times during this time [3]. As well as the high smartphone usage, games are one of the most popular types of mobile applications and account for 43% of all smartphone usage [4].

With the high popularity of gaming, it can be used in a wider aspect than pure entertainment. The term gamification refers to the use of game design elements in non-game contexts. It can be used to turn boring tasks into something engaging [5].

Young people are one of the main groups that spend much time on the phone, ranging from 5 to 7 hours a day [6]. As well as spending much time on their phones, they take on a minimal share of total household work, particularly tasks done for others in the family [7]. This illustrates that they have a high motivation for spending time on their phones but lack motivation for doing chores.

Both of us have experienced situations in, e.g., collectives where chores can be unfairly distributed, and some end up doing more than others. In addition to this, we are well aware of the high usage of smartphones, which we want to use to create an application filled with elements and theories from relevant topics that can increase motivation and enjoyment when doing chores.

This Master's Thesis will examine how game design and gamification elements can increase the motivation, enjoyment, and engagement of people living together, such as families, collectives, cohabitants, or friends, by doing chores through a mobile application. Towards the end of the Master's Thesis, results from an experiment will show whether or not the application helped increase the motivation, enjoyment, and engagement of people living together to do chores, as well as their perception of chores in the household.

Chapter 2

# Problem Description and Context

This Master's Thesis is written in Autumn 2020 and Spring 2021, and is a 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 of the Master 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.) a fun and social activity for a group or a family.*
>
> *The project will include studying existing concepts, evaluating these concepts, designing a new concept, implementing the concept, and evaluating the concept with users.*

The result will be this thesis and its research, as well as a mobile application prototype. The prototype will target an audience of people living together, which can be families, collectives, cohabitants, and friends.

Chapter 3

# Reader's Guide

Those interested in the research process as a whole and the development of the prototype, from initial research to the final results, are welcome to read the complete thesis. The outline of the thesis is the following:

**Part II** includes the research goal and the research questions and a description of the research methodology used throughout this thesis. In **Part III** you will find an extensive preliminary study on several relevant topics for this thesis. In contrast, **Part IV** describes the prototype and discusses its technology, evaluation, testing, and implementation.

**Part V** includes the execution and results of the experiment, which will test the application for two weeks and see how it affects the users' motivation, engagement, and encouragement. Next, in **Part VI**, the research method will be evaluated, the results from the experiment will be discussed, and the project and application itself will be reviewed and evaluated.

Lastly, in **Part VII** there will be a conclusion of the project and how the results from the experiment contributed to answering the research questions and research goal. Future work will also be discussed.

Based on the outline, if the research methodology is of interest, you should read **Part II** and **Part VII** where the latter evaluates the research method and answers the research questions. If you are more interested study behind the thesis and the prototype, you are recommended to read **Part III**. For those only interested in reading about the actual prototype, it is suggested to jump forward to **Part IV** where its concept development, technology, implementation, testing, and results are discussed in detail. If you specifically want to see the result of the experiment, it is advised to focus on **Part V**.

# Part II

# Research Methodology

The second part of this Thesis includes the research goal and its research questions. The research methodology used in this project is also described.

Chapter 4

# Research Goal and Research Questions

This chapter presents the research goal and research questions of this Master's Thesis, using the GQM (Goal, Question, and Metric) approach introduced by Basili [8]. Firstly, the research goal is defined on a conceptual level; then, the research questions are defined on an operational level. Lastly, a set of metrics is defined on a quantitative level to answer the research questions. In this Thesis, a combination of qualitative and quantitative data is used as metrics to answer the research questions.

## 4.1 Research Goal

The research goal of this project is defined as:

> *Examine perceived user perceptions of a mobile application created to motivate, encourage, and engage household members to perform chores.*

This project aims to develop a concept that will be expressed through an application. The application will contain various elements and mechanics from games and gamification, where the goal is to improve planning and increase motivation and engagement to execute chores in a household.

## 4.2 Research Questions

This section contains the research questions for this Master's Thesis. They will substantiate the overall research goal by examining how the use of our application will affect the user's *motivation, engagement, enjoyment, and planning* regarding doing chores. Also, it is important to investigate the *usability* of the application. The research questions will also examine gamification concepts and other related theories implemented in our application.

**RQ1: What theories and concepts used in previous relevant applications work well for motivating chores?**

Researching which theories and concepts worked well for motivating doing chores in previous applications can be helpful when developing the concept and prototype for our application.

**RQ2: How is the user's motivation for doing chores affected by our application?**
This research question is crucial as it answers whether our application will fulfill the given task described in Chapter 2. It may also contribute to further research on the topic by giving answers on which concepts and theories worked well in our application.

**RQ3: How is the user's engagement with chores affected by our application?**
Increased engagement in doing chores may also lead to enhanced motivation. Therefore this research question is of high importance.

**RQ4: How does the user perceive the usability of our application?**
This is a key aspect of our application because a negative user experience affects the whole application for the worse, including user motivation and engagement.

**RQ5: How is the user's enjoyment towards doing chores affected by our application?**
Having fun when doing chores may increase both the user's engagement and motivation to do chores. The research question will investigate whether the application made chores more fun or not.

**RQ6: To which extend does the use of our application affect the household's perception of chores?**
Part of our research goal is to simplify the planning of chores for a household and consequently make them easier to execute. This may lead to perceive chores as more fun, resulting in more chores performed and increased motivation.

**RQ7: How is the group dynamic of the household affected by using our application?**
Researching how our application affects the group dynamic is useful to gain more insight because improved group dynamic naturally leads to better engagement and motivation to execute chores.

Chapter 5

# Research Method

This chapter describes the research method to be used in this project. We will perform a preliminary study with a literature review, create and test a prototype, use methods to generate data, and analyze the data. The green boxes highlight the steps we will take. We discuss these throughout this chapter. The white boxes give an overview of other steps we could have taken. The planned phases of this Thesis are illustrated in Figure 5.1, which is the research process model [9]. All steps and choices made will be explained throughout the chapter, except *Experiences and motivation* explained in the motivation section of this thesis, Section 1.

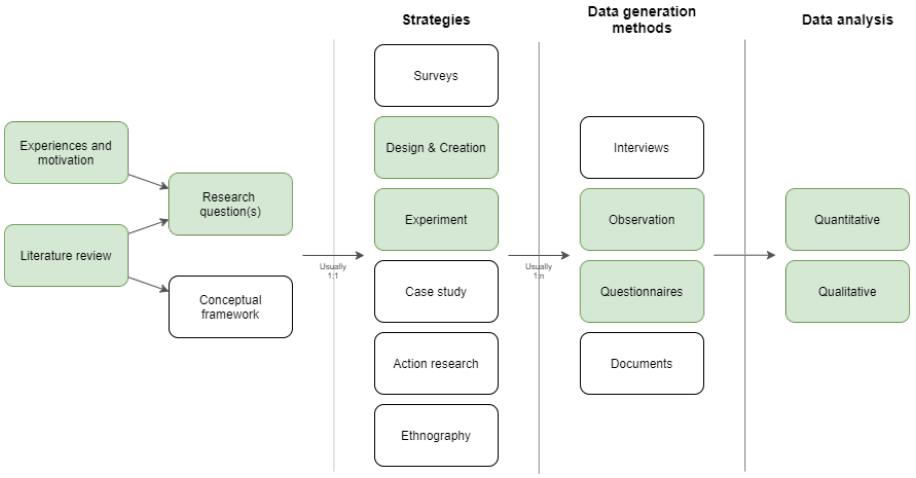



**Figure 5.1:** Research method - Phases of the Master's thesis

## 5.1 Literature Review

The first phase of this Master's Thesis will include a literature search on existing literature and application relevant to our project. We will use Google Scholar when performing a preliminary study on various relevant topics to understand the task.

The literature study will be performed using citation and snowballing methods [10, 11]. The latter is an effective method to identify new references. One investigates the references of already cited articles and articles citing the same articles as oneself. Our supervisor recommended some of the articles. Some we will find using the snowballing method, and others by using the citation method on those recommended and found. We will use some relevant keywords for our project when searching for relevant articles for the pre-study. Amongst them are *serious games, gamification, reward systems, intrinsic and extrinsic motivation, smartphones, social interaction*, and *chores*.

Additionally, other relevant work will be reviewed, including three previously written Master's Theses and three articles on gamification and housework. Hopefully, the conclusions of these will give us a helpful overview of what works and what does not, and more importantly, why. The literature review will make a great foundation and a good starting point for creating a concept and a prototype.

## 5.2 Design & Creation

This phase consists of three phases; concept creation, prototyping, and implementation, and will result in a mobile application.

### 5.2.1 Concept creation

We need to use everything we learned in the literature review to create a fitting concept. Here we will decide which aspects of gamification and its aids to use and the application's core functionality and high-level design.

### 5.2.2 Prototyping

A low-fidelity prototype based on the concept with minimal focus on design will be made and tested. This allows us to test the functionality and alter it accordingly quickly. The prototype will be tested on fellow students and in multiple iterations. The low-fidelity prototype can develop into a high-fidelity prototype with an increased focus on design over the iterations. All prototypes will be digital and mainly made with the online tool Figma [12], which is user-friendly and effective for creating and testing prototypes, subject to change.

### 5.2.3 Implementation

In the end, we will develop the application based on the high-fidelity prototype and the proposed solution. We will use the Kanban method during the implementation [13]. We

both have good experiences with its simplicity of breaking up requirements into smaller tasks and sorting them into suitable categories using a Kanban board. This makes it easy to cooperate and keep track of the process.

### 5.2.4 User Testing

During concept creation and prototyping, several users will test the results. Such tests are essential to gather objective feedback on both design and functionality of the application. The tests will be performed at the end of each design/prototype iteration and will result in a new iteration if necessary.

## 5.3 Experiment

After developing the application, we will test the application on the target group to answer the research questions defined in Section 4.2. The experiment will consist of a two-week period where users get to try the application to form a good impression. Afterward, their impressions will be used to evaluate the application by generating data that can be analyzed and answer the research questions.

### 5.3.1 Observations

Observation is an effective method to discover what users do when using the application [9]. What users report does not always align with their actual actions. To observe users' usage of our application, we have two options. The first one is to physically watch them use the application and see how they use it. Given the situation we are in with COVID-19, this is reckless. Therefore we will opt for the second option, which is better in many ways - using a web analytic service [14]. The analytic service will be integrated into our application and provide anonymous statistics of how users use the application, such as which pages they visit, which functionality is most used, and which pattern they behave in, to name a few. This will give us more detailed observations in a greater volume than the physical observation method. However, the trade-off is that we lose vital aspects, such as the emotions and body language of the users.

### 5.3.2 Questionnaires

While observations through an analytic service will give us some data on how users behave, they will not tell us anything about how they feel. Therefore we will also give all participants self-administered questionnaires with pre-defined questions relevant to the research questions. We will send out one questionnaire before the testing and another one afterward. The questions will mostly be based on the Likert scale, where answers are a degree of agreement or disagreement, with the five alternatives *agree strongly, agree, neither agree nor disagree, disagree*, and *disagree strongly* [9]. Other types of questions will also be present to get relevant information about the respondents and elaborate answers. The answers will provide even more data to interpret in the next step, the data analysis.

### 5.3.3 Validity and Reliability

It is important to ensure that the data being generated is valid and reliable. Oates described a problem with overt observation called the Hawthorne Effect; knowing the researcher is observing them, the users might modify their answers [9]. However, due to our observation being an analytic service, it will not be in the same room and physical space as the participants. This might mitigate the Hawthorne effect.

The experiment will last three weeks, which is sufficient testing time to indicate how the application will impact the participants in the long term. However, the data analysis can only be as good as the data generated. Therefore, it is important to carefully construct the experiment and questionnaires to get objective and useful data.

## 5.4 Data Analysis

Given our data format, we will use a combination of quantitative and qualitative data analysis. The data about user interactions from the observations will be quantitative, as will most of the answers from the questionnaires. However, the questionnaire will include some open and elaborate qualitative questions.

### 5.4.1 Quantitative

Observations of user behavior in the application through an analytic service will provide us with large quantitative data on all users. So will the questionnaires. This data can be analyzed to find patterns and see *what* users do and feel, but it cannot tell us *why*.

It will also allow us to compare behavior based on different variables. For instance, by asking questions about gender and age segment on the first and second questionnaires, it is possible to group and compare their thoughts towards motivation, engagement, and so on before and after using the application.

The Mann-Whitney test will be used to compare the results from the two questionnaires and calculate the probability value of the difference. The test is a non-parametric test where the distributions of two independent sets of values are calculated to get the significance of differences between the two sets [15].

### 5.4.2 Qualitative

The questionnaire will also consist of free text fields where users can give more specific feedback, contributing to the qualitative analysis. Quantitative data may provide numbers indicating that something is good or bad, but not always *why*. Therefore the users must have the opportunity to provide more detailed feedback which can substantiate the quantitative data.

# Part III

# Preliminary Study

The third part of this Thesis includes a comprehensive preliminary background study on relevant topics such as serious games, theory on motivation and engagement, gamification, social interaction, and reward systems. Also, there will be reviews on previous related work, existing relevant applications, and chore-related applications.

Chapter 6

# Serious Games

This chapter describes different definitions of serious games. It will also address some of its most important use cases and most used domains. Finally, both the positive and negative aspects of the concept will be discussed.

## 6.1 What Are Serious Games?

There are many definitions of serious games, and this section will focus on three of them. Sawyer defined serious games as ”any meaningful use of computerized game/game industry resources whose chief mission is not entertainment” in 2002 [16]. His definition has been of great inspiration for other later definitions. Michael & Chen simplified it to ”games that do not have entertainment, enjoyment or fun as their primary purpose.” [17]. Zyda, on the other hand, took it a step further and described serious games as ”a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.” [18], bringing specific fields into the definition. We will use the latter definition throughout this Master's thesis.

## 6.2 Use Cases

While not all definitions mention computer games specifically, they all offer a good foundation for explaining serious games. Although serious games can be applied to nearly anything, we will focus on digital serious games.

Even in the digital environment, serious games can be applied to most things. Zyda stated that some of the most frequently used fields are government or corporation training, education, health, public policy, and strategic communication. The following subsections discuss the ones we find most appropriate; exergames, education, healthcare, and training.

### 6.2.1 Exergames

Exergames are the combination of exercising and playing digital games and require the player to physically move to play and progress in the game [19, 20]. Various sensors and input elements are used to capture and detect user motions. Exergames are health-beneficial and can be useful for people that find it hard to allocate time and establish motivation to perform exercises every day. Yoo and Kay developed an in-place virtual reality exergame called VRun, that detects the user's motion through the smartphone's accelerometer [21]. The user would run through a virtual world, shown in Figure 6.1.

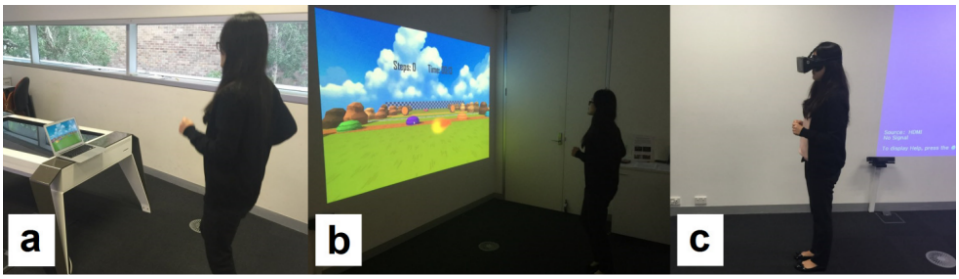



**Figure 6.1:** Screenshots from VRun [21]

Their study proved that this type of exercise was fun and made it possible to exercise anywhere. The participants preferred the large display due to its size and not wearing the headset during longer exercises.

Exergames can also be used to promote fun while performing physical activities. One example is the popular game Wii Sports Club that features different sports games such as tennis or bowling [22]. The player holds and uses the Wii Remote Plus controller to capture motions displayed on a screen, e.g., throwing a bowling ball. Another example, and the most successful one, is Pokémon Go. It motivates users to spend more time walking outdoors through an augmented reality mobile game. Users walk around in the physical world to collect items and fight battles in the game. A systematic literature reviewed performed by Wang shows that Pokémon Go has a positive effect on physical, mental, and social health [23].

### 6.2.2 Education

When the growth of the PC market emerged in the 1990s, the phrase edutainment was used to describe games developed for educational purposes or education through entertainment. Even though it became popular, its success was limited. The results of edutainment have been described as "boring games and drill-and-kill learning" [24], and consequently not ideal for the main target group, school children. With limited success in mind as well as sinking interest in the concept, the industry shifted from edutainment towards serious games [17]. As a result, more and more serious games have been implemented in the education domain, and some have impacted education methods globally. The best and most

relevant example being Kahoot!, a game-based learning platform with over 70 million monthly users [25]. Figure 6.2 shows an example of Kahoot, both on mobile and desktop.

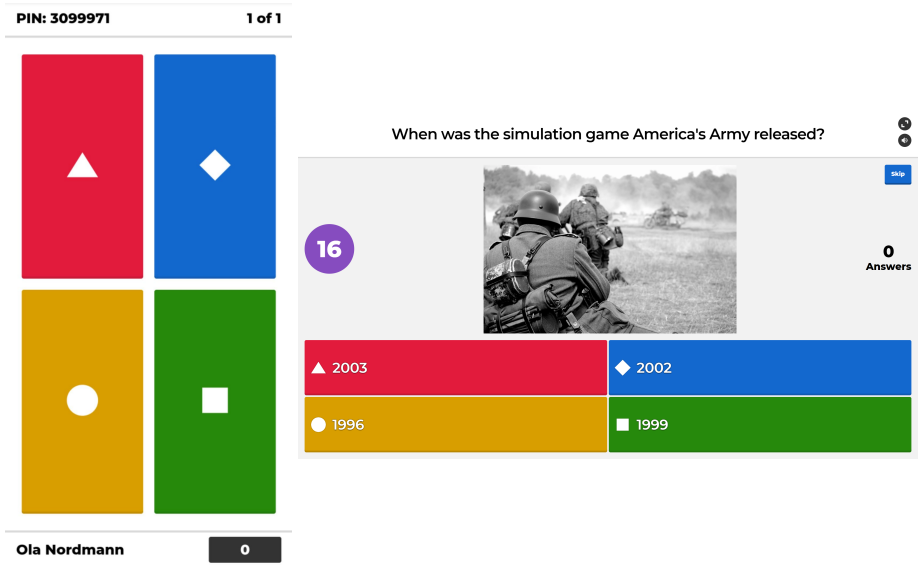



**Figure 6.2:** Screenshots from Kahoot!

### 6.2.3 Healthcare

Susi et al. discuss the many opportunities of serious games in health-related areas. These include both physical and mental health, as well as healthcare training. Not to be confused with the health of fictive characters or items in video games, some examples of popular use cases mentioned by Susi et al. are fitness, recovery and rehabilitation, diagnosis of mental illness, surgery training, and education of self-care [26]. The variety is great, but the common for them all is that they are important tools that can help improve personal health in some way.

### 6.2.4 Training

As mentioned in the previous section on health, serious games can train surgery personnel. This is achieved through simulation games and can be applied to many other fields as well. The military was one of the first domains to integrate serious games into their training. About four thousand years ago, India and China used games called Chaturanga and Wei Hei to prepare their troops for battles [26]. Ever since it has been frequently used to train soldiers for war, and with the emergence of digital games came simulations. A great example of this is the U.S Army, which already in 1981 started to use a customized version of Battlezone on Atari as a training tool. Later, in 2002, they released the simulation game America's Army, which in retrospective has been described as "the first successful and well-executed serious game that gained total public awareness" by Sawyer [16].

## 6.3 Benefits and Challenges

It is also important to highlight that even though serious games have many benefits, they have some disadvantages. Mitchell and Savill-Smith mention several possible consequences of serious games, including health problems such as headaches, fatigue, and mood swings, as well as psycho-social issues such as depression and social isolation [27]. We should, however, keep in mind that their study is 16 years old and that the effects of serious games could have evolved in either direction since then.

We know that serious games bring forth many positive effects as well as negative ones. Squire and Jenkins focus on the important aspect of simulation games. In many fields, you are put in situations where it is critical to perform as well as possible, and simulation games make it possible to prepare for such critical situations in a safe and non-consequential manner [28]. Additionally, Mitchell and Savill-Smith note that serious games can positively impact a handful of skills of many kinds, including ”analytical and spatial skills, strategic skills and insight, learning and recollection capabilities, psychomotor skills and visual selective attention.” [27].

## 6.4 Summary

This chapter has highlighted different definitions of serious gaming to give a general overview and understanding of the topic. Different aspects and domains have been discussed, addressing the positive use cases of serious gaming and the positive and potential negative consequences. This gives us a convenient overview of the topic to be used when defining our product concept, but the most important part to consider is the discussion about the benefits and challenges of serious games.

Chapter 7

# Theories on Motivation

This chapter describes motivation with a focus on intrinsic and extrinsic motivation. Different models and frameworks for motivation will be addressed to determine how and if they can motivate people, both in real life and in games.

## 7.1 Intrinsic and Extrinsic Motivation

How we perceive motivation can be divided into two definitions; intrinsic motivation and extrinsic motivation. When someone is intrinsically motivated to perform an action, they are ”based on the inherent satisfaction derived from the action itself” [29]. So they perform a task because they enjoy doing it, not because they get a reward for it. However, the latter is precisely what extrinsic motivation is, as defined by Tranquillo and Stecker [30]. Therefore, when someone is extrinsically motivated, they perform a task because they enjoy the reward they get from doing it. It is important to note that these two types of motivation are not opposites or black and white; but rather, they overlap and can be hard to differentiate when experienced [31].

## 7.2 Skinner’s Box

Psychologist Skinner carried out experiments to measure behavior relative to reinforcement [32, 33]. Skinner’s box is an operant conditioning chamber placed in a laboratory with an animal inside the chamber. The box consists of a response lever and a food dispenser that dispenses food. In the experiments, food was dispensed in different conditions. Animals were split into three groups with different conditions. For the first group of animals, food was dispensed in a fixed interval, meaning they would receive food at given intervals without doing anything. The results show that this method of reinforcement was ineffective. They did not have to perform any actions to get rewarded, so they did not. The second group also received food at intervals, but these were not fixed. The time between each dispense was variable and arbitrary. The result was the same here as in the first group. On the other hand, group number three had to work for their food. It was dispensed after

interacting a set number of times with the response lever. Since the animals did not know how many times they had to interact with the lever to get food, they interacted more frequently and consistently than the other groups. They understood the connection between interactions and food dispensing, and it proved reinforcement based on actions to be a good motivator.

## 7.3 Self-determination Theory

Self-determination theory (SDT) is a motivational framework describing how different factors affect different kinds of motivation. SDT concerns everything from intrinsic motivation to extrinsic motivation and amotivation. It states that self-determined motivation leads to improved behavior, enjoyment, and well-being. Low self-determined behavior, on the other hand, has the opposite effect [34].

The theory specifically brings forth a hypothesis of three psychological human needs - competence, autonomy, and relatedness [35]. Competence means that humans crave a feeling of mastery and reaching desired and clear goals. Autonomy is about freedom and control of one's own choices and behavior. Relatedness refers to a connection to others and the feeling of experiencing some kind of relationship. When these needs are satisfied, humans experience enhanced motivation and well-being. When they are not, we experience ill-being and decreased motivation.

In regards to games, studies demonstrate that allowing players to experience competence, autonomy, and relatedness makes the game more enjoyable to play [36, 37]. One study describes how the feeling of competence can be facilitated through appropriate rewards and feedback and that relatedness can be achieved through social interaction with others [38].

## 7.4 Flow

Csikszentmihalyi has conducted comprehensive research on the concept of flow [39]. Or rather, the concept of flow is the result of his research. He wanted to research why and what makes performing tasks pleasant. He describes the concept of flow as something "so gratifying that people are willing to do it for its own sake, with little concern for what they will get out of it, even when it is difficult or dangerous". The research also investigated how to achieve the flow experience and concluded that it is a mix of eight elements; (1) a task to be completed, (2) the ability to concentrate on a task, (3) that concentration is possible because the task has clear goals, (4) that concentration is possible because the task provides immediate feedback, (5) the ability to exercise a sense of control over actions, (6) a deep but effortless involvement that removes awareness of the frustrations of everyday life, (7) the concern for self disappears, but a sense of self emerges stronger afterward, and (8) the sense of duration of time is altered. According to these elements, flow can be achieved while performing a task within any domain. Later, others built upon Csikszentmihalyi's flow description with a specified focus on games.

## 7.5 The Gameflow Model

The gameflow model is a direct result of the extension of Csikszentmihalyi's concept of flow, carried out by Sweetser and Wyeth. They look at the eight elements of flow and adapt them to games to create a model of enjoyment in games - the gameflow model. This model also consists of eight key elements; concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction, [40]. They are not identical to Csikszentmihalyi's elements of flow, but they can all relate to them. Together they describe everything needed, according to Sweetser and Wyeth, to make a game enjoyable. In short, the game should require the player's full attention and *concentration*, it should be *challenging* and match the player's *skill level* while allowing them to feel *control* over their actions and experience skill growth. To support this, the game should have *clear goals* and give *suitable feedback* along the way, making players feel connected to the game. Additionally, the game should allow players to *interact socially* to evolve *immersion* in the game. The more involved players feel the more effortless the game will feel, and the more gameflow they will experience. It is important to note that not all eight elements are required to experience flow, but they can all contribute to it.

## 7.6 Malone's Framework for Intrinsic Motivation

To understand this phenomenon properly, Malone has defined a framework for intrinsic motivation. The framework is based on three essential traits that are essential to achieve intrinsic motivation; challenge, fantasy, and curiosity [41]. The following subsections will discuss the three traits and give a better overview of Malone's framework.

### 7.6.1 Challenge

Every game needs a challenge, and to achieve this, it is important that players must be provided some goal whose attainment is uncertain, Malone states as a result of his research. He also found that a goal should have three key characteristics to be motivating. A goal should (1) be personally meaningful, (2) be obvious or easily generated, and (3) provide performance feedback to measure whether they are reaching their goal.

However, a goal could have all three characteristics but still fail to intrinsically motivate the player. Malone explains that there needs to be some uncertainty as to whether the goal will be reached or not. If a player is sure to achieve the goal or not achieve it, the challenge is not exciting enough.

The reason for challenges being essential is that it engages the player's self-esteem. Completing a challenge makes players feel better, while on the flip side, failing a challenge can make players feel worse. It is important to find a balance where failing a challenge does not have a severe negative impact. We do not want players quitting the game because they failed a challenge.

To properly balance this, games should either have different difficulty levels or automatically adjust the level difficulty to adjust for player skills. A challenge that is too easy or

too difficult will kill the excitement. On the other hand, a good way to boost excitement is to have different levels of goals to adjust for the difficulty and increase uncertainty.

### 7.6.2 Fantasy

Malone suggests introducing a fantasy aspect to make the game environment even more interesting and appealing. Fantasies can also be divided into intrinsic and extrinsic. *Extrinsic fantasy* depends on using the skill, but not vice versa. This could be a fantasy goal, such as defeating a dragon or avoiding a fantasy disaster, such as saving the princess from a monster. With *intrinsic fantasy*, the fantasy depends on the skill, but the skill also depends on the fantasy. This means that the relationship between fantasy and skill is a continuous one, where they are both adjusted accordingly. A popular example of this is that the player's character has abilities dependent on the power-ups they pick up. Malone claims that intrinsic fantasies are more interesting and more instructional than extrinsic fantasies.

Other important aspects related to fantasy are the emotional and cognitive aspects. When it comes to the latter, Malone explains how effective metaphors and analogies can be in helping learners understand new things. For the emotional aspects, it is clear that emotions that evolved from games can tempt players to keep playing. However, it is also clear that the same fantasies will not always appeal to the same players. A possible solution to combat this is to either include different methods of customization to let the players control parts of the fantasies themselves or include several fantasies to accomplish a general appeal.

### 7.6.3 Curiosity

The third and perhaps most important ingredient of intrinsic motivation is, according to Malone, curiosity. Arousing and satisfying the player's curiosity is key to keep them maintained in the game. This is achieved by providing an *optimal level of informational complexity*. The environment should be dynamic and reflect the player's knowledge to be neither too challenging nor too simple.

Curiosity can be split into two parts; *sensory curiosity* and *cognitive curiosity*. The former describes changes of sound, colors, or other sensory stimuli in the environment to engage the player and can be used to decorate the environment or give feedback. The latter involves the player's willingness to improve their knowledge structure. This is triggered by providing enough but not too much information so that players feel their existing knowledge seems incomplete, inconsistent, or unsparsimonious.

## 7.7 Summary

Throughout this chapter, motivation has been defined and different models of motivation have been addressed. The most relevant model for us to consider is Malone's framework for intrinsic motivation and its three traits - challenge, fantasy, and curiosity. It is widely

used and potentially a great tool for motivating users of our app to perform chores. Additionally, Skinner's box and its findings in reinforcement behavior are important takeaways. We have to consider self-determination theory and the fact that providing players a sense of competence, autonomy, and relatedness will make a game more enjoyable. Lastly, the gameflow model will be used to correctly implement different aspects of motivation in our application and a tool to retrospectively measure if it was done successfully.

Chapter 8

# Gamification

This section will define gamification, its history, and its connection with serious gaming. It will also discuss some benefits and challenges regarding gamification.

## 8.1 What is Gamification?

Gamification is a popular term that has several definitions. In 2011 Deterding et al. conducted a study where the aim was to define gamification, resulting in ”the use of game design elements in non-game contexts” [42]. Other scientists have also carried out studies to understand what gamification is, and in 2014 Yohannis et al. described gamification as ”a process that integrates game elements into gameless objects to have gameful characteristics” [43]. Three years later, when Houtari & Hamari studied gamification and service marketing, they ended up with a definition that reads as follows: ”Gamification refers to a process of enhancing a service with affordances for gameful experiences to support users' overall value creation” [44]. Although they are all great definitions, we will use Yohannis et al.'s definition in this Master's thesis.

From our own experience with games and their elements, such as badges and levels, we believe that it can be a good idea to include them in non-game contexts that normally might be somewhat straightforward and mundane. People use games mainly as a source of fun and relaxation. Thus, including such game elements in dull tasks might contribute positively.

## 8.2 History of Gamification

Although gamification has become more and more popular in recent years, it has been around for quite some time. 'Gamification' was officially born in 2002, when the well-known game developer Nick Pelling decided to create a game for non-game purposes [45]. However, the idea of gamification was used many years before its birth date. In the late 1800s, the stamp company Sperry & Hutchinson distributed stamps to their customers

based on how much money they spent. These stamps could be exchanged for products at various shops [46]. Also, the use of badges has been present for a century in Boy and Girl Scout [47].

## 8.3 Serious Games and Gamification

Serious games and gamification are often compared to each other, and Deterding et al. describe how they are related. Serious games are about designing full-fledged games used beyond entertainment, while gamification uses various *game elements* in the game design [42]. These elements are also known as *game atoms* [48].

In their study, Reeves and Read established a list of ”ten ingredients for great games”, which consists of self-representation with avatars, three-dimensional environments, narrative context, feedback, reputations, ranks, and levels, marketplaces and economies, competition under rules that are explicit and enforced, teams, parallel communication systems that can be easily configured and time pressure [49]. They emphasize that not all of these ingredients are always needed when developing a game. With the right adjustments, a small amount of them can be enough [49]. We agree that not all ingredients are needed in every game, but it depends heavily on the type of game. For example, in a calm and time-consuming adventure game, time pressure and competition might not be necessary. Also, to be clear, a game does not have to be in a three-dimensional environment if the story triggers the player's excitement and engagement.

It can also be useful to see what other researchers have observed in terms of game design elements. According to Bossomaier, the elementary mechanisms of gamification are *points, badges, leader boards, and levels* [47]. Basten adds *feedback* and *goals* to this list of elements [50].

Further into their study, Deterding et al. state that in the same way there are ”serious” health, training, and news games, gamification can be adopted in health, training, news, etc [42]. However, as Kiryakova et al. convey, a serious game is a whole game with a predetermined goal, which is not the purpose of gamification [51].

Their surveys on literature reviews classified game design elements on varying levels of abstraction, shown in Table 8.1. These levels were included in their definition, arguing that *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) **characteristic for games** (rather than play or playfulness) **in non-game contexts** (regardless of specific usage intentions, contexts, or media of implementation) [42].

## 8.4 Benefits and Issues

To decide whether to use elements from gamification or not, it is necessary to look into its benefits and issues.

| 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 8.1:** Levels of Game Design Elements of Various Abstraction [42]

Anderson et al. did a study on how badges can influence user behavior on the question-answering site Stack Overflow. To analyze this, they created a model, which arose some interesting results. The use of badges proved to increase overall user participation. However, the placement of the badges must be done carefully to enhance their motivational effect [52].

Another research on badges is Hakulinen et al.'s empirical study on how achievement badges could affect students' motivation and encouragement. A set of students were divided into two groups. One group received badges after completing their achievements, while the other group worked normally without receiving badges. The study showed that the achievement badges made the students more motivated and engaged in their work and more self-reflected. Also, the group using badges received more overall points than those who performed a traditional study [53]. They also revealed that not all badges gave equally good results. One badge was achieved by having no errors, which could lead to less motivation for the task if a student got an error. Another badge was rewarded by completing the task fast, possibly affecting accuracy and carefulness [53]. This indicated that it is important that the choice and design of badges are being made carefully.

Barrio et al. performed a study on how gamification could improve Student Response Systems (SRSs), which are tools for students to give instant feedback to the lecturers [54]. Students were divided into two groups, one group using gamified SRSs, while the other

group used non-gamified SRSs. Findings from the study proved that the students who used SRS with gamification had higher motivation, better attention, and better learning performance than those exposed to normal SRS [54]. Wang et al. also conducted a study on this topic. 384 students were divided into three groups to learn the same topic but differently. The first group used a traditional paper quiz, the second one used a non-game-based SRS, and the last one used the game-based SRS Kahoot!. Findings from the study proved that game-based SRS significantly improved motivation, engagement, enjoyment, and concentration. However, the difference between the traditional paper quiz and the game-based SRS in terms of learning outcomes was not statistically significant [55].

As gamification is increasing in popularity, it is important to ensure that users' privacy is respected. Mavroeidi et al. conducted a study regarding the major concerns of gamification and privacy [56]. They created a model to link various game elements to privacy concerns, revealing that most of the elements violated privacy. E.g., achieving badges based on a user's location violates anonymity and other privacy requirements [56]. Therefore, such a model should be used when creating an application that uses gamification to make the users feel safe in terms of privacy.

## 8.5 Summary

This chapter included some definitions of gamification, its connection with serious games, as well as benefits and issues related to the topic. We have learned that gamification has been shown to increase motivation and participation [52, 53, 54]. To achieve these benefits, the correct game elements must be used [57], and they must be designed properly [53]. Also, privacy must be taken into account when implementing gamification [56].

The takeaway from this chapter relevant to our project is the list of game design elements from Reeves and Read. Looking into issues correlated with gamification is also necessary to be aware of them when developing our prototype.

Chapter 9

# Reward Systems

This chapter describes reward systems, their characteristics, and how players utilize various rewards. Also, seven different reward types will be presented.

## 9.1 What are Reward Systems?

Most games give rewards to players when they have completed a task. These rewards can encourage and motivate the players to play further or compromise to ease any potential disappointment [58]. According to Reeves and Read, showing rewards outside games can provide social meaning, e.g., showing your friends about an achievement you just managed to accomplish [49]. Wang and Sun state that rewards can provide intrinsic motivation, meaning they make the game fun to play, not just about the extrinsic factors, which point to the reward itself [58]. Pagulayan et al. argue that players should be rewarded properly to get them to continue playing the game [59].

Salen and Zimmerman describe how to create a meaningful play, which is the key aspect of successful game design [60]. Meaningful play appears when the relationship between player actions and outcomes is discernable (immediate outcome) and integrated into the game [60]. Reward systems can contribute to meaningful play by providing immediate feedback after the player has performed an action or giving virtual items that can be used later in the game.

According to Brown and Cairns, learning new games takes much effort [61]. Therefore, the rewards given to the player should correspond with the amount of time and effort the player puts into the game [61]. Pagulayan et al. state that feedback is a crucial part of the game and that player learning and amusement can be difficult to achieve without it [59]. Also, such feedback is important as it inspires the players to master the game [62].

## 9.2 Reward Characteristics

In their study, Wang and Sun identified four different reward characteristics used to analyze how different rewards affect players [58]:

1. **Social value:** Players will gather, showing off their scores, badges, and avatars.
2. **How rewards affect gameplay:** Player types can be defined based on what type of rewards they want the most [58]. Following Bartle's Taxonomy, the player types are *killers*, who seek to develop their avatars by defeating others, *achievers*, who want to progress their character by winning in games, *explorers*, whose goal is to gather new/unique rewards by exploring the world and *socialisers* who want to interact with other players [63].
3. **Suitability of a reward:** When a player is completing a task, the reward must be suitable for the work performed; harder tasks require greater value.
4. **Time required to earn a reward:** Rewards should be timed properly to avoid player frustration. Also, there should be rewards for different players, allowing more people to play than just the most committed.

## 9.3 Utilizing Rewards

In most games, players can determine how to utilize their earned rewards. Wang and Sun offer four different categories for utilizing rewards in a dual-axis, shown in Figure 9.1. The horizontal axis *self-others* represents personal amusement versus community amusement, while the vertical axis *progress-casual* represents how serious the gamer is.

In the first category, *advancement*, rewards are used to progress in the game. Wang and Sun mention that players have more fun if they think their skills are improving. Through the rewards [58]. Secondly, in the *review* category, players like looking at their collection of achievements or admire their impressive and equipped avatars. According to Formanek, reviewing rewards contributes to entertainment and a sense of accomplishment [64].

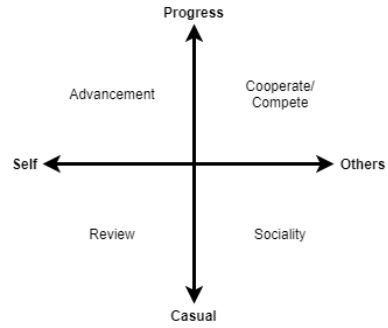



**Figure 9.1:** Reward usage classification [58]

The third category, *sociality*, includes players that show off their achievements to other players, sharing their performances to establish status. The fourth and final category is *cooperate/compete*. The players share their rewards with their teammates to cooperate against a common goal or use their rewards to gain an advantage over other players.

## 9.4 Reward Types

The following sections represent different reward types based on the findings of Wang and Sun [58].

Hallford and Hallford argue that reward types can be identified in four different ways; glory, sustenance, access, and facility [65].

### 9.4.1 Score Systems

Score systems are often used in various games to evaluate player performance. Also, since these systems do not directly affect the actual gameplay, they are used as a self-evaluation tool and compare players against each other, putting the scoring system into Hallford's *glory* classification [65].

Figure 9.2 shows the scoring system in Fifa Ultimate Team Weekend League. The players will receive rewards based on how many wins they get out of 30 games. In the online strategy game Tribal Wars, points are gained by upgrading buildings and conquering other players, and the goal is to reach the highest amount of points when the game ends. Score systems are also to be found in games like World of Warcraft and Call of Duty to rank players and compare them to each other. Score systems are also used outside the online gaming world and can be found in games as Yatzy, various card games, and board games such as Ticket to Ride.


**Figure 9.2:** Score system in Fifa Ultimate Team Weekend League

### 9.4.2 Experience Points

In games where players have an avatar, it is prevalent with an experience points system. The avatar receives some experience points by completing certain tasks, depending on their difficulty and type. When the player has earned a specific amount of experience points, the avatar will level up and grow in various skills, such as strength and defense. Thus, these types of systems are classified as *facilities* [65].

In contrast to score systems, experience point systems are bound to the avatar rather than a single gameplay and are not used for player ranking but instead reflect time and dedication. Also, these systems affect the gameplay directly since some tasks might be easier to accomplish when the avatar's skills are growing and give the player new challenges to tackle.

### 9.4.3 Items

The item granting rewards system is used a lot in RPGs (Role-Playing Games) and MMORPGs (Massive Multiplayer Online Role-Playing Games) and allows the players to gather virtual items around in the game world. Depending on the player's interest, items can be classified as *facility/glory* [65].

Items can motivate the players in between missions and encourage them to explore the game world. Gathering a lot of rare items may result in increased social value.

### 9.4.4 Resources

In numerous games, players gather resources to, e.g., build buildings, craft items, and cook food. Unlike items, resources are mainly used for practical game use and do not directly affect the gameplay. Hallford and Hallford classify resources as *sustenance* [65].

Figure 9.3 shows an example of gathering resources in Minecraft by chopping wood which can be used to build houses and craft items.

**Figure 9.3:** Resources in Minecraft

### 9.4.5 Achievements

Achievements are badges and titles bound to a player account or an avatar and can be accomplished by completing specific tasks. They encourage players to take on tasks of varying difficulty and explore the game world. By finally completing a task, players might feel a sense of mastery, thus ending up being classified as *glory* by Hallford and Hallford [65].

Achievements can also contribute to social meaning for players by showing off their set of achievements to others. Figure 9.4 shows an achievement list in Red Dead Redemption 2 where 10 tasks must be completed before the player can be classified as a ”Master Hunter”.


**Figure 9.4:** Master Hunter achievements from Red Dead Redemption 2

### 9.4.6 Feedback Messages

Feedback is used to motivate and encourage players by giving instant rewards for their actions. Such rewards can be text, photos, sounds, and videos. They do not affect the gameplay directly. However, giving players praise can affect their behavior and emotion [66]. The player needs to know what is happening. Figure 9.5 shows an example of receiving feedback when performing a ”Nice”-throw in Pokémon Go.

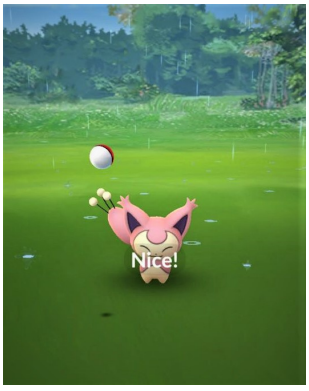



**Figure 9.5:** Feedback in Pokémon Go

### 9.4.7 Animations / Cinematic Scenes

Animations and Cinematic scenes are used to reward players when completing a task, starting a new one, or are ending the game. They intend to motivate the players in further playing and might tell the player something important about the back story of the task they are starting on. Such animations are often visually attractive. Figure 9.6 shows a cinematic scene when starting a task in Red Dead Redemption 2.


**Figure 9.6:** Cinematic scene from Red Dead Redemption 2

### 9.4.8 Unlocking Mechanisms

Unlocking mechanism reward systems give the players access to new game content (new levels and places in the game world etc.) after completing tasks of specific requirements. Such systems are therefore classified as *access* by Hallford and Hallford [65].

According to Malone, incompleteness and inconsistency are among the most important reasons for human curiosity [41]. By progressively exposing the game content, the player's intrinsic motivation can increase.

### 9.4.9 Summary

This chapter describes what reward systems are, their characteristics, how players utilize rewards by classifying them as advancement, review, sociality, cooperation/compete, and how reward systems are used, which are very relevant for this thesis. Also, several reward systems are mentioned, following the study of Wang and Sun [58]. To maintain player curiosity, motivation, encouragement, and learning, they should be given rewards for completing tasks.

In terms of developing applications for making chores more fun, the most relevant and important reward types mentioned in this chapter are firstly achievements, which may display accomplishments such as an x amount of chores completed. Secondly, if an avatar is to be implemented in the application, experience points could be relevant to upgrade

the avatar. Also, to continuously inform the user about their actions, good feedback is important.

Chapter 10

# Social Interaction

As most games now have great opportunities for multiplayer gaming, social interaction between the players is unavoidable. This chapter sheds light on the social factors connected with gaming.

## 10.1 Social Gaming and Motivation

According to Reeves and Read, people's motivations to play games are either social or personal. The social ones are based on competition or cooperation [49]. With competition, players interact by playing against each other. In cooperation, players are working together towards a goal, which may lead to social relationships and casual conversations. Reeves and Read argue that many people play games just for this reason [49].

Ravaja et al. state that playing against another human raises more positive emotions, spatial presence, and engagement than playing single-player [67]. Social interaction through games is also proven to increase the player's enjoyment, which further contributes to the player's intention to continue playing the game [68]. It is also shown that games with online social interaction lead to fewer gaming symptoms, such as depression and loneliness [69].

According to Ekman et al., "Contemporary gaming is often a highly social activity" [70, p. 327]. By having others in the same game session, the perceived competence and enjoyment are affected positively [71].

## 10.2 Interaction Through Teams

As mentioned in the chapter on gamification, *teams* were one of the ten ingredients for great games identified by Reeves and Read.

There is a high amount of social interaction between players in such teams. Games can provide interaction opportunities that are to be found in real life, and the players will

get to know each other better. Reeves and Read also state that gamers think it engaging when being involved in a team [49]. Also, to focus on the mission or other tasks in-game, the team members may exchange thoughts about other non-game-related topics, such as politics and work [49].

## 10.3 The Game Session

Ekman et al. define *the game session* as when players and spectators share a situation from their perspective [70]. Salen and Zimmerman offer two ways the players can interact with each other / there can arise a conflict between players; cooperation (players win/lose together) and competition (not everyone can place in first) [60]. During the game session, a communication structure is implemented so the players can communicate when working together on a mission. This can be done via in-game communication mechanics, such as a chat channel or VoIP (Voice over Internet Protocol) [70].

In their study, Ekman et al. also argue that when including players who already know each other in the game session, it will differ from when playing with strangers. This is known as the socioemotional context [70].

## 10.4 Examples of Social Interaction in Games

In the intense co-op game A Way Out, two people team up to break out of prison [72]. Throughout the story, each of the players must solve their tasks to able to continue to the next checkpoint together. Figure 10.1 shows an example where the players must cooperate to escape a building. For example, one player must distract the guard while the other steals his keys. This makes the players dependent on each other, making the game engaging and entertaining.

**Figure 10.1:** Screenshot from A Way Out [73]

Social interaction is also often to be found in competitive games like Counter-Strike. According to Rambusch et al., social interaction within the team is crucial to developing the players and is important when practicing or fighting against other teams [74].

Another example of social interaction is in World of Warcraft, where players work together in ”raids” which are different challenges with varying difficulties. In such raids, the players fight against bosses, which requires cooperation amongst the players to defeat the boss.

## 10.5 Summary

In most games, social interaction plays a big part. Playing with or against another human increases engagement and enjoyment. Being part of a team includes interaction between the team members when performing various tasks together in a shared game session using different communication channels. The most important takeaways from this chapter are how people interact with each other through games and how this can increase enjoyment and engagement.

Chapter 11

# Related Work on Gamification

This chapter presents related work to this thesis. Two previously written Master's Thesis and four articles will be examined to map similarities and differences between this Master's Thesis and the related work.

## 11.1 The Effect of Points and Audio on Concentration, Engagement, Enjoyment, Learning, Motivation, and Classroom Dynamic Using Kahoot!

Wang and Lieberoth studied how the game-design elements *sound and points* used in the game-based learning platform Kahoot! affected the students' motivation, concentration, engagement, enjoyment, learning outcome, and classroom dynamic [75]. The reason behind this study was that the majority of previous studies on this topic considered game-based learning as a whole rather than focusing on specific elements.

Having the same lecture presented, 593 students were divided into four groups, all using Kahoot! in different ways. One group used Kahoot! with audio and points, one group only had points, one group only had audio, and one group had neither (no audio or points), as illustrated in Figure 11.1

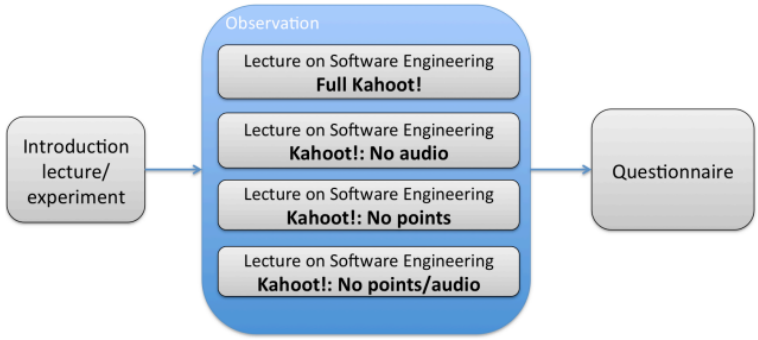



**Figure 11.1:** How the experiment was carried out in Wang and Lieberoth's study [75]

Their experiment resulted in some interesting findings:

- **Concentration:** There was a significantly lower concentration amongst the students when playing Kahoot! without audio and points. There was no statistically significant difference among the other variations.
- **Engagement:** Whether points were used or not had a big impact on their engagement. Also, a smaller portion of the students felt more bored using no audio and points.
- **Enjoyment:** Both audio and points were important in terms of having fun when doing the quiz.
- **Learning:** All variations seemed to affect perceived learning positively. However, using no points had a small negative effect on learning outcomes.
- **Motivation:** With no audio or points, most of the students agreed that they did not attempt to do very well. Some students said that the quiz felt more like a formal test when using only points without audio.
- **Classroom dynamic:** The effect of audio was the most important to have a high spirit and a good atmosphere in the classroom. However, using both audio and points resulted in the best experience for the students.

Wang and Lieberoth conclude that the game-design elements audio and points positively impact the students' concentration, engagement, enjoyment, learning outcome, motivation, and relationship to each other. However, they did not give much attention to complex relationships in the data set, which could have revealed even more.

## 11.2 Does Educational Gamification Improve Students' Motivation? If So, Which Game Elements Work Best?

Chapman and Rich performed a study examining how gamification used in education increased students' motivation. They also did a deeper examination of which game elements

worked best [76].

For over two years before the study, they developed a platform for assignments and other school-related tasks. It included 15 game elements used to enhance the student's experience. 124 students participated in their experiment and tried out the platform. During the course, the students were allowed to switch from a gamified interface to a traditional interface and vice versa. More than half of the students said that they preferred the gamified approach.

At the end of the experiment, the students answered a survey using a scale ranging from "Much less" to "Much more" about how the platform increased motivation and how the various game elements contributed to achieving this.

67% of the students said that the gamified approach to the course was much more motivating than the traditional course. Also, the most motivating game elements were progress tracking and feedback.

## 11.3 Gamification and Web-based Homework

In his study on gamification and web-based homework, Goehle examines video game mechanics and how they can improve engagement among students performing online mathematics homework [77]. To do so, two common video game systems, levels and achievements, were integrated into the online homework program *WeBWorK*.

The study starts by researching and defining gamification and different aspects of video game systems, including levels and achievements. According to Goehle, the most difficult part of creating a leveling system in a video game is creating an engaging task but argues that these tasks are often already defined in gamification since it usually revolves around some main tasks, such as solving math problems in this case. He also highlights the importance of implementing increasing difficulty to climb levels, making new levels infrequent rewards. When reaching a new level, players should be rewarded. The most common reward is to increase the player's ability, but one cannot simply increase the student's mathematical skills in this case. Instead, Goehle suggests rewarding the students "powers" or "spells" they can use to manipulate their grade directly or indirectly by getting help on certain problems, extending the deadline, or other similar abilities. When it comes to achievements, the study divides them into three categories; (1) achievements earned in the normal course of gameplay, (2) achievements requiring extra effort but still earned in normal gameplay, and (3) achievements requiring players to accomplish a goal unrelated to the normal gameplay. All three types serve a purpose to enhance engagement and interest in gamification.

After implementing levels and achievements in WeBWorK, students got experience points (XP) for completing a homework problem. After accumulating enough XP to reach the threshold, a new level was unlocked. The threshold increased with every level, making every new level a bit harder to reach. Additionally, achievements were implemented as rewards for both visible and invisible goals. Whenever a new goal or level was reached, feedback was given right away, as shown in Figure 11.2. It was also possible for players

to share their achievements and progress on their Facebook walls to enhance engagement.

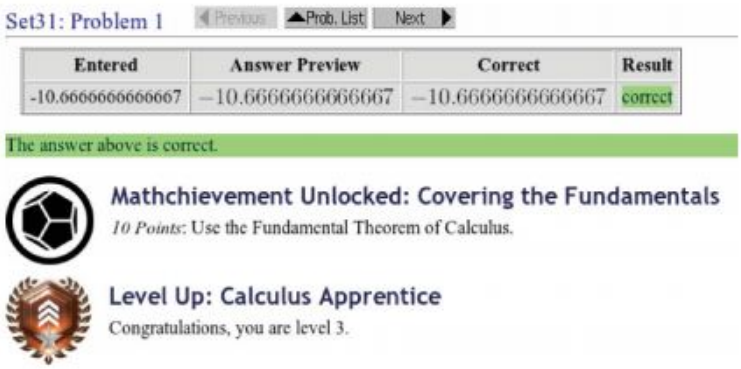



**Figure 11.2:** A partial schreenshot of an achievement and level notification - Taken from [77]

The improved version of WeBWorK with gamification was tested on 60 students over 16 weeks in a Calculus I course. Twenty-nine of the subjects in the experiment responded to a questionnaire regarding the solution. The vast majority of these, 93%, said they kept track of their achievements and levels, while 89% said they actively tried to earn achievements. The system did not seem to affect the student's performance, but the results show that at least half of the participants found the gamification aspect of the system engaging.

## 11.4 Gamification and Family Housework Applications

In their study, Bjering et al. examined how gamification is used in various applications for family housework, also known as chore apps [78]. Using a classification framework for education applications and game design element theory, they analyzed 15 different chore applications. The apps were evaluated on the following parameters; *product, description, user, functionality, motivation/rewards, game elements, pedagogical design, user interface, universal design, technical solution*, and *overall impression*. An example of such an evaluation is given in Figure 11.3. Bjering et al. stated that a gamified approach towards housework might positively and negatively affect the family's interaction.

| PRODUCT | DESCRIPTION | USER | FUNCTIONALITY | MOTIVATION/ REWARD | GAME ELEMENTS | PEDAGOGICAL DESIGN | USER INTERFACE | UNIVERSAL DESIGN | TECHNICAL | OVERALL IMPRESSION |
|---|---|---|---|---|---|---|---|---|---|---|
|  YOU RULE CHORES Opposite Inc | "You Rule is a powerful chore management app that gives parents ultimate control over family productivity while transforming kids into happy chore-doing maniacs." | Children are the main users, age 5-11. Up to 6 siblings can use the app.  | Includes a guide on how to use the app. The children choose a character, which level up when they do tasks. Parents are a referee and approve the tasks, give out rewards. | Extrinsic: Gold coins for each task, varies in amount. The child makes a wishlist on things or adventures they want to have or do. Competition in who will reach the weekly goal first. | • Leaderboard with visual progression<br>• Reward<br>• Levels<br>• Gold coins<br>• Competition | Hybrid Instructive/ manipulable: Game app, overt extrinsic rewards, goal and mission: a weekly finish line, compete with other siblings. Some capacity to make choices, e.g. level of difficulty and type of chore. | Two interfaces; one for children and one for parents. Both interfaces have a good screen resolution. | Handdrawn pictures in all slides.Visual progression. The tasks are only written in text. Music and sounds from different characters. | App for ios. Cost: 39 NOK<br><br>Only available at one phone or ipad (does not syncronize through internet)<br><br>English language. | Nice app, well designed with a great use of game elements. A bit strange concept of having a parent referee. |

**Figure 11.3:** An example of Bjering et al.'s evaluation of chore applications. [78]

Before analyzing the applications, they did a comprehensive theoretical background study on motivation and gamification. During their study on motivation, they touched on topics such as behaviorism, social cognitive theory, and self-determination. Regarding their study on gamification, they discovered some criticism against it, which was about the extravagant use of points and reward systems. Bjering et al. agree with this criticism and states that by moving past the superficial application of just points, gamification can increase user engagement using different types of game design elements.

When analyzing the applications, they used the aforementioned classification framework for education applications. The key finding from this analysis was that most of the applications were characterized as instructive or somewhat manipulable, resulting in a lack of constructive applications; most of the applications focused on extrinsic motivation than intrinsic motivation; most of the applications targeted individuals of the family, rather than the entire family.

At the end of the study, Bjering et al. discuss these finding by looking into how the chore applications can help increase the intrinsic motivation of the family members, with a focus on the three principles from self-determination theory; competence (the feeling of mastery), autonomy (freedom of participation) and relatedness (meaningful interaction with other members of the household). Their discussion resulted in the following suggestions, which can be taken into account when creating chores application that uses gamification:

1. let the family act as explorers that together can create new ways of doing chores
2. more focus on autonomy, relatedness, and competence, and reduce the use of extrinsic rewards.
3. more focus on collaboration amongst the family members, instead of having them work individually.

## 11.5 Improving User Experience with Gamification and Reward Systems

Kartevoll performed a study on mobile games, gamification, and housework to encourage children to do chores at home [79]. He initially conducted a pre-study with reviews of game-related theories such as game design, game mechanics, gamification, and motivation to start this off. He also reviewed applications related to the topic to determine which aspects worked well. Kartevoll found that frequent and various rewards could serve as an effective motivator.

The pre-study laid a solid foundation for the next step in the study - a proposed solution, an application prototype, designed to encourage children to perform chores and enhance the enjoyment of it through gamification. Kartevoll designed a reward model to be used in the prototype, using virtual gems as rewards and triangularity. Triangularity means facing the player with two options; one with low risk and low reward, and one with high risk and high reward. With these foundations, a prototype was made using Unity.

The prototype was tested on 22 children in an experiment. It should be noted that since

the experiment only lasted for a short period, the effects over a longer period are unclear. As is the use in an actual family, since the experiment was performed in a controlled environment on children only. However, the results suggest that the solution positively affects every category examined. A key result Kartevoll found is since a reward model does not necessarily impact the execution of a task, it cannot make the task's motivation intrinsic.

## 11.6 Gamification of Chores

Almankaas and Sørmo conducted a study on how gamification elements in an application can make chores more motivating, enjoying, and encouraging [80]. First of all, they did an extensive pre-study on several relevant topics such as serious gaming, motivation, gamification, social interaction, and reward types. Several theories and elements from these topics were used to develop the concept and prototype.

Three ideas for an application came to mind during their concept development phase. The two first concepts (Chorify and Chorify-boat) were partly developed and evaluated. Important errors that could lead to failing their project goal were disclosed and removed in their final fully developed prototype: Spot. Spot offers social interaction through the evaluation of each other's completed chores. Based on the evaluation, the users receive diamonds as a currency used in the in-game store to buy real-life rewards. Figure 11.4 shows screenshots of the application of Spot.

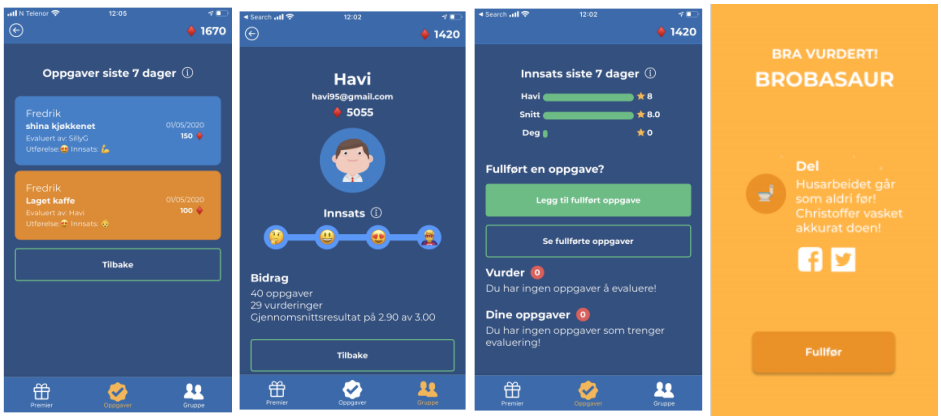



**Figure 11.4:** Screenshots from Spot

With their prototype in place, they conducted an experiment with 58 participants that lasted two weeks. The goal was to examine whether their application Spot managed to increase motivation, enjoyment, and encouragement in doing chores. By providing two questionnaires; one before and one after the experiment, their key findings were:

1. the application motivated and encouraged the users in doing chores

2. comparison between users was an important factor in motivating the users

3. the users' starting points in terms of doing chores seemed to be very important regarding the motivational impact of the application.

Almankaas and Sørmo concluded that their experiment was successful, and their research goal was accomplished. Due to the similarity and success of their project, it is very much relevant for this Thesis.

## 11.7 Similarities and differences

This section compares the reviewed related work and this thesis in terms of similarities and differences.

### 11.7.1 The Effect of Points and Audio on Concentration, Engagement, Enjoyment, Learning, Motivation, and Classroom Dynamic Using Kahoot!

The main similarity between Wang and Lieberoth's study and this thesis is to investigate how game-design elements can affect motivation, engagement, enjoyment, and group dynamic. They also analyzed the effect of learning and concentration, which was not relevant and, therefore, not included in this thesis. While Wang and Lieberoth had a specific focus on the game-design elements points and audio, our focus lies more on gamification in general. Wang and Lieberoth's target group are students, while ours are families, collectives, and cohabitants.

### 11.7.2 Does Educational Gamification Improve Students' Motivation? If So, Which Game Elements Work Best?

Chapman and Rich's study are also quite similar to ours. They also investigated if gamification could improve motivation. However, they then focused more on which game element worked best towards increasing motivation. On the other hand, we examine how gamification in general (several game elements, utilizing rewards) improves motivation in addition to several more factors, such as engagement.

### 11.7.3 Gamification and Web-based Homework

Whereas we implement various gamification elements in a mobile application, Goehle examines how the game elements, levels, and achievements can improve engagement when put into an online homework system. However, there are some similarities, where both Goehle and us use experience points to progress towards a goal. Also, Goehle introduces rewards, immediate feedback, and social interaction.

### 11.7.4 Gamification and Family Housework Applications

Firstly, we both have the same focus; gamification and housework. However, Bjering et al. examine how gamification is implemented in different applications while developing an application and implementing gamification. When analyzing how the application can increase motivation, Bjering et al. consider three principles from self-determination theory; competence, autonomy, and relatedness. We focus on motivation, engagement, enjoyment, and household dynamic. Nevertheless, we agree that collaboration is better than individual work. By moving past the superficial application of just points, gamification can increase user engagement using gamification.

### 11.7.5 Improving User Experience with Gamification and Reward Systems

Like us, Kartevoll conducted a study on gamification and how rewards can increase motivation and enhance the enjoyment of doing chores. We also did a similar pre-study on topics such as motivation and gamification. However, Kartevoll's target group is mainly children, whereas ours is families, collectives, and cohabitants.

### 11.7.6 Gamification of Chores

As we had the same project assignment as Almankaas and Sørmo, the studies turned out to be quite similar. They also conducted a pre-study, including topics such as serious gaming, motivation, gamification, social interaction, and reward types. Both created a prototype that was tested on families, collectives, and cohabitants in an experiment.

## 11.8 Summary

In this chapter, four related articles and two related Master's Thesis have been reviewed. The review includes a summary of the article, pointing out focal points related to this thesis. The chapter also presented similarities and differences between the reviewed articles and this thesis. The most important takeaways from this chapter are inspiration from the articles and learning that similar strategies impact motivation and engagement.

Chapter 12

# Application Reviews

This chapter will look at successful applications and applications created for the same purpose as this thesis; motivate and encourage the household members in doing chores. The applications will be examined on how they use reward types and how they motivate users.

Finally, the types of rewards used in the examined applications will be discussed and considered if they can motivate people to do chores in our application.

## 12.1 Non-chore Related

The following section discusses two non-chore-related applications with gamification and presents the reward types and motivation used in them.

### 12.1.1 Duolingo

Duolingo is an online language learning application available on multiple platforms. Through 50 different courses, users can learn over 20 languages. The courses have various subjects, everything from traveling to everyday phrases. The users start with simple tasks, which become more difficult over time, resulting in a great learning curve.

Duolingo is and joyful and beautiful application filled with game design elements, and as they state on their website: ”Gamification poured into every lesson” [81]. When logging in several days in a row, the users receive a streak. On the front page, there is an overview of all courses, where the available ones are colored and the currently locked ones are grey and unavailable, which creates curiosity and motivation for the user. When going through the lessons, the users will experience a lot of visuals, animations, and sounds. After completing a lesson, the users are rewarded with gems that can be used in the shop to buy hearts, upgrade the owl, or other upgrades. When the user has completed all lessons of a course, they are rewarded with a crown which can be used to compare themselves to other users. The users also receive experience points which are used in a league ranking

system. Overall there is a vast amount of gamification put into Duolingo, see Figure 12.1 for screenshots from the game.

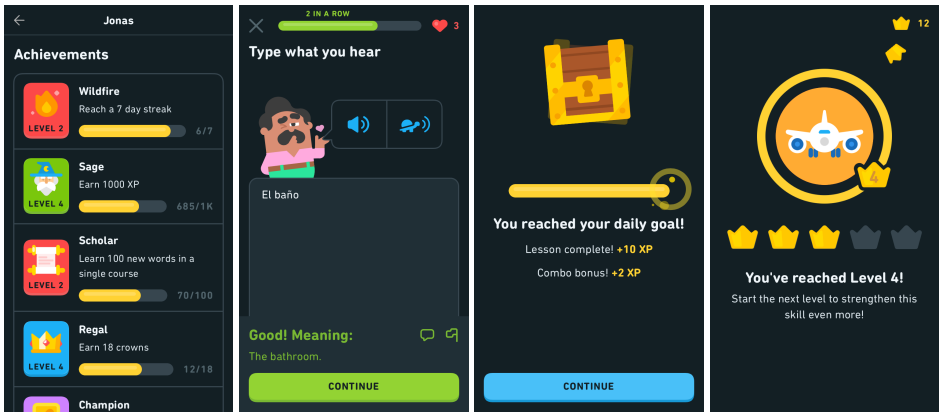



**Figure 12.1:** Screenshots from Duolingo

As mentioned above, Duolingo offers many ways to reward and motivate users. Table 12.1 shows an overview of such reward types and motivational factors.

| Reward types | Motivation |
|---|---|
| Gems as currency | Learn new languages |
| Levels | Complete levels |
| Feedback | Unlock new courses |
| Experience points | Social interaction (online forum) |
| Hidden courses that unlock after completing levels | Compete against others in leagues |
| Achievements | Upgrade the avatar |
| Feedback | Play several days in a row to acquire a streak |
| Crowns as number of courses completed | |

**Table 12.1:** Rewards and motivation in Duolingo

### 12.1.2 Hold

Hold is a mobile application made to keep users off their phones. Users are rewarded for not using their phones. Initially, the application was designed to help students not get distracted by notifications and other stimulating focus thieves, but it now targets everyone instead of only students. The concept is simple enough. As shown in Figure 12.2, your phone is ”locked” when you start a new Hold session, called *to hold*. A timer starts, and for every 20 minutes reached, points are rewarded for not using other applications. However, the timer stops, and you have to start at zero again if the Hold application is closed. If the user *holds* several days in a row, a streak is rewarded.

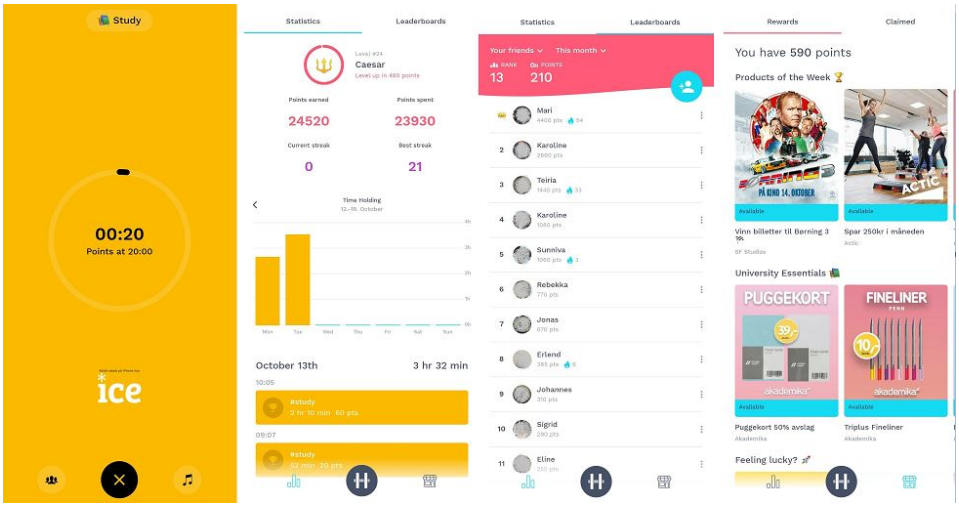



**Figure 12.2:** Screenshots from Hold

To motivate social interaction, it is also possible to *hold* with others. Bluetooth is then enabled and used to search for others *holding* nearby. If someone is found, a group session is started, and the users gain additional points. Another socially motivated functionality in the application is the leaderboards in which users can compare themselves with Facebook friends or other students in their university.

Points earned can be used to buy items in the store. These items are real-life rewards made possible by sponsors. Some examples of items are scratch cards, discounts, free coffee, and lottery tickets to various competitions. This gives users a real incentive to use the application and acquire points.

Table 12.2 shows a summarized list of all reward types and motivations in the application.

| **Reward types** | **Motivation** |
|---|---|
| Points as currency | Buy items in store |
| Levels | Complete levels |
| Increased Points | Work with others - Social interaction |
| Feedback | Hold several days in a row to acquire a streak |
| Leaderboards | Compete against others |
| Items | Get real-life rewards |

**Table 12.2:** Rewards and motivation in Hold

### 12.1.3 Summary

The non-chore-related applications Duolingo and Hold are quite different, but they use similar reward and motivation types. They are not traditional games but use gamification to implement aspects from games to motivate players. Both applications have implemented levels, feedback, social interaction, and currency to buy rewards. Duolingo does, however, have more reward types, such as achievements and hidden rewards, while Hold has leaderboards and the opportunity to buy real-world items. Both applications use social interaction, competition, streaks, and completing levels as motivation.

## 12.2 Chore Related

This section discusses two chore-related applications with gamification and presents the reward types and motivation used in them.

### 12.2.1 Nipto

Nipto is a mobile application for organizing chores in a household. A member creates a ”team” and can invite other members or create a controlled member. This is suitable for, e.g., families with children. Each member has its own ”Nipto” - a dinosaur avatar, which is meant to keep happy by doing chores. If a member has performed badly doing chores, they will receive an inconsolable Nipto.

Together, the team can create a list of available rewards. Each member selects their preferred rewards from the list, and the member that got the most points at the end of the week receives their selected rewards. This creates competition amongst the team members, where each wants to win their selected rewards. The team members can keep track of each score, motivating and encouraging them to better than the others. See Table 12.3 for a full list of rewards and how the application can motivate.

The application offers pre-defined chores, or they can create new ones. Each member can validate their own or other’s chores and receive points. They can also give bonus points to each other.

Overall this is a good application, with a great and joyful design, shown in Figure 12.3 However, as each team member can create and even validate their own chores, it could be difficult to keep control of whether the member did the chore or not. More elements from gamification could be implemented, e.g., achievement and more upgrade opportunities. The use of the application may be tedious in the long run.


**Figure 12.3:** Screenshots from Nipto

| Reward types | Motivation |
|---|---|
| Real rewards for winning | Competition against others |
| Score points | Overview of completed tasks |
| Visuals | Work as a team - Social interaction |
| Nipto's mood | Keep Nipto happy |

**Table 12.3:** Rewards and motivation in Nipto

### 12.2.2 OurHome

OurHome is an application that also focuses on coordinating chores in a household. It makes it possible to create fairly customizable groups. The group creator chooses up to several task categories applied to the group, e.g., bedroom, maintenance, or garden.

Unlike Nipto that has a more playful design, OurHome operates with a more professional look but also implements the use of joyful icons and colors, as seen in the screenshots in Figure 12.4. This makes the application suitable for different types of households.

The user picks chores from a to-do list and may mark them as complete. Like Nipto, there is no evaluation of each other's tasks, which may result in less control of what each other is doing. The users receive points for doing chores, which can be used to claim rewards. The reward system is also quite similar to Nipto's. Any user can create their own reward and define costs.

On the front page of the application, the users see each other's points, which can motivate them to complete more chores. Each user can also set weekly target points that may work as a motivator. See Table 12.4 for rewards and motivation in OurHome.

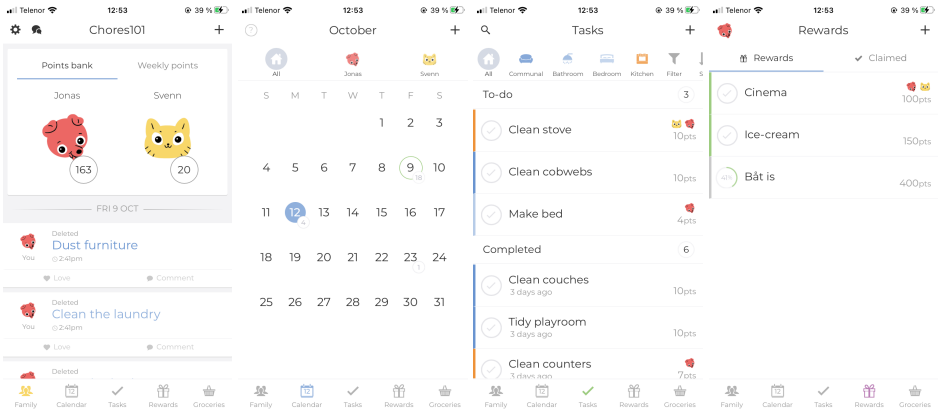



**Figure 12.4:** Screenshots from OurHome

| Reward types | Motivation |
|---|---|
| Feedback | Overview over tasks and points |
| Score points | Competition to have most points |
| Real-life rewards | Overview over completed tasks |
| Progress bar of points and target points | Upcoming tasks in calendar |
| | Cooperate on tasks |

**Table 12.4:** Rewards and motivation in OurHome

### 12.2.3 Summary

Nipto and OurHome are applications developed to make chores more fun and organized. Both applications provide a points system where the members receive points for completed chores. However, the way users receive rewards is different. In Nipto, the user with the most points at the end of the week receives rewards, while in OurHome, the points are being used as currency to purchase real-life rewards.

Neither of the applications provides an evaluation of chores, which might result in some people completing chores without actually doing them. Such an evaluation of chores should be considered in our application to ensure that users do not receive points without an evaluation.

## 12.3 Discussion

This section compares the two non-chore-related applications with the two chore-related applications to find similarities and differences in reward types and motivation used.

### 12.3.1 Reward Types

Looking at the four reviewed applications, both the non-chore-related and chore-related applications use many of the same reward types. They all use a points system and give feedback when tasks are completed. Two of them, one non-chore and one chore-related, have the opportunity to buy real-life rewards with earned currency. Only the non-chore-related applications have implemented levels.

### 12.3.2 Motivation

The main motivational factor from both types of applications came from completing something; levels in the non-chore related and tasks/chores in the chore related. Also, social interaction occurred in all applications. Comparing your score with others motivates the users to perform better, whether to learn another language, hold more or complete more chores. Three of the applications also make it possible to cooperate on tasks, contributing to even more social interaction.

## 12.4 Summary

In this chapter, two non-chore-related and two chore-related applications have been reviewed and analyzed in terms of rewards and motivation. Take away from this chapter is how these applications use elements from gamification and how they can be motivating and engaging. Most elements from these applications, such as levels, achievements, feedback, and points, are all relevant. Also, especially in the chore-related application, we have learned some pitfalls that must be avoided, such as not including the evaluation of chores.

# Part IV

# Prototype

The fourth part of this Thesis presents the concept and prototype development and its several iterations. Firstly, in Chapter 13, the concept is described over two iterations, including a user test in between to evaluate it and to get feedback. When constructing the concept, the prototyping tool Figma was used, described in Chapter 14, along with the other technologies used when developing the prototype. Chapter 15 presents the proposed solution, elaborating mostly on functionality and the prototype's main user flow. Following in Chapter 16 are the functional and non-functional requirements based on the proposed solution. Chapter 17 includes a comprehensive description of the high-fidelity prototype, the third iteration of the prototype development. This chapter includes several screenshots and descriptions of the different screens that are to be found in the application. At the end of the chapter, a user test of the high-fidelity prototype follows. In Chapter 18, the final solution is presented, including additions and changes from the high-fidelity prototype. Chapter 19 describes the software architecture, which gives a broader understanding of the architecture and database. Lastly, in Chapter 20, validation of requirements is provided.

Chapter 13

# Concept

This section describes the concept of the application as well as the development of it. The concept was formed by adjusting and iterating initial ideas through prototyping, testing, and evaluation. The prototypes were created with Figma, a collaborative tool for designing interfaces and interactive prototypes, see Section 14.1.1. The concept, Tidy, was described, initialized, prototyped, tested, and evaluated through two iterations.

Several brainstorming sessions resulted in the concept Tidy. The word ”tidy” means having things organized and in order. The main concept of Tidy is to provide enjoyment and engagement regarding doing chores in a household. Each user has their own rocket, where each week’s goal is to acquire enough XP to reach or get the closest to the moon. The weekly contest winner will receive a boost the upcoming week, and XP is gathered by completing and evaluating each other’s chores. Each chore has a currency and XP value range, and how much the user gets is based on evaluations from others. Instead of picking their own chores, they are distributed through fun and gamified planning sessions at the beginning of the week.

The in-game currency can be used to buy real-life rewards and in-game items, such as upgrades to the rocket. The weekly contest, the reward system, and the evaluation of each other’s chores contribute to social interaction in the form of cooperation and competition. Each household starts with an initial set of chores and rewards, which can be customized later on.

## 13.1 Iteration 1

This section presents the first iteration in the concept phase, including a description of the different interfaces and functionality, user testing, and an evaluation of the process.

### 13.1.1 Interfaces and Functionality

This section describes the different interfaces and their functionality. Gestalt principles and Don Norman's design principles are taken into account and will be discussed [82, 83].

#### Login and Registration

The login view shown in Figure 13.1 is relatively standard, presenting the rocket on its way to the moon for the first time to the user. The login and register buttons are designed to ”invite” the user to click them and thereby trigger an action, which is the perceived affordance of the buttons, meaning how the user perceives that the object can be used [83]. These buttons are used all over the application to achieve *consistency*, another design principles of Don Norman; similar elements should achieve similar tasks [83].

Throughout the registration process, the user types in their user credentials, select an avatar, and gets the opportunity to change the color of their rocket, shown in Figure 13.2. The gestalt principle *similarity* is present here. The user connects the different elements by seeing the selected color in three different places on the page [82].

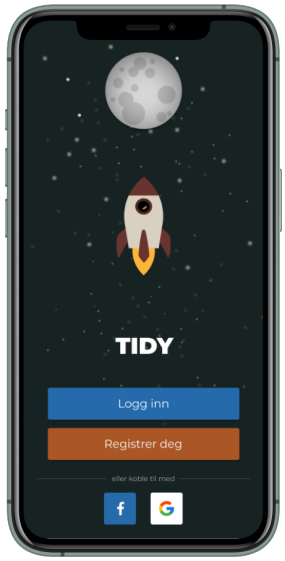



**Figure 13.1:** Login

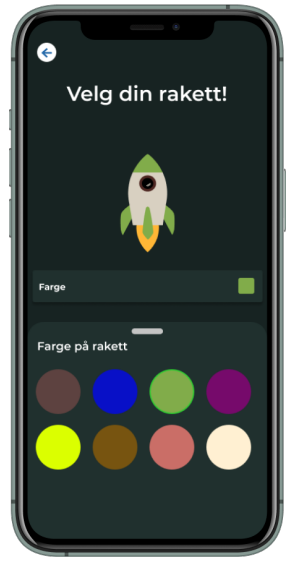



**Figure 13.2:** Change rocket

### Create or Join Group

After creating an account, the user can either create or join a group. The simple design gives the user a quick overview of the two available choices. To maintain the design principle of *consistency* [83] across the application, the buttons used here are the same as in the login view, and they perform the same type of operations here. The blue primary button here joins an *existing* group, just like the blue button on the login screen logs in to an *existing account*. The orange secondary button creates a *new* group here and a *new* account on the login screen.


**Figure 13.3:** Create/join group


**Figure 13.4:** Rules

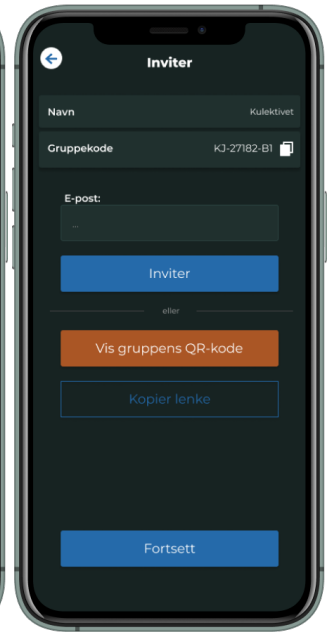



**Figure 13.5:** Invite

### Home


**Figure 13.6:** Home

The home page shown in Figure 13.6 presents the leader board of all the users and their progress on reaching the moon. The rocket of the current user is highlighted.

### Planning

upcoming week to delegate the chores. There are several ways to decide this, but the intention is to make the process fun or engaging. Therefore, the delegation of chores is decided through a game. The group can select one of three games, as shown in Figure 13.7.

The planning screen is designed with a focus on high *visibility* of functionality [83]. There are only three options here, and excess information and noise are removed to highlight these. Strong colors are also used on the options to draw attention to them.

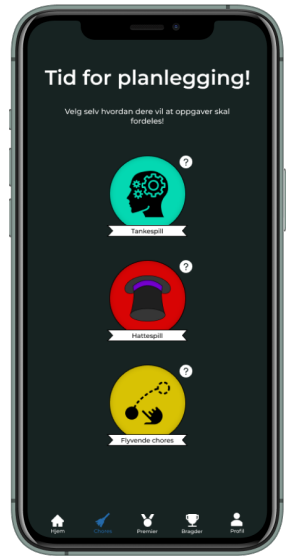



**Figure 13.7:** Planning chores


**Figure 13.8:** *The Hat Game*

The hat game is one of the options to plan the delegation of chores. The game is simple and played on only one device. Each household member swipes up on a hat in random turns to make cards appear out of it. The cards show which chores they received, as shown in Figure 13.8.
Simplicity and visibility are essential design aspects here as well. It should be clear which actions the user should take throughout the game, so the design is clean and self-explanatory.

The flying chores game is a mini-game where users play to delegate chores, shown in Figure 13.9. In turn, each player sling shoot chores into user's baskets, including their own. The player whose basket a chore lands in gets the chore. This makes the planning phase fun and creates competition amongst the users. If a user already has a maximum of large, medium, or small chores, their basket is removed to avoid having too much/less work.

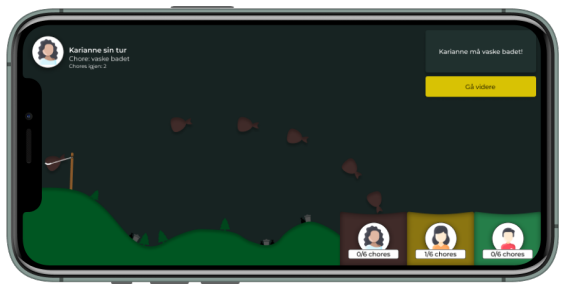



**Figure 13.9:** *Flying chores*

### Chores and Evaluation

Figure 13.10 shows an overview of the user's weekly chores. The chores are grouped according to their category (repeating, remaining, or completed chore), which is the gestalt principle *proximity*; elements that are close to each other are more related [82].

When the user has completed a chore, they can add a comment and a picture of their work, shown in Figure 13.11. The checkmark icon at the top of the page corresponds to the icon in the list of completed chores, connecting them and telling the user that they have come to the right place.

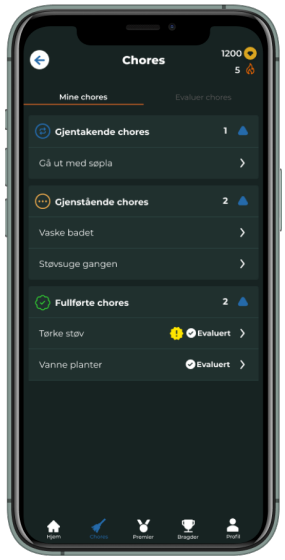



**Figure 13.10:** Chores overview


**Figure 13.11:** Completing a chore

The list shown in Figure 13.12 contains chores completed by others ready to be evaluated, which brings them to the view shown in Figure 13.13. In this view, the chore details from the user that completed the chore and the evaluation details are separated. The pending icon is also present in the list and on the evaluation page.

Based on the performance done by the user, the evaluator gives a score of 1 to 5 shiny soaps. Additionally, the evaluator has the option to add a comment and pictures.

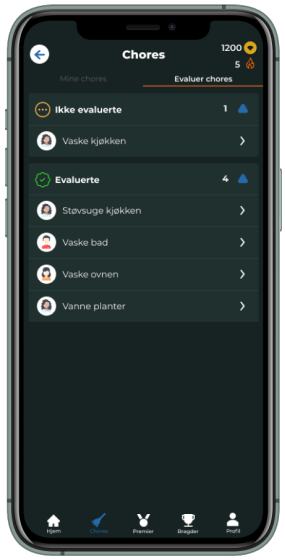



**Figure 13.12:** Evaluation overview

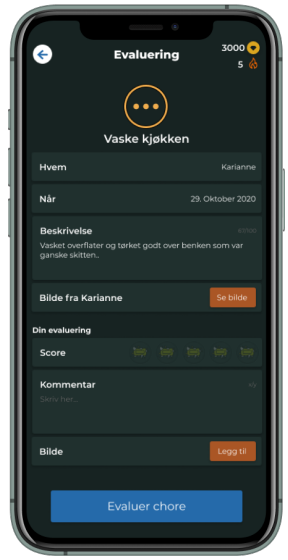



**Figure 13.13:** Evaluating a chore

## Achievements

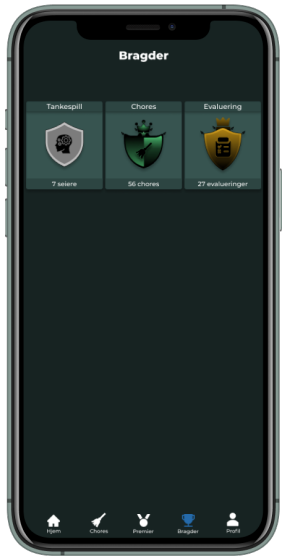



**Figure 13.14:** Achievements

Figure 13.14 shows the achievements screen, which is a simple list of all achievements the user has earned. Achievements are used to engage the user and can be earned in many different ways, such as performing chores and evaluations or winning planning games.

### Store

Figure 13.15 shows the overview of the store. It is separated into available rewards and already-bought items. Each store element consists of a title, a small description, and its value. Some items require both streaks and currency to able to buy them. If the user clicks an element in the store, they get more information about it and the opportunity to buy it.

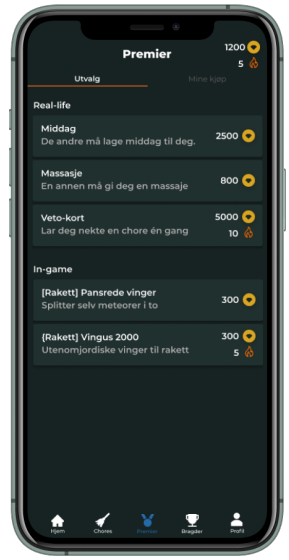



**Figure 13.15:** Store overview


**Figure 13.16:** *Bought reward*

If the user has used a real-life reward, they can be marked as ”used”, as shown in Figure 13.16. Marking rewards as used will delete them.

#### Profile and Edit Rocket

Users can view and edit their personal information such as age, email, and password in the profile view. Additionally, they can edit their rocket, as shown in Figure 13.17. The body color, flame color, and wing shapes can be edited. The latter two can be bought in the store.

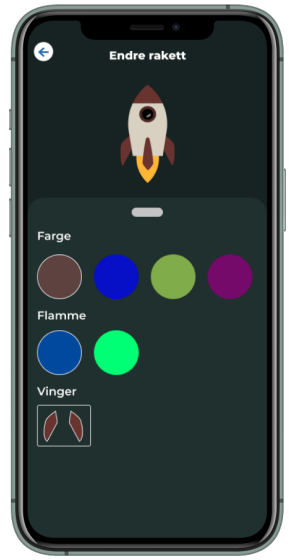



**Figure 13.17:** Edit rocket

### 13.1.2 User testing

As Figma makes it possible to navigate between the different frames in the prototype, it can be shared with other users to perform a user test. By opening a link, users are given access to test the prototype on their devices. This was also the best option due to Covid-19. A Google Form was created with tasks for the user test, shown in Table 13.1. The users also had the option to type in a reply for the given task.

| # | Task |
|---|---|
| 1 | Register user and create a group |
| 2 | Plan weekly chores |
| 3 | Complete chore: wash bathroom |
| 4 | Evaluate a chore |
| 5 | View achievements |
| 6 | Buy an in-game reward |
| 7 | Change color of the rocket's flame |

**Table 13.1:** Tasks in concept prototype user testing

A total of 6 people participated in the prototype user testing, which resulted in some great feedback on design and functionality, described in section 13.2. At the end of the test, a poll asked how the participants liked the idea, shown in Figure 13.18. 1 is ”very bad” and 5 is ”very good”.

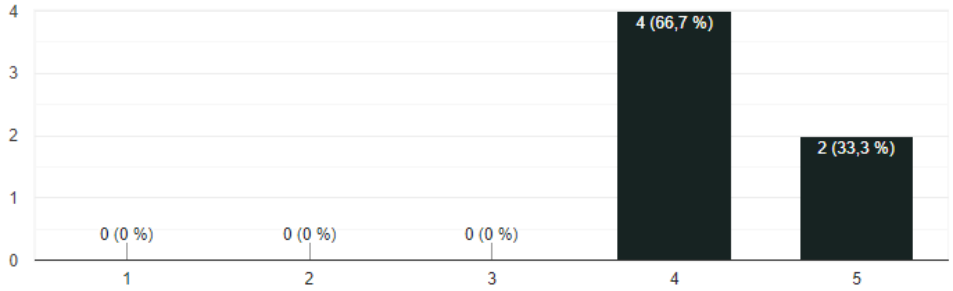



**Figure 13.18:** Prototype user test

### 13.1.3 Evaluation

After the first iteration of developing and testing the concept and prototype, some minor flaws were discovered. However, we believe they can be fixed rather easily and that the concept has a solid foundation to build upon.

## 13.2 Iteration 2

Based on feedback from user testing in the first iteration, some changes were made to the prototype in iteration two. Most of the changes were small and based on design, but some were also based on functionality. Most of the steps from the first iteration was carried out in this iteration as well. Initially, the challenges found in the prototype were addressed and solved. Some solutions were directly proposed in the feedback, while others were results of brainstorming based on the feedback. Further, the solutions were implemented in the prototype. As most of the changes were based on feedback from the users, it was unnecessary to test the second iteration of the prototype.

### 13.2.1 Changes from the Previous Version

This section contains an overview of changes from the previous version based on the feedback from user testing and general feedback.

#### Flying chores

To include the rocket more in the mini-game, we decided to make some changes to flying chores. Instead of sling-shooting chores into each other’s baskets, the rocket is being

launched into space, dropping chores on their way. This also makes it possible to add upgrades to the rocket in the store.


**Figure 13.19:** Changes to flying chores

### The Hat Game

The hat game got primarily positive feedback, but one common issue was that it was difficult to read the text on the cards. Therefore we made the cards larger and increased the font size. Additionally, the cards drawn are aligned and displayed to make it feel more like a physical deck. It is possible to swipe the cards, and Figure 13.20 shows the new design.

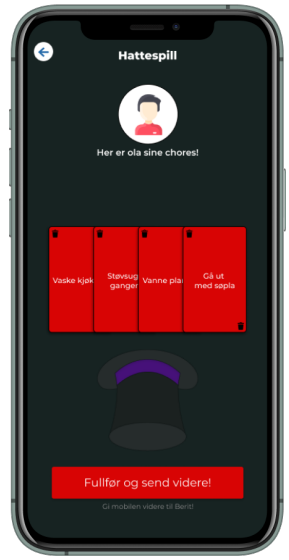



**Figure 13.20:** Changes to the Hat Game

### Evaluation of Chores

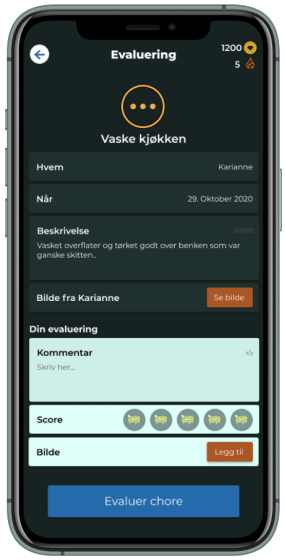



**Figure 13.21:** Changes to Evaluation

There was some confusion on the evaluation page, considering who had done the task and who evaluated it. The evaluation section got a new background color to make this clearer, shown in Figure 13.21. The gestalt principles *Similarity* and *Proximity* were followed, which states that similar items tend to have the same functionality and grouped items tend to be more related [82].

### Achievements

The changes on the achievements page were not based on feedback from iteration one, but an improvement we found when testing the prototype ourselves. The old design made it difficult to present information about each achievement and only allowed for a title and a short description. By switching from a grid view to a vertical list, each achievement could be larger and fit more information inside. Figure 13.22 shows the new design of the achievement screen.

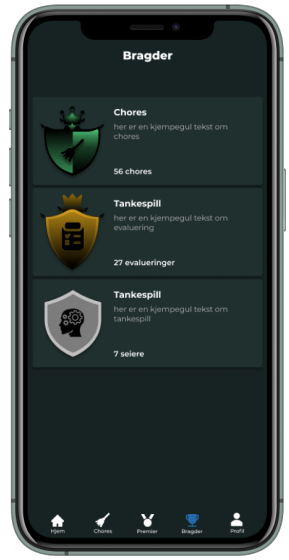
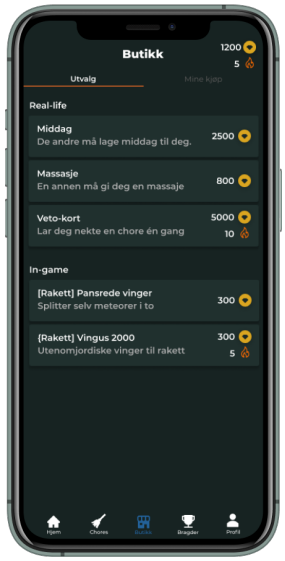



**Figure 13.22:** Changes to Achievements

### Store




A small change was made to the store, which previously was named *rewards*. Some users got confused by the name giving in Norwegian between rewards (premier) and achievements (bragder). To make this clearer, we renamed the rewards page to store and changed the icon from a medal to a store, as shown in Figure 13.23.

**Figure 13.23:** Changes to the Store

## 13.2.2 New functionality

### Player Information

Functionality to view information about other players was implemented. More information about the user is displayed by pressing their rockets on the home page, shown in Figure 13.24. As mentioned in Section 7.6.3, curiosity is one of the most important things to increase intrinsic motivation. Therefore the information is not very detailed. However, it shows some interesting data about how many chores and evaluations the user have completed. This might increase the user's motivation to complete even more chores themselves.

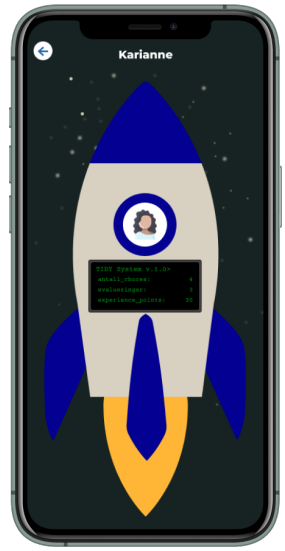



**Figure 13.24:** Information about another user

### 13.2.3 Evaluation

Iteration two resulted in a concept and a prototype we are fairly confident in moving forward with. It has been user-tested, and flaws have been discovered and fixed. Some aspects, such as the mini-games, have not been possible to test properly in the prototype and will be tested better in the next phase.

The concept phase has highlighted the importance of user testing and its feedback. We have experienced that small details that can be hard to spot when creating the concept with a tunnel vision can greatly improve the user experience when addressed.

Overall, we are pleased with the result and are ready to move into the development phase with the concept Tidy.

Chapter 14

# Potential and Chosen Technologies for the Proposed Solution

This chapter discusses the technologies used in the proposed solution and the considered but not chosen technologies. The choices will be explained and accounted for.

## 14.1 Design

Before we started to develop the application, it had to be designed. None of us are designers, so a simple-to-use yet complex design tool was desired. Preferably one on which both of us could work on the same project.

### 14.1.1 Figma

Figma [84] is a free web-based collaborative design and prototyping tool. Teams can work together on the same project in real-time, and it has a vast amount of relevant tools and functionality to simplify the design and prototyping processes. We used Figma to create the first drafts of the application and further design improvements. No other design tools were considered since both team members had prior experience with Figma, and the tool fulfilled all requirements for visualizing, designing, and prototyping. In retrospect, our confidence in Figma proved worthy, and no problems were encountered. It was a useful tool throughout the whole process.

## 14.2 Framework

When researching which framework to develop the application in, it boiled down to two contenders; Unity and React Native. This section discusses both frameworks, highlighting their respective advantages and disadvantages. Additionally, a third framework, Expo, and its compatibility with React Native are discussed.

### 14.2.1 Unity

Unity is a framework for developing cross-platform games [85]. It includes a game engine allowing for two- and three-dimensional games to be created and virtual reality and augmented reality games. In other words, it is perfected for creating games, which of course, would be a great advantage considering our use case. However, the framework is written in and requires knowledge of the programming language C#. Prior knowledge to C# would be optimal, but unfortunately, not something we possessed.

### 14.2.2 React Native

React Native is another framework for developing cross-platform applications [86]. However, in contrast to Unity, where the focus is on games, React Native focuses on general mobile applications. The framework, developed by Facebook, makes it possible to make applications that can run on both Android and iPhones. This can be done while still implementing native capabilities instead of making one application for each platform.

Both of us had a decent amount of prior experience with React Native, so a solution with this framework would be time-saving and preferred.

The framework is, however, not optimized for game development. A consequence of this is a lack of default game engines and physics engines in React Native. Both are needed for developing the games we had in mind. Luckily for us, there are multiple open-source third-party libraries providing game engines to React Native. After researching, we decided that the React Native Game Engine library [87] combined with the JavaScript physics engine Matter.js [88] would be a good fit. This would allow us to benefit from our experience with React Native and JavaScript while still fulfilling the need to develop games. Therefore the choice was simple, and we decided to use React Native as the application framework.

### 14.2.3 Expo

After choosing to use React Native, we looked into another framework, Expo. Expo is built around React Native to provide a seamless experience while developing cross-platform applications [89]. Building and releasing applications for both Android and iPhone can be a hassle with plain Native since you need a Mac to build applications for iPhone. However, Expo solves this by allowing everyone to build applications for both Android and iOS easily. A downside is that Expo always is a step behind the latest React Native releases since it is built around it. We concluded that this would not be a problem now since all functionality we need is already implemented in React Native and Expo. Therefore we decided to use Expo and React Native to simplify deployment and testing on both platforms.

## 14.3 Firebase

Firebase is a development tool for creating mobile and web applications [90]. The platform offers a high amount of services relevant to app development, such as storage, building, cloud functions, performance monitoring, analytics, and authentication, to name a few.

Firebase integrates well with React Native, so we decided to use some of its functionalities in our app. This section describes the services we use and how we use them.

### 14.3.1 Realtime database

The Firebase Realtime Database service is, just like the name suggests, a database that allows us to store and query application data in real time. The data is synchronized in real-time to everyone connected. This makes for a seamless and smooth user experience. It is a good fit for a group-based application like ours, where everyone in a group should be shown the same information at all times.

### 14.3.2 Firebase Analytics

A crucial service provided by Firebase is Firebase Analytics. The analytics solution allows you to track, monitor, and gain insight into user behavior. It works by simply adding events in the application that are sent to Firebase and displayed in the Firebase Analytics console. For example, when a button is pressed in the app, an Analytics event is triggered and sends information about the button press to Firebase Analytics. This lets us easily understand how users behave and what they do in the application. Any crashes and errors are also reported, making it a useful tool to discover problems. As mentioned in section 5.4, we want to perform data analysis on user interactions. The data on user behavior from Firebase Analytics will be used to find patterns or other observations.

Chapter 15

# Proposed Solution

This chapter presents the proposed solution for the application Tidy in the development phase.

## 15.1 User Flow in the Proposed Solution

This section describes the essential parts of the user flow in the proposed solution, shown in Figure 15.3.

### 15.1.1 Planning

The planning phase occurs when the current weekly competition is complete. See Section 15.1.6 for more details on the weekly competition. The planning is intended to be a social thing between the group members, and as Chen et al. state, social interaction is important to enhance perceived enjoyment [68]. This might result in better group dynamics and perceptions of the application.

Before the planning starts, the group decides how to plan and distribute chores for the upcoming weekly competition. There are currently two planning games; Hat Game (random distribution of chores) and Rocket Chores ( the users drop chores on each other). After completing the planning, the chores are given to the respective users.

### 15.1.2 Chores and evaluations

When completing a chore, the user can add a description and a photo to show off their work to the others in the group, who all are potential evaluators. The evaluator gives the completed chore a score from 1 to 5, which determines how many coins and XP the user who completed the task earns, see Figure 15.1. This will encourage the users to complete the chore well. It is also possible for the evaluator to add a comment and a photo if it is something they want to point out, e.g., ”Good job washing the bathroom, except the tap on the sink could have been done better, see image”. The user who completed the

chore also gets a notification on their phone to view the evaluation. Evaluating each other chores leads to social interaction between the users, resulting in a sense of relatedness [38]. According to self-determination theory, relatedness is experiencing relationships with others [35]. The feeling of enhanced group relationship and being involved in a team leads to increased engagement [49].

As seen in Figure 15.1, there is a change in the evaluation process from the concept. In Figure 13.13, soap stars were used to determine the evaluation score. However, as the images were quite small, it was not clear enough that it was small shiny soaps. Therefore we decided to use stars instead, which are much more common and have a clear meaning the users can relate to.


**Figure 15.1:** Different scores give different rewards

### 15.1.3 Achievements

Whenever the user completed certain actions, such as completed or evaluated $x$ amount of chores, they receive badges for their work, which according to Hakulinen et al., may increase both motivation and encouragement [53]. The presentation of the new badge occurs as a fade-in animation with music and confetti, making the experience of receiving a new badge exciting.

### 15.1.4 TidyCoins and XP

As mentioned in Section 15.1.2, the users receive coins called TidyCoins and Experience Points (XP) after a completed chore is evaluated or when evaluating a chore. The coins work as in-game currency, which is being used in the store to buy in-game or real-life rewards. The XP is used in the weekly competition to move their rocket further towards the moon and is reset after the competition has ended.

### 15.1.5 Store

The in-game store includes both in-game rewards and real-life rewards. The in-game rewards are mainly visual upgrades to their rockets, such as a new rocket flame or wings. Showing off new upgrades may encourage each other to perform even better. The real-life rewards are intended to increase social interaction amongst household members.

The concept mentioned that some items would require a long enough streak to buy. After consideration, this idea was not further explored.

The real-life rewards are customizable, allowing the groups to adjust and determine the most appropriate rewards for the group.

### 15.1.6 Weekly competition

When creating a group, the creator decides a competition length between one to four weeks. During this period, there is social interaction in competition amongst the users to gain the most XP to have their rockets reach the closest to the moon. As mentioned in Chapter 10, such social interaction increases the player's enjoyment and willingness to continue playing [68]. For example, not winning the weekly competition might encourage the users to perform even better next competition.

The weekly competition winner gets a double coin boost for the next competition. As we learned in Chapter 9, the given rewards should correspond with the time and effort spent [61]. Therefore, it is appropriate that the winner gets a boost.

## 15.2 Firebase Analytics

As the users follow the user flow and navigate through the application, various user events are logged in Firebase Analytics. These are being used to improve the development of the application further. A selection of these events can be seen in Table 15.1. The rest are to be found in Appendix A.1.

| # | Events |
|---|---|
| 1 | AcceptUser |
| 2 | Check_ChoresOrPlanning |
| 3 | Complete_chore |
| 4 | CreateGroup |

**Table 15.1:** A selection of user events

## 15.3 Customization

In the application, there are two ways of customization on group level; chores and real-life rewards. Firstly, adding, editing, and deleting chores for a group is important, as different groups and households have different chores to be completed. Each group starts with an initial list of relative normal chores, such as going with the trash and washing the bathroom. Secondly, the group can add, edit and delete rewards. A collective and cohabitants might want different rewards on their rewards list and should therefore be able to customize them as well.

The user may also customize their profile by changing their profile image and visuals on their rocket. To have the user's interest and motivation towards using the application, it is important to be able to customize the experience, as stated by Turkay and Adinolf [91].

## 15.4 Feedback

To ensure gameflow, clear feedback on the user's actions is fundamental. Feedback also leads to better concentration and establishing a sense of control over the task [39, 40]. In the application, the user receives feedback in the form of a notification bar at the top of the screen every time they act, such as completing a chore, see Figure 15.2. When achieving a new badge, the users receive both positive audible and textual feedback. Similarly, as they receive positive feedback, the users receive an orange-colored notification when an error prevents them from acting.


**Figure 15.2:** Feedback when completing a chore

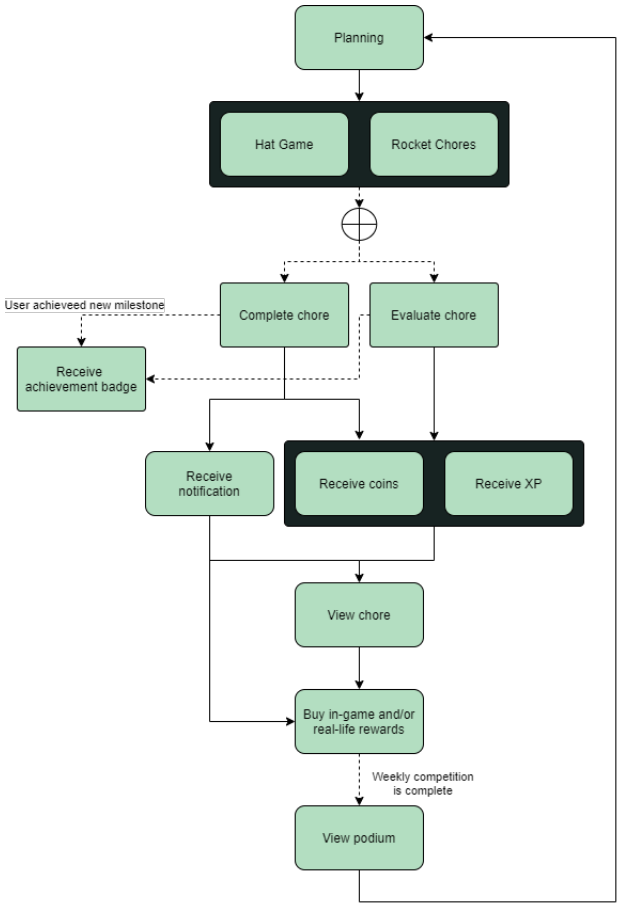



**Figure 15.3:** User flow in the Proposed Solution

Chapter 16

# Requirements

This chapter describes both functional and non-functional requirements for the application Tidy. They are established based on the preliminary study and the concept and prototype development, and the progression of the developed solution.

## 16.1 Functional Requirements

The following section presents the functional requirements for the application Tidy, available in Table 16.1. A functional requirement is a function that the application must be able to perform [92]. The most right column includes the requirement's priority, where *High* is a must-have, *Medium* is a should-have, and *Low* is nice to have.

| ID | Description | Priority |
|---|---|---|
| F1 | The user should be able to register with an email, password, username, and a rocket color | High |
| F2 | The user should be able to add a profile picture | Medium |
| F3 | The user should be able to change the profile picture | Low |
| F4 | The user should be able to reset the password | High |
| F5 | The user should be able to log in | High |
| F6 | The user should be able to log out | Low |
| F7 | The user should be able to create a group with a group name and competition length | High |

| ID | Description | Priority |
|---|---|---|
| F8 | The user should be able to join a group with a group code | High |
| F9 | The user should be able to accept or decline a group request | High |
| F10 | The user should be able to receive a notification when accepted to a group | Medium |
| F11 | The user should be able to change the rocket color | Low |
| F12 | The user should be able to add, edit or delete chores | High |
| F13 | The user should be able to add, edit or delete rewards | High |
| F14 | The user should be able to copy the group code to clipboard | Medium |
| F15 | The user should be able to distribute chores through planning | High |
| F16 | The user should be able to edit chores, rewards or competition length before planning | Medium |
| F17 | The user should be able to get an overview over the current chores distribution | High |
| F18 | The user should be able to get an overview of their own chores | High |
| F19 | The user should be able to add or change a description and pictures of their chores | High |
| F20 | The user should be able to mark their chore as completed | High |
| F21 | The user should be able to evaluate other completed chores | High |
| F22 | The user should be able to add a comment, score and pictures when evaluating a chore | High |
| F23 | The user should be able to receive a push notification when their chore is evaluated | High |
| F24 | The user should be able to view an evaluated chore | High |
| F25 | The user should be able to receive coins and xp when their chore is completed | High |

| ID | Description | Priority |
|---|---|---|
| F26 | The user should be able to receive coins and xp when they have completed an evaluation | High |
| F27 | The user should be able to achieve an achievement when completing or evaluating a chore | High |
| F28 | The user should be able to view all their achievements | High |
| F29 | The user should be able to view available rewards | High |
| F30 | The user should be able to buy available rewards | High |
| F31 | The user should be able to mark bought rewards as used | Medium |
| F32 | The user should be able to view a leader board of the current weekly competition | High |
| F33 | The user should be able to see statistics about other users | Medium |
| F34 | The user should be able to view a podium with results of a finished competition | High |
| F35 | The user should be able to view a podium with results of a previos finished competition | Medium |
| F36 | The application should give receive appropriate feedback when an action has been performed | High |
| F37 | The application should log user events | High |

**Table 16.1:** Functional requirements

## 16.2 Non-functional requirements

This section presents the non-functional requirements for the application Tidy, available in Table 16.2. According to Glinz, a non-functional requirement is an attribute or a constraint of a system [93]. For instance, NF1 and NF2 are time-bound.

| ID | Description | Type |
|---|---|---|
| NF1 | It should not take more than 3 minutes to understand how to register a user and create/join a group | Usability |
| NF2 | It should not take more than 5 minutes to understand the user flow and learn how to use the application | Usability |
| NF3 | Evaluating a completed chore should take no longer than 1 minute | Usability |
| NF4 | The application should run without any errors | Availability |
| NF5 | The real-time database should be available 95% of the time | Availability |
| NF6 | Reading and writing to the database should be done through secure protocols | Security |
| NF7 | Adding/removing in-game rewards and displaying them in the store should take no longer than 1 hour | Modifiability |

**Table 16.2:** Non-functional requirements

Chapter 17

# High-Fidelity Prototype of the Proposed Solution

This chapter describes the high-fidelity prototype and the functionality of Tidy. The first section sheds light on the different screens and functionality of the high-fidelity prototype. The second section describes the high-fidelity prototype testing and its results.

## 17.1 High-Fidelity Prototype

In this section, the high-fidelity prototype is expressed in detail. As we already were satisfied with the design and the feedback from the first user test was good, we decided to start develop the application and use is as the high-fidelity prototype. It is based on the proposed solution described in Chapter 15.

### 17.1.1 Start screen, Login, and Registration

The start screen is the first view the user sees, having the option to either log in to an existing account or create a new one. The login and register screens are shown in Figure 17.1 and 17.2. The user uses their email to create their account, making it possible to reset the password and log in to multiple devices.

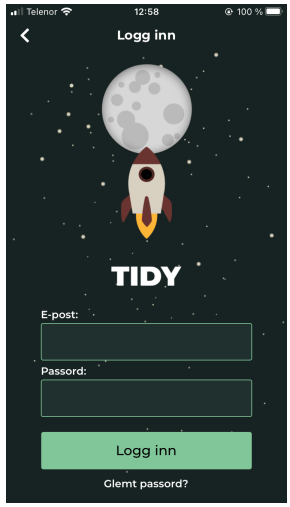



**Figure 17.1:** Login view

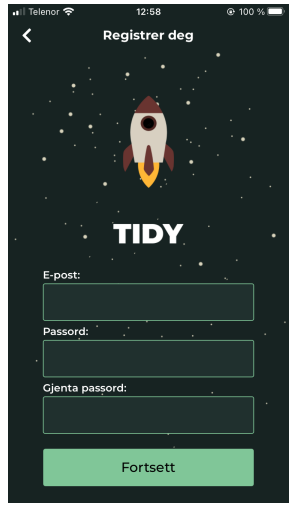



**Figure 17.2:** Register view

### Registration

After registering with a valid email, the user selects a user name and chooses a profile picture if desired, as shown in Figure 17.3 Next, the user selects a color to their rocket, shown in Figure 17.4. The profile picture and the rocket color can be updated later.

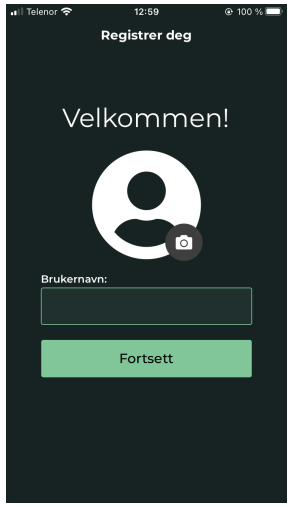



**Figure 17.3:** Choosing user name

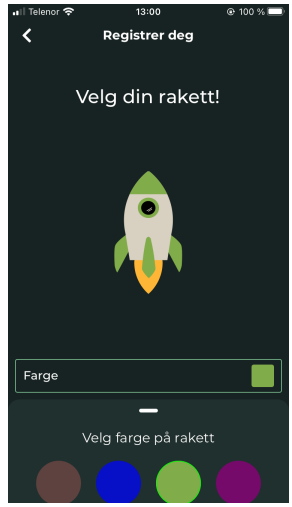



**Figure 17.4:** Selecting rocket color

### 17.1.2 Creating a group

After registration, the user is presented with two options; joining a group or creating a new one, as seen in Figure 17.5. If the user logs out during registration, they will be sent to this screen the next time they log in.


**Figure 17.5:** Joining or creating a group

When creating a group, the user firstly types in a group name, shown in Figure 17.6. Secondly, the user specifies some rules for the group. The prototype only has one customizable rule; competition length. However, the screen is created to fit in other rules easily, as illustrated in Figure 17.7. Next, the user can edit an initial list of standard house chores given to the group. This list can also be edited later on. Lastly, the user is sent to an overview page, currently displaying the group name and the group code used by other users to request to join the group, shown in Figure 17.8

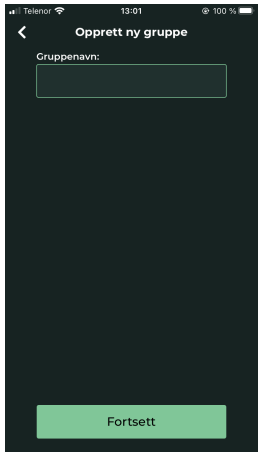



**Figure 17.6:** Group name

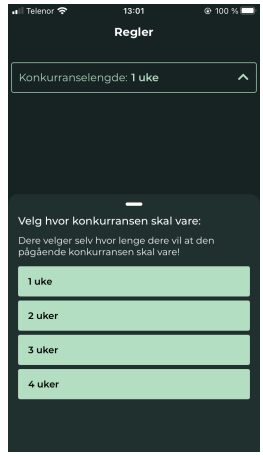



**Figure 17.7:** Competition length

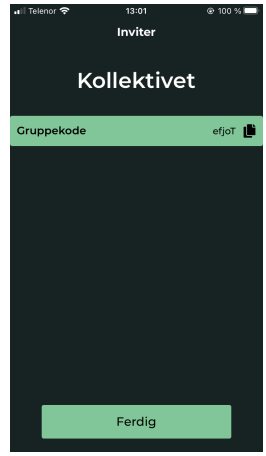



**Figure 17.8:** Group overview

### 17.1.3 Joining an existing group

If the user wants to join an existing group, they need to type in the group code, as seen in Figure 17.9. This is to ensure that not everyone can join your group. Further, the user is sent to a waiting screen, waiting for one group member to accept the request, as illustrated in Figure 17.10. Here the user can also refresh the view by scrolling down.

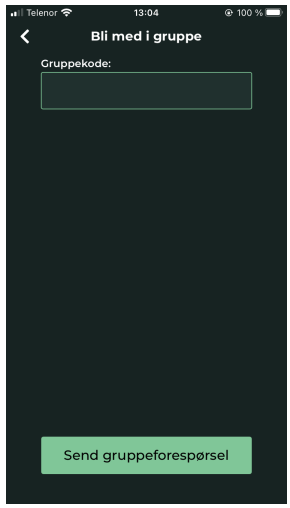



**Figure 17.9:** Group code


**Figure 17.10:** Waiting screen

### 17.1.4 Home

The home page is the main page in the application, showing the overview of the current weekly competition, as shown in Figure 17.11. The view is set in space, getting a feeling that your rocket is on the way upwards. The user closest to the moon is the one with the most XP. It is also possible to click one of the rockets to get some extra information about the user, such as how many chores they have completed, as seen in Figure 17.12. A settings wheel is placed at the top left corner, described in the next section.


**Figure 17.11:** Home

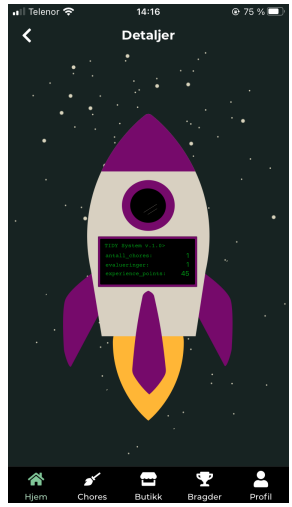



**Figure 17.12:** User details

### 17.1.5 Settings

There are several options on the group settings screen, such as copying the group code, editing chores, and rewards, and viewing pending group requests. This is illustrated in Figure 17.13.

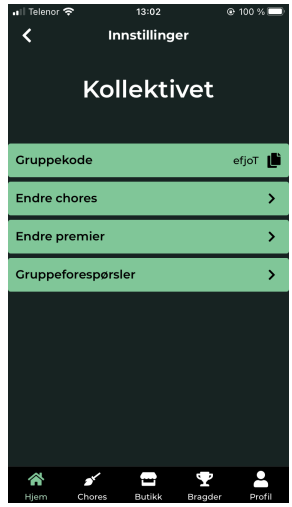



**Figure 17.13:** Settings

### Edit Chores

If the group wants to edit the list of chores for the upcoming weekly competition, they have the option to do so at the edit chores view, as seen in Figure 17.14. Here, they may also add new chores. As shown in Figure 17.15, the chores' name, chore type (regular or repeating chore), and the chore difficulty are shown in the editor view. The higher the difficulty, the higher the reward. When the user chooses between different difficulties, the reward item ("Belønninger") updates. They also have the option to delete the chore.


**Figure 17.14:** Edit chores


**Figure 17.15:** Chore Editor

### Edit Rewards

Editing rewards is very similar to editing chores. Every group is given an initial standard reward: to cook dinner for someone else, as seen in Figure 17.16. They also have the opportunity to create new rewards. When editing a reward, they can change the rewards' name, description, and price, shown in Figure 17.17.

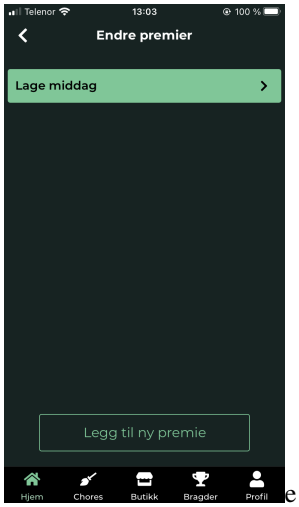



**Figure 17.16:** Edit chores


**Figure 17.17:** Chore Editor

### Group Requests

As described in Section 17.1.3, a new group request occurs when a new user joins your group, as illustrated in Figure 17.18. They can accept or decline the request by pressing a user, as shown in Figure 17.19. This is a tool to keep unwanted users away from the group.

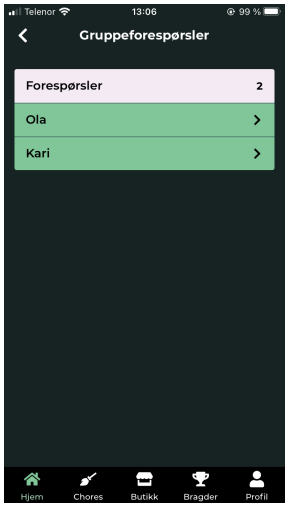



**Figure 17.18:** Group requests

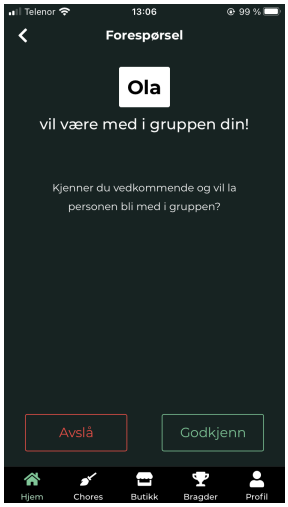



**Figure 17.19:** Group request

### 17.1.6 Planning

The planning process is one of the essential parts of the application since it is during this phase chores get distributed to the users. It starts with a pre-planning screen, as seen in Figure 17.20. It is possible to edit chores or adjust the competition length before starting the planning itself. As illustrated in Figure 17.21, the planning page consists of two planning options; Hat Game and Rocket Game.

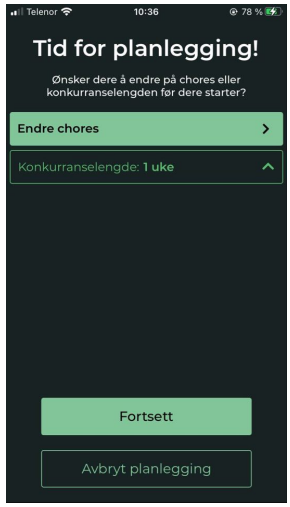



**Figure 17.20:** Pre-planning

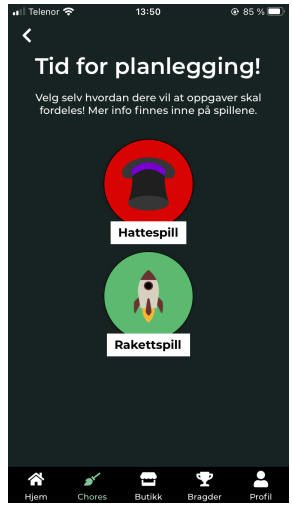



**Figure 17.21:** Planning options

Both planning games have their own start page, showing all the players and the game rules, shown in Figure 17.22 and 17.23. Only one user may enter the planning page, so the household must be gathered and use the same device when planning.

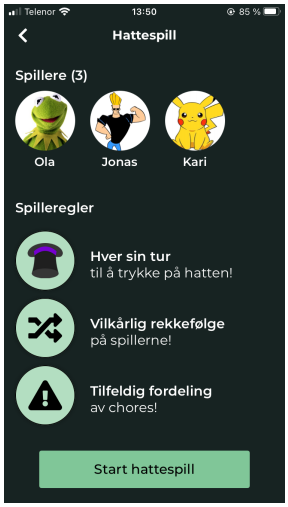



**Figure 17.22:** Pre-planning

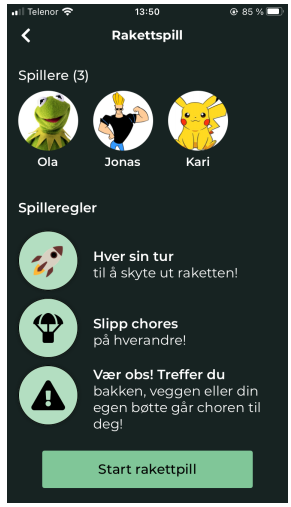



**Figure 17.23:** Planning options

### Hat Game

The Hat Game is turn-based and distributes chores randomly based on the number of users in the group and the total chore weight. The chore weight is based on the chore's difficulty, ranging from 1 to 3. The group themselves sets this. For instance, cleaning the bathroom might have a greater workload than emptying the dishwasher. This, of course, depends on what kind of preferences the group has. As seen in Figure 17.24, the user gets a set of chores by pressing the magical hat, shown in Figure 17.25.

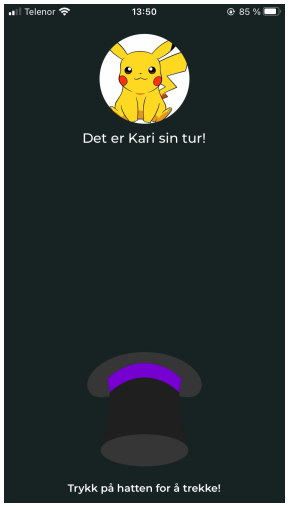



**Figure 17.24:** Pressing the magical hat


**Figure 17.25:** Viewing given chores

### Rocket Chores

The Rocket chores game lets the users decide more on the outcome of the chore distribution. This game is also turn-based, where each user chooses the rocket angle and force, as illustrated in Figure 17.26. The rocket is then launched into the game area, which is also set in space similar to the home page. There are elevating boxes representing all the users in the group in this area. When the rocket is flying, the user can drop a chore, as shown in Figure 17.27.


**Figure 17.26:** Pressing the magical hat

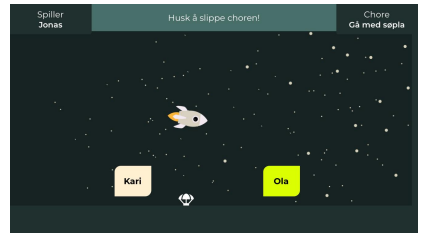



**Figure 17.27:** Pressing the magical hat

### Chore Overview

When the planning is complete, the user is sent to a chore overview page, showing the chores for all users for the upcoming weekly competition, as illustrated in Figure 17.28.

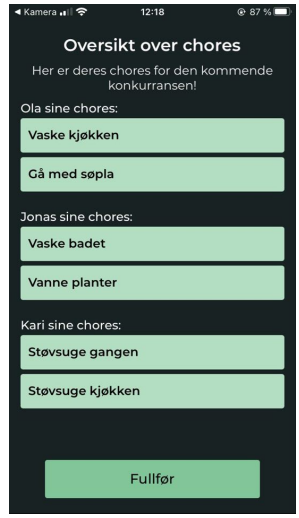



**Figure 17.28:** Chore overview

### 17.1.7 Chores

The user uses the ”Chores” tab to plan and view distributed chores. If the planning is complete, the user is sent to the ”My chores” screen, as shown in Figure 17.29. On this screen, the user can see the status of their chores.

#### Completing a chore

By pressing on a chore, they get the opportunity to complete it. They may also add a description and a picture, as seen in Figure 17.30. By pressing ”Fullfør chore”, the chore is set to complete. However, the user can change their description or add new photos until an evaluation has been given.

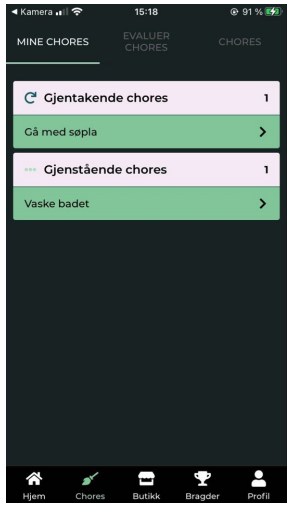



**Figure 17.29:** My chores


**Figure 17.30:** Completing a chore

#### Evaluating a chore

At the ”Evaluer chores” tab, all completed chores by other users will appear, as shown in Figure 17.31. Users may evaluate as many chores as they prefer. They also get 100 coins and 10 XP by evaluating. The user is sent to the evaluation screen by pressing on a chore, as shown in Figure 17.32. The evaluator gets to add a comment, give a score from 1 to 5 that determines the actual coins and XP reward, and add images. When ”Evaluer” is pressed, the user who completed the chore gets a push notification on their phone.

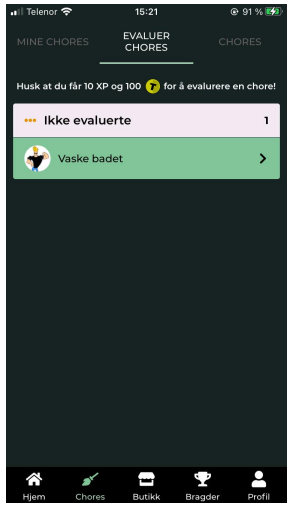



**Figure 17.31:** Chores available for evaluating

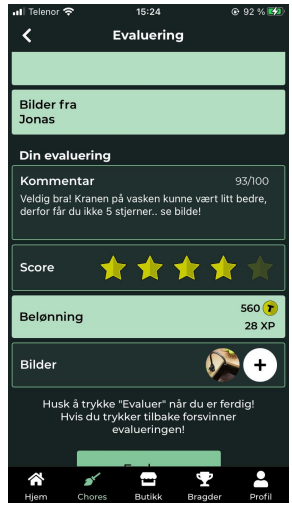



**Figure 17.32:** Evaluating a chore

### View evaluated chore

By either pressing the push notification or navigating to ”My Chores”, the user will see that one of their chores has been marked with a ”checked” mark and the text ”Evaluert”, meaning that one of the other users of the household has evaluated the completed chore, as seen in Figure 17.33. The user can see the evaluation, the score, and the reward given by pressing the chore, as shown in Figure 17.34.

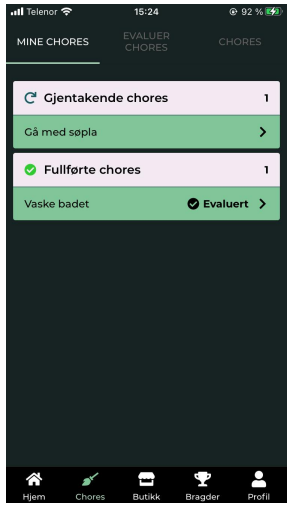



**Figure 17.33:** Chore is evaluated

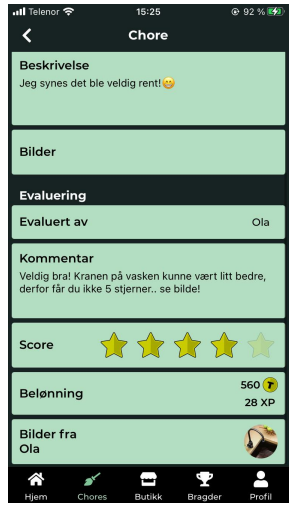



**Figure 17.34:** Viewing an evaluated chore

### 17.1.8 Achievements

Whenever a user evaluates or completes a chore, their respective statistic increases. By completing x amount of chores, the user will be given a new badge. This pops opp in an animation show with confetti, shown in Figure 17.35. Their achievement badges are also available at any time at the ”Bragder” tab, as illustrated in Figure 17.36.

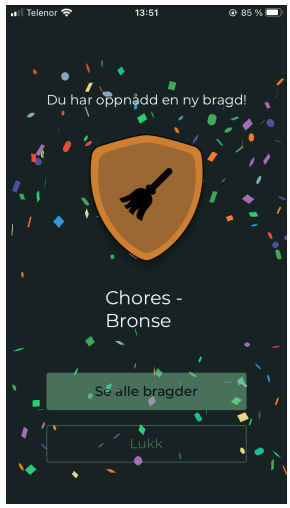



**Figure 17.35:** New achievement

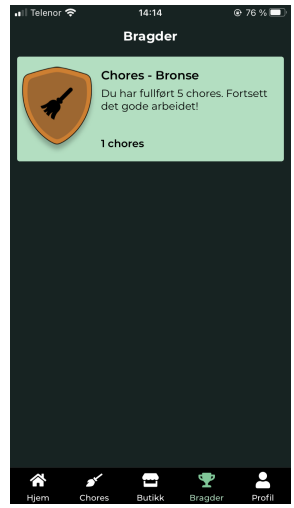



**Figure 17.36:** Achievements overview

### 17.1.9 Store

In the Store, the users will find real-life and in-game rewards, as shown in Figure 17.37. Currently, there are only real-life rewards created by the group themselves. The rewards are listed with a name, a short description, and a price. By pressing on one of these, they get to know more about the reward and get the option to buy it, as illustrated in Figure 17.38. If the user tries to buy a reward without enough funds, they get a red feedback notification at the top of the screen.


**Figure 17.37:** Store


**Figure 17.38:** Real life reward

When a reward is bought, it gets listed in the ”Mine kjøp” tab. To keep it as simple as possible, this list of items is similar to the one shown in Figure 17.33. By clicking into a bought reward, they get the option to mark it as ”used”, meaning that the reward has been completed or used. This will remove the reward from the list of bought rewards.

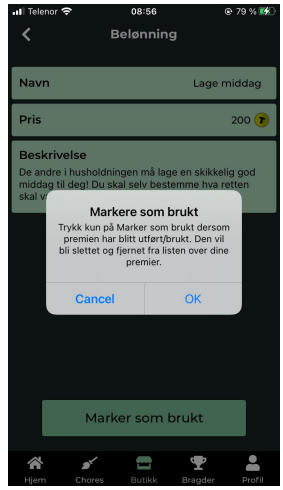



**Figure 17.39:** Mark bought item as used

### 17.1.10 Profile

The profile page, shown in Figure 17.40, includes the user’s name, email, amount of coins, XP, and profile picture. By pressing the profile picture, the user can change it if there is a need for customization. If the user wants to edit their rocket, they press the button labeled ”Endre rakett”. As illustrated in Figure 17.41, it is currently only possible to change the color of their rocket. However, as soon as in-game rewards are available, this will be the place to customize your rocket with visual upgrades.

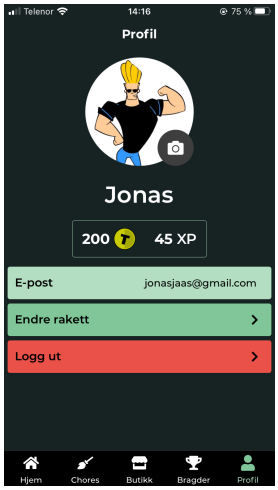



**Figure 17.40:** Profile

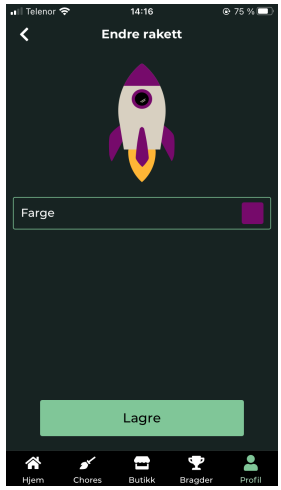



**Figure 17.41:** Real life reward

### 17.1.11 Weekly Podium

When the weekly competition is complete, the users are sent to a podium the next time they log in / refresh the home page, as shown in Figure 17.42. The users with the most XP get placed on the podium, while the rest are listed below. The winner gets a double coin boost for the upcoming competition, expressed in a notification at the top of the screen. The user who receives the boost will see a ”2x” icon on their home screen, as shown in Figure 17.43. When the users click ”Ferdig”, the podium is closed. However, if they want to view previous competitions, they are available in the settings.

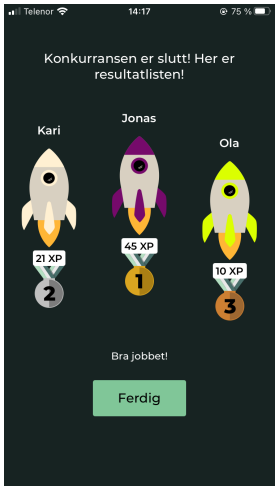



**Figure 17.42:** Weekly podium


**Figure 17.43:** Coin boost

## 17.2 High-Fidelity Prototype Testing

This section includes a description of the high-fidelity prototype testing phase and its results. The test was to detect flaws and get feedback on the application. As the prototype was fully developed, the testing took place on an actual phone, increasing the overall user experience. Due to Covid-19, we tested the prototype on the members of our own households.

### 17.2.1 Execution of the test

Before initiating the test itself, the participants were provided a description of the application and the purpose of conducting such a test. To get insight into the participant's mindset during the test, they were asked to think aloud. Also, to ensure that the participant did not feel any pressure, they were ensured that they could quit at any time.

The participants were given 10 test questions, available in Table 17.1.

| # | Task |
|---|---|
| 1 | Register user and create group |
| 2 | Log into ”test@tidy.no” and join the first group |
| 3 | Plan chores for the upcoming weekly competition and add some rewards! |
| 4 | Complete a chore |
| 5 | Evaluate a chore with ”test@tidy.no” |
| 6 | View the evaluated chore |
| 7 | Buy a reward |
| 8 | Mark the reward as used |
| 9 | Edit the color of your rocket |
| 10 | See information about another user |

**Table 17.1:** Tasks in high-fidelity prototype user testing

### 17.2.2 Results

This section contains the results of the high-fidelity prototype testing. Overall, the testing went very well, and the testers understood the functionality and user flow of the application. Some various layout problems were discovered during the test. The testers thought that using the application would lead to better planning and organizing of chores and being more motivated to do them and evaluate the work of others.

Some testers missed an introduction to the application during testing, explaining the most essentials concepts. Such an introduction guide would heavily improve the overall understanding and improve the user experience.

### Group Requests

The testers had no issues joining a group, but one tester struggled to find group requests when acting as a member on the inside of the group. The tester asked if it was possible to change the settings wheel on the home screen to include a number representing the number of group requests, making it more intuitive to understand that they had to press the settings wheel.

### Rewards

Adding, editing, and deleting rewards went very well. However, some testers mentioned that both short and long description on chores was unnecessary and took too much time and did not add very much value to the user experience.

Chapter 18

# Final solution

This chapter presents the final solution based on changes and additions added to the application. These changes and additions are mainly based on the high-fidelity prototype testing, other tests performed during the development phase, and continuous brainstorming throughout the iterations. The first section describes the changes in functionality or layout from the proposed solution to the final solution, while the second section presents additions to the solution.

## 18.1 Changes to the solution

Whether a change was implemented to the solution was based on time spent, effort, and how much value it would add.

### 18.1.1 Rewards

There was both a short and a long description of rewards in the proposed solution. As several testers felt that it took an unnecessary amount of time to fill in both, the long description was removed, and the maximum length of the short description was slightly increased.

### 18.1.2 Deciding competition length

Another change from the proposed solution is how the competition length is decided. Previously, the groups had the option to select a competition between one and four weeks, where the competition always ended on a Monday. However, as different groups might have different opinions on when to end their competition, we implemented a solution to choose the end date for the competition from a calendar. The end date is set on the pre-planning page.

### 18.1.3 Colors


**Figure 18.1:** Group request indicator

Originally, the main color in the Hat Game was red, but since this color is often related to danger and something ”not good,” we decided to change it to a light green color used in the rest of the application, as shown in Figure 18.1. This was done to avoid any confusion amongst the users.

## 18.2 Additions to the solution

The reasoning for adding elements to the solution was whenever a tester felt that something was missing or had feedback that would improve the user experience. The testers' suggestions were taken into account and considered adding to the solution. Whether the suggestions should be included or not was also based on time spent, effort, and how much value it would add.

### 18.2.1 Amount of Group Requests Indicator

One tester thought that an indicator representing the number of unanswered group requests on the home page would benefit. To avoid users being unsure of how many group requests there were and where to find them, we decided to add them to the solution, as shown in Figure 18.2.


**Figure 18.2:** Group request indicator

### 18.2.2 Onboarding

Onboarding is a process the users go through the first time they open the application. It is a tutorial on how the application works and how to use it. As several testers were unsure of various functionality and content, we decided to add an onboarding guide, as seen in Figure 18.3. For instance, one tester mentioned that it was confusing to hide the bottom

menu that pops up when changing color on the rocket. To ensure the best possible user experience, a guide regarding the menus and keyboards was added, as shown in Figure 18.4. As mentioned, users only have to go through the onboarding once. However, the guide can always be found and viewed again on the profile page.


**Figure 18.3:** Onboarding


**Figure 18.4:** Onboarding - Menus and Keyboard

### 18.2.3 Flag on the moon

A way to increase the competition amongst the users is to indicate who won the previous weekly competition and got closest to the moon. This was solved by adding a flag on the moon where the flag's color corresponds with the rocket color of the previous competition winner. Seeing that someone else "currently owning the moon" might encourage users to perform even better. Also, being the one with their flag on the moon might lead to a feeling of success and greatness.


**Figure 18.5:** Group request indicator

### 18.2.4 Statistic page


**Figure 18.6:** Statistic page

An idea introduced early in the concept phase, but that was temporarily excluded due to low priority was a statistic page. As the development phase went well, we decided to add it anyway. The statistic page, shown in Figure 18.6, includes statistics about almost all the user's actions in the application. Knowing how many chores you have performed or the total amount of stars you have received might be an interesting feature for the users.

### 18.2.5 In-game rewards

To let the users upgrade and customize their rockets' color and flame color, we decided to add in-game rewards, as shown in Figure 18.7. This allows the users to show of their hard work through fancy and exclusive colors, and could work as motivation through social interaction. If another user got a new rocket color, you might want the same.


**Figure 18.7:** In-game rewards

### 18.2.6 Rocket Flame Color

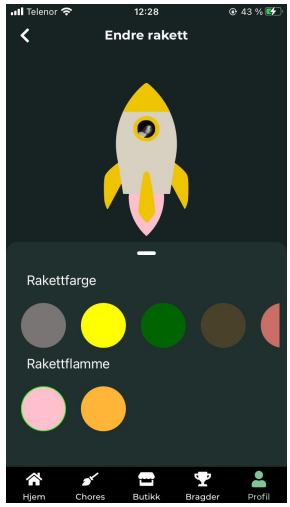



**Figure 18.8:** Adjusting rocket flame

To stand out even more amongst the group members, we decided to add custom rocket flame colors. The only way to get them is by buying them at the store, making them very exclusive, see Figure 18.8

### 18.2.7 Repeating chores

As some chores are being performed several times during a week by several people, e.g., going out with the trash, we decided to implement repeating chores. These are chores that are added and customized the same way as normal chores, but everyone in the group can do them several times during a competition. Previously, as mentioned in Section 17.1.5, chores had the *type* attribute that could be normal or repeating. As repeating chores was implemented, this attribute was removed. To summarize, users receive *normal* chores when planning a competition. This can only be completed once while *repeating* chores can be completed several times by several group members, as shown in Figure 18.9.

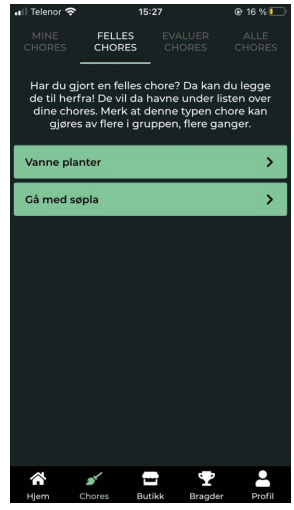



**Figure 18.9:** Repeating chores

Chapter 19

# Software Architecture

This chapter will discuss the overall architecture overview, showing the relations between frontend and backend and the more specific architecture inside the backend and inside the frontend.

## 19.1 Architecture Overview

Figure 19.1 shows the overall architecture overview of the application. As the figure illustrates, the architecture is based on a client-server model [94]. The client is the frontend, the part the end-users see. The server is the backend, the part end users do not see.

The client is based on a mobile application on React Native. The Expo framework is included outside of the client-side in the diagram because it is used to run and build the application during development. Additionally, a push notification service provided by Expo, expo-notifications, is used to send out push notifications to users.

The client-side communicates securely with the server-side. The server side consists of Firebase, which has direct implementation with React Native. Firebase includes many services, but we use analytics, database, storage, and authentication services. Through these, all data required in the application is stored, and the authentication service allows users to access only their own relevant data. Data and information are sent securely between the client-side and the server-side through the HTTPS protocol.

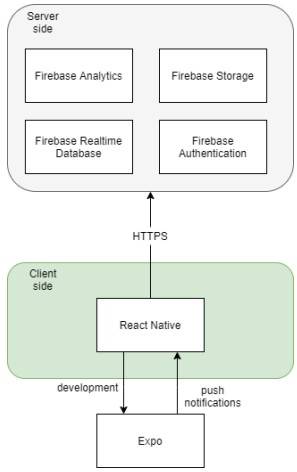



**Figure 19.1:** Architecture overview

## 19.2 Database

The Firebase Realtime Database consists of three main tables. The entity-relationship model in Figure 19.2 illustrates the tables and their relations. In short, each group can have multiple users, while a user can only be part of one or zero groups. Also, a user can have many achievements, while an achievement is not exclusive and can be given to multiple users. The tables in the model are somewhat simplified, and some of the values are lists or objects containing more comprehensive data, such as the value of the chore that contains a list of all current chores for the user. However, the model gives a quick and sufficient overview of the database to understand how the data work together.

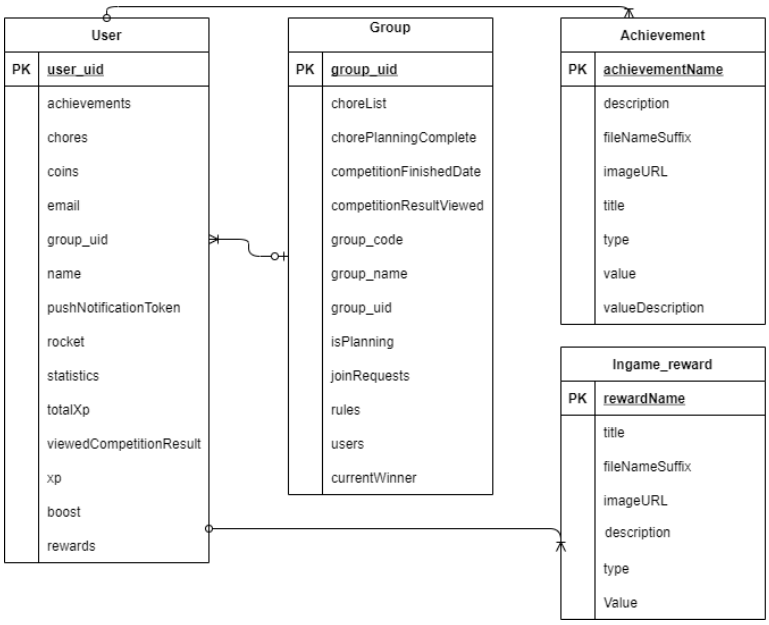



**Figure 19.2:** Firebase Realtime Database Entity Relationship Model

## 19.3 React Native

The client-side, the React Native application, is built by several components, services, screens, and globally shared values. Figure 19.3 shows the overview of these and the folder structure. Each square in the figure is a folder in the source code. The full diagram of all React Native components can be seen in Appendix B.1, while this section briefly discusses the functionality of each folder and how the application interacts across folders.

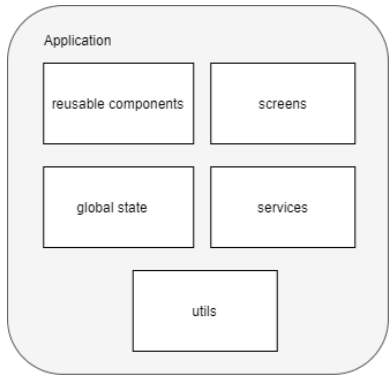



**Figure 19.3:** React Native architecture overview

### 19.3.1 Components

Many of the components, such as buttons and list items, are appropriately reused in different application parts. Others are not fit to be reused but are still separate components to isolate and simplify the code. Architecturally the reused components are placed outside of the screen folders in their own folder, while components only used on one screen naturally are placed in their respective screen folders.

### 19.3.2 Screens

The screens make up the user interface of the application. Each screen consists of one or more components, both reusable and non-reusable. Much of the logic behind what to show is also handled in the screen components, but it often depends on global values.

### 19.3.3 Global state

The global state is used to maintain a consistent and synchronized set of data across the whole application. Whenever a value is changed in one component, the same value gets updated in other components. Many state management libraries exist for React Native, with the most popular being Redux and MobX. However, since our global state is relatively small, we decided to try a lightweight library called *use-global-hook*[95], making a global store accessible through a React Hook.

Additionally, we have some global constants. These are not changed or fetched from any external source; they are hard-coded in their own file. This file is also accessible from anywhere in the project, and it includes constant values such as different colors used in the user interface.

### 19.3.4 Services

The data stored in the global state are mostly fetched from the database. The fetching is done through services. Simply put, services are functions retrieving data from the server. Different parts of the application require different data, so the services are divided to fit these needs. One service fetches information about the user, another about the group, and so on.

### 19.3.5 Utils

The idea of utils, or utilities, is to group functions that can be helpful across the application. Our utils map only consists of one file called *helpers.js*, and as the name suggests, it consists of helpful functions. Examples of such functions are sorting functions and refresh functions.

Chapter 20

# Testing and Validation of Requirements

This chapter outlines the testing approach to the functional requirements of the application. Further, validation of both functional and non-functional requirements is provided.

## 20.1 Approach

During the development phase, a large amount of smaller issues were created in our project to avoid taking on too large tasks that could be time-consuming and unnecessarily complicated over time. Whenever such an issue was completed, it was moved into the testing phase, and a pull request was created. A pull request is a request to merge code we are currently working on into the rest of the development code containing additions/changes. To merge the code and thereby complete the issue, the pull request had to be reviewed and approved by the other developer. The process of testing each other's issues was carried out in such a way that new functionality was tried out without discussing the issue in particular in advance, giving a best-possible objective view on the task. This ensured full testing of the issue, checking if it was working or not. It also contributed to discovering new bugs and flaws in the code.

## 20.2 Validation of Functional Requirements

The requirement was marked as validated and complete when all issues correlated to a functional requirement were completed, tested, and approved. All functional requirements and their respective status are available in Table 20.1. The last column named *Notes* gives more detailed description on the requirement's status.

| ID | Description | Status | Notes |
|---|---|---|---|
| F1 | The user should be able to register with an email, password, username and a rocket color | Complete | A sequence of screens guiding the user through the registration process. |
| F2 | The user should be able to add profile picture | Complete | The user is able to add a profile picture both during registration and on the profile page. |
| F3 | The user should be able to change profile picture | Complete | The user is able to change profile picture both during registration and on the profile page. |
| F4 | The user should be able to reset password | Complete | Given that a valid email is used, the user can reset password on the login page. |
| F5 | The user should be able to log in | Complete | By entering valid user credentials at the login page, the user is authenticated through Firebase and logged into the application. |
| F6 | The user should be able to log out | Complete | By clicking the log out button at the profile page, the user is no longer authenticated and successfully logged out of the application. |
| F7 | The user should be able to create a group with group name and competition length | Complete | A sequence of screens guiding the user thruogh the process of creating a group. |
| F8 | The user should be able to join a group with a group code | Complete | By entering a valid group code, the user sends a join request to the group. |
| F9 | The user should be able to accept or decline a group request | Complete | By entering the group request screen found at the settings, the user can click into pending requests and accept or deny the request. |
| F10 | The user should be able to receive a notification when accepted to a group | Complete | When someone has accepted the group request, the user will receive a push notification on their mobile phone. |
| F11 | The user should be able to change rocket color | Complete | The user is able to change rocket color both during registration and on the profile page. |
| F12 | The user should be able to add, edit or delete chores | Complete | By entering the edit chores screen found at the settings, a button allows the user to add a new chore. By pressing a chore, the user has the options to edit or delete it. |

| ID | Description | Status | Notes |
|---|---|---|---|
| F13 | The user should be able to add, edit or delete rewards | Complete | By entering the edit rewards screen found at the settings, a button allows the user to add a new reward. By pressing a reward, the user has the options to edit or delete it. |
| F14 | The user should be able to copy the group code to clipboard | Complete | The user is able to copy the group code to clipboard at the group overview screen at the end of group creation, or at the settings screen. |
| F15 | The user should be able to distribute chores through planning | Complete | The user has the option to either plan and distribute chores through hat game or rocket chores. Both games are a sequence of screens. |
| F16 | The user should be able to edit chores, rewards or competition length before planning | Complete | By pressing the chores tab before chores is planned, the user enters the pre-planning screen, where it is possible to edit chores, rewards or the competition length. |
| F17 | The user should be able to get an overview over the current chores distribution | Complete | When the user is complete with the planning, a screen with chore overview shows. This screen is also available after planning is complete at the chores tab, under the chores overview tab. |
| F18 | The user should be able to get an overview their own chores | Complete | By clicking the chores tab after chores is planned, the user gets an overview over their chores. |
| F19 | The user should be able to add or change a description and pictures to their chores | Complete | By pressing a chore, the user gets to add and change description and pictures. |
| F20 | The user should be able to mark their chore as completed | Complete | By pressing the ”fullfør chore” button at the chore screen, the chore will be updated as completed. |
| F21 | The user should be able to evaluate other completed chores | Complete | Completed chores are available in the ”Evaluer” tab, and allows the user to evaluate others. |
| F22 | The user should be able to add a comment, score and pictures when evaluating a chore | Complete | By pressing a complete chore at the evaluer tab, the user has the option to add a comment, score and pictures to the evaluation. |
| F23 | The user should be able to receive a push notification when their chore is evaluated | Complete | When another user has evaluated a chore, the application will send a push notification to the user who completed the chore. |

| ID | Description | Status | Notes |
|---|---|---|---|
| F24 | The user should be able to view an evaluated chore | Complete | Evaluated chores are available in the same screen as the other chores, but marked with a check mark and the text ”Evaluated”. |
| F25 | The user should be able to receive coins and xp when their chore is completed | Complete | The application sends coins and xp to the respective user when someone has evaluated their completed chore. |
| F26 | The user should be able to receive coins and xp when a they have completed an evaluation | Complete | The application sends coins and xp when the user has completed an evaluation. |
| F27 | The user should be able to achieve an achievement when completing or evaluating a chore | Complete | When the user has completed enough chores or evaluations to achieve an achievement, a screen with an achievement animation shows. |
| F28 | The user should be able to view all their achievements | Complete | All the achievements are available at the ”Bragder” tab |
| F29 | The user should be able to view available rewards | Complete | All available rewards can be seen on the store screen |
| F30 | The user should be able to buy available rewards | Complete | If enough funds are available, the user is able to buy rewards by pressing the buy button at the reward screen |
| F31 | The user should be able to mark bought rewards as used | Complete | By pressing a bought reward at the bought tab, the user has the option the mark the reward as used. |
| F32 | The user should be able to view a leader board of the current weekly competition | Complete | The home screen shows the leader board of the current weekly competition. |
| F33 | The user should be able to see statistics about other users | Complete | By pressing another user at the home page, the user will see statistics about other users. |
| F34 | The user should be able to view a podium with results of a finished competition | Complete | If a competition is finished, a screen with a weekly podium shows. |
| F35 | The user should be able to view a podium with results of a previous finished competition | Complete | By clicking into previous competition found at the settings, the user will get a list of previous competitions. |
| F36 | The application should give receive appropriate feedback when an action has been performed | Complete | When the users perform an action, the application displays a feedback bar that shows that the very top of the screen. |
| F37 | The application should log user events | Complete | When the users perform a specific action, such as login in or completing a chore, the application log these event through Firebase Analytics. |



**Table 20.1:** Validation of Functional requirements

## 20.3 Validation of Non-Functional Requirements

To evaluate and validate the non-functional requirements, the fina

The answers from the final questionnaire was used to validate the non-functional requirements. Hence, the experiment had to be completed. All non-functional requirements and their respective status are available in Table 20.2. The last column named *Notes* gives more detailed description on the requirement's status.

| ID | Description | Status | Type | Notes |
|---|---|---|---|---|
| NF1 | It should not take more than 3 minutes to understand how to register a user and create/join a group | Complete | Usability | This requirement was tested on several people and was successful for everyone. |
| NF2 | It should not take more than 5 minutes to understand the user flow and learn how to use the application | Partly complete | Usability | All testers managed to navigate and understand the application, but some understood the flow of the application faster than others. The reason for this is how well they read the onboarding guide. |
| NF3 | Evaluating a completed chore should take no longer than 1 minute | Complete | Usability | The evaluation did not take longer than 1 minute in general. However, it also varied from user to user, as their evaluation comments and the number of pictures differed. |
| NF4 | The application should run without any errors | Incomplete | Availability | During the experiment, several errors were reported from the users. |
| NF5 | The real-time database should be available 95% of the time | Complete | Availability | No downtime on the Firebase was detected during the experiment. |
| NF6 | Reading and writing to the database should be done through secure protocols | Complete | Security | Communication with the database was done through the secure HTTPS protocol and database rules. In addition, no users reported data loss or data theft during the experiment. |
| NF7 | Adding/removing in-game rewards and displaying them in the store should take no longer than 1 hour | Complete | Modifiability | An admin web application was created to add in-game rewards instantly. |

**Table 20.2:** Validation of Non-Functional requirements

# Part V

# Execution and results

The fifth part of this Thesis presents the execution and the results of the experiment. The first chapter will describe the research context, the participants taking part in the experiment, and the different data generation methods used. The second chapter will show the results of the questionnaires and observations.

# Chapter 21

# Execution

This chapter will present the execution of the experiment. A detailed description of the research context, the participants, and the data generation methods will be provided.

## 21.1 NSD Form

This Master's Thesis is a research project that collects and processes personal data. It had to be reported through a form to NSD - Norsk senter for forskningsdata (Norwegian Centre for Research Data). The form included what personal data would be collected, project information, who was responsible for data processing, information on the participants, documentation, data processing, data security, and project duration. The form was sent to NSD 26th of January 2021 and approved 11th of March 2021.

## 21.2 Research Context and Participants

Our application testing took place from the 11th of April 2021 to the 25th of April 2021. Test subjects of different ages, gender, and living situations were invited. The participants first had to accept a consent schema due to data privacy to participate in the project. When all household participants had given their answers to the consent form, they received an information email regarding the first questionnaire and how to download the application, both on Android and iOS. As the application requires that all group members own a smartphone, families with children were excluded, focusing more on partners and collectives.

To ensure neutral answers and avoid familiarity bias the utmost, participants were told to give their most honest answers in the questionnaires. As the experiment occurred as a remote test, there was a low threshold for the participants to ask questions or provide feedback. This was, for example, about getting started with the application or if they had any troubles.

## 21.3 Questionnaires

The participants in the experiment answered two questionnaires, one at the start and one at the end. As this section describes, the two questionnaires included many of the same questions to compare the motivation, engagement, distribution, household dynamic, and enjoyment related to chores before and after engaging with our application. The final questionnaire also includes some questions to measure if and how various application functionality impacted these aspects related to chores.

### 21.3.1 Likert Scale

The questionnaires are designed to capture how the participants feel about certain statements. The Likert Scale, a psychometric scale, [96] is used to capture this. As illustrated in Figure 21.1, the scale consists of five points, from one extreme point to another. The extreme points measure how strongly the participants feel a certain feeling about the statement in question. In the mentioned example figure, the extreme points are *strongly disagree* and *strongly agree*, to measure the level of agreement. In another statement, we wanted to measure engagement level, so the extreme points are *not engaged* and *strongly engaged*. A benefit of the Likert Scale is that it can trigger participants to recall similar or relatable experiences. Hopefully, using this scale brings out more genuine responses by using feelings the participants can relate to chores. Another benefit is that the Likert Scale can be adjusted to fit the project. For instance, it does not have to be a five-point scale used in this thesis. It can also be three points, seven points, or nine points. Further, the extreme points do not necessarily have to be from disagree to agree. For example, if the statement states something about interest, the extreme points could have been from *not interested* to *strongly interested*.

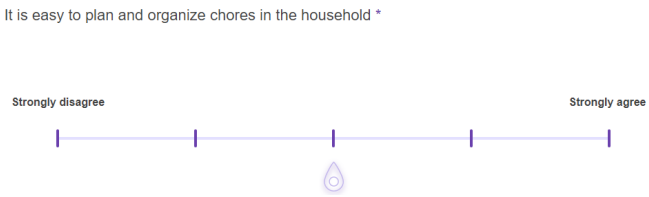



**Figure 21.1:** Likert Scale Example

### 21.3.2 First questionnaire

The first questionnaire was sent out to the participants before installing and testing the application. It consisted of 14 questions. The full first questionnaire is available in Appendix C.1. Firstly, four general information questions were gathered, as shown in Table 21.1. These questions were asked to identify our target group and have the opportunity to group the results from the final questionnaire based on gender, age, and household.

| ID | Questions |
|---|---|
| 1 | How old are you? |
| 2 | What is your gender? |
| 3 | How do you live? |
| 4 | How many people live in your household? |

**Table 21.1:** Information questions in the first questionnaire

The last ten questions and statements in the first questionnaire, available in Table 21.2, were about the participants' motivation, engagement, and enjoyment towards chores and questions about organizing, chore distribution, and house dynamics. This information would be necessary and interesting to know in advance of using the application. Statement 5-9 and 11-13 were five-points Likert scale statements, while question 10 was a free-text answer which asked about how many chores the participants performed on average weekly. Question 14 also allowed the participants to write free-text answers, contributing to our qualitative data results.

| ID | Questions / Statements |
|---|---|
| 5 | How motivated are you to do chores? |
| 6 | How engaged are you to do chores? |
| 7 | It is easy to plan and organize chores in the household |
| 8 | It is a fair distribution of chores in the household |
| 9 | The group dynamic in the household is superb |
| 10 | How many chores do you complete each week on average? |
| 11 | It is fun to do chores |
| 12 | It is important to do chores |
| 13 | It is difficult to do chores |
| 14 | Is there something you want to add regarding chores? |

**Table 21.2:** Comparable questions in the first questionnaire

### 21.3.3 Final questionnaire

At the end of the experiment, the final questionnaire was sent out to the participants. To compare the results from the final questionnaire with the results from the first questionnaire, the same fourteen initial questions and statements asked in the first questionnaire,

available in Table 21.1 and 21.2, were added to the final questionnaire. Additionally, statements regarding motivation, engagement, and enjoyment of using the application, as well as its usability, were added. See Table 21.3 for a selection of the questions and statements. The reason for these questions and statements was their high relevance to the research questions of this Thesis, see Section 4.2. All questions and statements from the final questionnaire are available in Appendix C.2. It is worth noting that in this questionnaire and its result discussions, the term *excitement* is used interchangeably with the term *engagement*.

| ID | Questions / Statements |
|---|---|
| 15 | By using the application, i was motivated to do chores |
| 23 | By using the application, i was excited to unlock a new achievement |
| 28 | By using the application, I thought is was fun to earn coins and experience points |
| 36 | I thought it was easy to understand what my chores was |

**Table 21.3:** Selection of questions and statements in the final questionnaire

## 21.4 Observations

As mentioned in Section 5.3.1, physical observations could not be carried out due to Covid-19. However, the biggest reason not to perform physical observations was the high number of participants. Thus, using a web analytic service would be much more efficient. Using such a service made it possible to collect anonymous quantitative data on the application's users' behavior. Therefore, a list of 21 unique user events was created in Firebase Analytics, available in Appendix A.1.

### 21.4.1 User Behaviour

During the experiment, Firebase Analytics captured user events and updated us daily on how the users used the application. However, due to data privacy and data minimization, no data that could track back to the users was gathered. This limited our options to filter the collected data into separate groups. Available data enabled us to make interesting statistics regarding the application's usage over the two weeks the experiment lasted.

### 21.4.2 Realtime tracking

Firebase Analytics comes with another interesting tool called Realtime, making it possible to see how users use the application in real-time, as shown in Figure 21.2. Firstly, seeing that the users are using the application daily was a huge motivation. Also, seeing which user event was the most trending may indicate what stage the users are at, whether it was planning or they just finished a competition.

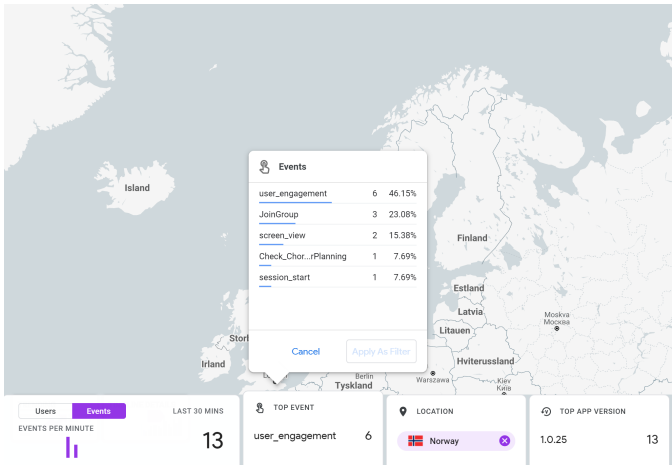



**Figure 21.2:** Firebase Analytics Realtime tracking example

Realtime also tracks what version of the application the active users are using. If the numbers of errors reported are high in this time period, it could indicate that we should notify the users about updating the application to the latest and error-free version.

Chapter 22

# Results

This chapter covers the results from the data generation methods used during the experiment to collect data. The first section presents the participants that took part in the experiments. Following, the results from the questionnaires will be displayed, and lastly, the data obtained from observations of user behavior in the application will be provided.

## 22.1 Participants

In total, 68 people answered the consent schema handed out at the beginning of the experiment. Of these 68 people, 59 between 19 and 32 years old answered the first questionnaire, while we registered 72 unique application registrations. However, this number might be incorrect, as some participants registered several times due to registration flaws. Some people did not answer the first questionnaire or sign up for the application because they were unaware that the entire household had to participate. Figure 22.1 shows an overview of registrations during the experiment. As seen in the figure, several registrations came in the middle of the first week of the experiment. At this point, some errors in the application were discovered and fixed, and a new version of the application was published. After updating, some groups experienced trouble with their accounts for unknown reasons. We, therefore, reached out to the respective groups, deleted their accounts, and told them to re-register.

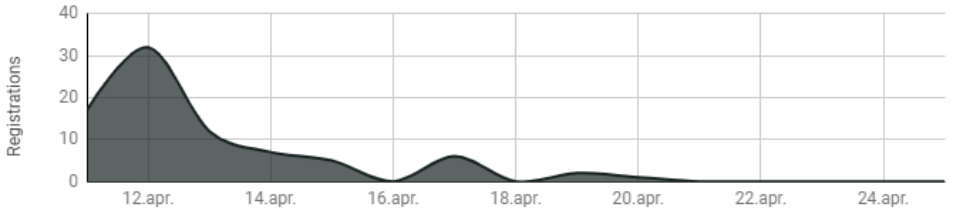



**Figure 22.1:** Application registrations during the experiment

50 of the respondents of the first questionnaire also answered the final questionnaire and can therefore be used to compare answers. The distribution of gender, age, and household that took part in the entire experiment can be seen in Figure 22.2. This figure shows that the participants were male or female, older or younger than 25 years old, and either living with a partner or in collective. We decided to split the participants at age 25 because the average participant was 24.5 years old.

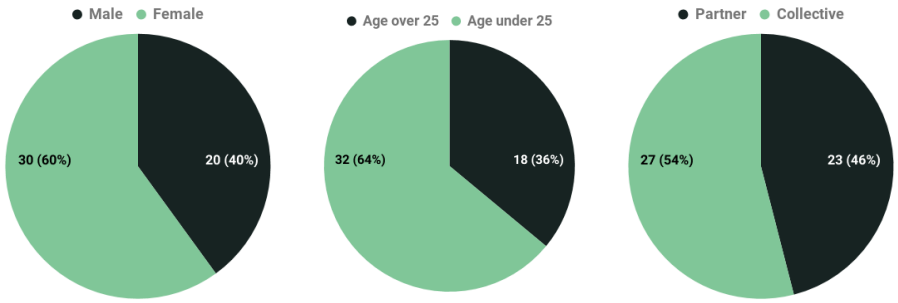



**Figure 22.2:** Gender, age and household distribution for the final questionnaire

## 22.2 Results from Questionnaires

This section presents the results of the questionnaires handed out to the participants at the beginning and the end of the experiment. The tables shown in this section show results from the final questionnaire, or both questionnaires compared. However, if interested, the plain results from the first questionnaire can be found in Appendix C.3.1. To understand the statements and results from the questionnaire better, we decided to rephrase questions 5 and 6 into statements. As mentioned in Section 21.3.1, the questionnaires used a five-point Likert Scale. However, due to readability, the statistics were summarized and presented in tables where the original five-point Likert scale was shortened to a three-point Likert Scale.

Additionally, those tables where the probability value (the probability of difference between two groups) are calculated, will only include results where $p < 0.10$. The reasoning for this is only to include significant and nearly significant (borderline) results. With a significance level set to 5%, p-values that are below 0,05 can be concluded as statistically significant. These values are highlighted in bold. The complete results from the final questionnaire are available in Appendix C.3.2. The tables shown in the rest of this chapter consists of the following columns:

- **ID:** The number of the statement
- **Statement:** The statement given to the participants
- **Group:** Used to group and compare groups, e.g. male and female participants

- **n:** The number who responded the given statement
- **D:** Disagreeing respondents - strongly disagree and disagree, summed together.
- **N:** Neutral respondents
- **D:** Agreeing respondents - strongly agree and agree, summed together.
- **p:** Probability value

### 22.2.1 Results from both Questionnaires Compared

The following sections present the results of the comparable statements given in both questionnaires. These statements consider the participant's motivation, engagement, and enjoyment towards chores and their perception of chore distribution and group dynamic in the household. Firstly, a comparison between answers from all participants will be provided. Furthermore, the answers are grouped by gender, age, and household.

#### All Participants

Table 22.1, shows that the users increased their motivation to do chores after using the application. Further, more participants agreed that they were engaged to do chores, and the results indicate that they also felt it was easier to plan and organize chores in the household. Lastly, the participants had more fun doing chores after using Tidy.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Before | 59 | 20% | 48% | 32% | **0.0037** |
| | | After | 50 | 10% | 28% | 62% | |
| 6 | I am engaged to do chores | Before | 59 | 15% | 49% | 36% | **0.0268** |
| | | After | 50 | 10% | 38% | 52% | |
| 7 | It is easy to plan and organize chores in the household | Before | 59 | 17% | 24% | 59% | 0.0749 |
| | | After | 50 | 4% | 18% | 78% | |
| 11 | It is fun to do chores | Before | 59 | 64% | 31% | 5% | **<.0001** |
| | | After | 50 | 24% | 50% | 26% | |

**Table 22.1:** Results comparing before and after.

#### Gender

Table 22.2 shows a great increase in females' motivation towards chores, while it also indicates that males also got more motivated. Furthermore, both gender thought it was more fun to do chores after using the application.

| ID | Statement | Gender | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Male | Before | 26 | 23% | 42% | 35% | 0.1112 |
| | | | After | 20 | 10% | 35% | 55% | |
| | | Female | Before | 33 | 18% | 52% | 30% | **0.0075** |
| | | | After | 30 | 10% | 23% | 67% | |
| 11 | It is fun to do chores | Male | Before | 26 | 65% | 31% | 4% | **0.0036** |
| | | | After | 20 | 25% | 50% | 25% | |
| | | Female | Before | 33 | 64% | 30% | 6% | **0.0013** |
| | | | After | 30 | 23% | 50% | 27% | |

**Table 22.2:** Results comparing before and after grouped by gender including results from Mann-Whitney test comparing before and after.

### Age

Table 22.3 shows that participants older or equal to 25 years old were more motivated to chores after using the application. Further, the results indicate that the younger age group engaged in doing chores to a more considerable degree than the older age group. Lastly, the results show that both age group's enjoyment of chores increased during the experiment.

| ID | Statement | Age | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Age >= 25 | Before | 23 | 17% | 57% | 26% | **0.0102** |
| | | | After | 18 | 6% | 22% | 72% | |
| | | Age < 25 | Before | 36 | 22% | 42% | 36% | 0.0526 |
| | | | After | 32 | 13% | 31% | 56% | |
| 6 | I am engaged to do chores | Age >= 25 | Before | 23 | 13% | 44% | 44% | 0.3632 |
| | | | After | 18 | 11% | 39% | 50% | |
| | | Age < 25 | Before | 36 | 17% | 53% | 31% | 0.0708 |
| | | | After | 32 | 9% | 38% | 53% | |
| 11 | It is fun to do chores | Age >= 25 | Before | 23 | 78% | 17% | 4% | **0.0006** |
| | | | After | 18 | 22% | 44% | 33% | |
| | | Age < 25 | Before | 36 | 56% | 39% | 6% | **0.0062** |
| | | | After | 32 | 25% | 53% | 22% | |

**Table 22.3:** Results comparing before and after grouped by age including results from Mann-Whitney test comparing before and after.

### Household

Table 22.4 shows that partners got much more motivated to do chores than collectives. The results indicate that partner's engagement towards chores was higher than collectives'. The same pattern follows; partners felt it was easier to plan and organize chores during the test period. Lastly, the results reveals that both households had more fun doing chores during the test period.

| ID | Statement | Household | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Partner | Before | 28 | 25% | 46% | 29% | **0.001** |
| | | | After | 23 | 4% | 17% | 78% | |
| | | Collective | Before | 31 | 16% | 48% | 36% | 0.2297 |
| | | | After | 27 | 15% | 37% | 48% | |
| 6 | I am engaged to do chores | Partner | Before | 28 | 25% | 50% | 25% | 0.0571 |
| | | | After | 23 | 13% | 35% | 52% | |
| | | Collective | Before | 31 | 7% | 48% | 45% | 0.3974 |
| | | | After | 27 | 7% | 41% | 52% | |
| 7 | It is easy to plan and organize chores in the household | Partner | Before | 28 | 18% | 32% | 50% | **0.0038** |
| | | | After | 23 | 0% | 9% | 91% | |
| | | Collective | Before | 31 | 16% | 16% | 68% | 0.3409 |
| | | | After | 27 | 7% | 26% | 67% | |
| 11 | It is fun to do chores | Partner | Before | 28 | 68% | 25% | 7% | **0.0001** |
| | | | After | 23 | 13% | 48% | 39% | |
| | | Collective | Before | 31 | 61% | 36% | 3% | **0.015** |
| | | | After | 27 | 33% | 52% | 15% | |

**Table 22.4:** Results comparing before and after grouped by household including results from Mann-Whitney test comparing before and after.

### 22.2.2 Results on Application Usage from the Final Questionnaire

This section presents the results from the final questionnaire regarding motivation, engagement, and enjoyment by using the application. First, the results will be presented for all participants before dividing them into gender, age, and household type to compare these.

#### All Participants

Table 22.5 shows that most participants got motivated to do chores by using the application. The aspects that motivated people the most were viewing the rockets of household members to see their progress and buying real-life rewards while unlocking new achievements and purchasing in-game rewards were the least motivating parts.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 14 | By using the application, I was motivated to do chores | 50 | 8% | 22% | 70% |
| 15 | By using the application, I was motivated by unlocking new achievements | 50 | 40% | 40% | 20% |
| 16 | By using the application, I was motivated by buying real-life rewards | 50 | 34% | 24% | 42% |
| 17 | By using the application, I was motivated by buying in-game rewards | 50 | 58% | 34% | 8% |
| 18 | By using the application, I was motivated by viewing the other members rockets too see their progress | 50 | 22% | 16% | 62% |
| 19 | By using the application, I was motivated by not doing the same chores each week | 50 | 34% | 34% | 32% |

**Table 22.5:** Answers from final questionnaire on motivation from using the application

Table 22.6 shows that almost half of the participants agreed that they were excited to evaluate others, whereas even more got excited to receive evaluations. Buying real-life rewards excited most, while unlocking achievements and buying in-game rewards triggered little excitement.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 20 | By using the application, I was excited to evaluate others | 50 | 20% | 32% | 48% |
| 21 | By using the application, I was excited to see how the other members in the household evaluated my chores | 50 | 20% | 26% | 54% |
| 22 | By using the application, I was excited to unlock a new achievement | 50 | 52% | 38% | 10% |
| 23 | By using the application, I was excited to buy a real-life reward | 50 | 28% | 24% | 48% |
| 24 | By using the application, I was excited to buy a in-game reward | 50 | 58% | 30% | 12% |
| 25 | By using the application, I felt like buying an in-game rewards because others in the household did | 50 | 62% | 22% | 16% |

**Table 22.6:** Answers from final questionnaire on engagement from using the application

The results in Table 22.7 show that majority of participants enjoyed the application in general. The most enjoyed functionality was comparing their rocket to others'. People also enjoyed earning coins and experience points, customizing rockets and rewards, and buying real-life rewards. The least enjoyed functionality was buying in-game rewards.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 26 | I thought the application was fun to use | 50 | 8% | 26% | 66% |
| 27 | By using the application, I thought it was fun to earn coins and experience points | 50 | 14% | 30% | 56% |
| 28 | By using the application, I thought it was fun to compare my rocket's progress to the others in the household | 50 | 16% | 10% | 74% |
| 29 | By using the application, I thought it was fun to customize chores and rewards | 50 | 10% | 36% | 54% |
| 30 | By using the application, I thought it was fun to customize my rocket | 50 | 40% | 16% | 44% |
| 31 | By using the application, I thought it was fun to buy real-life rewards | 50 | 32% | 14% | 54% |
| 32 | By using the application, I thought it was fun to buy in-game rewards | 50 | 50% | 32% | 18% |

**Table 22.7:** Answers from final questionnaire on enjoyment from using the application

Table 22.8 shows that people had some trouble using the application the first time, but it became easier to understand after using it for a while. Most people also thought it was easy to understand what their chores were and how to customize chores and rewards.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 33 | It was easy to understand how the application worked the first times i used it | 50 | 26% | 28% | 46% |
| 34 | I thought the application was easy to use | 50 | 12% | 30% | 58% |
| 35 | I thought it was easier to understand how the application worked after using it for a while | 50 | 4% | 18% | 78% |
| 36 | I thought it was easy to understand what my chores was | 50 | 12% | 8% | 80% |
| 37 | I thought it was easy to customize chores and rewards | 50 | 10% | 26% | 64% |

**Table 22.8:** Answers from final questionnaire on usability from using the application

As shown in Table 22.9, almost half of the participants agreed that they would continue to use the application. At the same time, the majority stated that the application would be a great tool for planning, organizing, and completing chores.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 38 | I would continue using the application if possible | 50 | 32% | 24% | 44% |
| 39 | I think the application would be a great tool when planning, organizing and completing chores | 50 | 10% | 12% | 78% |

**Table 22.9:** Answers from final questionnaire on general from using the application

### Gender

Table 22.10 shows that males to a larger degree got excited to evaluate other's chores than females. Further, the results indicate that males thought it was easier to use the application.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 20 | By using the application, I was excited to evaluate others | Male | 20 | 10% | 25% | 65% | **0.0228** |
| | | Female | 30 | 27% | 37% | 37% | |
| 35 | I thought it was easier to understand how the application worked after using it for a while | Male | 20 | 5% | 10% | 85% | 0.0594 |
| | | Female | 30 | 3% | 23% | 73% | |

**Table 22.10:** Results from using the application grouped by gender, including results from Mann-Whitney test comparing male and female.

### Age

When dividing participants into age groups of below and over or equal to 25 years old, Table 22.11 shows some interesting results. The statistics indicate that the older age group got more motivated to do chores using the application and by buying real-life rewards. Further, the results reveal that the older age group got more excited by evaluating others, viewing the evaluations from others, and buying real-life rewards. On the other hand, the younger age groups got more excited by buying in-game rewards.

Regarding enjoyment, the older group enjoyed doing chores to a higher degree than the younger group. Lastly, both age groups felt that the application could be a great tool for planning, organizing, and completing chores. However, the older group agreed more than the younger group, indicating that the older age group has more faith in the application.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 14 | By using the application, I was motivated to do chores | Age >= 25 | 18 | 11% | 6% | 83% | 0.0735 |
| | | Age < 25 | 32 | 6% | 31% | 63% | |
| 16 | By using the application, I was motivated by buying real-life rewards | Age >= 25 | 18 | 22% | 17% | 61% | 0.0606 |
| | | Age < 25 | 32 | 41% | 28% | 31% | |
| 20 | By using the application, I was excited to evaluate others | Age >= 25 | 18 | 6% | 39% | 56% | **0.0485** |
| | | Age < 25 | 32 | 28% | 28% | 44% | |
| 21 | By using the application, I was excited to see how the other members in the household evaluated my chores | Age >= 25 | 18 | 0% | 33% | 67% | **0.0307** |
| | | Age < 25 | 32 | 31% | 22% | 47% | |
| 23 | By using the application, I was excited to buy a real-life reward | Age >= 25 | 18 | 22% | 6% | 72% | **0.0344** |
| | | Age < 25 | 32 | 31% | 34% | 34% | |
| 25 | By using the application, I felt like buying an in-game rewards because others in the household did | Age >= 25 | 18 | 78% | 22% | 0% | **0.0301** |
| | | Age < 25 | 32 | 53% | 22% | 25% | |
| 31 | By using the application, I thought it was fun to buy real-life rewards | Age >= 25 | 18 | 17% | 6% | 78% | **0.0228** |
| | | Age < 25 | 32 | 41% | 19% | 41% | |
| 39 | I think the application would be a great tool when planning, organizing and completing chores | Age >= 25 | 18 | 6% | 6% | 89% | 0.0721 |
| | | Age < 25 | 32 | 13% | 16% | 72% | |

**Table 22.11:** Results from using the application grouped by age, including results from Mann-Whitney test comparing age groups.

### Household

Table 22.12 shows that partners were more motivated than collectives to do chores by using the application. This trend continues as partners got more motivated to buy real-life rewards. The results also indicate that partners got motivated by not doing the same chores each week.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 14 | By using the application, I was motivated to do chores | Partner | 23 | 9% | 9% | 83% | **0.0094** |
| | | Collective | 27 | 7% | 33% | 59% | |
| 16 | By using the application, I was motivated by buying real-life rewards | Partner | 23 | 9% | 17% | 74% | **<.0001** |
| | | Collective | 27 | 56% | 30% | 15% | |
| 19 | By using the application, I was motivated by not doing the same chores each week | Partner | 23 | 30% | 26% | 44% | 0.0823 |
| | | Collective | 27 | 37% | 41% | 22% | |

**Table 22.12:** Results on motivation from using the application grouped by household, including results from Mann-Whitney test comparing households.

The same pattern as in motivation can be found in the results regarding engagement, as seen in Table 22.13. Partners were generally more excited to use the application, seeing how others evaluated their chores and by buying rewards.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 20 | By using the application, I was excited to evaluate others | Partner | 23 | 13% | 26% | 61% | **0.0401** |
| | | Collective | 27 | 26% | 37% | 37% | |
| 21 | By using the application, I was excited to see how the other members in the household evaluated my chores | Partner | 23 | 4% | 26% | 70% | **0.0054** |
| | | Collective | 27 | 33% | 26% | 41% | |
| 23 | By using the application, I was excited to buy a real-life reward | Partner | 23 | 13% | 0% | 87% | **<.0001** |
| | | Collective | 27 | 41% | 44% | 15% | |
| 24 | By using the application, I was excited to buy a in-game reward | Partner | 23 | 44% | 35% | 22% | **0.011** |
| | | Collective | 27 | 70% | 26% | 4% | |

**Table 22.13:** Results on engagement from using the application grouped by household, including results from Mann-Whitney test comparing households

Table 22.14 shows that partners also enjoyed the application more than collectives. As seen earlier, partner's relations to real-life rewards were much better than for collectives. The results also indicate that partners enjoyed buying in-game rewards to a higher degree than collectives.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 26 | I thought the application was fun to use | Partner | 23 | 4% | 17% | 78% | **0.0143** |
| | | Collective | 27 | 11% | 33% | 56% | |
| 31 | By using the application, I thought it was fun to buy real-life rewards | Partner | 23 | 9% | 0% | 91% | **<.0001** |
| | | Collective | 27 | 52% | 26% | 22% | |
| 32 | By using the application, I thought it was fun to buy in-game rewards | Partner | 23 | 39% | 39% | 22% | 0.0708 |
| | | Collective | 27 | 59% | 26% | 15% | |

**Table 22.14:** Results on enjoyment from using the application grouped by household, including results from Mann-Whitney test comparing households.

Regarding usability, Table 22.15 shows that partners found the application easier to use than collectives, both first time and in general. The same pattern follows; partners thought it was easier to understand their chores. Lastly, partners also found it more fun to customize chores and rewards.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 33 | It was easy to understand how the application worked the first times i used it | Partner | 23 | 13% | 22% | 65% | **0.011** |
| | | Collective | 27 | 37% | 33% | 30% | |
| 34 | I thought the application was easy to use | Partner | 23 | 4% | 22% | 74% | **0.0066** |
| | | Collective | 27 | 19% | 37% | 44% | |
| 36 | I thought it was easy to understand what my chores was | Partner | 23 | 4% | 0% | 96% | 0.0516 |
| | | Collective | 27 | 19% | 15% | 67% | |
| 37 | I thought it was easy to customize chores and rewards | Partner | 23 | 4% | 26% | 70% | **0.0427** |
| | | Collective | 27 | 15% | 26% | 59% | |

**Table 22.15:** Results on usability from using the application grouped by household, including results from Mann-Whitney test comparing households.

Table 22.16 shows that there were more partners than collectives that would continue to use the application. Furthermore, the results show that partners, to a higher degree than collectives, thought the application would be a great tool for planning, organizing, and completing chores.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 38 | I would continue using the application if possible | Partner | 23 | 13% | 26% | 61% | **0.0051** |
| | | Collective | 27 | 48% | 22% | 30% | |
| 39 | I think the application would be a great tool when planning, organizing and completing chores | Partner | 23 | 4% | 9% | 87% | **0.0113** |
| | | Collective | 27 | 15% | 15% | 70% | |

**Table 22.16:** Results on general from using the application grouped by household, including results from Mann-Whitney test comparing households

## 22.3 Results from Observations

This section describes the results from observations of user events in Firebase Analytics. As mentioned in Section 21.4.1, no data that could track back to the users was gathered due to data privacy and data minimization. The following graphs give indications of the application's usage throughout the experiment.

Figure 22.3 shows the number of times users pressed the rocket on the home page. The numbers state that the users were checking the status of the other members of the household quite often. These numbers correspond well with the answers from statement 18 found in Table 22.5.

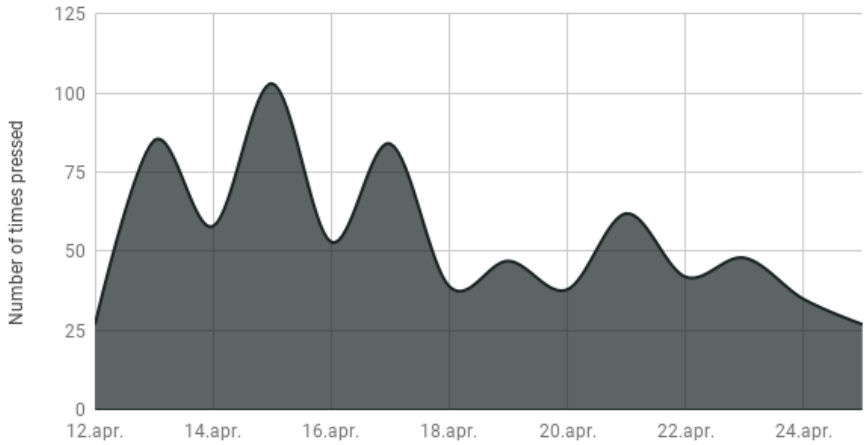



**Figure 22.3:** Number of times rocket was pressed

### 22.3.1 Comparison between completed chores and evaluated chores

Figure 22.4 shows a comparison between the number of completed chores and the number of evaluated chores. It shows a good balance between them, meaning that most users were good at evaluating each other in a reasonable time after a chore was set to complete.

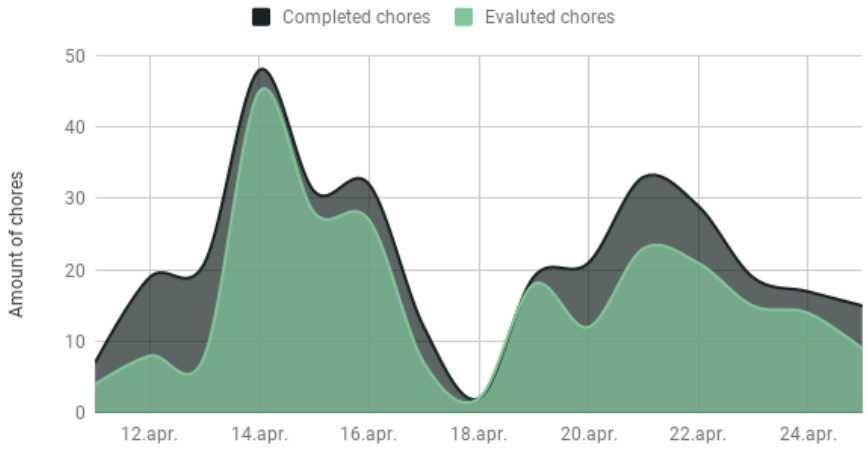



**Figure 22.4:** Completed chores compared with evaluated chores

### 22.3.2 Comparison between hat games and rocket chores played

Figure 22.5 is the comparison between the number of times the users played hat game and rocket chores. The numbers state that rocket chores were the most popular planning game initially. A reason for this might be that users wanted to explore the application in the early phases and therefore chose the most time-consuming game. The hat game became more popular later on, most likely because most users had already tested rocket chores or had less time to plan their upcoming competition. For the rest of the competition, both games' popularity was quite similar.

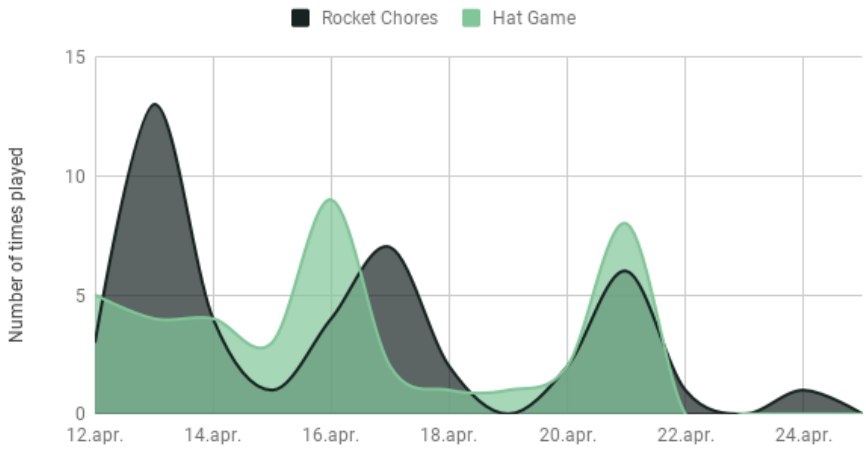



**Figure 22.5:** Hat game compared with rocket chores

### 22.3.3 Comparison between real-life and in-game rewards purchased

Figure 22.6 shows the comparison between the amount of real-life and in-game rewards bought in the application. At the beginning of the experiment, the users thought it was fun to try out rewards. However, as time went by, fewer and fewer rewards were bought. This correlates well with the answers from statements 16 and 17 found in Table 22.5, 23 and 24 found in Table 22.6, and 31 and 32 found in Table 22.7.

These data taken from Firebase Analytics shows that the users only bought 15 real-life rewards and 11 in-game rewards during the experiment.

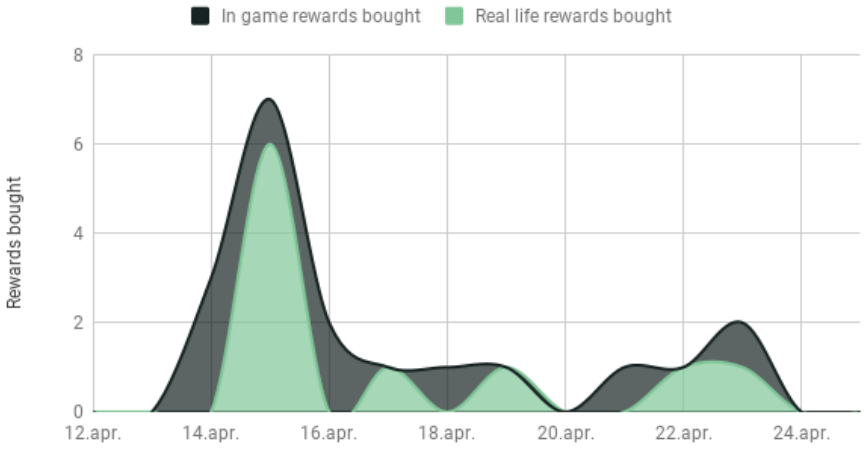



**Figure 22.6:** Real life rewards compared with in-game rewards

# Part VI

# Discussion

The sixth part of this Thesis presents the discussion and evaluation of the research methods, result analysis, and a project and application evaluation.

# Chapter 23

# Result Analysis

This chapter provides a thorough analysis of the results presented in Chapter 22. Firstly, the results will be discussed towards theories from the pre-study. Furthermore, the differences in the results from both questionnaires that were statistically significant and borderline statistically significant will be discussed and analyzed.

## 23.1 How Results align with Theory

This section looks at the elements from the pre-study theories implemented in the application and examines their impact on the results.

### 23.1.1 Reward Systems

Rewards systems can consist of several types of rewards. The types used in Tidy are reviewed below.

#### Score systems and Experience Points

Tidy coins were implemented to combine a score system and a currency to evaluate user performance. Experience points (XP) are also used as a measure of dedication. When a user got one of their chores evaluated, they received coins and XP based on the quality of their work. The intention was to make the act of doing chores more engaging.

Data from questionnaire two shows a slight agreement among participants that it was fun to earn coins and experience points, with 56% agreeing, as seen in Table 22.7.

#### Items

Two types of items were implemented; in-game rewards and real-life rewards. The in-game rewards are cosmetics for the user avatars (their rockets), while the groups themselves create real-life rewards.

As discussed in Section 22.2.2, the in-game rewards did not motivate, excite, or enjoy the participants. This is also verified by the low number of in-game rewards purchased (11), shown in Table 22.6.

Since users must collect enough coins over time to buy these rewards, the results might have differed if the experiment lasted longer. However, the available data suggest that in-game rewards are not an efficient tool to boost motivation or excitement.

As for real-life rewards, the results are a bit more positive. Data in Figure 22.6 shows that the number of real-life rewards purchased was also low (15), but participants reported neutral feelings towards them. Partners experienced a higher increase in motivation and excitement towards real-life rewards than other groups. One reason for the increase related to real-life rewards compared to in-game rewards could be that groups create their own real-life rewards and customize them to their needs.

#### Achievements

Participants reported that achievements gave them neutral motivation and slightly below neutral excitement. In the free-text question, some participants also provided useful feedback as to why they had this perception of achievements:

> *"Achievements were a little exciting, but felt really random. There was somehow no point in achieving them or to easily know how or what needed to be done to achieve them. One could not see other's achievements either."*

> *"Regarding achievements, it would have been more fun to try to achieve them if I knew some progress on how to achieve them. I never knew which achievements that were available so i did not get motivated to achieve them. For instance if the app said: "complete one new chore to reach gold level" i would have been motivated more"*

They raise some important points. There should absolutely be a way to monitor your progress towards achievements. Additionally, seeing what others have achieved can also have a social impact, as mentioned in Section 9.4.5.

### 23.1.2 Social Interaction

When asked if it was fun to compare their rocket's progress to others in the household, a high amount (74%) of participants agreed. The same applies to the question asking if it was motivating to view the progress of others' rockets, where 62% agreed. Almost half of the participants, 48%, got excited by evaluating others' chores, while 54% got excited when someone evaluated their chores.

> *"My main motivation from using the application was to see how many points I had in comparison to my partner. It was fun to see who could gather the most points each week."*

All in all, these social interactions implemented in Tidy based on the preliminary study in Chapter 10 had a significant effect on motivation, excitement, and enjoyment towards

chores.

### 23.1.3 Motivation

As mentioned in Section 22.2.2, the participants experienced increased overall motivation after using Tidy for two weeks, where 70% of the participants agreed. To find out exactly what caused this increase, we look at the previous parts of this section. It has brought up the effects of different game theory elements in motivation, engagement, and enjoyment. We can derive that social interaction had the most positive impact on motivation, that achievements and real-life rewards had a medium/neutral impact, and that in-game rewards negatively impacted the perceptions.

## 23.2 Result Analysis by Groups

This section discusses the results group by group, highlighting the statistically significant and borderline statistically significant differences and their reasons.

### 23.2.1 All participants

All participants experienced an increase in motivation to do chores after using the application. The percentile of people who agreed that they were motivated to do chores went from 32% to 62% (p=0.0037). The most motivating factor for all participants was viewing other household member's rockets to see their progress. 62% of participants were motivated by this. The second most motivating factor was buying real-life rewards, at 42%. In-game rewards were the least motivating functionality by a good margin. Only 8% agreed it was motivating, and 58% disagreed.

The results also show an increase in engagement to do chores. Before using Tidy, 36% of participants reported that they were engaged to do chores, while the percentile afterward was 52% (p=0.0268). What engaged participants the most was seeing how other household members evaluated their chores, followed by evaluating others and buying real-life rewards. Around half of the participants got excited by this. On the other hand, achievements and in-game rewards only excited about 1 in 10 participants. Elements with social interaction were the most exciting ones. Evaluating others and receiving evaluations is direct social interaction, while real-life rewards are constructed by the groups themselves and therefore have a social aspect.

Only 5% of participants thought it was fun to do chores before using Tidy. Afterward, 26% agreed to the same statement. This shows that even though most people still do not enjoy performing chores, Tidy contributed to a significant increase of participants who enjoy it ($p<=0.001$). 74% of participants enjoyed comparing their rocket's progress to others in the household, making it the most enjoyed functionality. Although not as many, some participants also enjoyed earning coins and XP, customizing chores and rewards, and customizing their rockets. These are pure game-based functionalities and show that gamification helped to increase enjoyment. However, yet again, few participants enjoyed purchasing in-game rewards.

### 23.2.2 Gender

The application helped improve motivation towards chores for both genders. 20% more males agreed that they were motivated to do chores after using the application, while it had a more significant impact on the females. 30% said they were motivated to do chores before the experiment, while 67% said the same after using tidy for two weeks (p=0.0075).

In contrast, the males got more motivated by not doing the same chore each week. These results may indicate that the female participants were more interested in the application's content, while the males got more motivated through social interaction by comparing their progress to others. Another result that confirms this is that males got more excited to evaluate others in the household than females. 65% males and 37% females agreed on this (p=0.0228).

Furthermore, both genders felt it was more fun to do chores after using the application. The males and females that agreed it was fun to do chores went from 4% to 25% and 6% to 27%, respectively (p=0.0036 (males) and p=0.0013 (females)). The reason why the participants found it enjoyable to use the application differs. Females found it more fun to earn coins and experience points and customizing content, while males enjoyed the content more.

### 23.2.3 Age

Both age groups got more motivated to do chores after using the application. However, the age group at 25 years old or older went from 26% to 72% which agreed that they are motivated to do chores (p=0.0102). For the younger age group, 20% more agreed that they got motivated (p=0.0526, borderline).

The results indicate that the older age group (61%) got more motivated than the younger age group (31%) by buying real-life rewards (p=0.0606, borderline), in addition to tracking their progress against others. This indicates that the older age group got more motivated through the application content and social interaction.

Another interesting result is that the younger age group increased in 18% who agreed they were engaged to do chores after using the application (p=0.0708, borderline). The results on application usage show that the older age group got more engaged by using the application, seeing how others evaluated their chores, and buying real-life rewards (p=0.0485, p=0.0307, and p=0.0344, respectively). On the other side, 25% of the younger age group compared to 0% of the older age group agreed that they felt like buying an in-game reward because others did (p=0.0301). These results show that the older age group was already quite engaged to do chores. In comparison, the younger age group engaged by customizing and comparing their rockets to other household members.

Going further, both age groups thought it was fun to use the application, going from 4% to 33 % on the older age group and 6% to 22% on the younger age group (p=0.0006 (older age group) and p=0.0062 (younger age group)). Both age groups seemed to enjoy everything the application provided. Nevertheless, the younger group enjoyed the most earning coins and experience points, while the older age group thought it was more fun to

buy real-life rewards. For the latter, 78% of the older age group, and 41% of the younger age group, agreed (p=0.0228).

### 23.2.4 Household

When grouping participants by household types, the results show a significant increase in motivation to do chores for participants living with a partner. The motivation increased from 29% to 78% (p=0.001). Partners also show significant differences in other aspects. When asked if it was easy to plan and organize chores in the household, 50% of partners agreed before using the application, and 91% agreed after using it (p=0.0038). For collectives, the only large change was in terms of enjoyment. The number of collective participants who thought it was fun to do chores went from 3% to 15% (p=0.015).

The results show that partners experienced more significant changes than collectives in terms of motivation (p=0.0094), engagement (p=0.0401), and enjoyment (0.0143).

These numbers show us that the application had a significant and positive effect on partners living together in terms of motivation, planning and organization, and enjoyment. Although satisfied with the results for partners, we recognize that the numbers for collectives are not as pleasing. However, we are happy that collectives also experienced increased enjoyment towards chores due to the application.

### 23.2.5 Usability

The results show that the application might have been challenging to understand when using it for the first time. Luckily, this got easier with time, and in the end, 78% of participants agreed it was easier to understand after using it for a while. 4 out of 5 thought it was easy to understand what their chores were. We want this number to be even higher since it is a key part of the use case. The same is true for customizing chores and rewards. 64% thought it was easy to do, which is too low. However, we are happy that most people understood more after using the application for a while.

Interestingly, 67% of males thought the application was easier to use after a while, compared to 37% of females (p=0.0594, borderline). The same can be said about households. More partners (65%) than collective participants (30%) thought the application was easy to use the first time (p=0.011). However, the numbers evened out after using the application for a while, to 83% and 74%, respectively. More interestingly, 96% of partners thought it was easy to understand what their chores were, which is high compared to collectives, where the percentile was 67% (p=0.0516, borderline). Partners also found it easier to customize chores and rewards compared to collectives (p=0.0427). It is difficult to know why, but one explanation could be that collectives have more users that can act as noise in the application.

## 23.3 Summary

Results show that after two weeks of application usage, overall motivation towards chores increased from 32% to 62%. Females, participants of 25 years old or older, and partici-

pants living with partners were the groups that experienced significant increases in motivation. Likewise, the engagement towards chores went from 35% to 52% for all participants. The number of participants who enjoyed chores went from 5% to 26%. Both males and females, both age groups, and participants living with a partner saw significant changes here.

It is also clear that some of the elements from the pre-study theories impacted the results more than others. 56% of participants enjoyed earning coins and XP. For many, especially for partners, purchasing real-life rewards had sound effects on motivation, excitement, and engagement. However, very few participants benefited from in-game rewards. In fact, most disliked them. The most beneficial element was social interaction in comparing rockets, evaluating each other, and competing about earning the most points. These functionalities all had a positive impact on motivation, excitement, and enjoyment.

Chapter 24

# Evaluation of Project and Application

This chapter presents an evaluation of the project and describes an evaluation of the process, application design, functionality, and software architecture.

## 24.1 Project Evaluation

Despite the COVID-19 situation, the process was completed without any major issues. Most of the time, we worked together at the university campus, making it easy to communicate and cooperate. However, during periods of lockdown, we had to work from home. At this point, COVID-19 had been around for some time. We had already adapted to the circumstances of working from home and were prepared to do so if the situation required it. During the periods of working from home, we communicated through Messenger and Google Hangouts. Therefore, the lockdowns did not cause any setbacks in the process.

Apart from the mentioned communication methods, no other part of the process changed when we worked from home. We used Github's built-in project kanban board [97] to manage the project workflow. There we created tasks and issues, delegated them, and tracked their progress. As a result, the work was efficiently completed and validated.

## 24.2 Application Evaluation

The following sections give an evaluation of the application's design, functionality, and architecture.

### 24.2.1 Evaluation of Design

As the graphical design of the application is the first thing the users' experience, it was important for us having it clean and minimalist. We, therefore, spent a large amount of

time in Figma to develop the design.

Before starting the development of the design, we found it necessary to choose the right theme for the application. After several brainstorming sessions, we ended up with the theme set in space, making it easier to choose the right colors and designing the various components used in the application. An important experience from previous projects is that you often get ”blind” to your own design when working on it daily. Therefore, we found it useful to get feedback from test users, our supervisor, and the others in our household.

After developing our concept design in Figma, we started developing the application and used it as the high-fidelity prototype. As we were satisfied with the design and the feedback was good, we did not find it necessary to run another iteration in Figma. This way, we saved much time, and the work went more smoothly and efficiently.

### 24.2.2 Evaluation of Functionality

We managed to implement all of the functionality we wanted to. Most of them turned out as we predicted, but others did not. While researching, we visioned multiple mini-games to choose from when planning chores. However, we underestimated the difficulty of developing games in React Native and ended up with only one proper game, mainly because of time restraints. There are two games for planning chores in the application, but the Hat Game does not contain a game engine or many game elements. The Rocket Game is a proper game in those regards, but even that includes more constraints than we envisioned. We imagined a more interactive game where users could drag and drop the rocket but ended up with a button-based game instead. However, we are not unhappy with the result, and we are sure we could achieve our envisioned results given more time.

Furthermore, some bugs and errors were discovered by users during the experiment. This was expected, and most of them were minor. However, one breaking bug was discovered early on, which forced us to push an update to the application during the experiment. One group experienced an app crash when their competition was finished, and they were unable to proceed. This would have happened to every group of two people without an update. Luckily for us, their competition ended some days before most others, giving us enough time to locate the error, fix it, and push out a working app version to Play Store and App Store.

### 24.2.3 Evaluation of Architecture

The software architecture, although simple, proved to be both efficient and sufficient. Having all the server-side services gathered in Firebase was beneficial in terms of simplicity during development and overviews during the experiment. When setting up the database service, we encountered an authentication problem where all users could access everyone’s user data. The problem was fixed by implementing secure database rules. After properly initiating the services, React Native could communicate easily and securely with the database and the other services.

Utilizing the Expo framework with React Native worked flawlessly and made it effortless

to test the application on our own devices during development. The thoughtful construction of the application's source code structure made it possible to maintain a good overview without complications.

Chapter 25

# Evaluation of Research Methodology

In the first section of this chapter, an evaluation and discussion of the research methods used in this thesis will be presented. Lastly, possible threats to the validity of the results are described.

## 25.1 Methods

The data generation methods used in this thesis were introduced in Section 5.3. The following sections evaluate these methods after being used in the experiment.

### 25.1.1 Questionnaires

Two questionnaires were sent out to the participants before and after the experiment. It is a really efficient research method to collect quantitative data from the participants in a short time, as they are easy to go through. Also, we could compare data quite easily by giving some of the same questions in both questionnaires. However, as questionnaires have many pros, they also some cons. The participant might not understand the question. If the questionnaire is being completed together with others, their opinions might be affected and not as honest as they would have been if they completed it alone. If the questionnaire is too long, the participant might get bored and rush through the rest of the questions.

Another issue with questionnaires is that some people can forget to complete them, reducing the number of participants in the project, resulting in fewer results. To avoid this, we sent out friendly reminders. Since some participants had forgotten it and others got the mail with the questionnaire marked as spam, this friendly reminder worked quite well.

### 25.1.2 Observations

By logging events in the application in Firebase Analytics, we got a nice overview of which functionalities were most used. The numbers could indicate what worked well and what did not, based on usage. Low usage could result from errors not allowing users to perform an event or simply not enjoying it. Either way, the numbers were a great tool for generating a great amount of quantitative data.

While questionnaires tell us what users say they have done, this does not always match what they actually did. Because of its nature, observations alone do not explain the intentions behind user actions. However, the observations provide an objective way to confirm or deny the claims in the questionnaires. For example, if data from the questionnaire says users were motivated by performing a certain action, we can look at observation data and see how often the action was actually performed. This acts as an extra layer of quality assurance on the questionnaire data.

## 25.2 Threats to validity

When generating data through observations and questionnaires, there might have been some factors that would reduce the validity of the results. The fact that the experiment was carried out at home might have resulted in the participants affecting each other's opinions when answering the questionnaires.

Additionally, even though it would be ideal, the participants themselves are not totally random. The best way for us to gather an adequate amount of participants was to use our network. As a result, most of them are friends, family, colleagues, and household members. This could have impacted the validity of the questionnaire answers since they might not be entirely neutral or honest. To prevent this as best we could, we informed the participants of the importance of honest feedback and ensured that their answers were anonymous.

Another important issue is that families, maybe the most important user group, are not represented in the results from the experiment. Therefore, the results are not generalizable beyond couples and collectives.

The experiment lasted for two weeks, which might not have been long enough to provide valid results. Some of the participants might have been busy with other things, such as school or work. Two weeks might not have been long enough for the users to learn how to utilize the application to its full potential. Also, it might require use over a longer period of time for all the effects to take place, both positive and negative.

# Part VII

# Conclusion and future work

The seventh and final part of this Thesis presents the project's conclusion. The first section will answer the research questions and research goal. The second and final section of this Thesis will describe the future work, including a presentation of application flaws and new ideas that could help improve the application and solution.

Chapter 26

# Conclusion

In this thesis, we have performed a preliminary study in which we researched game-related theories such as serious games, theories on motivation, gamification, reward systems, and social interaction, as well as related work on gamification. The related work included two previous Master's Thesis' on the same topic, four articles on gamification, and four related mobile applications.

With a solid foundation from the preliminary study, a new concept was developed and modified through iterations of continuous user testing and evaluations and resulting changes. This resulted in a proposed solution used to develop a high-fidelity prototype. After testing the high-fidelity prototype, the final solution was created, resulting in a mobile application called Tidy published on App Store and Play Store.

Tidy is an application for planning and organizing chores in a household. The application is space-themed and lets household members compete about racing their rockets to the moon in time-limited competitions. At the start of each competition, chores get distributed through fun mini-games. Users can progress their rockets towards the moon by completing or evaluating chores. This also earns them TidyCoins to purchase in-game cosmetics or customized real-life rewards. Users also earn encouraging achievements for their hard work. The competition winner receive a boost in the upcoming competition, and their flag is planted on the moon to symbolize their victory.

To test the effects of the application, we performed an experiment on 50 participants. The participants firstly answered a questionnaire about their relationship with chores. All the participants then downloaded our application and used it for two weeks in their respective households. After these two weeks they answered another questionnaire with many of the same questions as in the first questionnaire and some new ones regarding application usability.

The results show that the application had significant positive effects on motivation, engagement, and enjoyment of chores. Based on these results, we conclude that implementing gamification elements in mobile applications can positively affect people's perception of chores.

## 26.1 Fulfillment of the Research Questions

This section answers all research questions stated at the beginning of this thesis, in Section 4.2.

### 26.1.1 RQ1: What theories and concepts used in previous relevant applications work well for motivating chores?

In Chapter 12 we reviewed four relevant applications for motivating users; two chore-related and two non-chore-related. We found that both non-chore-related applications used gamification elements such as levels, feedback, social interaction, currency, streaks, and rewards. They also included aspects such as achievements, leaderboards, and real-world items. The chore-related applications also used many of the same elements, but they also included a points system where users received points for completing chores. As the reviewed applications are successful, these elements are considered to work well for motivating people to perform chores.

### 26.1.2 RQ2: How is the user's motivation for doing chores affected by our application?

After using the application, participants experienced increased motivation to do chores, changing from 32% to 62% agreeing to being motivated (p=0.0037). This tells us that even though not everyone is motivated, the application affected people positively. When dividing participants by groups, we also found some specific groups with a larger increase than others. These were females (p=0.0075), people equal to or older than 25 (p=0.0102), and people living with partners(p=0.001). These groups showed the highest increase in motivation by using our application.

### 26.1.3 RQ3: How is the user's engagement with chores affected by our application?

User's engagement after using the application was also positively affected. Before using the application 35% of users reported being engaged to do chores, while 52% reported being engaged after using it (p=0.0268). No specific groups experienced a significant change in engagement, but everyone as a whole did.

Furthermore, males in the age group 25 years old or older living with a partner, was most engaged by evaluating other's chores and having their own chores evaluated. Females were more into unlocking new achievements to boost their engagement.

### 26.1.4 RQ4: How does the user perceive the usability of our application?

The results from the experiment show that some users struggled a bit when using the application for the first time. Only 46% of participants said it was easy to understand the application the first time they used it. 58% reported that the application was easy to

use in general, and 78% thought it was easier to understand how the application worked after using it for a while. It seems that after slight struggles in the beginning, most users understood the application after using it for a while.

Compared to collectives, more partners thought the application was easy to use the first time (p=0.011), that it was easy to use in general (p=0.0066), that it was easy to understand what their chores were (p=0.0516, borderline), and that it was easy to customize rewards and chores (p=0.0427).

### 26.1.5 RQ5: How is the user's enjoyment towards doing chores affected by our application?

The results show that the application really helped the users having fun when doing chores. In fact, for all participants, males and females, the old and young age group, partners and collectives, the differences in the results from both questionnaires showed that the application increased the enjoyment (p=<0.0001, p=0.0036, p=0.0013, p=0.0006, p=0.0062, p=0.0001, p=0.015, respectively). There was no real difference between genders or age groups, but partners had more fun using the application than collectives, 78% compared to 56% (p=0.0143).

The results indicate that females found it more fun to buy rewards and unlocking new achievements, while males liked the social interaction aspect more. Partners living together enjoyed buying real-life rewards more (91%) compared to collectives (22%) (p=<0.0001). The same is shown for the older age group (78%) compared to the younger age group (41%) (p=0.0228). On the other side, collectives seemed to enjoy the social aspects of it through competition more.

### 26.1.6 RQ6: To which extend does the use of our application affect the household's perception of chores?

The use of the application improved the household's perception of chores. The results show that users found it easier to plan and organize chores after using the application, and the number of participants that agreed on this went from 59% to 78% (p=0.0749, borderline).

Partners living together found it easier to plan and organize chores in the household after using the application, where 41% more agreed (p=0.0038).

### 26.1.7 RQ7: How is the group dynamic of the household affected by using our application?

The questionnaires show that the household dynamic was not affected by the use of the application. However, the results from this statement showed that 80% of all participants, genders, both age groups, and both types of households agreed on a good group dynamic before and after using the application. This result is already high and indicates that the household dynamic in the collectives and the partners living together were already good before the experiment and was maintained during the two weeks of using the application.

## 26.2 Fulfillment of the Research Goal

The research goal of this thesis was defined as:

> *Examine perceived user perceptions of a mobile application created to motivate, encourage, and engage household members to perform chores.*

The research goal was divided into research questions to answer it more thoroughly. Each research question has been answered, and the results show that Tidy, the mobile application created, increased motivation, engagement, and enjoyment for household members to plan, organize and perform chores. With the results from answering the research questions, we can conclude that the research goal is fulfilled.

# Chapter 27

# Future Work

This chapter describes the future work for the application. Firstly, the implementation of the application and its flaws based on feedback from the experiment will be described. Secondly, a description of new ideas for the application based on the constructive feedback from the free text area in the final questionnaire is provided. Lastly, future research and testing of the application will be presented in a what-if scenario with unlimited resources and time.

## 27.1 Application Flaws During the Experiment

During the experiment, several flaws and bugs were reported from the users. One error where a group with two users had finished their competition caused the application to crash. However, this was reported early in the first week of the experiment, and we managed to fix the issue and uploaded the problem to Apple Store and Google Play before anyone else experienced the problem. Later on, no issues that caused the application to break was reported. Nevertheless, minor bugs and flaws were discovered by the users during the experiment. These are shown in Table 27.1, where the columns are described as:

- **ID:** The ID of the bug / flaw
- **Bug :** The bug / flaw reported by the user(s)
- **Priority:** The importance of fixing the bug / flaw
- **Effort to fix:** How much effort, time and resources needed to fix the bug / flaw

| ID | Bug | Priority | Effort to fix |
|---|---|---|---|
| 1 | Sometimes Push Notification failed to deliver | High | Medium |
| 2 | Sometimes Push Notification on evaluations crashed the application | High | Medium |
| 3 | Users requested native swipe functionality which was disabled during the testing phase | High | High |
| 4 | Evaluations sometimes did not register and had to be done several times | Medium | Medium |
| 5 | Evaluations sometimes viewed the wrong evaluator name | Medium | Medium |
| 6 | The keyboard overlaps sometimes buttons and text input fields | Low | Low |

**Table 27.1:** Reported bugs during the final test

Firstly, sometimes push notifications failed to deliver. This problem occurred as one mobile device may only hold one push notification token used to send push notifications. As mentioned earlier, some users had to register several times, which may have been causing this issue. One way to fix the problem is to give the users a new push token each time they open the application. Going further, the reason for push notifications to crash the application may be because of the aforementioned issue with push tokens. The swipe functionality was removed to avoid any user ending up on an infinite loading screen. To fix this, the routing system in the application must be looked into and maybe given an overhaul. Regarding evaluations, they sometimes did not register and viewed the wrong evaluator name. This may be because the data was not correctly fetched and posted to the database when several users used the application simultaneously. Lastly, the issue with the keyboard overlapping buttons or input field might be very annoying for some users, as its hides information on the page. This can be fixed by focusing on the input field or the button being pressed.

## 27.2 New Ideas for the Application

On the final questionnaire, the users had the option to add a free-text answer at the very end. Many of the participants gave important and good feedback on the application after using it for two weeks. These are shown in Table 27.2, where the columns are described as:

- **ID:** The ID of the idea / improvement
- **Idea / Improvement :** The idea / improvement provided by the user
- **Effort to implement:** How much effort, time and resources needed implement the idea / improvement into the application

Some of the ideas will be explored in depth, explained how they could have been implemented and what effect they would have.

| ID | Idea / Improvement | Effort to implement |
|---|---|---|
| 1 | [Feedback] Users should be able to report an evaluation they are not happy with | Medium |
| 2 | [Feedback] Users should be able to view progress on upcoming achievements | Medium |
| 3 | [Feedback] Users should receive more push notifications reminding them of chores, encouraging them etc. | Medium |
| 4 | [Feedback] It should be possible to do normal chores several times | Medium |
| 5 | [Feedback] Add time estimation on planning games | Medium |
| 6 | [Feedback] It should be possible to switch chores with other users | Medium |
| 7 | [Feedback] Users should be able to cancel an ongoing competition | Low |
| 8 | [Feedback] Users should be able to edit their user in the application | Low |
| 9 | [Feedback] Repeating chores should have been better explained when planning | Low |
| 10 | [Feedback] Add description to chores | Low |

**Table 27.2:** Improvements and ideas based on feedback

Some users mentioned that it should have been possible to report an evaluation they were not happy with. This is a good idea as it could have contributed to more social interaction between the two.

One of the most common feedback on the application that occurred several times was that the users should be able to see progress on upcoming achievements. This could have been implemented by having the users see the two or three next achievements but faded out and how much work they would have to do to achieve it.

Many users also forgot to use the application without daily or weekly reminders. The application should therefore send out push notifications to the users more often. For instance, if a user has not completed a chore in two or three days, they should get a reminder encouraging them to complete their chores. They should also receive a push notification if there is a new chore to evaluate.

Another common feedback was that an ongoing competition should be possible to cancel. The reason for this might be that some chores were wrongly customized or the competition end date was wrong. When testing out the application for the first time, some users managed to plan a competition without the rest of the household being part of the group. An easy ”cancel” button should be available for the groups, making it possible to re-plan.

Repeating chores should also have been explained better. It was explained in the onboarding and after the planning process. However, they should also have been described when planning.

### 27.2.1 Make the Application Family-friendly

Initially, families with children were intended to be included in the experiment. However, as the application required that each member had their own mobile phone, they were excluded. For future work, the application should be suitable for families with children. Several participants also expressed this in the free-text area in the final questionnaire:

> *”It would have been the perfect app for families with children (...).”*

> *”Smart and motivating app, with a simple and cool design, which I think would fit very well, especially in collectives and families with children.”*

This can be achieved by allowing parents to create accounts for their children and function as admin users. The parents should also create rewards and evaluate their children’s chores. The space theme might also be more suitable for families with children.

## 27.3 Further Research and Testing

As previously pointed out, a similar experiment should be conducted on other target groups, such as families. No families, only collectives and partners, participated in this experiment. An experiment with families should, of course, be done after making the application family-friendly. However, it should be similar to the one conducted in this thesis to easily compare the results on different target groups.

Additionally, we imagine that new experiments with some new criteria could benefit the research. Firstly, the participants should be randomly selected to avoid any bias. Secondly, the number of participants should be larger since the experiment benefits from more quantitative data. Lastly, the time period of the experiment should be expanded. Two weeks might not be enough to see all effects of the application. An experiment lasting at least one month could help us better understand the effects over longer periods. This experiment could be conducted on all target groups to give a fair basis to compare the results between them.

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# Appendices

Appendix A

# Tables

## A.1 Firebase Analytics User Events

| # | Events |
|---|---|
| 1 | AcceptUser |
| 2 | Check_ChoresOrPlanning |
| 3 | Complete_chore |
| 4 | CreateGroup |
| 5 | Edit_completed_chore |
| 6 | EditChore |
| 7 | EditReward |
| 8 | Evalute_chore |
| 9 | JoinGroup |
| 10 | Login |
| 11 | Logout |
| 12 | Planning_complete |
| 13 | Purchase_ingameReward |
| 14 | Purchase_reward |
| 15 | PushNotification_Approved |
| 16 | PushNotification_Evaluation |
| 17 | Register |
| 18 | RocketPressed |
| 19 | Start_HatGame |
| 20 | Start_RocketGame |
| 21 | UpdateRocket |

**Table A.1:** All user events gathered in Firebase Analytics

Appendix B

# Figures

## B.1 React Native Components

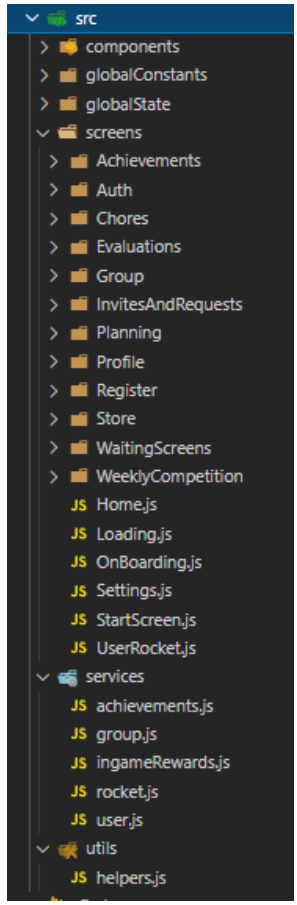



**Figure B.1:** Overview of React Native components

Appendix C

# Questionnaires

## C.1 First Questionnaire


**Figure C.1:** First questionnaire - Part 1

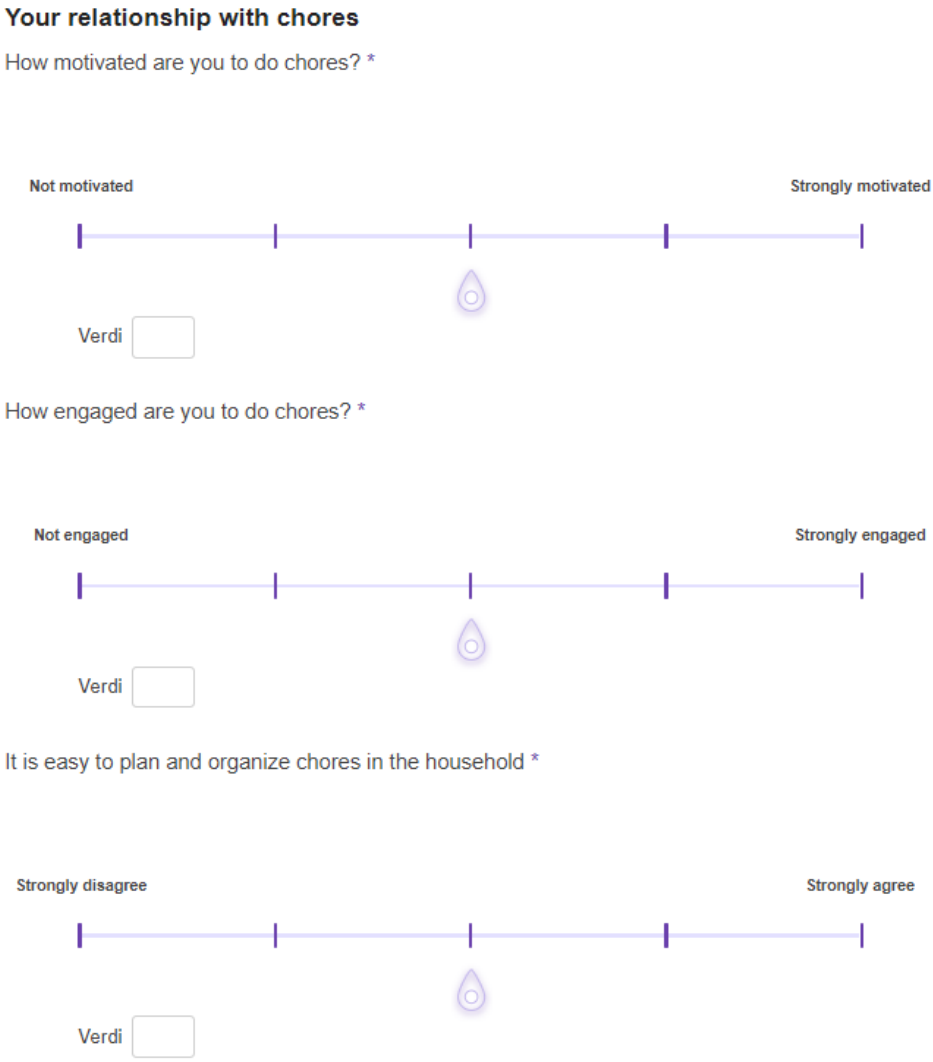



**Figure C.2:** First questionnaire - Part 2

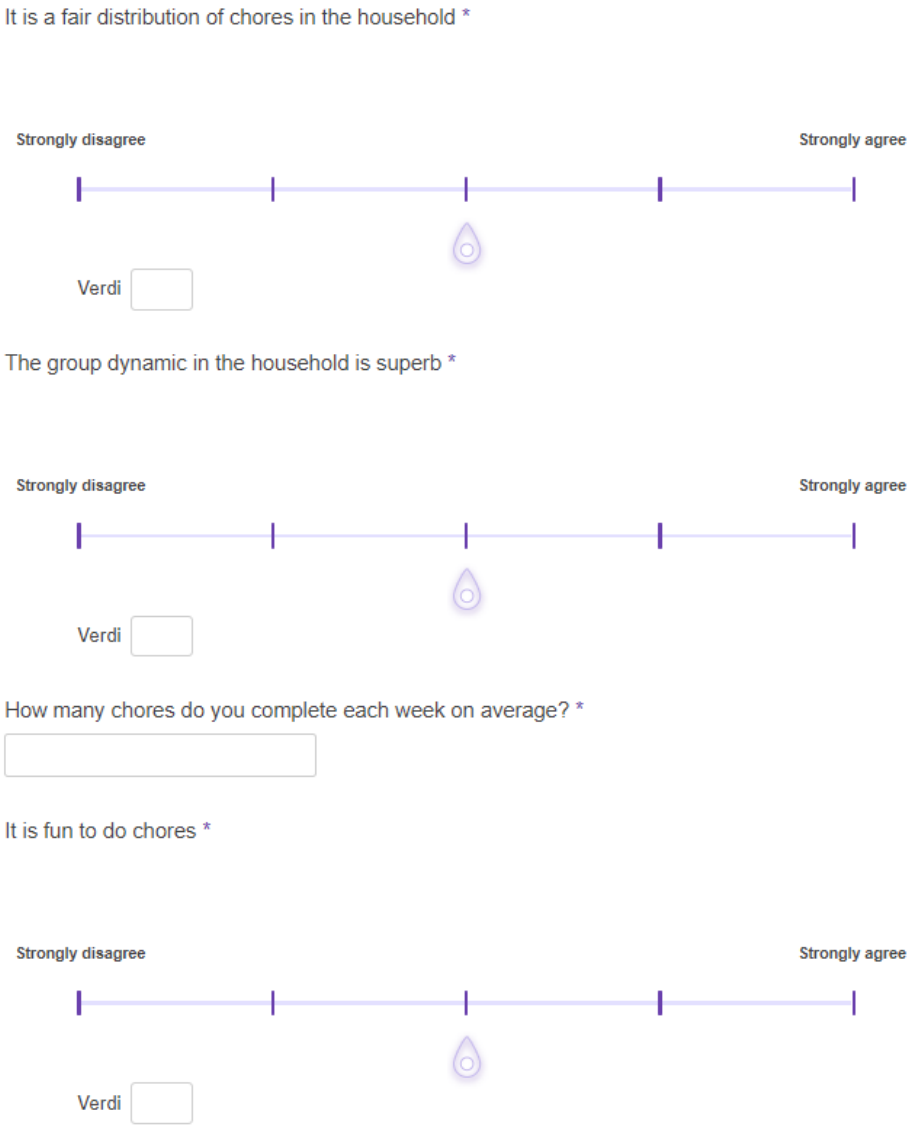



**Figure C.3:** First questionnaire - Part 3

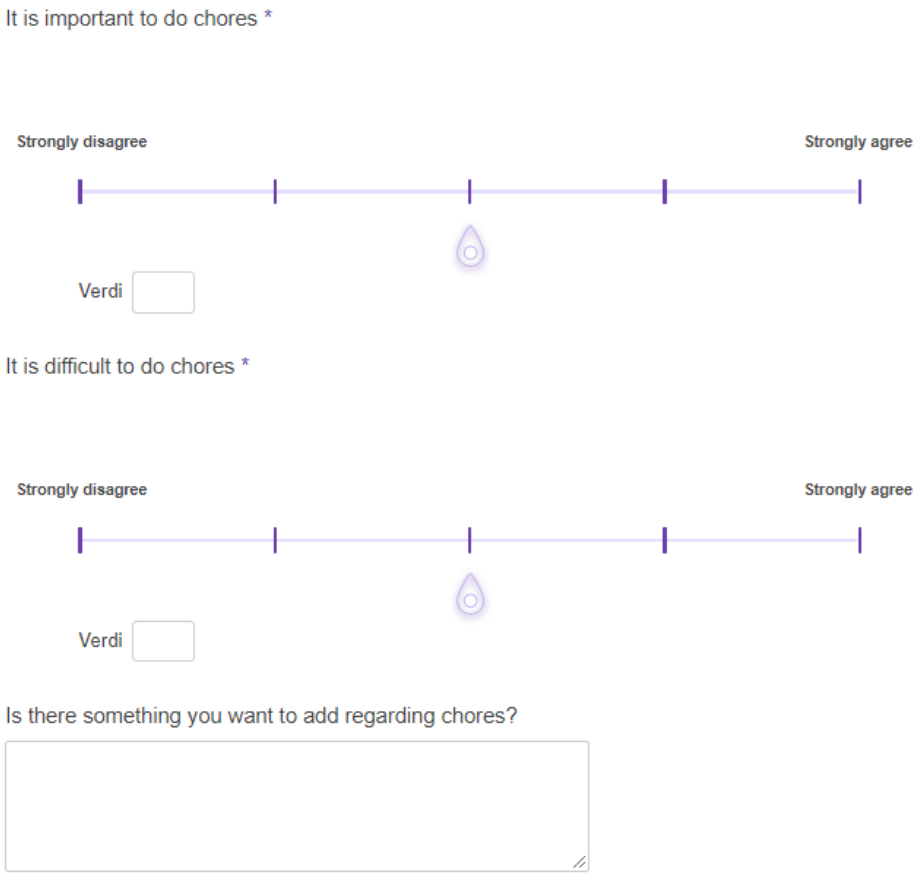



**Figure C.4:** First questionnaire - Part 4

## C.2 Final Questionnaire


**Figure C.5:** Final questionnaire - Part 1

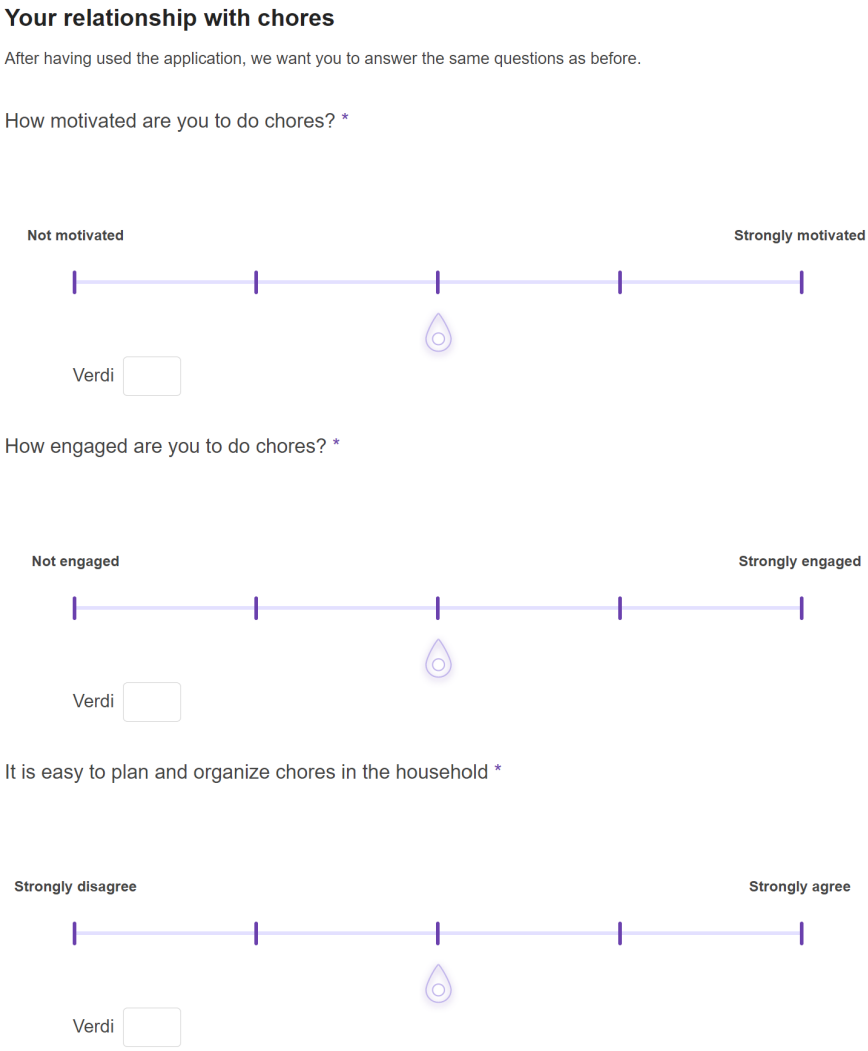



**Figure C.6:** Final questionnaire - Part 1

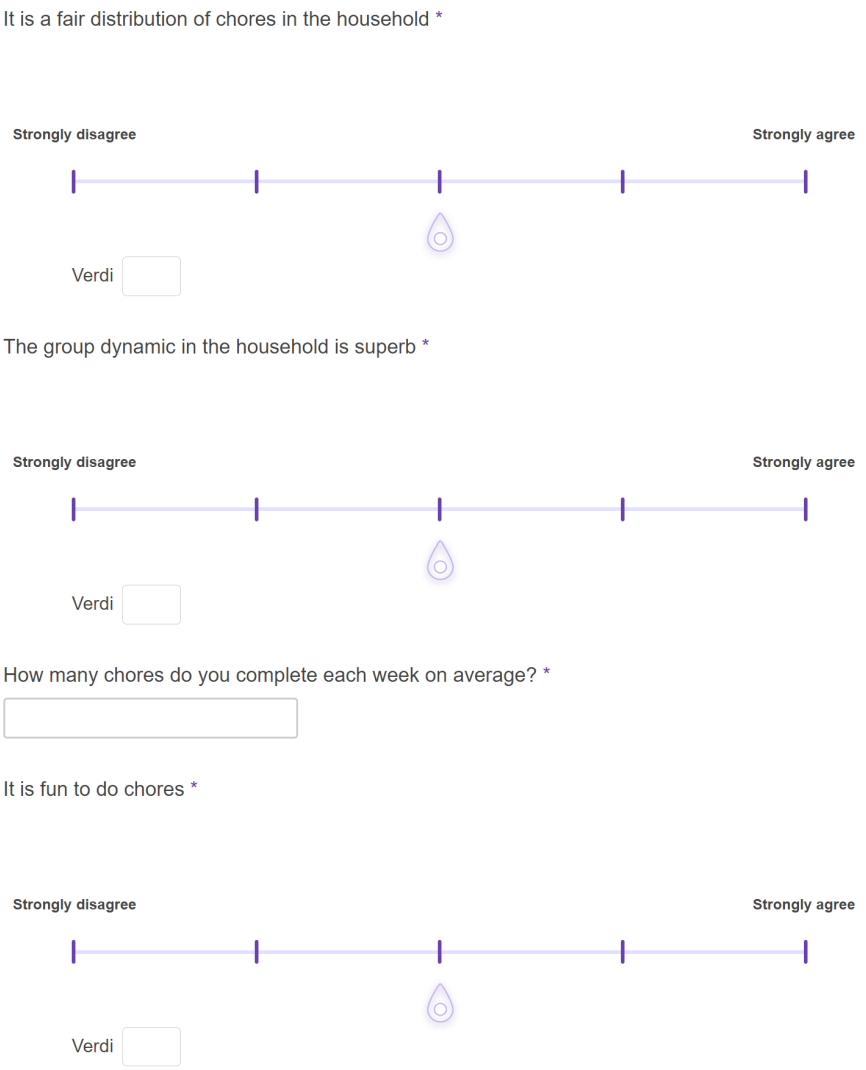



**Figure C.7:** Final questionnaire - Part 2

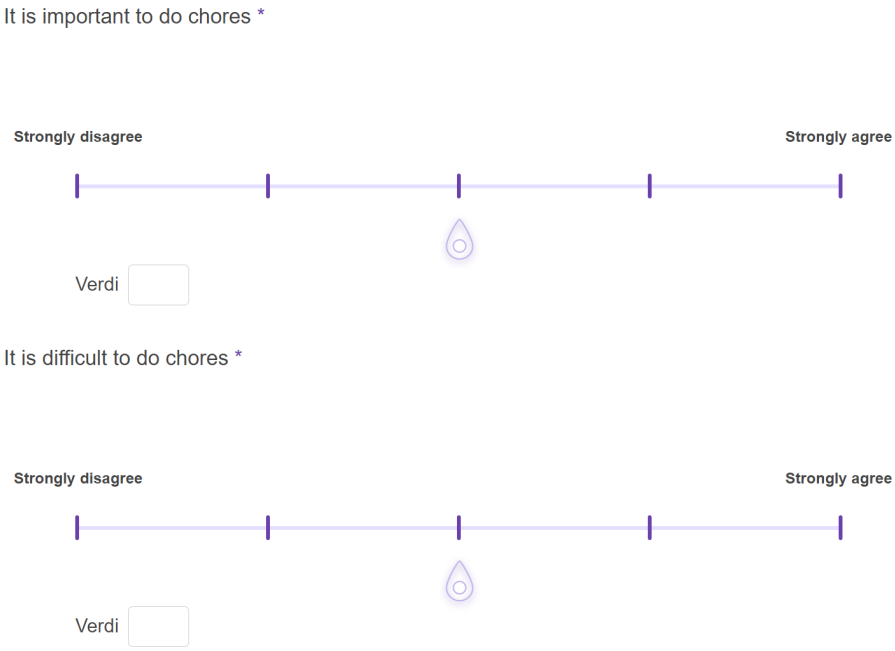



**Figure C.8:** Final questionnaire - Part 3

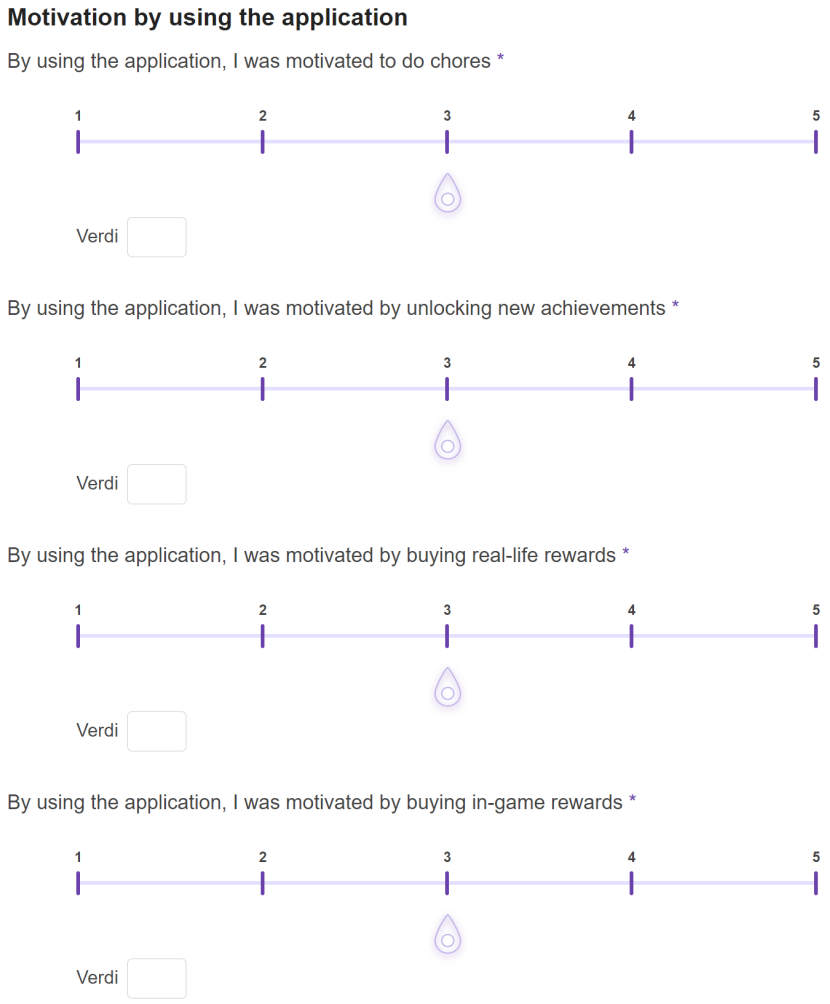
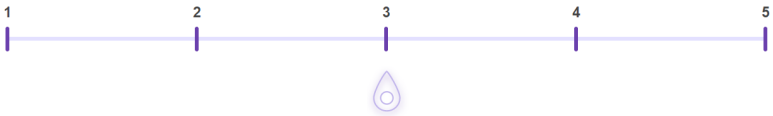


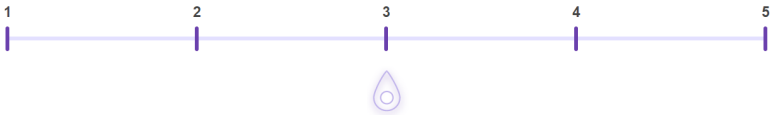

**Figure C.9:** Final questionnaire - Part 4

By using the application, I was motivated by viewing the other members rockets too see their progress *




Verdi

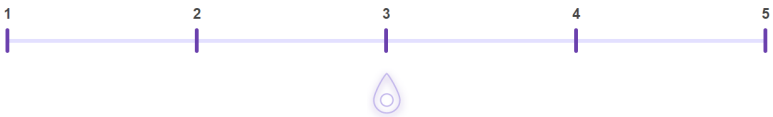
By using the application, I was motivated by not doing the same chores each week *




Verdi

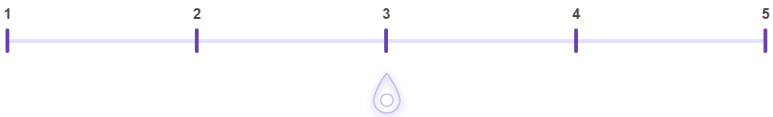
### Engagement by using the application

By using the application, I was excited to evaluate others *




Verdi

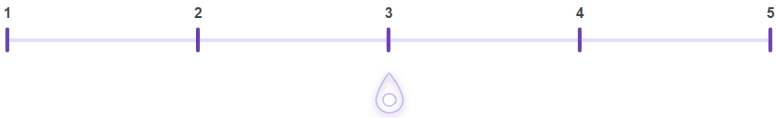
By using the application, I was excited to see how the other members in the household evaluated my chores *




Verdi

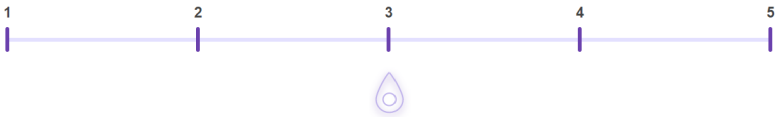
**Figure C.10:** Final questionnaire - Part 5

By using the application, I was excited to unlock a new achievement *



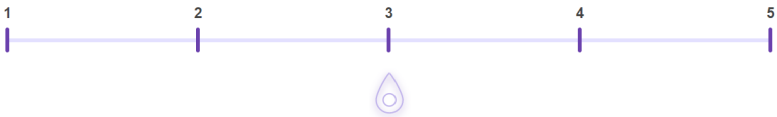

Verdi

By using the application, I was excited to buy a real-life reward *



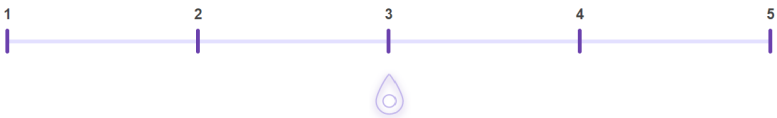

Verdi

By using the application, I was excited to buy a in-game reward *




Verdi

By using the application, I felt like buying an in-game rewards because others in the household did *

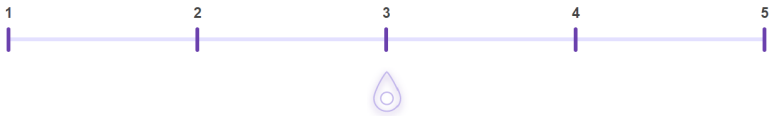



Verdi

**Figure C.11:** Final questionnaire - Part 6

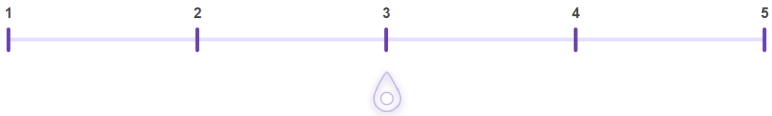
## Enjoyment by using the application

I thought the application was fun to use *



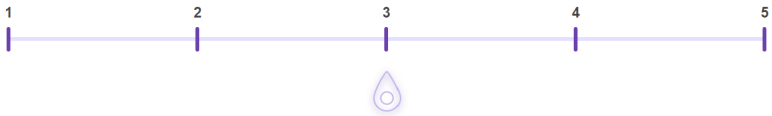

Verdi

By using the application, I thought it was fun to earn coins and experience points *



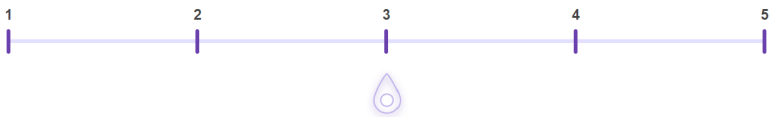

Verdi

By using the application, I thought it was fun to compare my rocket's progress to the others in the household *




Verdi

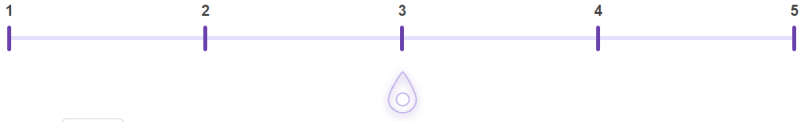
By using the application, I thought it was fun to customize chores and rewards *




Verdi

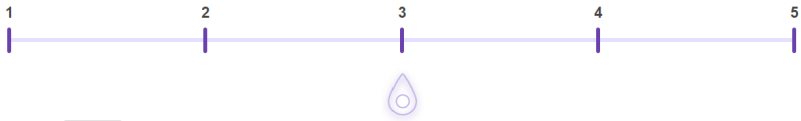
**Figure C.12:** Final questionnaire - Part 7

By using the application, I thought it was fun to customize my rocket *




Verdi

By using the application, I thought it was fun to buy real-life rewards *




Verdi

By using the application, I thought it was fun to buy in-game rewards *


Verdi

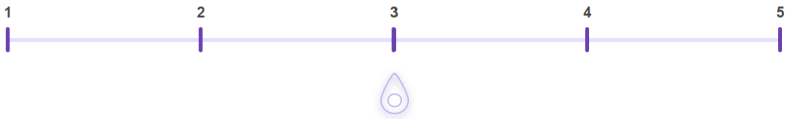
## Usability of the application

It was easy to understand how the application worked the first times i used it *


Verdi

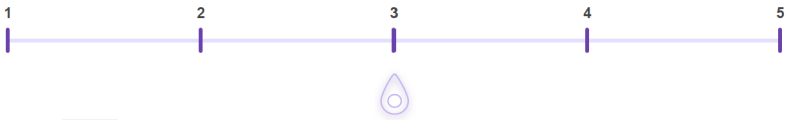
**Figure C.13:** Final questionnaire - Part 8

I thought the application was easy to use *



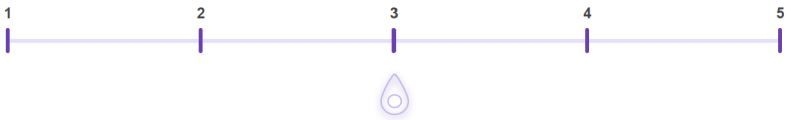

Verdi

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



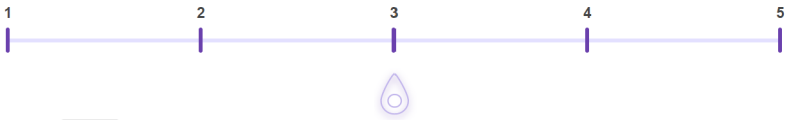

Verdi

I thought it was easy to understand what my chores was *




Verdi

I thought it was easy to customize chores and rewards *




Verdi

**Figure C.14:** Final questionnaire - Part 9

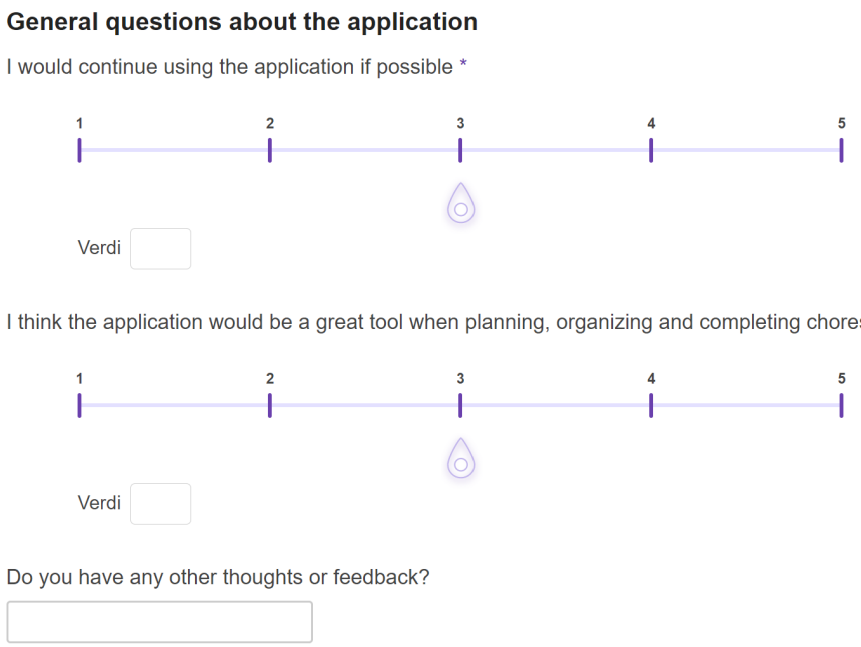



**Figure C.15:** Final questionnaire - Part 10

## C.3 Results from Questionnaire

Those tables where the probability value (the probability of difference between two groups) are calculated, will only include results where p $<$0.10. The reasoning for this is only to include significant and nearly significant results. P-values that are below 0,05 can be concluded as statistically significant. These values are highlighted in bold. The tables consists of the following columns:

- **ID:** The number of the statement
- **Statement:** The statement given to the participants
- **Group:** Used to group and compare groups, e.g. male and female participants
- **n:** The number who responded the given statement
- **D:** Disagreeing respondents - strongly disagree and disagree, summed together.
- **N:** Neutral respondents
- **D:** Agreeing respondents - strongly agree and agree, summed together.
- **p** Probability value

### C.3.1 Results from the First Questionnaire

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 5 | I am motivated to do chores | 59 | 20% | 48% | 32% |
| 6 | I am engaged to do chores | 59 | 15% | 49% | 36% |
| 7 | It is easy to plan and organize chores in the household | 59 | 17% | 24% | 59% |
| 8 | It is a fair distribution of chores in the household | 59 | 17% | 15% | 68% |
| 9 | The group dynamic in the household is superb | 59 | 7% | 12% | 81% |
| 11 | It is fun to do chores | 59 | 64% | 31% | 5% |
| 12 | It is important to do chores | 59 | 0% | 2% | 98% |
| 13 | It is difficult to do chores | 59 | 75% | 20% | 5% |

**Table C.1:** Results from the first questionnaire

| ID | Statement | Group | n | D | N | A |
|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Age >= 25 | 23 | 17% | 57% | 26% |
| | | Age < 25 | 36 | 22% | 42% | 36% |
| 6 | I am engaged to do chores | Age >= 25 | 23 | 13% | 44% | 44% |
| | | Age < 25 | 36 | 17% | 53% | 31% |
| 7 | It is easy to plan and organize chores in the household | Age >= 25 | 23 | 17% | 17% | 65% |
| | | Age < 25 | 36 | 17% | 28% | 56% |
| 8 | It is a fair distribution of chores in the household | Age >= 25 | 23 | 22% | 9% | 70% |
| | | Age < 25 | 36 | 14% | 19% | 67% |
| 9 | The group dynamic in the household is superb | Age >= 25 | 23 | 4% | 9% | 87% |
| | | Age < 25 | 36 | 8% | 14% | 78% |
| 11 | It is fun to do chores | Age >= 25 | 23 | 78% | 17% | 4% |
| | | Age < 25 | 36 | 56% | 39% | 6% |
| 12 | It is important to do chores | Age >= 25 | 23 | 0% | 0% | 100% |
| | | Age < 25 | 36 | 0% | 3% | 97% |
| 13 | It is difficult to do chores | Age >= 25 | 23 | 74% | 17% | 9% |
| | | Age < 25 | 36 | 75% | 22% | 3% |

**Table C.2:** Results from the first questionnaire grouped by gender

| ID | Statement | Group | n | D | N | A |
|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Age >= 25 | 23 | 17% | 57% | 26% |
| | | Age < 25 | 36 | 22% | 42% | 36% |
| 6 | I am engaged to do chores | Age >= 25 | 23 | 13% | 43,5% | 43,5% |
| | | Age < 25 | 36 | 17% | 53% | 31% |
| 7 | It is easy to plan and organize chores in the household | Age >= 25 | 23 | 17% | 17% | 65% |
| | | Age < 25 | 36 | 17% | 28% | 56% |
| 8 | It is a fair distribution of chores in the household | Age >= 25 | 23 | 22% | 9% | 70% |
| | | Age < 25 | 36 | 14% | 19% | 67% |
| 9 | The group dynamic in the household is superb | Age >= 25 | 23 | 4% | 9% | 87% |
| | | Age < 25 | 36 | 8% | 14% | 78% |
| 11 | It is fun to do chores | Age >= 25 | 23 | 78% | 17% | 4% |
| | | Age < 25 | 36 | 56% | 39% | 6% |
| 12 | It is important to do chores | Age >= 25 | 23 | 0% | 0% | 100% |
| | | Age < 25 | 36 | 0% | 3% | 97% |
| 13 | It is difficult to do chores | Age >= 25 | 23 | 74% | 17% | 9% |
| | | Age < 25 | 36 | 75% | 22% | 3% |

**Table C.3:** Results from the first questionnaire grouped by age over and under 25

| ID | Statement | Group | n | D | N | A |
|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Partner | 28 | 25% | 46% | 29% |
| | | Collective | 31 | 16% | 48% | 36% |
| 6 | I am engaged to do chores | Partner | 28 | 25% | 50% | 25% |
| | | Collective | 31 | 7% | 48% | 45% |
| 7 | It is easy to plan and organize chores in the household | Partner | 28 | 18% | 32% | 50% |
| | | Collective | 31 | 16% | 16% | 68% |
| 8 | It is a fair distribution of chores in the household | Partner | 28 | 21% | 21% | 57% |
| | | Collective | 31 | 13% | 10% | 77% |
| 9 | The group dynamic in the household is superb | Partner | 28 | 7% | 11% | 82% |
| | | Collective | 31 | 7% | 13% | 81% |
| 11 | It is fun to do chores | Partner | 28 | 68% | 25% | 7% |
| | | Collective | 31 | 61% | 36% | 3% |
| 12 | It is important to do chores | Partner | 28 | 0% | 0% | 100% |
| | | Collective | 31 | 0% | 3% | 97% |
| 13 | It is difficult to do chores | Partner | 28 | 79% | 14% | 7% |
| | | Collective | 31 | 71% | 26% | 3% |

**Table C.4:** Results from the first questionnaire grouped by household

### C.3.2 Results from the Final Questionnaire

### C.3.3 Results from both Questionnaires Compared

The tables in this appendix consists of the complete results from the final questionnaire.

**All Participants**

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Before | 59 | 20% | 48% | 32% | **0.0037** |
| | | After | 50 | 10% | 28% | 62% | |
| 6 | I am engaged to do chores | Before | 59 | 15% | 49% | 36% | **0.0268** |
| | | After | 50 | 10% | 38% | 52% | |
| 7 | It is easy to plan and organize chores in the household | Before | 59 | 17% | 24% | 59% | 0.0749 |
| | | After | 50 | 4% | 18% | 78% | |
| 8 | It is a fair distribution of chores in the household | Before | 59 | 17% | 15% | 68% | 0.3483 |
| | | After | 50 | 16% | 16% | 68% | |
| 9 | The group dynamic in the household is superb | Before | 59 | 7% | 12% | 81% | 0.4325 |
| | | After | 50 | 4% | 14% | 82% | |
| 11 | It is fun to do chores | Before | 59 | 64% | 31% | 5% | **<.0001** |
| | | After | 50 | 24% | 50% | 26% | |
| 12 | It is important to do chores | Before | 59 | 0% | 2% | 98% | 0.2776 |
| | | After | 50 | 2% | 0% | 98% | |
| 13 | It is difficult to do chores | Before | 59 | 75% | 20% | 5% | 0.4801 |
| | | After | 50 | 84% | 14% | 2% | |

**Table C.5:** Results comparing before and after including results from Mann-Whitney test comparing before and after.

## Gender

| ID | Statement | Gender | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Male | Before | 26 | 23% | 42% | 35% | 0.1112 |
| | | | After | 20 | 10% | 35% | 55% | |
| | | Female | Before | 33 | 18% | 52% | 30% | **0.0075** |
| | | | After | 30 | 10% | 23% | 67% | |
| 6 | I am engaged to do chores | Male | Before | 26 | 23% | 42% | 35% | 0.1112 |
| | | | After | 20 | 15% | 25% | 60% | |
| | | Female | Before | 33 | 9% | 55% | 36% | 0.2611 |
| | | | After | 30 | 7% | 47% | 47% | |
| 7 | It is easy to plan and organize chores in the household | Male | Before | 26 | 19% | 27% | 54% | 0.1271 |
| | | | After | 20 | 5% | 15% | 80% | |
| | | Female | Before | 33 | 15% | 21% | 64% | 0.1867 |
| | | | After | 30 | 3% | 20% | 77% | |
| 8 | It is a fair distribution of chores in the household | Male | Before | 26 | 19% | 12% | 69% | 0.4286 |
| | | | After | 20 | 15% | 30% | 55% | |
| | | Female | Before | 33 | 15% | 18% | 67% | 0.2709 |
| | | | After | 30 | 17% | 7% | 77% | |
| 9 | The group dynamic in the household is superb | Male | Before | 26 | 4% | 15% | 81% | 0.4721 |
| | | | After | 20 | 0% | 15% | 85% | |
| | | Female | Before | 33 | 9% | 9% | 82% | 0.3897 |
| | | | After | 30 | 7% | 13% | 80% | |
| 11 | It is fun to do chores | Male | Before | 26 | 65% | 31% | 4% | **0.0036** |
| | | | After | 20 | 25% | 50% | 25% | |
| | | Female | Before | 33 | 64% | 30% | 6% | **0.0013** |
| | | | After | 30 | 23% | 50% | 27% | |
| 12 | It is important to do chores | Male | Before | 26 | 0% | 0% | 100% | 0.1515 |
| | | | After | 20 | 5% | 0% | 95% | |
| | | Female | Before | 33 | 0% | 3% | 97% | 0.4641 |
| | | | After | 30 | 0% | 0% | 100% | |
| 13 | It is difficult to do chores | Male | Before | 26 | 69% | 27% | 4% | 0.1562 |
| | | | After | 20 | 90% | 10% | 0% | |
| | | Female | Before | 33 | 79% | 15% | 6% | 0.2236 |
| | | | After | 30 | 80% | 17% | 3% | |

**Table C.6:** Results comparing before and after grouped by gender including results from Mann-Whitney test comparing before and after.

## Age

| ID | Statement | Age | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Age >= 25 | Before | 23 | 17% | 57% | 26% | **0.0102** |
| | | | After | 18 | 6% | 22% | 72% | |
| | | Age < 25 | Before | 36 | 22% | 42% | 36% | 0.0526 |
| | | | After | 32 | 13% | 31% | 56% | |
| 6 | I am engaged to do chores | Age >= 25 | Before | 23 | 13% | 44% | 44% | 0.3632 |
| | | | After | 18 | 11% | 39% | 50% | |
| | | Age < 25 | Before | 36 | 17% | 53% | 31% | 0.0708 |
| | | | After | 32 | 9% | 38% | 53% | |
| 7 | It is easy to plan and organize chores in the household | Age >= 25 | Before | 23 | 17% | 17% | 65% | 0.1112 |
| | | | After | 18 | 0% | 6% | 94% | |
| | | Age < 25 | Before | 36 | 17% | 28% | 56% | 0.1922 |
| | | | After | 32 | 6% | 25% | 69% | |
| 8 | It is a fair distribution of chores in the household | Age >= 25 | Before | 23 | 22% | 9% | 70% | 0.2358 |
| | | | After | 18 | 17% | 11% | 72% | |
| | | Age < 25 | Before | 36 | 14% | 19% | 67% | 0.484 |
| | | | After | 32 | 16% | 19% | 66% | |
| 9 | The group dynamic in the household is superb | Age >= 25 | Before | 23 | 4% | 9% | 87% | 0.488 |
| | | | After | 18 | 0% | 17% | 83% | |
| | | Age < 25 | Before | 36 | 8% | 14% | 78% | 0.4404 |
| | | | After | 32 | 6% | 13% | 81% | |
| 11 | It is fun to do chores | Age >= 25 | Before | 23 | 78% | 17% | 4% | **0.0006** |
| | | | After | 18 | 22% | 44% | 33% | |
| | | Age < 25 | Before | 36 | 56% | 39% | 6% | **0.0062** |
| | | | After | 32 | 25% | 53% | 22% | |
| 12 | It is important to do chores | Age >= 25 | Before | 23 | 0% | 0% | 100% | 0.2946 |
| | | | After | 18 | 6% | 0% | 94% | |
| | | Age < 25 | Before | 36 | 0% | 3% | 97% | 0.3594 |
| | | | After | 32 | 0% | 0% | 100% | |
| 13 | It is difficult to do chores | Age >= 25 | Before | 23 | 74% | 17% | 9% | 0.3336 |
| | | | After | 18 | 89% | 6% | 6% | |
| | | Age < 25 | Before | 36 | 75% | 22% | 3% | 0.3897 |
| | | | After | 32 | 81% | 19% | 0% | |

**Table C.7:** Results comparing before and after grouped by age including results from Mann-Whitney test comparing before and after.

**Household**

| ID | Statement | Household | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|---|
| 5 | I am motivated to do chores | Partner | Before | 28 | 25% | 46% | 29% | **0.001** |
| | | | After | 23 | 4% | 17% | 78% | |
| | | Collective | Before | 31 | 16% | 48% | 36% | 0.2297 |
| | | | After | 27 | 15% | 37% | 48% | |
| 6 | I am engaged to do chores | Partner | Before | 28 | 25% | 50% | 25% | 0.0571 |
| | | | After | 23 | 13% | 35% | 52% | |
| | | Collective | Before | 31 | 7% | 48% | 45% | 0.3974 |
| | | | After | 27 | 7% | 41% | 52% | |
| 7 | It is easy to plan and organize chores in the household | Partner | Before | 28 | 18% | 32% | 50% | **0.0038** |
| | | | After | 23 | 0% | 9% | 91% | |
| | | Collective | Before | 31 | 16% | 16% | 68% | 0.3409 |
| | | | After | 27 | 7% | 26% | 67% | |
| 8 | It is a fair distribution of chores in the household | Partner | Before | 28 | 21% | 21% | 57% | 0.0934 |
| | | | After | 23 | 13% | 13% | 74% | |
| | | Collective | Before | 31 | 13% | 10% | 77% | 0.1922 |
| | | | After | 27 | 19% | 19% | 63% | |
| 9 | The group dynamic in the household is superb | Partner | Before | 28 | 7% | 11% | 82% | 0.3085 |
| | | | After | 23 | 4% | 9% | 87% | |
| | | Collective | Before | 31 | 7% | 13% | 81% | 0.4129 |
| | | | After | 27 | 4% | 19% | 78% | |
| 11 | It is fun to do chores | Partner | Before | 28 | 68% | 25% | 7% | **0.0001** |
| | | | After | 23 | 13% | 48% | 39% | |
| | | Collective | Before | 31 | 61% | 36% | 3% | **0.015** |
| | | | After | 27 | 33% | 52% | 15% | |
| 12 | It is important to do chores | Partner | Before | 28 | 0% | 0% | 100% | 0.496 |
| | | | After | 23 | 4% | 0% | 96% | |
| | | Collective | Before | 31 | 0% | 3% | 97% | 0.2033 |
| | | | After | 27 | 0% | 0% | 100% | |
| 13 | It is difficult to do chores | Partner | Before | 28 | 79% | 14% | 7% | 0.4443 |
| | | | After | 23 | 87% | 9% | 4% | |
| | | Collective | Before | 31 | 71% | 26% | 3% | 0.4207 |
| | | | After | 27 | 82% | 19% | 0% | |

**Table C.8:** Results comparing before and after grouped by household including results from Mann-Whitney test comparing before and after.

### C.3.4 Results on Application Usage from the Final Questionnaire

#### All Participants

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 14 | By using the application, I was motivated to do chores | 50 | 8% | 22% | 70% |
| 15 | By using the application, I was motivated by unlocking new achievements | 50 | 40% | 40% | 20% |
| 16 | By using the application, I was motivated by buying real-life rewards | 50 | 34% | 24% | 42% |
| 17 | By using the application, I was motivated by buying in-game rewards | 50 | 58% | 34% | 8% |
| 18 | By using the application, I was motivated by viewing the other members rockets too see their progress | 50 | 22% | 16% | 62% |
| 19 | By using the application, I was motivated by not doing the same chores each week | 50 | 34% | 34% | 32% |

**Table C.9:** Results on motivation from using the application.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 20 | By using the application, I was excited to evaluate others | 50 | 20% | 32% | 48% |
| 21 | By using the application, I was excited to see how the other members in the household evaluated my chores | 50 | 20% | 26% | 54% |
| 22 | By using the application, I was excited to unlock a new achievement | 50 | 52% | 38% | 10% |
| 23 | By using the application, I was excited to buy a real-life reward | 50 | 28% | 24% | 48% |
| 24 | By using the application, I was excited to buy a in-game reward | 50 | 58% | 30% | 12% |
| 25 | By using the application, I felt like buying an in-game rewards because others in the household did | 50 | 62% | 22% | 16% |

**Table C.10:** Results on engagement from using the application.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 26 | I thought the application was fun to use | 50 | 8% | 26% | 66% |
| 27 | By using the application, I thought it was fun to earn coins and experience points | 50 | 14% | 30% | 56% |
| 28 | By using the application, I thought it was fun to compare my rocket's progress to the others in the household | 50 | 16% | 10% | 74% |
| 29 | By using the application, I thought it was fun to customize chores and rewards | 50 | 10% | 36% | 54% |
| 30 | By using the application, I thought it was fun to customize my rocket | 50 | 40% | 16% | 44% |
| 31 | By using the application, I thought it was fun to buy real-life rewards | 50 | 32% | 14% | 54% |
| 32 | By using the application, I thought it was fun to buy in-game rewards | 50 | 50% | 32% | 18% |

**Table C.11:** Results on enjoyment from using the application.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 33 | It was easy to understand how the application worked the first times i used it | 50 | 26% | 28% | 46% |
| 34 | I thought the application was easy to use | 50 | 12% | 30% | 58% |
| 35 | I thought it was easier to understand how the application worked after using it for a while | 50 | 4% | 18% | 78% |
| 36 | I thought it was easy to understand what my chores was | 50 | 12% | 8% | 80% |
| 37 | I thought it was easy to customize chores and rewards | 50 | 10% | 26% | 64% |

**Table C.12:** Results on usability from using the application.

| ID | Statement | n | D | N | A |
|---|---|---|---|---|---|
| 38 | I would continue using the application if possible | 50 | 32% | 24% | 44% |
| 39 | I think the application would be a great tool when planning, organizing and completing chores | 50 | 10% | 12% | 78% |

**Table C.13:** Results on general from using the application.

## Gender

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 14 | By using the application, I was motivated to do chores | Male | 20 | 10% | 10% | 80% | 0.2177 |
| | | Female | 30 | 7% | 30% | 63% | |
| 15 | By using the application, I was motivated by unlocking new achievements | Male | 20 | 40% | 55% | 5% | 0.1736 |
| | | Female | 30 | 40% | 30% | 30% | |
| 16 | By using the application, I was motivated by buying real-life rewards | Male | 20 | 30% | 35% | 35% | 0.484 |
| | | Female | 30 | 37% | 17% | 47% | |
| 17 | By using the application, I was motivated by buying in-game rewards | Male | 20 | 55% | 40% | 5% | 0.4247 |
| | | Female | 30 | 60% | 30% | 10% | |
| 18 | By using the application, I was motivated by viewing the other members rockets too see their progress | Male | 20 | 25% | 10% | 65% | 0.3669 |
| | | Female | 30 | 20% | 20% | 60% | |
| 19 | By using the application, I was motivated by not doing the same chores each week | Male | 20 | 30% | 30% | 40% | 0.3228 |
| | | Female | 30 | 37% | 37% | 27% | |

**Table C.14:** Results on motivation from using the application grouped by gender, including results from Mann-Whitney test comparing male and female.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 20 | By using the application, I was excited to evaluate others | Male | 20 | 10% | 25% | 65% | **0.0228** |
| | | Female | 30 | 27% | 37% | 37% | |
| 21 | By using the application, I was excited to see how the other members in the household evaluated my chores | Male | 20 | 5% | 35% | 60% | 0.1762 |
| | | Female | 30 | 30% | 20% | 50% | |
| 22 | By using the application, I was excited to unlock a new achievement | Male | 20 | 50% | 45% | 5% | 0.4761 |
| | | Female | 30 | 53% | 33% | 13% | |
| 23 | By using the application, I was excited to buy a real-life reward | Male | 20 | 25% | 25% | 50% | 0.4641 |
| | | Female | 30 | 30% | 23% | 47% | |
| 24 | By using the application, I was excited to buy a in-game reward | Male | 20 | 55% | 30% | 15% | 0.2743 |
| | | Female | 30 | 60% | 30% | 10% | |
| 25 | By using the application, I felt like buying an in-game rewards because others in the household did | Male | 20 | 60% | 15% | 25% | 0.3897 |
| | | Female | 30 | 63% | 27% | 10% | |

**Table C.15:** Results on engagement from using the application grouped by gender, including results from Mann-Whitney test comparing male and female.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 26 | I thought the application was fun to use | Male | 20 | 10% | 20% | 70% | 0.4052 |
| | | Female | 30 | 7% | 30% | 63% | |
| 27 | By using the application, I thought it was fun to earn coins and experience points | Male | 20 | 25% | 25% | 50% | 0.1587 |
| | | Female | 30 | 7% | 33% | 60% | |
| 28 | By using the application, I thought it was fun to compare my rocket's progress to the others in the household | Male | 20 | 15% | 5% | 80% | 0.4522 |
| | | Female | 30 | 17% | 13% | 70% | |
| 29 | By using the application, I thought it was fun to customize chores and rewards | Male | 20 | 10% | 50% | 40% | 0.2207 |
| | | Female | 30 | 10% | 27% | 63% | |
| 30 | By using the application, I thought it was fun to customize my rocket | Male | 20 | 35% | 15% | 50% | 0.3745 |
| | | Female | 30 | 43% | 17% | 40% | |
| 31 | By using the application, I thought it was fun to buy real-life rewards | Male | 20 | 25% | 10% | 65% | 0.1251 |
| | | Female | 30 | 37% | 17% | 47% | |
| 32 | By using the application, I thought it was fun to buy in-game rewards | Male | 20 | 45% | 25% | 30% | 0.1562 |
| | | Female | 30 | 53% | 37% | 10% | |

**Table C.16:** Results on enjoyment from using the application grouped by gender, including results from Mann-Whitney test comparing male and female.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 33 | It was easy to understand how the application worked the first times i used it | Male | 20 | 20% | 20% | 60% | 0.102 |
| | | Female | 30 | 30% | 33% | 37% | |
| 34 | I thought the application was easy to use | Male | 20 | 5% | 25% | 70% | 0.1469 |
| | | Female | 30 | 17% | 33% | 50% | |
| 35 | I thought it was easier to understand how the application worked after using it for a while | Male | 20 | 5% | 10% | 85% | 0.0594 |
| | | Female | 30 | 3% | 23% | 73% | |
| 36 | I thought it was easy to understand what my chores was | Male | 20 | 10% | 5% | 85% | 0.3483 |
| | | Female | 30 | 13% | 10% | 77% | |
| 37 | I thought it was easy to customize chores and rewards | Male | 20 | 15% | 20% | 65% | 0.2005 |
| | | Female | 30 | 7% | 30% | 63% | |

**Table C.17:** Results on usability from using the application grouped by gender, including results from Mann-Whitney test comparing male and female.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 38 | I would continue using the application if possible | Male | 20 | 20% | 25% | 55% | 0.1056 |
| | | Female | 30 | 40% | 23% | 37% | |
| 39 | I think the application would be a great tool when planning, organizing and completing chores | Male | 20 | 10% | 10% | 80% | 0.3936 |
| | | Female | 30 | 10% | 13% | 77% | |

**Table C.18:** Results on general from using the application grouped by gender, including results from Mann-Whitney test comparing male and female.

## Age

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 14 | By using the application, I was motivated to do chores | Age >= 25 | 18 | 11% | 6% | 83% | 0.0735 |
| | | Age < 25 | 32 | 6% | 31% | 63% | |
| 15 | By using the application, I was motivated by unlocking new achievements | Age >= 25 | 18 | 50% | 33% | 17% | 0.2033 |
| | | Age < 25 | 32 | 34% | 44% | 22% | |
| 16 | By using the application, I was motivated by buying real-life rewards | Age >= 25 | 18 | 22% | 17% | 61% | 0.0606 |
| | | Age < 25 | 32 | 41% | 28% | 31% | |
| 17 | By using the application, I was motivated by buying in-game rewards | Age >= 25 | 18 | 61% | 28% | 11% | 0.4247 |
| | | Age < 25 | 32 | 56% | 38% | 6% | |
| 18 | By using the application, I was motivated by viewing the other members rockets too see their progress | Age >= 25 | 18 | 33% | 0% | 67% | 0.3557 |
| | | Age < 25 | 32 | 16% | 25% | 59% | |
| 19 | By using the application, I was motivated by not doing the same chores each week | Age >= 25 | 18 | 39% | 28% | 33% | 0.4641 |
| | | Age < 25 | 32 | 31% | 38% | 31% | |

**Table C.19:** Results on motivation from using the application grouped by age, including results from Mann-Whitney test comparing age groups.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 20 | By using the application, I was excited to evaluate others | Age >= 25 | 18 | 6% | 39% | 56% | **0.0485** |
| | | Age < 25 | 32 | 28% | 28% | 44% | |
| 21 | By using the application, I was excited to see how the other members in the household evaluated my chores | Age >= 25 | 18 | 0% | 33% | 67% | **0.0307** |
| | | Age < 25 | 32 | 31% | 22% | 47% | |
| 22 | By using the application, I was excited to unlock a new achievement | Age >= 25 | 18 | 56% | 33% | 11% | 0.4325 |
| | | Age < 25 | 32 | 50% | 41% | 9% | |
| 23 | By using the application, I was excited to buy a real-life reward | Age >= 25 | 18 | 22% | 6% | 72% | **0.0344** |
| | | Age < 25 | 32 | 31% | 34% | 34% | |
| 24 | By using the application, I was excited to buy a in-game reward | Age >= 25 | 18 | 61% | 28% | 11% | 0.409 |
| | | Age < 25 | 32 | 56% | 31% | 13% | |
| 25 | By using the application, I felt like buying an in-game rewards because others in the household did | Age >= 25 | 18 | 78% | 22% | 0% | **0.0301** |
| | | Age < 25 | 32 | 53% | 22% | 25% | |

**Table C.20:** Results on engagement from using the application grouped by age, including results from Mann-Whitney test comparing age groups.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 26 | I thought the application was fun to use | Age >= 25 | 18 | 6% | 33% | 61% | 0.3707 |
| | | Age < 25 | 32 | 9% | 22% | 69% | |
| 27 | By using the application, I thought it was fun to earn coins and experience points | Age >= 25 | 18 | 22% | 33% | 44% | 0.2451 |
| | | Age < 25 | 32 | 9% | 28% | 63% | |
| 28 | By using the application, I thought it was fun to compare my rocket's progress to the others in the household | Age >= 25 | 18 | 22% | 6% | 72% | 0.484 |
| | | Age < 25 | 32 | 13% | 13% | 75% | |
| 29 | By using the application, I thought it was fun to customize chores and rewards | Age >= 25 | 18 | 22% | 28% | 50% | 0.3228 |
| | | Age < 25 | 32 | 3% | 41% | 56% | |
| 30 | By using the application, I thought it was fun to customize my rocket | Age >= 25 | 18 | 39% | 11% | 50% | 0.352 |
| | | Age < 25 | 32 | 41% | 19% | 41% | |
| 31 | By using the application, I thought it was fun to buy real-life rewards | Age >= 25 | 18 | 17% | 6% | 78% | **0.0228** |
| | | Age < 25 | 32 | 41% | 19% | 41% | |
| 32 | By using the application, I thought it was fun to buy in-game rewards | Age >= 25 | 18 | 56% | 28% | 17% | 0.4443 |
| | | Age < 25 | 32 | 47% | 34% | 19% | |

**Table C.21:** Results on enjoyment from using the application grouped by age, including results from Mann-Whitney test comparing age groups.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 33 | It was easy to understand how the application worked the first times i used it | Age >= 25 | 18 | 22% | 22% | 56% | 0.2743 |
| | | Age < 25 | 32 | 28% | 31% | 41% | |
| 34 | I thought the application was easy to use | Age >= 25 | 18 | 11% | 28% | 61% | 0.3372 |
| | | Age < 25 | 32 | 13% | 31% | 56% | |
| 35 | I thought it was easier to understand how the application worked after using it for a while | Age >= 25 | 18 | 6% | 17% | 78% | 0.3483 |
| | | Age < 25 | 32 | 3% | 19% | 78% | |
| 36 | I thought it was easy to understand what my chores was | Age >= 25 | 18 | 11% | 6% | 83% | 0.3936 |
| | | Age < 25 | 32 | 13% | 9% | 78% | |
| 37 | I thought it was easy to customize chores and rewards | Age >= 25 | 18 | 11% | 28% | 61% | 0.4325 |
| | | Age < 25 | 32 | 9% | 25% | 66% | |

**Table C.22:** Results on usability from using the application grouped by age, including results from Mann-Whitney test comparing age groups.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 38 | I would continue using the application if possible | Age >= 25 | 18 | 28% | 22% | 50% | 0.2483 |
| | | Age < 25 | 32 | 34% | 25% | 41% | |
| 39 | I think the application would be a great tool when planning, organizing and completing chores | Age >= 25 | 18 | 6% | 6% | 89% | 0.0721 |
| | | Age < 25 | 32 | 13% | 16% | 72% | |

**Table C.23:** Results on general from using the application grouped by age, including results from Mann-Whitney test comparing age groups.

### Household

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 14 | By using the application, I was motivated to do chores | Partner | 23 | 9% | 9% | 83% | **0.0094** |
| | | Collective | 27 | 7% | 33% | 59% | |
| 15 | By using the application, I was motivated by unlocking new achievements | Partner | 23 | 39% | 39% | 22% | 0.3783 |
| | | Collective | 27 | 41% | 41% | 19% | |
| 16 | By using the application, I was motivated by buying real-life rewards | Partner | 23 | 9% | 17% | 74% | **<.0001** |
| | | Collective | 27 | 56% | 30% | 15% | |
| 17 | By using the application, I was motivated by buying in-game rewards | Partner | 23 | 52% | 35% | 13% | 0.102 |
| | | Collective | 27 | 63% | 33% | 4% | |
| 18 | By using the application, I was motivated by viewing the other members rockets too see their progress | Partner | 23 | 22% | 13% | 65% | 0.4052 |
| | | Collective | 27 | 22% | 19% | 59% | |
| 19 | By using the application, I was motivated by not doing the same chores each week | Partner | 23 | 30% | 26% | 44% | 0.0823 |
| | | Collective | 27 | 37% | 41% | 22% | |

**Table C.24:** Results on motivation from using the application grouped by household, including results from Mann-Whitney test comparing households.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 20 | By using the application, I was excited to evaluate others | Partner | 23 | 13% | 26% | 61% | **0.0401** |
| | | Collective | 27 | 26% | 37% | 37% | |
| 21 | By using the application, I was excited to see how the other members in the household evaluated my chores | Partner | 23 | 4% | 26% | 70% | **0.0054** |
| | | Collective | 27 | 33% | 26% | 41% | |
| 22 | By using the application, I was excited to unlock a new achievement | Partner | 23 | 48% | 35% | 17% | 0.1762 |
| | | Collective | 27 | 56% | 41% | 4% | |
| 23 | By using the application, I was excited to buy a real-life reward | Partner | 23 | 13% | 0% | 87% | **<.0001** |
| | | Collective | 27 | 41% | 44% | 15% | |
| 24 | By using the application, I was excited to buy a in-game reward | Partner | 23 | 44% | 35% | 22% | **0.011** |
| | | Collective | 27 | 70% | 26% | 4% | |
| 25 | By using the application, I felt like buying an in-game rewards because others in the household did | Partner | 23 | 61% | 17% | 22% | 0.4641 |
| | | Collective | 27 | 63% | 26% | 11% | |

**Table C.25:** Results on engagement from using the application grouped by household, including results from Mann-Whitney test comparing households.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 26 | I thought the application was fun to use | Partner | 23 | 4% | 17% | 78% | **0.0143** |
| | | Collective | 27 | 11% | 33% | 56% | |
| 27 | By using the application, I thought it was fun to earn coins and experience points | Partner | 23 | 17% | 26% | 57% | 0.3446 |
| | | Collective | 27 | 11% | 33% | 56% | |
| 28 | By using the application, I thought it was fun to compare my rocket's progress to the others in the household | Partner | 23 | 17% | 13% | 70% | 0.4522 |
| | | Collective | 27 | 15% | 7% | 78% | |
| 29 | By using the application, I thought it was fun to customize chores and rewards | Partner | 23 | 13% | 22% | 65% | 0.1151 |
| | | Collective | 27 | 7% | 48% | 44% | |
| 30 | By using the application, I thought it was fun to customize my rocket | Partner | 23 | 30% | 17% | 52% | 0.1423 |
| | | Collective | 27 | 48% | 15% | 37% | |
| 31 | By using the application, I thought it was fun to buy real-life rewards | Partner | 23 | 9% | 0% | 91% | **<.0001** |
| | | Collective | 27 | 52% | 26% | 22% | |
| 32 | By using the application, I thought it was fun to buy in-game rewards | Partner | 23 | 39% | 39% | 22% | 0.0708 |
| | | Collective | 27 | 59% | 26% | 15% | |

**Table C.26:** Results on enjoyment from using the application grouped by household, including results from Mann-Whitney test comparing households.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 33 | It was easy to understand how the application worked the first times i used it | Partner | 23 | 13% | 22% | 65% | **0.011** |
| | | Collective | 27 | 37% | 33% | 30% | |
| 34 | I thought the application was easy to use | Partner | 23 | 4% | 22% | 74% | **0.0066** |
| | | Collective | 27 | 19% | 37% | 44% | |
| 35 | I thought it was easier to understand how the application worked after using it for a while | Partner | 23 | 0% | 17% | 83% | 0.1423 |
| | | Collective | 27 | 7% | 19% | 74% | |
| 36 | I thought it was easy to understand what my chores was | Partner | 23 | 4% | 0% | 96% | 0.0516 |
| | | Collective | 27 | 19% | 15% | 67% | |
| 37 | I thought it was easy to customize chores and rewards | Partner | 23 | 4% | 26% | 70% | **0.0427** |
| | | Collective | 27 | 15% | 26% | 59% | |

**Table C.27:** Results on usability from using the application grouped by household, including results from Mann-Whitney test comparing households.

| ID | Statement | Group | n | D | N | A | p |
|---|---|---|---|---|---|---|---|
| 38 | I would continue using the application if possible | Partner | 23 | 13% | 26% | 61% | **0.0051** |
| | | Collective | 27 | 48% | 22% | 30% | |
| 39 | I think the application would be a great tool when planning, organizing and completing chores | Partner | 23 | 4% | 9% | 87% | **0.0113** |
| | | Collective | 27 | 15% | 15% | 70% | |

**Table C.28:** Results on general from using the application grouped by household, including results from Mann-Whitney test comparing households.

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# Gamification of Chores

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