NTNU

Norwegian University of
Science and Technology

A Study of The Use of Socialization, Prompting and Empowering Elements in Mobile ICT to Promote Behavior Change in Physical Activity

Andreas Næss

Eirik Stadheim

Abstract

Context: Only 32 % of the Norwegian population meet the recommended levels of physical activity. The consequences of inactivity is a cost not only concerning the subjects themselves, but also the population in general. Both absence from work and health care expenses have to be covered by the society. The use of mobile Information and Communications Technology (ICT) has proven to be an effective way to increase PA.

Objectives: The objective of this research is to create a mobile ICT intervention based on social, prompting and empowering elements, and use this intervention to find out more about how the three different elements affect participation in the intervention. By social elements we mean both sociality using ICT, and sociality happening in real life without the use of ICT. By prompting we mean reminding the participants about the intervention. By empowering we mean letting the participants take control over their own intervention.

Method: A smartphone application was designed and created. A group of 10 subjects used the application, before an evaluation was conducted, consisting of usability questionnaires and interviews. In-depth interviews were later conducted with five subjects to get data on how the different elements of the intervention worked. The development of the intervention was guided by the Social Cognitive Theory and Cognitive Evaluation Theory.

Results: The smartphone application Ludi was created. It is a social network for people who want to do physical activity together. The focus is on openness, so that people without a great network of friends can find people to be active together with. The results of our research support a social intervention, with focus on the interplay between sociality on the ICT device and real life sociality. Prompting is somewhat controversial; people said they did not like to get too many notifications on their phones. Social network-triggered prompts were preferred over typical system-generated reminders. People tended to like having control of their own intervention; however most people believed they might benefit from less control if the intervention was guided by a professional in the initial phase.

Conclusions: Social and empowering elements seemed to be working well in a physical activity intervention. Prompting could work if the content was relevant, especially social or context-aware prompts. The two theories used worked well to guide the development of the intervention.

Sammendrag

Kontekst: Kun 32 % av den norske befolkningen når de anbefalte nivåene for fysisk aktivitet. Inaktivitet har ikke bare konsekvenser for stillesittende mennesker selv, men også befolkningen som helhet. Både arbeidsfravær og helseutgifter må bli dekket av samfunnet. Bruken av mobil informasjon og kommunikasjonsteknologi (IKT) er bevist å være et effektivt hjelpemiddel for å øke folks grad av fysiske aktivitet.

Mål: Målet med denne forskningen er å lage en mobil IKT-intervensjon basert på sosialisering, varslinger og selvkontrollerende elementer. Intervensjonen skal brukes til å utforske hvordan disse tre elementene påvirker deltakelse i en løsning der atferdsendring i fysisk aktivitet er sentral. Med sosialisering menes elementer som fremmer sosialitet både ved bruken av IKT, men også i det virkelige liv, uten støtte av IKT. Varslinger er påminnende/motiverende meldinger som blir sendt til deltakere i intervensjonen. Med selvkontrollerende elementer, mener vi funksjoner i intervensjonen som gir brukere en høy grad av selvkontroll for å øke deres indre motivasjon til deltakelse.

Metode: En applikasjon for smarttelefoner ble designet og utviklet. En gruppe bestående av 10 personer prøvde applikasjonen, før en evaluering ble utført. Evalueringen bestod av et spørreskjema og intervjuer knyttet til brukervennlighet. Senere ble mer grundige intervjuer utført med fem personer. Resultatet fra disse intervjuene ble brukt til å utforske de tre elementene; sosialitet, varslinger og selvkontroll. Utviklingen av intervensjonen var ledet av sosial kognitiv teori, samt kognitiv evalueringsteori.

Resultater: Smarttelefonapplikasjonen Ludi ble utviklet. Denne applikasjonen er et sosialt nettverk for personer som vil utføre fysisk aktivitet sammen. Applikasjonen fokuserer på åpenhet, slik at personer uten et stort nettverk av venner kan finne folk å være aktiv sammen med. Resultatet av denne forskningen støtter idéen om en sosial intervensjon, der fokuset er på samspillet mellom det å være sosial på en IKT-enhet og i det virkelige liv. Varslinger var litt mer omdiskutert; folk likte ikke å motta for mange varsler. Varslinger trigget av deres sosiale nettverk var foretrukket fremfor system-genererte påminnelser. Folk likte å ha stor grad av kontroll over egen intervensjon, men det kom også frem at det å ha mindre kontroll i oppstartfasen kunne være positivt, så lenge intervensjonen var ledet av en profesjonell.

Konklusjon: Sosiale og selvkontrollerende elementer så ut til å fungere bra i en fysisk aktivitets-intervensjon. Varslinger kan fungere hvis innholdet er relevant, spesielt sosiale meldinger og meldinger generert ut i fra kontekst. De to teoriene som ble brukt fungerte godt til å lede utviklingen av intervensjonen.

Preface

This report is Andreas Næss and Eirik Stadheim's master's thesis in Computer Science at the Norwegian University of Science and Technology, written in the spring of 2016. The study is done in the context of Social Inclusion Technology Group at SINTEF.

We want to thank our supervisor, Babak A. Farshchian, for excellent guidance throughout the project. Also we thank the people who took the time to test our product and give us valuable feedback.

Trondheim, June 8, 2016

Table of Contents

List of Tables

List of Figures

Abbreviations

ICT = Information and Communications Technology
PA = Physical Activity

Chapter 1

Introduction

Report Overview

- *1. Introduction*
- *2. Related Research*
- *3. Ludi:A Social App for Increased Physical Activity*
- *4. Technology*
- *5. First Iteration*
- *6. Second Iteration*
- *7. Conclusion and Future Work*

In this chapter we introduce the project by looking at the social issue of inactivity, what is meant by behavior change, and how mobile ICT has the potential to influence behavior change in physical activity (PA). We finish up with a short description of our research questions and research method.

1.1 Physical Inactivity

Today, only 32% of the Norwegian population meet the recommended levels of PA which is 150 minutes of moderate or 75 minutes of vigorous activity per week [1, 2]. The modern lifestyle has enabled increased sedentary behaviours among people [3]. Throughout history, manual labour has been an important factor of exercise. Nowadays, as technology interventions have become more prominent in people's work lives, it is important to be self-aware in order to obtain the recommended levels of PA.

Studies have shown that people's lack of PA can bring a lot of complications. Some examples are: high blood pressure, higher risk of developing certain cancers and chronic diseases, depression and anxiety [4]. PA not only prevents devastating chronic diseases, but also increases people's physical and psychological well-being. The consequences of inactivity is a cost not only concerning the subjects themselves, but also the population in general. Both absence from work and health care expenses have to be covered by the society. The think tank "Friends of Europe" claims that inactivity costs the European economy 80 billion euros each year [3]. The expenses are related to the four major chronic diseases: coronary heart disease, type 2 diabetes, colorectal and breast cancer. Lack of PA is today the fourth-leading risk factor for all global deaths [3]. If both the mortality rate and expenses related to inactivity could be reduced, it would benefit the society greatly.

World Health Organization defines physical activity as "any bodily movement produced by skeletal muscles that requires energy expenditure" [5]. In real life the term is somewhat subjective, as it can have a different meaning for different individuals; people with high sedentary time numbers might consider walking as PA, whereas more active people refer to physical activity as more vigorous exercises. We refer to physical activity as at least moderate intensity exercise such as walking.

1.2 Behavior Change and Self-Awareness

In this report we refer to behavior change as any modification or transformation of human behavior. Changing people's behavior to improve their health is an extensive task. Bad habits like poor diet and lack of exercise are often hard to break. As a result, there have been designed interventions to help individuals discard their bad habits. People are more accessible for interventions when notable events occur. An example of a notable event can be when an individual receives a message from a doctor that he is on path to develop a chronic disease. This is a good opportunity to introduce a health behavior change mechanism. The best solution however, is to be proactive and self-aware of your own health situation. In this case, you can maintain moderate levels of PA and prevent the development of chronic diseases [6].

If subjects are not self-aware of their own sedentary behaviors, they will need external inputs in order to realize their problem. It is important that they are notified and included in a health intervention program before diseases propagate.

In [7], J. Kruk says that: "Behaviour change interventions should motivate and support people to understand the short, medium and longer-term consequences of their health-related behaviours, for themselves and others". Subjects that partake in a behaviour change program has to be self-aware of their own situation, as they have the main responsibility for their own behaviour.

1.3 Mobile ICT as an Intervention Technique

The use of mobile Information and Communications Technology (ICT) has proven to be an effective way to increase people's PA [8, 9]. Multiple mobile ICT products with incorporated PA elements already exist. Wearable GPS and pedometers are examples of popular ways to track PA. Recently with the increased development of smart devices, new opportunities have arisen. For example, it is now possible to use the built in accelerometer in smartphones as a step counter. Also, smart devices enable communication over the Internet and they can easily run 3rd party applications. As a result, the fitness app market has increased, and it has become easier to develop specifically tailored apps for different consumers. In Section 2.4 we show examples of previous successful mobile ICT interventions that focus on behavior change in PA.

1.4 Research Questions

In this research, we will look at the use of mobile ICT to deal with the problem of inactivity. We want to create an intervention that targets sedentary people – of all age groups – who are in need of a behavior change in PA. We will design and implement a product based on behavior change theories, which will guide the research to answer our research questions.

The main objective of this research is summarized in the research question below. For a more exhaustive explanation of the research question, see Section 2.3.

RQ 1: By the use of mobile ICT, how do we create a behavior change intervention with social, prompting and empowering elements, that aims at increasing the PA levels for the general population?

We have included the following sub questions to support the main research question:

- *RQ 1.1: How can the interplay between being social in real life and on a mobile ICT device affect engagement in a PA intervention?*

- *RQ 1.2: How can the use of prompting and different prompting mechanisms affect engagement in a PA intervention?*

- *RQ 1.3: How can the users' empowerment affect participation in a PA intervention?*

1.5 Method

In this section we explain the project's research method. For more details on the specific iterations, see Chapter 5 and 6.

1.5.1 Research Process

The research started off with a literature review, which is elaborated in [10]. Based on the results from this review and our own motivation to produce a tool that can help people get more physically active, we chose to design and develop a product.

The decision to design and develop a product rather than just designing a concept, was made because we believed it would be favorable for the users to test a real system, instead of just being presented with an idea; we believed it would yield a better response from the testers. Also, we wanted to create a tangible product, and hoped the system would be used when we were finished with our master's thesis. We see ourselves as fairly skilled programmers, and did not think that would be an obstacle for the creation of the product.

As for the data generation methods, both qualitative and quantitative data was gathered. During the first iteration of our research, we conducted a usability test, where quantitative data was generated from a multiple choice questionnaire. Qualitative data was gathered from free text questions in the questionnaire, and additional interviews.

During the second iteration, we conducted some in-depth interviews to generate qualitative data on how people experienced the intervention. In particular we wanted answers directly related to our research questions, but also the parts of the system that is not directly related to the research questions.

Figure 1.1 illustrates our research process.
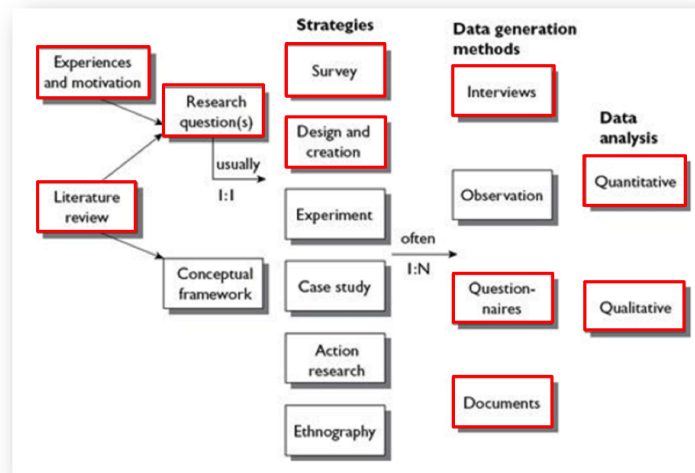
Figure 1.1: The research process

1.5.2 Iterative Research

We followed an iterative design methodology when conducting our research. Characteristics of this workflow, is that it cycles through a series of steps and refines the product. The result of one cycle will be used as input in the next. The intention of this workflow is to overall improve the quality of the product because it enables us to detect serious problems early in the development process.

We divided the research into two iterations, where each iteration included four phases (Figure 1.2). In addition, the literature survey we conducted as a basis of this project can be seen as a "pre-iteration", yielding a total of three iterations. Figure 1.1 shows which research strategies and data-generation methods are used in total during all iterations. Below follows a description of each iteration, with relation to both Figure 1.1 and Figure 1.2.

Pre-iteration:

It started off by reviewing the literature on mobile ICT and behavior change in PA. As a result, we came up with research questions. We used survey as the strategy with documents as the data-generation method, to get quantitative data on the topic.

First Iteration:

The research questions were based on experiences from the pre-iteration/literature survey. Design and creation was the research strategy, with questionnaire and interviews as data-generation methods. The result was both qualitative and quantitative data.

1. *Planning:* Focus on initial design, where we looked at our previous study

to investigate different possibilities. We came up with a concept from our findings, and created an implementation plan.

2. *Implementation:* We studied different technologies that best suited our intervention. We developed the first prototype, and a web-page to be used in the testing phase.

3. *Testing:* A usability test was conducted supported by a questionnaire and interviews.

4. *Evaluation:* The results from the usability test were evaluated.

Second Iteration:

Second iteration was based on the same research questions as the first iteration. Design and creation was the strategy, with interviews to generate qualitative data.

1. *Planning:* Changes from the previous iteration were prioritized. We started planning in-depth interviews concerning our research questions.

2. *Implementation:* The highest prioritized changes proposed in the usability test were implemented.

3. *Testing:* A more in-depth testing of the new application was performed. Data regarding the research questions were gathered from interviews.

4. *Evaluation:* The data was evaluated against the research questions.
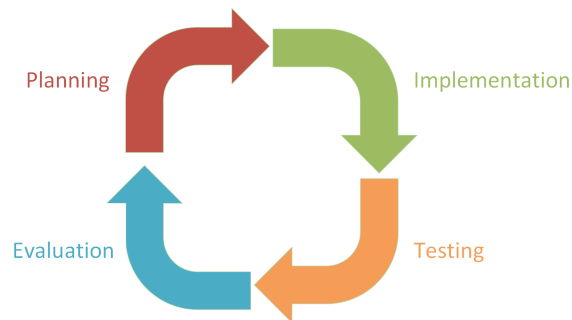
Figure 1.2: Iterative Development

1.6   Structure of the Report

Below is an overview of the chapters of this report. The two first chapters are introductions to the study and research related to it. Chapter 3 is a summary of the application created as a product of the study, while in Chapter 4 the technology used for the application is discussed. In Chapter 5 and 6 the two iterations are explained, results are provided and discussed. Chapter 7 contains a brief conclusion, limitations to the study and some thoughts on future work.

Report Overview

- *1. Introduction*
- *2. Related Research*
- *3. Ludi:A Social App for Increased Physical Activity*
- *4. Technology*
- *5. First Iteration*
- *6. Second Iteration*
- *7. Conclusion and Future Work*

Chapter 2

Related Research

Report Overview

- *1. Introduction*
- ***2. Related Research***
- *3. Ludi:A Social App for Increased Physical Activity*
- *4. Technology*
- *5. First Iteration*
- *6. Second Iteration*
- *7. Conclusion and Future Work*

In this chapter we first explore some popular behavior change theories. We then discuss the literature review that we conducted the fall before this master's thesis was written. We also explain our research questions, before we conclude by explaining the need for this research.

2.1   Behavior Change Theories

According to [11], behavior change theories are useful to:

- "Understand why people do or do not practice health promoting behaviors."
- "Help identify what information is needed to design an effective intervention strategy."

- "Provide insight into how to design a program so it is successful."

Examples of popular health behavior change theories are:

- *Social Cognitive Theory* [12] explains how behavioral change is determined by environmental, personal and behavioral elements. Albert Bandura says that individuals can learn not only through their own experiences, but also by observing the actions of others and the results of those actions. In [11], they noted some of the theory's key constructs that are relevant to health behavior change:

  - **Observational learning** A person's ability to learn by watching the actions and outcomes of others' behavior.

  - **Reinforcement:** External or internal responses to a person's behavior that affect the likelihood of continuing or discontinuing a behavior. The rewards should increase for a positive behavior, and decrease for a negative.

  - **Self-control:** A person's ability to control his behavior when faced with temptations and impulses.

  - **Self-efficacy:** A person's confidence in his ability to successfully perform a behavior.

- *The Transtheoretical Model* (Figure 2.1, inspired by [11]) describes a sequence of steps a person cycles through before achieving a successful behavior change [13]:

  - **Precontemplation:** The individual has no intention to change in the nearest future. He might not even be aware of his own problem.

  - **Contemplation:** The individual is now aware of his problem. Opportunities to change are considered, but no commitment is made. He learns how problems are developed and maintained, and he now has a desire to change.

  - **Preparation:** The individual now realizes he can change, and is planning for change.

  - **Action:** The individual has committed to make a behavioral change, and is adapting to new habits. He is encouraged to strengthen his commitment in order to avoid moving back to a previous stage. Self-efficacy is important to succeed in this stage.

  - **Maintenance:** The individual concentrates on the new healthier behavior, and tries to avoid relapse.
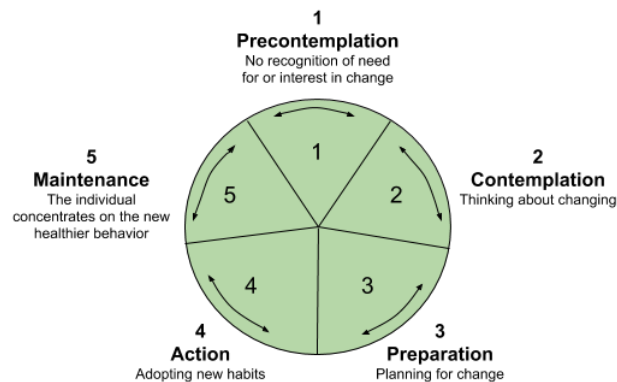
Figure 2.1: The Transtheoretical Model

- *Self-Determination Theory* [14] is a motivational theory that studies human motivation and personality. It consists of five mini theories:

    - Cognitive Evaluation Theory

    - Organismic Integration Theory

    - Causality Orientations Theory

    - Basic Psychological Needs Theory

    - Goal Contents Theory

  The one mini theory that was most relevant to this research was Cognitive Evaluation Theory [15]. It explores the interactions between the extrinsic and intrinsic motives on people. When people experience intrinsic motivation, they perform actions that they are internally driven to perform; the actions might be enjoying, rewarding and satisfying in themselves. When people experience extrinsic motivation, they perform actions based on the rewards the actions entail. E.g. an individual receives a good grade by being extrinsically motivated by a teacher to do homework. People's performance can be very different depending on whether they are behaving for intrinsic or extrinsic reasons [16]. Intrinsic motivation tends to enhance persistence, well-being, and creativity.

2.2 A Review of Literature on Behavior Change in Physical Activity

In the fall of 2015 we performed a literature review on behavior change in physical activity [10] . By searching the document databases Scopus and PubMed for articles, and reading their titles and abstracts, we ended up with 25 primary studies to read. While reading them, we answered the following questions:

- What concepts or mechanisms of mobile interventions are shown to have effect on behavior change to promote physical activity?

- What technology is used?

- What user groups are studied?

- What behavior change results are achieved?

- What theories and mechanisms are used?

- What research methods are used in design and evaluation?

From the literature review, we found the following:

- Interventions based on social and prompting elements were generally more successful than others in terms of increased PA levels for the participants during the testing phase.

- The most used mobile ICT was the smartphone. Also motion-tracking devices were much used, often in combination with smartphones.

- People with chronic diseases was the user group targeted by the highest number of interventions. We found that a lot of interventions were tailored to specific user groups, which can be useful to reach out to people with certain commonalities that can be exploited in the intervention.

- The most successful intervention showed an average increase of 257 minutes of increased physical activity each week. Several other interventions showed results of more than 100 minutes of increased PA each week(or similar results)

- Social Cognitive Theory was the most used behavior change theory

- The most used research method was design and creation, followed by survey, experiment, case study and quasi-experiment

We thought that the most relevant findings from the literature review were the high success rate of social and prompting elements in the interventions. As they showed to be part of all the really successful interventions, we see it as at least an indication that these two concepts is what made the interventions work so well.

2.3 Research Questions

From the literature review we found two distinct elements to be included in an intervention that aims at performing behavior change in PA. The elements are:

- *Social features*: The intervention should include social elements.

- *Prompting*: The intervention should include prompting elements like reminders and motivational messages.

The above elements were present by themselves or together, in multiple mobile ICT interventions that have shown good results. We want to combine the elements in a mobile ICT intervention that aims at increasing people's PA levels.

In addition, we want to study empowerment. In literature there are many definitions of empowerment. In this article we refer to it as an individual's feeling of having control over his own situation. The term is often used to describe individuals' motivation to engage in tasks within an organization. Thomas and Velthaus [17] defines empowerment as "increased intrinsic task motivation", i.e. a person's intrinsic commitment to do a good job is motivated by the "pull" of the task, not the "push" of management. A task in our case, can be translated to doing PA. We want to increase individuals intrinsic motivation to participate in PA, by giving them control over their own intervention.

The objective of this research can be summarized in the following main research question and sub questions:

RQ 1: By the use of mobile ICT, how do we create a behavior change intervention with social, prompting and empowering elements, that aims at increasing the PA levels for the general population?

Sub questions:

- *RQ 1.1: How can the interplay between being social in real life and on a mobile ICT device affect engagement in a PA intervention?*

  By *on a mobile ICT device* we mean that you can have friends or post on message boards, but everything happens on the device(virtually). The real sociality happens when users actually meet and are social together in the real life. We want to study the interplay between these two forms of sociality. I.e. can we increase participation in the intervention by letting the users socialise on a mobile ICT device, and also during physical activities in real life?

- *RQ 1.2: How can the use of prompting and different prompting mechanisms affect engagement in a PA intervention?*

  We want to investigate prompting and see if there is a difference between automatically generated prompts and prompts triggered by social incidents. An example of automatically generated prompts can be weekly reminders to participate in the intervention, whereas social triggered prompts would be created from a specific stimuli. I.e. the system has a state, and when a user performs a specific action (changing the state), a prompt is generated to users in his network.

- *RQ 1.3: How can the users' empowerment affect participation in a PA intervention?*

  In a PA intervention, you can choose to give the participant no control over his own intervention by creating a plan he has to strictly follow. On the other hand, you can give the participant full control to plan the intervention himself. Hybrid approaches are also possible, where the participant has some influence over the intervention. We want to study whether the users' intrinsic motivation to engage in a PA intervention will increase by giving them more control of their own intervention.

2.4   Examples of Similar ICT Solutions

In our literature review we saw lots of concepts using mobile ICT to increase the PA levels of people in general, or of more specific user groups. Some of the more interesting ones were based on social and prompting elements.

H. Du et al. [18] created a smartphone intervention (Figure 2.2) to support groups in behavior change programs. They included social features(groups, posts and comments), prompting(reminding users of their goals), goals, analytical data, tracking and logging. The NutriWalking group, which focused on walking, saw an 157 minutes increase in PA levels each week.
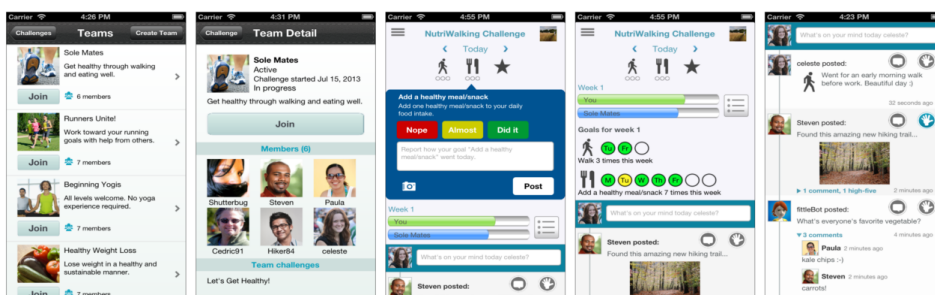
Figure 2.2: Fittle mobile application

R. Hurling et al. [19] created a web-based system (Figure 2.3), where the user logs steps recorded by a wrist-worn accelerometer. The system makes use of social features(message board), prompting(email or mobile phone reminders of their weekly training schedule), information providing, goals, analytical data and logging. They saw an increase of 2 hours 18 minutes PA each week, most of it moderate PA.

Figure 2.3: Get Active web application

C. Maher et al. [20] used a pedometer to track steps, and a Facebook web-application (Figure 2.4) to log and have social interactions with other users. After eight weeks, the participants of the intervention had increased their MVPA by 135 minutes each week, compared to the control group. However, at 20 weeks, the statistical differences were lost.
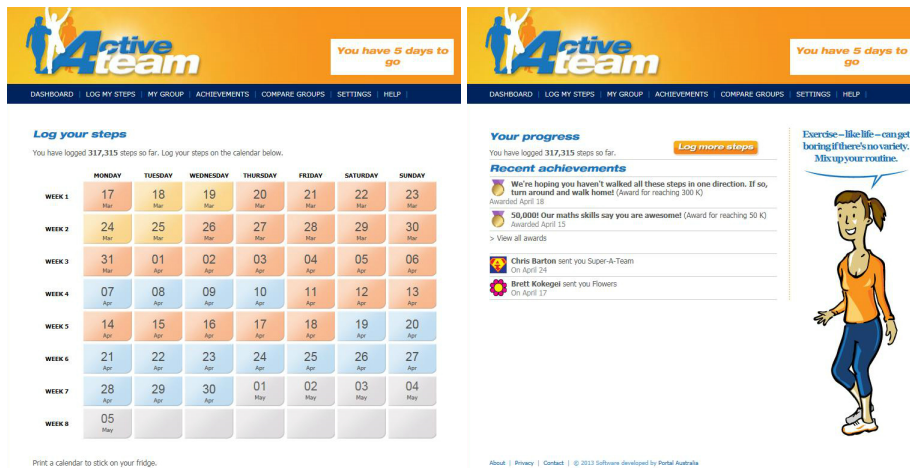
(a) Active Team step-logging calendar

(b) Active Team dashboard, showing step-logging progress, awards, and gifts

Figure 2.4: Active Team Facebook application

A. C. King et. al [21] created three different smartphone applications; one analytical, one social, and one affectional. The social application gave an average increase in moderate to vigorous physical activity (MVPA) of 257.1 minutes/week. Social features included a "virtual group", where the user was compared to other users, and a message board.

Figure 2.5: Analytic, social and affect applications

S. Fjeldsoe et al. [22] can show to good results(1.82 days/week increased PA) with a PA intervention for mothers with young children. It is based on prompting and social features, consultation, tailored feedback, information providing and logging. In contrast to lots of similar interventions, this one actually involves real life socialization between the users.

2.5   The Need for a New Solution

What separates us from the interventions mentioned in Section 2.4, is the combination of the following elements:

- We want people to be social not only within the application, but also in the real life, as a cause of the application. Other PA interventions using ICT focus a lot on which *application elements* can contribute to the user's goals(virtual sociality); not so much on how *relations outside the application* can contribute.

- We try to empower the users by letting them take control of their own intervention.

- We remind the users about the intervention, to help them on the path to achieving their goals.

You might say that we want to create something that is a hybrid of a typical PA application

and a social network like Facebook[1]. A typical PA application(like Endomondo[2]) incorporates some sociality inside the application in addition to the physical element, like being able to see how friends are doing. However, this is limited to the application. A typical social network(like Facebook) does not focus on physical activity, but goes all in on the sociality. On Facebook you can create events and carry them out in real life(virtual + real life sociality). We combine the two concepts with the PA element of PA applications and the combination of virtual and real life social elements of a social network.

One intervention that we are inspired by is the Co-Living project [25]. This intervention uses real-life socialization, where elderly people first interact through a mobile application, by creating and attending social activities, before they meet in the activities they have created. This intervention has much in common with what we create. The main difference is that the Co-Living intervention aims at increasing the users' sociality, while we aim at increasing the users' PA levels by the use of social features. Also, we create the application for all age-groups, while Co-Living was tailored to elderly people.

---

[1]A large social network with one billion users [23]

[2]A fitness app where you can track different activities [24]

Chapter 3

Ludi: A Social App for Increased Physical Activity

Report Overview

- *1. Introduction*
- *2. Related Research*
- **3. Ludi:A Social App for Increased Physical Activity**
- *4. Technology*
- *5. First Iteration*
- *6. Second Iteration*
- *7. Conclusion and Future Work*

In this chapter we first explore our concept, followed by a scenario describing the product and its main features. We then discuss how the behavior change theories were included in the intervention, and lastly we discuss the technology choices.

3.1   The Concept

As we explained in Section 2.3 we wanted to create a PA intervention that incorporated sociality, prompting and empowerment elements. By creating this intervention we wanted to answer our research questions concerning the three different elements(sociality, prompting and empowerment).

Based on our research questions and some inspiration from the Co-Living project [25], we found that we wanted to create a small social network application that will get people out and be more physically active during the week. As we explain in Section 3.5 we decided to go with a smartphone application.

It was important for us that this was not going to be just another application where the users could be social online. We wanted the users to meet up and be physically active together, instead of limiting the social interactions to the application. We accomplished this with social activities that are planned on the smartphone and carried out in real life.
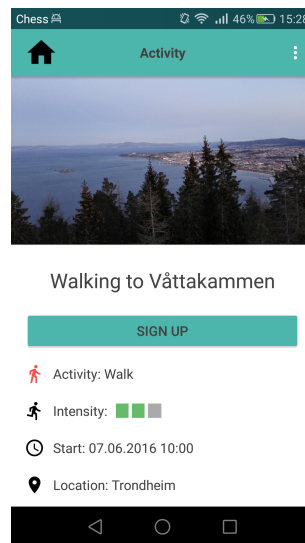
Figure 3.1: Activities planned on the smartphone is carried out in real life

The sociality was incorporated throughout the application. The activities are social events shared by the users. Users can see who is participating on the events and become friends with them. They can write posts on their profiles and activities, and comment on other users' posts and comments. The users have a news feed available to get instant information on what is happening in their social network.

Prompting as a way of reminding the users to get some exercise, was something we wanted to utilize as well. This is very neatly incorporated in today's mobile platforms, with the notification bars of both Android and iOS. The notifications do not feel too forced upon you, but are still accessible on the lock screen and in the notification bar, so they do not get forgotten. We wanted to look at different prompting mechanisms, as explained in Section 2.3, and how they affect the users' participation in the intervention.

Since this is an intervention that aims at helping people in general, we did not focus on a specific age-group. We envisioned that people of all ages would want to use the application. Since we target such a large user-group, we chose to keep the application easy to use without too much advanced functionality.

We thought that empowering the users through the intervention would motivate them to participate. In the application, we empowered the users by letting them create their own activities that other people could take part in. This means that there does not need to be any health-care professional creating the activities for the intervention participants. The participants can create the activities themselves.
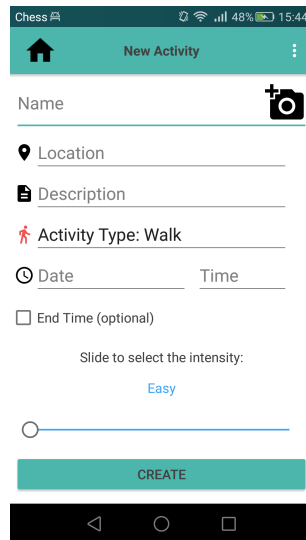
Figure 3.2: Users are empowered by having the option to create their own activities

This way, we incorporated the two elements we found in our literature study last fall together with the empowering element.

To summarize, our concept includes the following main functionality:

- Activities planned in the application, carried out in real life
- User profiles and friendships between users
- News feed with the latest information from your social network
- Post and comments on activities and user profiles

We have chosen to call our concept Ludi. To see how we have incorporated functionality related to our research questions in the final application, see Section 3.3.

3.2   Scenario

In this section, the application and its features will be presented by the use of a scenario.
The images of Thomas is retrieved from [26], while other images are of people who have
used the application and agreed that we could use the images.

Thomas Hansen

Thomas Hansen is a 35 year old man, who lives a sedentary lifestyle. He is not physically
active, and lacks a social life. He works in an office, and spends most of his free time
watching tv-shows and playing video games. Lately he has been suffering from back pain.
His doctor introduced him to Ludi, a mobile application and a social network that focuses
on increasing PA among people.

When Thomas first opens the application, he is met by a front page, where he has the
option to sign in or register a new profile (Figure 3.3a).

(a) Front page   (b) Login page   (c) Register page
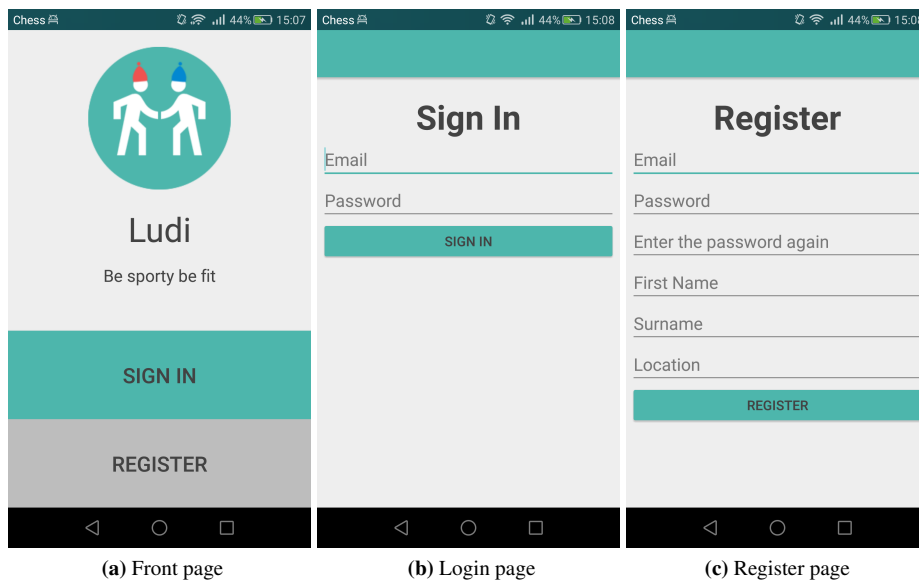
Figure 3.3: Front page, login page, and register page

He registers a new profile and fills out all the necessary input fields, shown in Figure 3.3c.

When the profile has been created, he is greeted by a welcome message, and the option to set a profile image.

(a) Default image   **(b)** Profile picture has been set
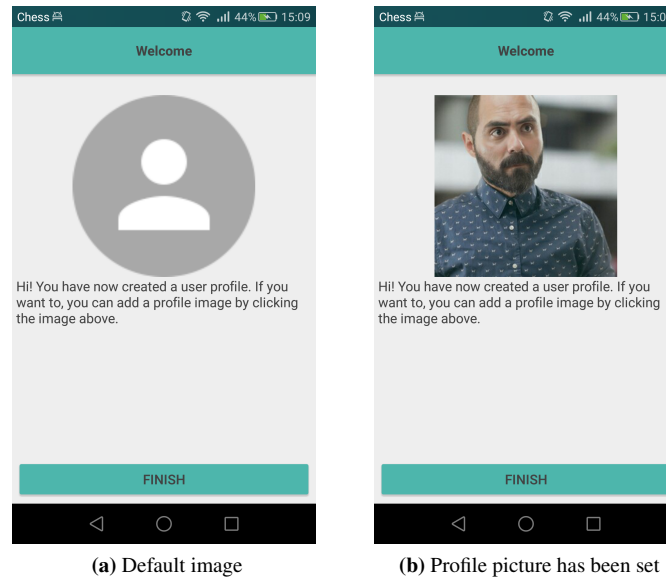
Figure 3.4: Welcome page

After selecting a profile image, he is redirected to the main page (Figure 3.5). The main page contains many features. From Figure 3.5a and Figure 3.5b, we can see that the page has 4 tabs; "News", "Recommended", "Attending" and "Mine". By clicking each tab, a different view will be shown. Thomas clicks the "News" tab and is presented with recent happenings in the system. This is essentially a news feed, whose purpose is to make it easier for Thomas to keep up with what is happening in his social network. Examples of news feed items are:

- A friend X has created an activity Y

- A friend X has just become friends with user Z

By clicking the "Recommended" tab, a list of recommended activities is displayed (Figure 3.5b). This list shows future activities that other users have created, which Thomas freely can attend. As of now, the recommendation of these activities are not implemented, thus it only displays all the activities in the system. In the future Ludi should take Thomas' profile information and relations into consideration when recommending activities.

(a) News feed   (b) Recommended activities
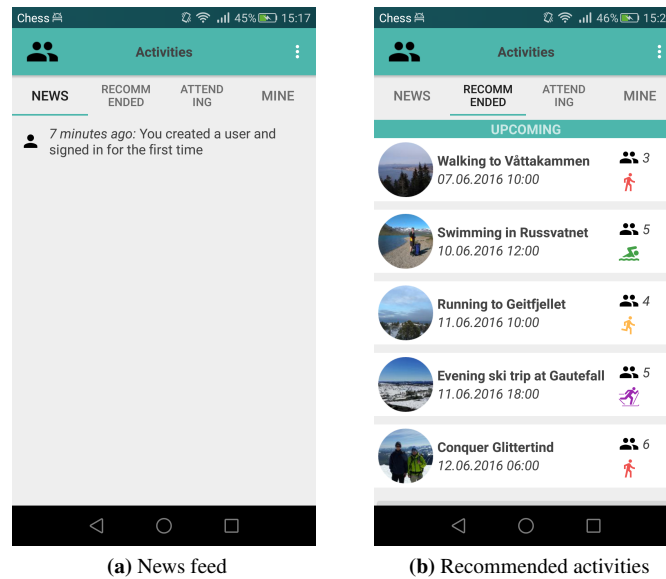
Figure 3.5: Main page

The number next to the black icon in the list (Figure 3.6), indicates how many users that have already signed up for this activity.

Figure 3.6: Number of participants

The colored icon just below illustrates the activity type. The activity types express which exercise will be performed during the activity. There are six pre-defined activity types, displayed in Figure 3.7. In the finished system the list of activity types should be extended to include a lot more activities.

(a) Walk   (b) Run   (c) Bike   (d) Ski   (e) Swim   (f) Other
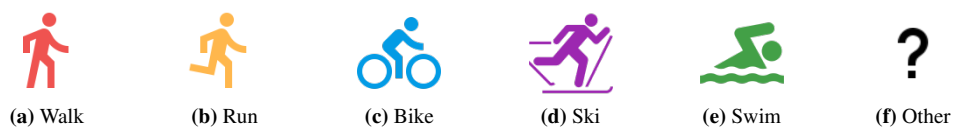
Figure 3.7: Activity type icons

Thomas clicks on the first list-item "Walking to Våttakammen", to read more about the activity (Figure 3.8).

(a) Activity view 1/2   **(b)** Activity view 2/2
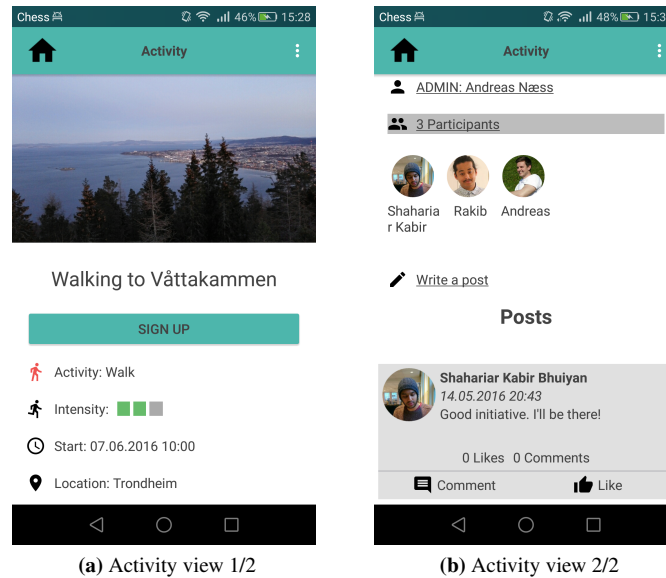
Figure 3.8: Activity page

On this page, all necessary information about the activity is shown. The attributes are shown with both icons and text. An activity also has an intensity scale ranging through easy, medium and hard (Figure 3.9), depending on the activity's vigorousness. The intensity is a subjective measure, and is set by the creator of the activity.

(a) Easy   **(b)** Medium   **(c)** Hard
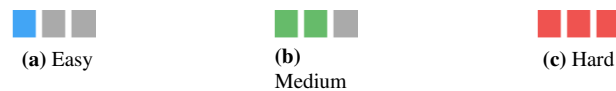
Figure 3.9: Intensity scale

Scrolling further down Thomas sees the post and comment section(Figure 3.8b). Each activity has a comment section, where the users can write posts and comments. They can also "like" both posts and comments.

Thomas skims through the information, and notes that the activity fits him well; the intensity is not too hard, the start time fits his schedule, and the trip as a whole looks appealing. Thomas attends this activity with the three other participants the next day.

During the activity Thomas connected with Rakib, who also participated. Thomas then went on and sent him a friend request in the application when he got home.

Other profiles can be found either by looking at the activity participants, friends of friends, or by search (Figure 3.10a shows the user search view).

(a) Profile search

(b) User profile, not friend
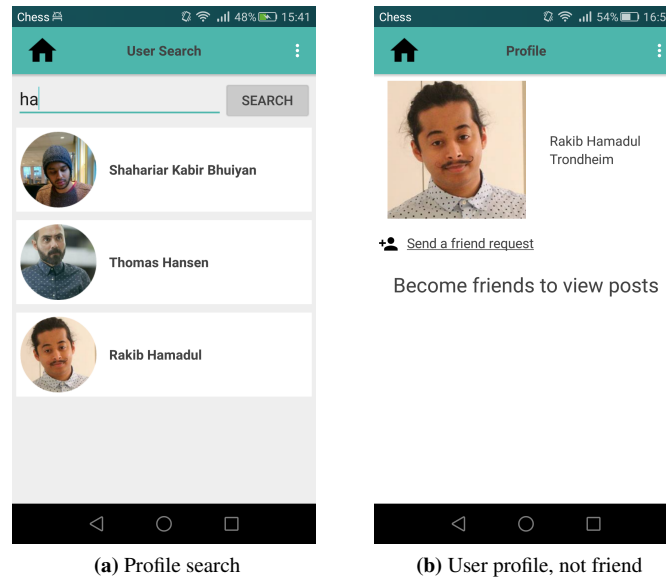
Figure 3.10: Search and add user

Thomas also got motivated to create an activity of his own. He did this by clicking the three white dots (menu button) in the top-right corner of the toolbar (Figure 3.11a). When the menu button is clicked, a dropdown-list will appear (Figure 3.11b). This list is used to navigate throughout the application, and is available in every view.

(a) Menu button

(b) Navigation dropdown-list
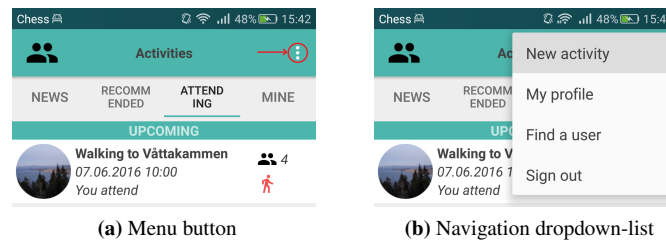
Figure 3.11: Navigating the application

By clicking "New activity" in the dropdown-list, the page to create an activity will be displayed (Figure 3.12a). All fields in this view has to be filled out, except for image and end time. When clicking activity type, the dialog frame in Figure 3.12b pops up, where the type of activity is selected.

(a) Create activity input fields

(b) Activity type dialog
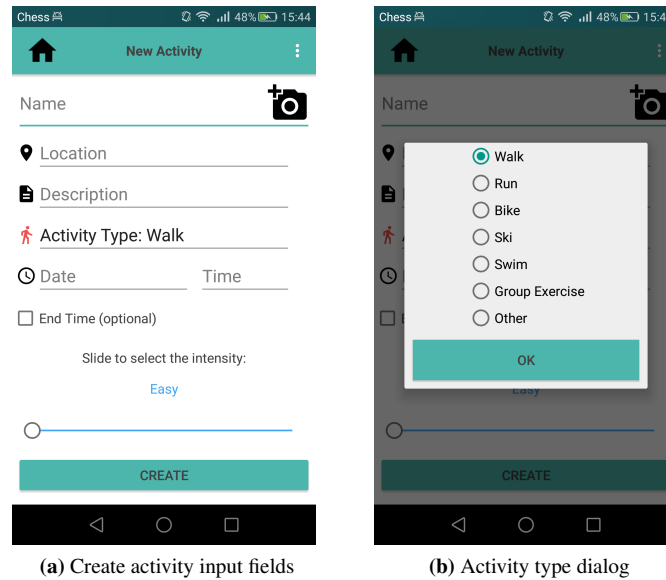
Figure 3.12: Create new activity

After the activity has been created, Thomas is redirected to the activity information page (Figure 3.13). Now that he is the activity administrator, he has the ability to edit and cancel the activity. Canceled activities are not deleted, but rather put in a state where they cannot be attended.

(a) Activity view 1/2

(b) Activity view 2/2
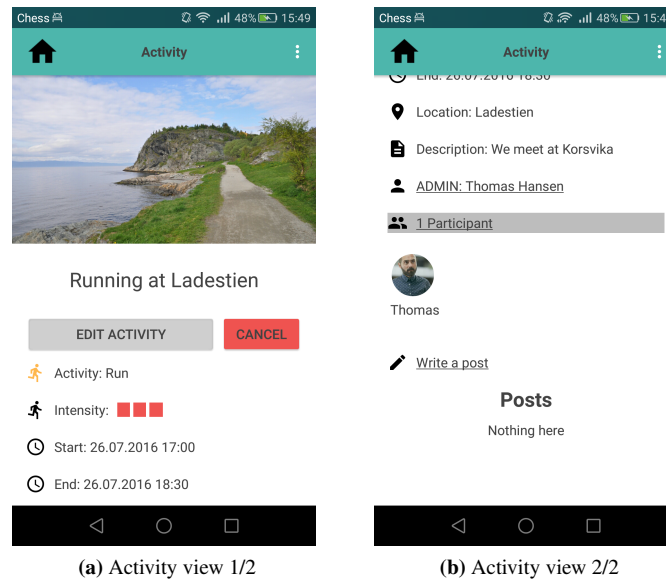
Figure 3.13: Activity page as admin

After the activity was successfully created, he navigates back to the main page by clicking the home button, located at the top-left of the toolbar (Figure 3.14).
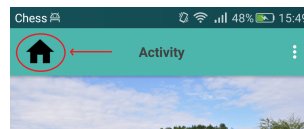
Figure 3.14: Home button

The home button is present everywhere in the application, except on the main page, where it is replaced by a button to display friend requests.

When Thomas reaches the main page, he realizes that he has received a friend request from another one who participated on the activity with himself and Rakib. This is indicated by the number next to the icon in the top-left corner of the toolbar (Figure 3.15a). Clicking the icon opens a dialog, where he can accept or reject the friend request (Figure 3.15b.

(a) New friend request **(b)** Friend request view
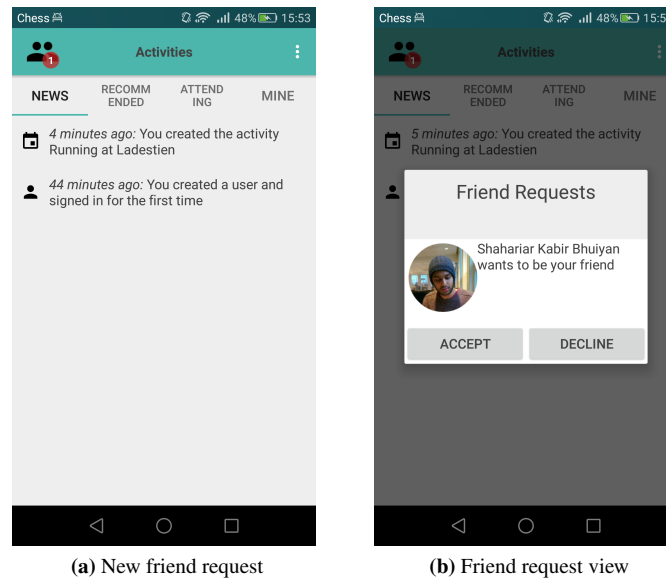
Figure 3.15: Friend request received at the main page

He accepts the friend requests, and resumes to check out his newly added friend's profile. Via the dropdown-list in the toolbar, Thomas first opens his own profile page (Figure 3.16).
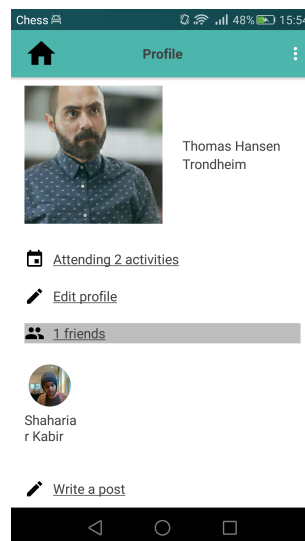
Figure 3.16: Thomas' profile

Looking at this page, he can see his newly added friend. He clicks his new friend's image (Figure 3.17).

Figure 3.17: New friend

On his friend's profile, he can read general profile information (first name, last name and location), which activities he is attending, which friends he has, and also posts and comments written on his profile.

(a) Friend's profile 1/2

(b) Friend's profile 2/2
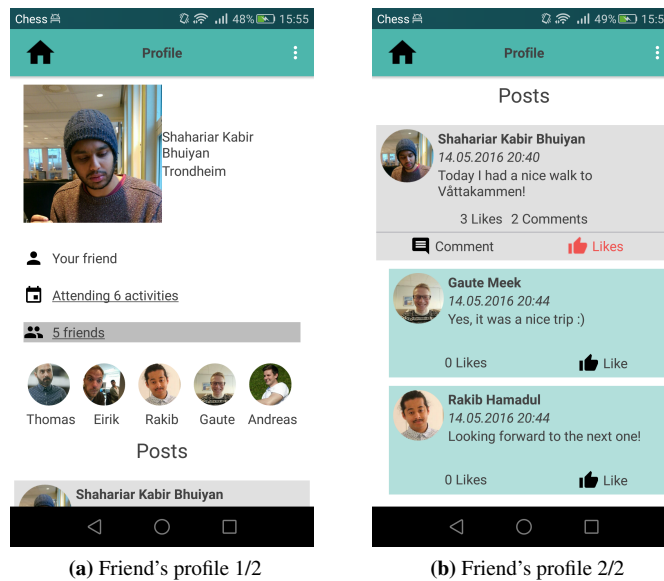
Figure 3.18: Friend's profile

After looking at his friend's profile, he goes back to his own and updates his information. Figure 3.19 shows the edit user views, where Thomas can update his profile information.

(a) Edit profile view   **(b)** Updated profile image   **(c)** Change password view
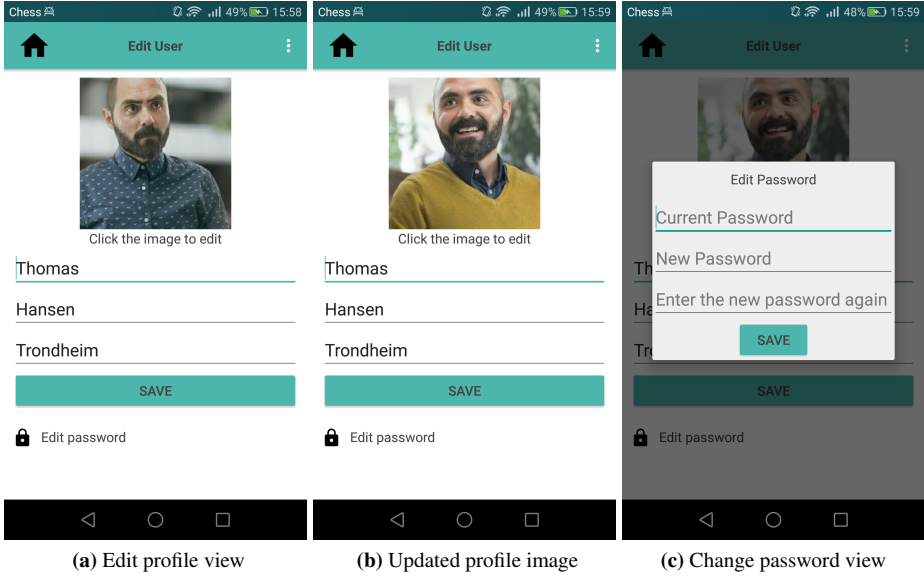
Figure 3.19: Profile and edit profile page

As Thomas increases his participation in the PA intervention, he also keeps making new friends. When his friends create new activities he is notified via push notifications (Figure 3.20). The notifications are either automatically generated reminders, or messages that are generated as a result of specific happenings in the system (e.g. Thomas receives a friend request, or a friend has created an activity). As a result of frequent use of Ludi, Thomas receives both physical and social benefits.
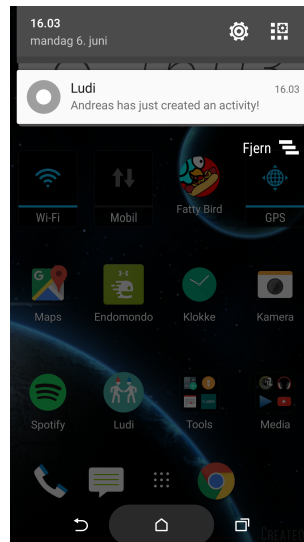
Figure 3.20: Push notification

3.3 Functionality and Research Questions

In this section we explain which functionality in the system that is added to support the three research questions. See Section 2.3 for the full text of the research questions.

RQ 1.1 Real Life and Virtual Sociality

To support the research question, we have added the concept of activities. As explained in Section 3.1 activities are physical activities you perform together with other people at a given time. This supports the interplay between the virtual and real life sociality(explained in Section 2.3), as the planning takes place virtually, while the activities are carried out in real life.

Items that further support the sociality is:

- News feed
- Friendships

- Post and comments

- User search

RQ 1.2 Prompting and different prompting mechanisms

To support the research question we have added prompting on special occasions. We wanted to look on different prompting mechanisms. Therefore we added both a typical system prompt(a periodic reminder to use the application) and prompts triggered by events in the user's social network (like when a friend has created an event).

RQ 1.3 Empowerment

To support the research question we let everyone create their own activities. In other words, you do not need a health care professional who is responsible to create activities. Letting users create their own activities empowers them to take control of their intervention.

3.4 Applied Theory

In order to be successful, a health behavior change intervention should be built upon behavior change theories [11]. We looked at several popular behavior change theories, and chose to build our intervention on both the Social Cognitive Theory, and Cognitive Evaluation Theory. A more general explanation of behavior theories can be found in Section 2.1. The decision to include these theories, was made by looking at what we wanted to accomplish with our intervention. The main element of our intervention is sociality. We knew from beforehand that interventions which included social elements tended to have good results in the form of increased PA [21, 22]. The main construct of the Social Cognitive Theory tells us that people can learn by looking at the results of other people's actions. We wanted to create an intervention that makes it easy for people to share their experiences with others, thus inspiring them to partake in the intervention.

Another element we wanted to study, was if the users' empowerment can affect participation in a PA intervention. Cognitive Evaluation Theory, the precursor of Self-Determination Theory, assumes that people sometimes are intrinsically driven to perform a task [27, 28]. When individuals feel intrinsic motivation, they are often more persistent and less likely to give up. On the other hand, if people are extrinsically driven, i.e. general practitioners, teachers, managers, etc. try to control the behavior of people, then they are more likely to suffer from exhaustion and drop out. We think that by focusing on empowerment, we might increase the likelihood of participation in the intervention.

The main constructs of both Social Cognitive Theory, and Cognitive Evaluation Theory were used to guide the development of our intervention.

In this section we explain how we applied some of the theories' key constructs in the intervention.

Social Cognitive Theory

In Section 2.1 we presented four key constructs of the Social Cognitive Theory that are relevant to health behavior change. We have tried to base our functionality on three of these constructs. We excluded self-control, as this is more related to temptations and impulses. The goal with our intervention is not to get people to eat healthy or stop using drugs, but to encourage physical activity.

Observational Learning:

People learn by watching the actions and outcomes of others people's behavior. We wanted to incorporate this construct in the application. As the application is a social network in 2016, the friendship relation is natural. We chose to implement a friend system partly because of the observational learning, and partly because it helps people find activities they want to participate in based on what activities their friends are participating in. By observing what your friends are attending, you know more about what you can attend yourself, based on your and your friends' shape.

We also added post and comment functionality, so that people can share their feelings about the activities. We think this is even more important for this construct, because you can learn more about how the person in question actually felt; if it looked like a hard activity, but the person thought it was okay and you know you are in about the same shape, it means that you probably are fit enough to participate in the same activities.

Reinforcement: Positive behavior in our application is to attend activities regularly, e.g. to do physical activities regularly. The reward, as we see it, is to get real social interaction with other people, in addition to getting fit. We did not incorporate any specific rewards in the system, as we think that if you are using the system without the intrinsic motivation to do physical activity, you probably use it because you want the social interactions you get by attending the activities. Meaning that if you want to be social by using the application, you need to attend the activities and stay in shape.

Self-efficacy: The self-efficacy of a person is determined by several factors, like experience, modeling and social persuasion. We have incorporated this construct in the following ways:

- Activity intensity: When a user creates an activity, the intensity of the activity is chosen. This gives other users an idea what to expect from the activity and comes as an addition to the description of the activity, which can go even more into detail about the activity. Say a user have attended a moderate activity before, and is unsure whether to attend another at a later time. We think that the intensity indicator and the user's own prior experience will give them enough self-efficacy to attend the event.

- Friends and posts/comments: As explained under Observational Learning, people model what other do, like their friends. If a person is unsure about attending an activity because of low self-efficacy, seeing a friend attend the activity might just raise his self-efficacy enough to make him attend the activity himself.

The news feed system is a feature that enhances both the observational learning and the

self-efficacy construct, because it makes the events happening in the user's network more available to him(events that as explained above affect both observational learning and self-efficacy).

Prompts are not directly based on theory. However, like the news feed the concept of social prompts is supported by Social Cognitive Theory in that they make the user aware of the different social network happenings, which again affect the observational learning and self-efficacy.

Cognitive Evaluation Theory

The Cognitive Evaluation Theory focuses on autonomy (an individual's freedom of his own will or action), and also how intrinsic motivation is affected by external inputs; autonomy and competence support intrinsic motivation, which is critical for engagement in activities. Ludi gives its users autonomy in the sense that they can plan and attend whichever activities they like. The degree of autonomy (empowerment) in Ludi is high. If the user-base is high enough, then each user will be presented with a wide range of different activities. The users have no predefined exercise strategy, thus they can freely decide which activities to attend. We chose to give the users high responsibility because we hypothesized that it might increase participation in the intervention.

The different functionality is mapped with the elements of the theories below. Table 3.2.

Table 3.1: Different functionality mapped with elements of the theories

Theory element	Functionality
Observational Learning	- Friends - Posts and comments - News feed - Prompts
Reinforcement	- The real life sociality occurring when participants meet and do activities together
Self-efficacy	- Activity Intensity - Friends - Posts and comments - News feed - Prompts
Autonomy	- By creating and attending whichever activity the users like, they have much freedom over the intervention

3.5   Choice of ICT platform

Our research question asks about the use of mobile ICT to create a behavior change intervention to increase physical activity in the general population. We asked ourselves, what mobile ICT is best suited for our concept? We had some alternatives, like smartphone applications, tablet applications, web applications(which can be used both on mobile devices and laptops or desktops) or applications for wearable devices like smart watches or smart armbands. Wearable devices could be combined with both smartphone-, tablet-, and web-applications as well.

The pros and cons for the different devices are listed in Table 3.2.

Table 3.2: Different mobile ICT

Device	Pros	Cons
Smartphone application	- Runs on a device that is easy to carry around - Accessible for a large amount of people - Native feel - Notifications deeply integrated in the popular platforms	- Can only be used on the platform(s) it is created for
Tablet application	- Large screen size makes it easy to operate - Native feel - Notifications deeply integrated in the popular platforms	- Not well suited for carrying around too much - Can only be used on the platform(s) it is created for
Web application	- Runs on most devices that include a web-browser, so is accessible for most people	- No native feel on any platform - Must be accessed through a web-browser - Notification support only on some platforms(mostly desktop web browsers)
Wearable application	- Extremely portable - Native feel - Notifications deeply integrated in the popular platforms	- Small screen size(or no screen at all) - Awkward input methods

What weighed the most for us when we chose the technology to use was the smartphone's portability combined with the large amount of people that owns a smartphone. We could also create a web application which could be accessed from a smartphone. However, we do

not think this is as easy to use, as the application will not be native for the system and has to be accessed through a web-browser. Also, there is no native notification support when using most smartphone web browsers(with Google Chrome on Android as an exception). This could be solved by sending emails or SMSs; however, we do not consider this a good solution, as the user will be dependent on other applications to fully utilize our application.

Tablet computers have become popular, and people find it easy to use because of the large screen size. However, we are creating an application that the user might want to carry with them, and the large size of the tablet makes it cumbersome for this usage.

The last category is wearable devices. We did not really consider this much, as few people has got them and they do not really fit our concept with it's limited input methods.

For more specifics about the choice of technologies see Section 4.1

Chapter 4

Technology

In this chapter we discuss the technology used, the architecture of the system, and the data model. In addition we provide an installation guide to the backend system.

4.1 Development Environment

Below is a list of the technology we used to develop Ludi.

- Native Android for the frontend
- Spring Framework for the REST API
- Hibernate as an object/relation mapping system between the API logic and the database
- PostgreSQL for persistence

We chose a simple REST API for the entrypoint to our backend. We used Spring Framework for this, as we wanted a popular framework preferably based on Java, with a large community. We chose the relational database PostgreSQL for persistence with Hibernate as an object/relation mapping system, to work with objects instead of directly towards the database entities.

Frontend we chose native Android. As this is a research project we do not need to support all platforms, and as we were both comfortable programming for the Android platform, that was the natural choice.
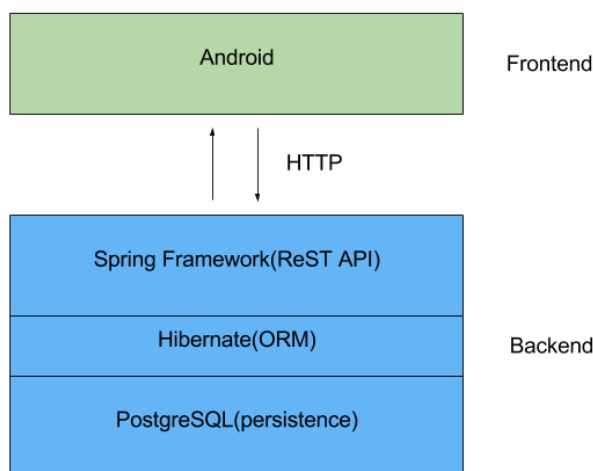
Figure 4.1: The technology stack

4.2 Architecture

In this section we look at the architecture of the system. The system consist of a backend and a frontend, making a typical Client-server architecture. To communicate between the back and front end, we use the HTTP protocol.

Frontend

Frontend we used the Model View Presenter pattern as the architectural pattern. This pattern says that the view communicates with the presenter, which again communicates with the model. In addition, we added an interactor layer. As we have a backend system to communicate with, it is natural to separate this interaction from the presenter layer. Figure 4.2 illustrates the Model View Presenter pattern. A package diagram for the frontend can be found in Appendix D.
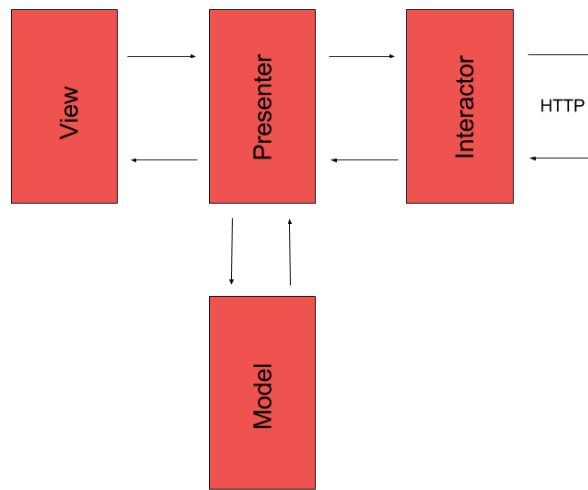
Figure 4.2: Model View Presenter

Backend

Backend we chose a layered architecture. The entrypoint to the backend is a controller layer, which accept HTTP requests. This layer communicates with a service layer, which again communicates with the hibernate model and the database. Figure 4.3 illustrates the layered architecture. A package diagram for the backend can be found in Appendix D.
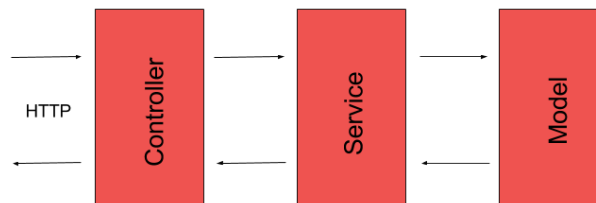
Figure 4.3: Layered architecture backend

4.3 Data model

Figure 4.4 shows the model of the database entities. Fields marked with a key are primary keys. Fields marked with a green arrow are foreign keys.
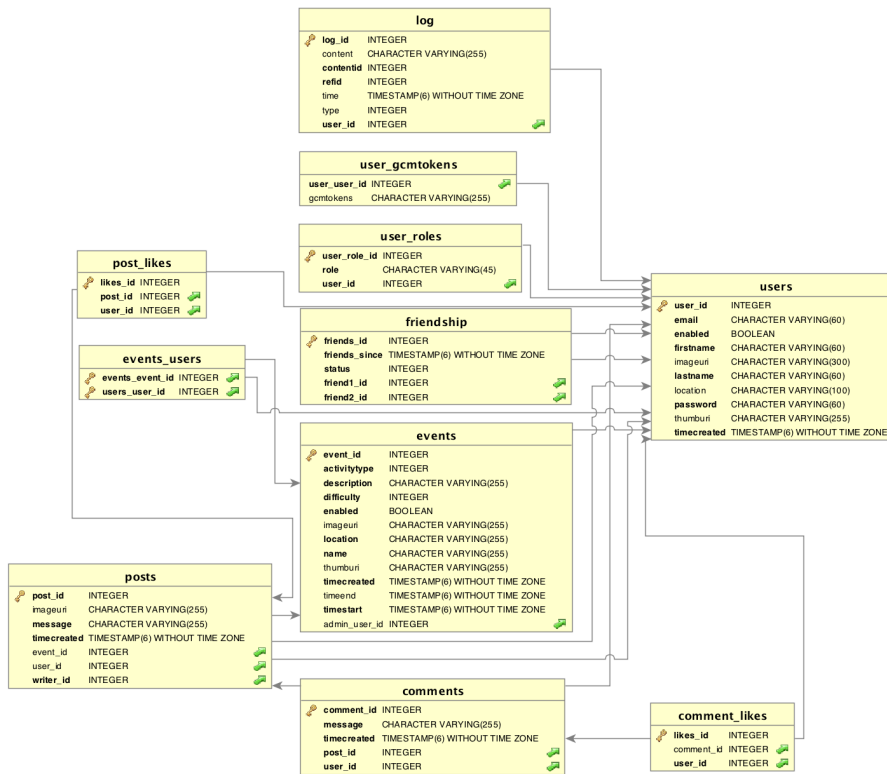
Figure 4.4: Data model

4.4 Using the API

All paths mentioned in this section are relative to the root of the *master-backend* directory, which is the Spring project that is an attachment to this report. It can also be downloaded from [29].

The REST API we created for our backend can be used to create applications for other devices as well as new applications on the Android platform. The most relevant platforms to develop for would be Apple's iOS and the web.

To develop a new application using the REST API, see the javadoc(located in */javadoc*) for documentation. An issue that might need to be resolved when creating a new application,

is the prompting feature. As it is implemented backend today, it works for Android and iOS devices. If an application for web is going to be created, some way of prompting the users need to be resolved. Possible solutions are email or SMS.

4.4.1 Installation guide

To install the backend API, you need the abovementioned Spring project. You need to follow the below steps to get it running.

- Set up a relational database supported by Hibernate [30].

- Access the file *src/main/resources/hibernate.cfg*. Edit the driver class, connection url, username, password and the hibernate dialect to match your database setup. The default configuration is for a PostgreSQL 9.5 database with the *PostgreSQL82Dialect* dialect using the *org.postgresql.Driver* driver.

- To make Hibernate initialize the database on project run edit the *hibernate.hbm2ddl.auto* entry in the same file to *create-drop*. To run the project later without dropping the tables, set this entry to *update* for the next run.

- To make sure the images get the right URL, access the *src/main/java/com/andreasogeirik/tools/Constants.java* file and set the *BACK-END_URL* to use your IP. Remember to still include the port and the slash at the end of the string.

- To run the project you need Maven 3, which can be downloaded from [31].

- Go to the root of the project in a terminal window and write *mvn clean package spring-boot:run -Drun.jvmArguments=´-Dserver.port={YOUR_PORT}´*

- If all the above is done correctly, the backend should be running on the specified port.

Chapter 5

First Iteration

Report Overview

- *1. Introduction*
- *2. Related Research*
- *3. Ludi:A Social App for Increased Physical Activity*
- *4. Technology*
- **5. First Iteration**
- *6. Second Iteration*
- *7. Conclusion and Future Work*

The first iteration started off with some planning of how to implement the functionality discussed in Section 3.1. Before implementing the functionality we did some work on designing the system, as explained in Section 5.1. After implementing the functionality, we had a usability test, see Section 5.3.

5.1 Design

After settling on the functionality, we did some work on the design of the system. We decided to create paper prototypes of the main functionality of the application. The paper prototypes were a good starting point for discussions about the design and were the first building blocks towards the final implementation of the first iteration. The prototypes can be seen in Appendix A.
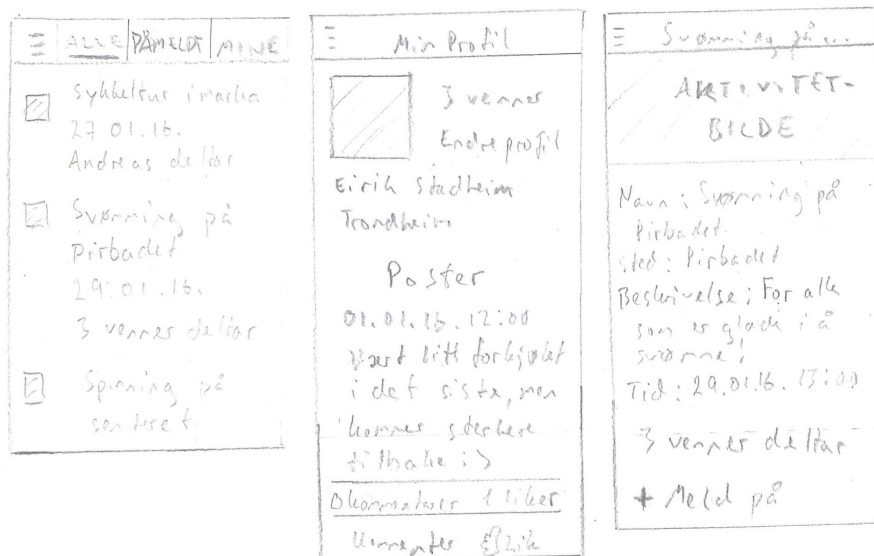
Figure 5.1: Some of the early paper prototypes

As we wanted the application to be easily usable for most people, we wanted to focus on people that are not that used to smartphones when we designed the system. In [32] they researched how well novice users understood buttons that showed icons, compared to buttons that showed text. They found that novice users preferred text over icons.

This made us decide to go with a lot of text for various user interface elements, instead of icons, as our early sketches show. Later, while implementing the system, we felt that the (largely)text-only interface got a little too plain. This is an application for motivating people, so we used icons in addition to make it more fun to use. However, we have kept the large amount of text, to keep it as easy to use as possible for all kinds of users.

We chose to mainly have a white background with dark gray text, to get high contrast and good readability for elderly people. In the post- and comment part of the system, we felt that we had to separate comments from posts in a clear way. As they look very alike and follow each other in the post- and comment-list, we decided to go with two different colors. A faint gray for the posts and a faint teal for the comments. By using the faint colors we maintained the high contrast, although a little less than the dark gray on white.

There might be big differences in the vision of the users of the system. Letting the users change the text size is a great way to make it accessible for everyone. We were planning on implementing a text size chooser, so that people could choose the text size that fit them the best. We scratched this when we realised that this can be chosen globally for the Android system. We had to make some modifications to the text views in our system to support this.

In the end we tried to create an easy-to-use design, without any cumbersome functionality. We did this on purpose, because especially novice users might find it hard to navigate when

there are too much functionality around. For example, we considered a map-functionality to specify the location for activities, but considered it more as an obstacle for the simplicity of the system.

In [33] they created a list of heuristics for UI designers focusing on small/smartphone screens for elderly people. We do not focus on elderly people in particular, but they are a part of our target group and should be kept in mind during design. We chose to follow the cognitive heuristics when creating the intervention, which is the heuristics we feel added most to the intervention. The cognitive heuristics are listed in Table 5.1 along with an explanation of our implementation(and a reason if we did not follow the heuristic).

Table 5.1: Cognitive heuristics for UI design of small-screen device

Heuristic	Our implementation
Shallow menus	Functionality is spread across action bar and different pages.
All information for a given need on one page	Mostly, we include all information on one page. The article says that scrolling should be avoided because of mnemonic problems. We have ignored this, as we have not found a good way to include the functionality and information we want without the use of scrolling.
Avoid deep hierarchies, group information	We have grouped information for each domain in their own pages of the application(user profiles, activities, news feed)
Select important actions and make them easiest	We have had focus on creating an easy-to-use application all around. However we have provided easy access to both recommended activities, the activities a user participates on, and is admin for, as we think this is the most important part of the system.
Be consistent with details of interface	We have tried to be consistent with the layout of the different pages, so that similar functionality works the same way across the pages.
Don't force use of multiple tasks	All tasks focus on one thing, so to not require any cognitive switching. Examples are create user, edit user, edit password, create activity, edit activity, join activity, withdraw from activity, search for user etc.

Support easy paths	We have provided a home button on all pages(except the home page), so that if the users get stuck in the application, they can always get to the familiar home page.

5.2 Product

After the first iteration the application had the following functionality:

- Login and registration
- User profiles: profile page, edit profile
- Activities: activity page, recommended activities list, attending activities list, my/admin activities list
- User search
- Post and comments on users and activities
- Notifications and a notification page where friend requests were shown

5.3   Usability Testing

After the first implementation, we conducted a usability test. This section will cover how the testing was performed, results of the tests, and a final discussion of the results.

5.3.1   How the Test was Performed

The usability test was initialized by inviting people in our network to test the application. The only requirement was to have access to an Android smartphone of version 4.1 or later. 10 people agreed to test the application. They were a combination of our friends and family. We sent out links to our web-site (Figure 5.2) where they could download the application. The testing process lasted one week, and each individual test took about 30 minutes to complete.

Figure 5.2: Ludi web page

The web page included a form that could be used to report bugs in the application. It also included a questionnaire which the users had to answer upon completing the usability test. The questionnaire was created following the System Usability Scale (SUS) standard [34]. The SUS contains 10 standardized questions that are often used to measure the usability of software systems. In addition to the 10 SUS questions, we also added questions of our own to target specific features of the application. Some of the questions used the Likert scale, just like the SUS. These questions were mostly there to get the people thinking before answering the free text questions in the end, where we would get specific opinions about the system.

After aggregating the results, we saw that some SUS questions did not do quite as good as we wanted. For that reason, we interviewed a selection of the people who answered the questionnaire, and asked them the reason behind their answers to the SUS questions. The entire questionnaire can be found in Appendix B. The results can be read in the next section.

5.3.2 Findings

In the following section we will give a summary of the results from the usability test. The questionnaire generated both quantitative and qualitative data. The quantitative data was generated from answers to the multiple choice questions, whereas the qualitative data was generated from questions where the users could input their own thoughts. The multiple choice questions followed an answering scale from 1 to 5, where 1 was strongly disagree, 2 disagree, 3 neutral, 4 agree, and 5 was strongly agree.

100% of the participants were male, and 90% were in the age group 22-29. 10% were in the age group 50-64.

The questions and answers in the coming sections were originally in Norwegian, and is translated for the purpose of this report. For a full bug report and a summary of the new/changed functionality the testers wanted, see Table C.1 and Table C.2 in Appendix C

System Usability Scale

A summary of the SUS questions and answers can be seen in Table 5.2. From the answers we calculated a SUS-score of 84.5.

Table 5.2: Answers to the System Usability Scale

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I think that I would like to use Ludi frequently.	22%	33%	33%	11%	0%
2. I found Ludi unnecessarily complex.	89%	11%	0%	0%	0%
3. I thought Ludi was easy to use.	0%	0%	0%	30%	70%
4. I think that I would need the support of a technical person to be able to use Ludi.	90%	10%	0%	0%	0%
5. I found the various functions in Ludi were well integrated.	0%	0%	0%	80%	20%
6. I thought there was too much inconsistency in Ludi.	70%	30%	0%	0%	0%
7. I would imagine that most people would learn to use Ludi very quickly.	0%	0%	20%	40%	40%
8. I found Ludi very cumbersome to use.	80%	10%	0%	10%	0%
9. I felt very confident using Ludi.	0%	0%	20%	20%	60%
10. I needed to learn a lot of things before I could get going with Ludi.	90%	10%	0%	0%	0%

Activities

We included five multiple choice questions about the activity functionality.

Table 5.3: Answers to the Activities

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
It was easy to participate on and withdraw from activities	0%	0%	10%	0%	90%
It was easy to create an activity	0%	0%	0%	20%	80%
The activities were easy to understand	0%	0%	10%	30%	60%
Finding people who have participated on a specific activity was easy	0%	0%	0%	20%	80%
Finding people you have been on an activity with was easy	0%	0%	33%	33%	33%

In addition, the question *"What do you think about the activity concept in Ludi?"* gave the following answers:

- "I thought it was cool, would maybe be a bit cooler with some motivational factors to participate."

- "Very good. This made it easy to be oriented about activities."

- "Nicely done. Easy to understand. Opens the possibility for local teams to gather easier and faster."

- "Easy and recognizable concept, does what it says."

- "It's very similar to Facebook events. I like the possibility in Ludi to specify type and intensity of the activity."

User Profiles

We included three multiple choice questions about the profile page.

Table 5.4: Answers to the profile page

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Creating a user profile was easy	0%	0%	0%	20%	80%
The profile page was tidy	0%	0%	0%	60%	40%
There was enough information about the users on their user profiles	0%	0%	56%	11%	33%

In addition, the question *"What do you think about the profile page?"* gave the following answers:

- "Okay, straight forward"

- "Quite okay. Depends on what you want to do. If you are already friends with the user, the profile page is good. But if I search for people I don't know, it is a bit too little information."

- "Tidy. Don't need many seconds to understand the profile page."

- "A bit too little information"

- "Nice, but I would like to see another color on the "Participating on X activities" button. Place of residence could have included country. You could have added some information about the age group the person belongs to."

- "I like watching the images. It's also interesting to read posts (wish there were more of them) and see what activities other people attend."

Posts and Comments

We included three multiple choice questions about the post and comments system.

Table 5.5: Answers to the posts and comments functionality

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Writing a post was easy	0%	0%	0%	11%	89%
Commenting on a post was easy	0%	0%	0%	0%	100%
In general the post and comment system was easy to use	0%	0%	0%	38%	62%

In addition, the question *"What do you think about posts and comments?"* gave the following answers:

- "Very nice to be able to create posts on other people's activities, to provide input or questions."

- "Good to have this choice. But for example "2 likes 1 comment" was a bit hard to click, when I wanted to see who likes the post."

- "Tidy and alright"

- "I don't like the way the comments are colored. I first thought the comments were my comments. I would also have wanted to see my own posts/comments colored/highlighted. Comments should be smaller, maybe have more indentation. If a post has many comments, this should be minimized(add a load more button or similar). It's too much to scroll with all the comments present."

- "One of the functionalities I liked the most. Easy to be social through them."

Uncategorized Questions

Three uncategorized multiple choice questions were also included.

Table 5.6: Answers to the uncategorized questions

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The icons that were used were easy to understand	0%	0%	40%	20%	40%
Finding other users' profiles was easy	0%	0%	30%	50%	20%
Adding friends was easy	0%	10%	0%	40%	50%

In addition, the question *"Have you got any further comments about Ludi?"* gave the following answers:

- "I thought the app was very good. Very nice to have a platform for this. If this was for example a Facebook event, many elderly would probably be scared to make a fool of themselves by making mistakes. Easier to keep control with Ludi :)"

- "There was no indication that there was a "Notifications"-page up left on the main page, but I found it after some clicks. It should have been moved up right and some text should be added."

- "The withdraw button on your own activities should be fixed. You could remove it because you cannot withdraw from own activities. Or you should be able to create a new leader/creator of the activity in case the creator withdraws, or delete it completely. Instead of delete activity, you could have "Cancel". Allow users to choose/recommend a type of age group for each activity. In the home feed users can receive recommendations."

Post-Questionnaire Interviews(SUS)

The answers to the interviews we did with users that had finished the questionnaire are summarized in this section. The answers explain why they gave the score they did on the SUS questions(if they did not give full score).

Question 1: I think that I would like to use Ludi frequently.

- *"I think that if all of my friends were in the application, I might use it more often."* (Tester nr. 2)

- *"I cannot be alone in the application, I need more friends to participate."* (Tester nr. 3)

- *"There already exist well established social networks. But I think the concept of angling the events towards physical activity is good"* (Tester nr. 6)

- *"As I already have a well established network on Facebook, it's hard to move."* (Tester nr. 9)

Question 2: I found Ludi unnecessarily complex.

- *"A little bit messy with the buttons and colors"* (Tester nr. 9)

Question 5: I found the various functions in Ludi well integrated.

- *"Some strange bugs occurred so that a user could add me multiple times, and sometimes two of the same activity was displayed in the list of activities"* (Tester nr. 2)

- *"There was a bug in the activity list, sometimes showing duplicate elements"* (Tester nr. 3)

- *"I had an error when uploading images, which made me feel insecure about the application"* (Tester nr. 6)

- *"Notifications on friend requests showed that I accepted my own friend request when a user accepted my request. Sometimes data wasn't loaded"* (Tester nr. 10)

Question 6: There was too much inconsistency in Ludi.

- *"Confusing navigation. I didn't understand the home button. It's not Android convention to use home buttons"* (Tester nr. 10)

Question 7: I would imagine that most people would learn to use Ludi very quickly.

- *"I was thinking about elderly people. Maybe they will find it too complex"* (Tester nr. 2)

- *"Some items don't look like buttons, it might be confusing to know what can be clicked, and what cannot"* (Tester nr. 9)

- *"I don't think everyone are as familiar with smartphones as I am."* (Tester nr. 6)

- *"People are different. It might be harder for someone else than it was for me"* (Tester nr. 3)

Question 8: I found Ludi very cumbersome to use.

- *"Some things were a little bit unintuitive. For example, the home button changed when navigating the app"* (Tester nr 2.)

Question 9: I felt very confident using Ludi.

- *"I don't like having pictures of myself in any app. It reduced my confidence slightly"* (Tester nr. 2)

- *"I don't like that everyone can comment on every activity"* (Tester nr. 6)

5.3.3   Discussion

From the SUS, the application received a score of 84.5 out of 100. This number is above what is considered average (68 is average) according to [34]. This might indicate that the usability of Ludi is good, but there are still some issues to solve.

Question 1 "I think that I would like to use Ludi frequently." had the lowest average score of all the questions. In the SUS interviews we got some good answers explaining why this question scored so low. It was much as we expected when we saw the low result. Some interview subjects said that they already use their well established social networks. We created the intervention much because other social network platforms, while they provide much of the same(and more) functionality, do not provide the PA focus and simplicity. We think that especially novice and the more elderly users will prefer Ludi to plan activities much because of its simplicity.

Question 5 "I found the various functions in Ludi were well integrated" shows that most functionality already is well integrated in Ludi. In the interviews we only got some response to a few bugs appearing, which we intend to fix in the next iteration.

Question 7 "I would imagine that most people would learn to use Ludi very quickly" scored lower than most questions. As the answers to the interviews say, people think that the application would be harder to use for e.g. elderly people than for themselves. This is backed up by the positive response to "I thought Ludi was easy to use". The group of respondents are mostly young people who are used to smartphone applications, and this reflects the answers.

Question 9 "I felt very confident using Ludi" did not score as well as we wanted, with 20% being only neutral. One mentioned that he did not like having pictures of himself in the app, while the other who answered said that the comment system on activities was too open(everyone can comment on an activity).

These are personal preferences. Profile images are a central part of the application, allowing users to recognize each other after participating on an activity. We think the openness of the comment system is natural, as people should not have to be attending the event yet only to ask a question about the event. You might have a lot of questions before you want to participate on an event.

On the other questions in the SUS category we more or less got positive answers.

Chapter 6

Second Iteration

Report Overview

- *1. Introduction*
- *2. Related Research*
- *3. Ludi:A Social App for Increased Physical Activity*
- *4. Technology*
- *5. First Iteration*
- ***6. Second Iteration***
- *7. Conclusion and Future Work*

The second iteration started after the evaluation of the usability test. We absorbed the feedback from the previous iteration, and started planning the next. The goal of this iteration was to conduct interviews that answered our research questions.

6.1   Planning and Implementation

Before we could do more in depth testing, we had to take care of bugs and implement additional functionality that was requested during the first iteration. The most comprehensive update was to implement a news feed. This feature was requested to further improve the sociality of the application. The news feed should notify users of "events" (not to be confused with activities) happening in the application. E.g. an activity has been created/canceled, or someone has written a post to an activity you are participating in.

It was also requested to implement activity types. These are different categories of physical activity, like running, hiking, swimming etc. The purpose of them is to make it easier for the users to see what an activity is all about.

6.2 Product

After the second iteration, the application had gone through the following major functionality changes:

- News feed: events from the network appears on the home screen

- Activity types: each activity has a type with it's own symbol

- Participants widget on activities and friend widget on user profiles, showing images of up to 10 participants/friends

- Canceling activities: instead of deleting activities, they are now only canceled. This makes it easier to keep track of the activity if it gets canceled. Earlier it only disappeared.

6.3 Interviews

6.3.1 Conducting the Interviews

At the end of the second iteration we let five people who had already used the application after the first iteration, use the new application. The five people had also completed the usability test last iteration. After they had tested the new application, we had an interview with each of them, where we explored different aspects of the application, and PA interventions in general.

The questions were divided into four categories:

- Opening questions: included some general questions on fitness applications and social networks in relation to physical activity/exercise.

- Social: included some general questions on sociality in relation to physical activity, and some specifically on the social elements included in Ludi.

- Prompting: included some questions about prompting in general and about different prompting mechanisms.

- Empowerment: included some questions about empowering users in an intervention.

The interview questions and a summary of the answers can be found in Section 6.3.2.

6.3.2 Results

In this section the answers from the interviews are summarized. A summary of the findings in relation to the research questions can be found in Figure 7.1.

Opening Questions

The interviews started off with some general questions on fitness applications and social networks in relation to physical activity.

1: Have you ever used a mobile fitness application?
Four respondents had used a mobile fitness application, one had not.

1.1: Do you use mobile fitness applications on a regular basis?
Two people used it on a regular basis.

1.2: Do mobile fitness applications have any effect for you?
People responded that they needed an app to get motivated and liked to have control over their everyday life. One responded that it had not had any effect on him, but believed it could have.

1.3: Do you miss anything from mobile fitness applications?
One wanted an app you would not grow tired of. Two people responded very specifically for the app they used. One of them wanted more exercises and some social features(StrongLifts 5x5[1]). The other wanted a larger selection of foods to track what he was eating and a better search engine(Samsung S-Health[2]).

1.4 Are mobile fitness applications something you would have used?
One respondent planned to start running and wanted to use a fitness app for that.

2: Do you use social media to plan exercise?
Two people used social media to plan exercise. One of them used a chat program. Another one had multiple Facebook groups for football on different geographic locations.

Social
The research question in relation to sociality was:

RQ 1.1: How can the interplay between being social in real life and on a mobile ICT device affect engagement in a PA intervention?

The social questions are listed below and include some general questions on sociality in relation to physical activity, and some specifically on the social elements included in Ludi.

3. What does Ludi provide that a typical fitness app(where the social element stays inside the application) does not?

One person did not view Ludi as a fitness app, and missed logging functionality and statistics. Two people said it was easier to join in on other's activities. One had more belief in training with other people, instead of just sharing the results. One said it was great if you

---

[1]A smartphone fitness application that focuses on strength training [35]
[2]A smartphone fitness application created by Samsung [36]

appreciate the sociality, but would maybe use a typical fitness app if the focus was hard exercises. One liked training alone and did not care much about the sociality.

3.1 Does the interplay between sociality inside the application and sociality in real life make you motivated?

One said that it can affect motivation, if people actually participate on the activities. One was most motivated by exercising alone. One was motivated by social activities, but needed friends to dare to attend. One said it was easier to be motivated to exercise together than alone.

4. What extra benefits do you get from Ludi that you will not get from an exercise group that is not based on ICT?

One said better overview of what the activity is all about. Two people said a lower threshold for joining an activity. One mentioned that the community around the activity will increase, as people have a place to discuss the activities where all participants are present. Another said that it is easy to check if the activity is not cancelled or that other people are participating.

On the contrary, one mentioned that the need of a smartphone and an Internet connection is negative.

5. What do you think about planning physical activities on the smartphone before carrying them out with other people?

All subjects liked the concept. One did not see the meaning of having a specific application for it. One mentioned that it is a higher chance of the activity actually happening. Another mentioned that it is great to have a platform just for physical activities, so that all the planning can be separated from other services like Facebook.

6. Do you see any negative sides to the fact that all activities in Ludi are social?

One said exposing what you are doing at different times. Another said that it limits the application's area of use. He did not think that was all negative however. It only means that all PA cannot be planned on Ludi. As an example he mentioned closed groups, where only invited users can join in.

7. Do you find it motivating to see which activities other people participate in?

All people agreed in some way. One mentioned it would be like a competition with his friends, which motivates him. Others mentioned that they would be motivated to participate if their best friend or other people participated. One said it could become annoying with time for some, and that some might get discouraged by seeing very active people. He himself would be motivated however.

8. Do you find it motivating to see what other people write about the activities they participate in?

One said he would not read it. Another said that it was not that exciting, but that it is useful if important information was posted. Another agreed on the latter. One mentioned that positive messages would be motivating, especially if you are a little unsure about or

not used to the activity. Another said that it if you are unsure about the activity, you can be assured by what is written about the activity and maybe recognize a few faces when you attend the activity.

9. If none of your friends attend an activity, do you see that as an obstacle for attending the activity?

One said it would be good to have friends when doing new activities, if you are scared of making a fool of yourself. Another said he probably would not be attending an activity if no friends attended. One mentioned that good information and posts about the activity will help people get past that obstacle. Another said that in a healthcare situation it would not matter, but if the application was used as an "everyday tool", it might be harder to attend without friends.

10. Do you see any negative sides to a social intervention?

One said it might be problematic for introvert people and suggested both private and public activities. Another mentioned that surveillance is a problem because people can know where you are at a given time. One said that it all depends on whether you are social by nature or not, but suggested that the application might help less social people past the social obstacle. Another mentioned that other features can be added to make the users keep using the application, for instance gamification elements.

Prompting

The research question in relation to prompting was:

RQ 1.2: How can the use of prompting and different prompting mechanisms affect engagement in a PA intervention?

The prompting questions are summarized below and include some questions about prompting in general and about different prompting mechanisms.

11: What do you think about being notified by the application about different events in the system?

Most people were afraid of being notified too often. It could be seen as spam, which could turn them away from the intervention. One requested that different notifications should have different ways of notifying the user. E.g. some notifications that are less important should not vibrate, they should be more hidden, and not take too much attention.

11.1: Would you be motivated by these notifications?

There were mixed feelings about whether notifications would motivate them to participate or not. Some said that it would motivate them if the notifications were relevant, others said that they would not be motivated by any notifications. One who said that he would not be motivated, said that the intrinsic motivation is more important than receiving a reminder to participate. But if he was already motivated to participate, then the notifications could be helpful to maintain exercising.

12: Would you be most motivated to participate in the intervention by motivational messages delivered periodically by the system, or social messages that occur as result of a

social happening in the system?

Everyone answered that they would be more motivated to participate by receiving notifi-cations as a result of social happenings. For some it was important that the messages they received contained information about their friends' actions in the system. It was suggested that a message can be a notification sent to the user as a result of a friend's participa-tion in an activity. One said that periodic messages would be ignored, and just "swiped away". One said that he would like to filter the notifications to avoid spam. One also said that generic system messages could work, but only if the messages were relevant enough. E.g. if the system tracked the users PA levels, then this data could be used to calibrate the frequency of the notifications. He also said that the system could not know if he had been active without using the application, and that he would not like to be prompted to get physically active if he had been active not using the application.

13: Do you see anything negative about receiving notifications?

They were afraid of receiving too much spam.

Empowerment

The research question in relation to empowerment was:

RQ 1.3: How can the users' empowerment affect participation in a PA intervention?

The questions on empowerment are listed below.

14: Would you like to have control over your own intervention, or would you like to have a fixed plan which is created by a health care specialist?

Overall, people liked to have more control. One said it depends on your goals. If the goal was to be more physically active, then it would be nice to have a health care specialist set up an initial plan. If the goal was to have fun, then it was preferred to have more self-control. Several agreed that setting up an initial plan by a specialist could work; one suggested that people are not the same and should get different treatment. Another said he would like control, but realised that if people are struggling, a plan could be a good thing.

15: Do you see any social challenges by giving the users high autonomy, like we do in Ludi?

One said that it can be challenging to create activities when you are new in the application. You don't know any people, and you are not sure if anyone will show up. Another said that by creating an activity, you are responsible for a successful execution, thus it can be frightening to create activities you don't have any previous experience with. Even though you want to do an activity, it can be tough to initiate because it might be expected that you have previous experience.

16: Do you see any negative sides by having too much control over your own intervention?

Two people said that if people are too lazy, it might be hard to partake in the intervention on their own. You might need an additional push from a specialist. Maybe the specialist should start the activities, so that people can build their network from there. One person

said that it might be overwhelming that everything is open, and you might not know where to begin.

6.3.3 Discussion

Social

From the interviews we saw that people were mostly positive towards the concept of planning activities socially within the application and performing them together in real life. It was mentioned that it was great to have a platform that specifically targeted physical activity. People's goals and level of extroversion were important factors of the motivation to participate in activities. If the goal is to focus on specific exercises e.g. weight lifting, or if the person is introverted, then Ludi might not be satisfying. We see that some exercises are better to perform alone, and that some people just prefer to exercise alone.

The fact that people are motivated by being active together, speaks for Ludi's focus on performing activities together. People liked the combination of being able to plan their activities on their smartphones and have all the information they needed about the activities there. This indicates that the interplay between sociality in the application and the real life sociality while doing the activities is something that works.

It was seen as motivating to see which activities other people participate in. People find it important to see how many others are participating, as a social activity without any people would be rather repellent. If other friends are participating, then the motivation to attend would increase even more. The optimal combination might be a mix of friends and strangers. When someone sees that a friend is participating, he might be motivated himself, and he might also expand his social network by being introduced to strangers. This is what we aimed for when we created Ludi, and the response we got indicates that this will work well.

Friends are an important factor of the intervention. Without friends in the system it could be challenging to attend and create activities. The goal of Ludi is to reach out to individuals who want to increase their PA levels, whether they have friends or not. We see that it might be hard to motivate introverted people by introducing them to the application without any further assistance. They might feel a social pressure to succeed, and thus be afraid to partake in the intervention. This problem can be addressed by introducing private activities in addition to the public ones. By including private activities, we can give health-care specialists permission to create activities for individuals in the same situation. People with commonalities might find it easier to attend activities together, as they can relate closer to each others' situation. We think this might reduce the social pressure one might feel to create and attend activities. Also by making the application too open, people might feel exposed, in the sense that everyone can see which activities they are attending. This might be a barrier for some to participate. Not everyone like to share their accomplishments and failures with people they do not know.

On the other hand, we want Ludi to be as open as possible. If the application is flooded with private activities, then the main benefit of a large open activity base is destroyed;

Ludi should reach as many people as possible. As one interview subject said, it is easy to join in on activities with people one do not know. This makes an extra opportunity for attending activities without the dependency on your friends and without having to do the activity alone.

Prompting

When it comes to prompting, people tended to be very negative about it in general. They explained that some mobile applications prompted them so much that they considered it spam. Regarding motivation, one disagreed that he would be motivated at all(but later said that some social prompts might work), while others admitted that it could motivate them if done the right way.

Everyone said they would be most motivated by prompts triggered by social happenings, like friends creating activities, while most people would not be very motivated by system-generated prompts. This was what we thought in the first place. It does not take long for people to see that a prompt is auto-generated from the system and this can make them lose interest, as they are often very repetitive. What we tried to do with the system-generated prompts was to make them context-aware, by checking the user's activity levels the coming week, before possibly sending a prompt. The message would say that they should plan some activity the next week.

One person discussed the context-aware messages, and said that they could motivate if they were relevant enough. However, he would not want the prompts if he had been physically active without using the application. This might be impossible for the system to know without any input from the user, like for instance tracking the user all the time. That is probably not feasible either, as it can drain the battery and users might not be too fond of being tracked at all times.

This makes us believe that system messages could need something more than only being context-aware. We believe a hybrid approach might be better. For instance, the system can know that the user has not been active lately, or has not planned to be active. Instead of sending some generic prompt to the user, the system could find happenings in the social network(like future activities) and use them as motivation for the prompt. This would be typical system messages in that their source is the system wanting to prompt the user to do PA; however they will disguise themselves as social prompts, which seem to be the preferred prompts to receive for most users.

Empowerment

In Ludi we give the users/participants all the control of the intervention. They can create their own and join other's activities. The results from the interviews support this way of doing it, as most people liked a lot of control. However, some discussed that it could be great with an initial plan set up by a health care professional, but preferred to have more autonomy as time goes by. One said that people that lack motivation might need help from a professional.

What is actually possible in Ludi, if input from health care professionals is wanted, is to make them arrange the activities. This way we allow the users to choose between

a high level of autonomy(by creating activities themselves) or lower levels(assisted by professionals).

In the interviews, someone discussed that the high autonomy might be challenging in the start, because people might be scared that no one will show up to their activity. We believe that some users, when new to the application, might be most comfortable in participating in other users' activities. However, as time passes we believe more people will get accustomed to the concept and will enjoy creating their own activities. Other users will be completely different, and will not have any problems taking the initiative in creating activities.

It was also mentioned that if someone is not familiar with an activity it might be hard to take the initiative, because he will be viewed as the one responsible for the successful execution of the activity. If that is the case, we think users will attend other people's activities of the same kind before they gain experience with the activity, and can create it on their own as well.

We could include other approaches, like motivational messages that tell the user to do something he has not done before, and that no one will make a fool of him. The reception these kinds of messages will have is hard to predict. Someone will probably be more comfortable after reading them. They might have a negative effect on others.

Evaluating the Theories

Social Cognitive Theory was used to guide the development of Ludi. It is hard to tell precisely whether the constructs of the theory worked or not. Most people seemed to like the concept of friends and seeing friends' activities, which supports both observational learning and self-efficacy. People liked posts and comments, but mostly to get information about activities, which is not the scope of any of the constructs. People were torn about the prompting, but seemed to like the social part of it, which is related to both observational learning and self-efficacy. Both the news feed and activity intensity were not discussed much in the interviews. People mostly liked the social reward after attending activities, supporting the reinforcement construct; however some mentioned that they liked training alone and did not need the social reward to motivate themselves.

We believe using the Social Cognitive Theory made us really evaluate the social features we wanted to add to Ludi. Our results does not strengthen the theory much, as some things were successful and others not so much. However it does not disprove the theory in any way, and we are content with the result of using it.

We also used the Cognitive Evaluation Theory to guide the development of Ludi. As mentioned, the subjects of the interviews were in general very positive to the high autonomy of Ludi. The fact that they liked it that much, tells us that the Cognitive Evaluation Theory seems to be working for our application and can be used in other projects where behavior change in PA is a target. However, one should not forget that people are different and might receive different effects by the same stimuli as other people.

Chapter 7

Conclusion and Future Work

Report Overview

- *1. Introduction*
- *2. Related Research*
- *3. Ludi:A Social App for Increased Physical Activity*
- *4. Technology*
- *5. First Iteration*
- *6. Second Iteration*
- ***7. Conclusion and Future Work***

In this chapter we make a brief conclusion, before we discuss some limitations to the study. We wrap up the chapter with some proposals to future work.

7.1 Conclusion

In this research we have created a PA intervention with the use of social, prompting and empowering elements. The intervention is in the form of a smartphone application called Ludi. Ludi is a social network where people can connect to be physical active together in the real life.

We found that people were generally positive to the concept of planning activities socially within the application and performing them together in real life. Most people preferred exercising together with other people, while some had a preference for exercising alone.

Prompting the users was something a lot of people was sceptical to. Social prompts was considered more motivational than prompts triggered automatically by the system. Context-aware system prompts was something that could work if the system was able to provide relevant information.

Having control over the intervention was something most people was fond of; however they also saw the potential of less personal control and more guidance from a health care professional, especially in the start of an intervention or if someone has low motivation.

A summary of the findings in relation to the research questions can be found in Figure 7.1.

7.2 Limitations

A limitation with this study is that the testing - both usability testing and interviews - has been performed with mainly a young age group. The application is made for all age groups, and it would have been interesting to get more information on how older age groups respond to the application. As we mention in the next Section, we have already planned testing with older adults.

In the initial design phase we did not use user-centered design. This can be seen as a limitation in the development of the product. However, the reason why we chose not to use it was that it could make the product deviate from our initial concept too much, so that our hypotheses/research questions would be hard to answer.

7.3 Future Work

Further research should include people from different user groups, especially related to age. A test with elderly users is already planned for the fall of 2016. The application can be ported to both iOS and Web(the most relevant platforms). The same backend could be used, but some modifications should be made to the prompting system if a web application is to be created. See Section 4.4 for more details.

Improvements to Ludi

The following improvements could be made in future versions of Ludi.

- Recommended activities should actually recommend activities. It now displays all activities in the system.

- The selection of activities should be extended to include a variety of different activities.

- Closed groups have been mentioned a lot by people trying Ludi. This is something that could be implemented, although in some ways it interferes with our concept of openness. We want Ludi to create friendships and connections between people. A thorough evaluation must be made to decide if this should be included or not.

Table 7.1: Summary of the findings on our research questions

Research question	Findings
RQ 1.1: How can the interplay between being social in real life and on a mobile ICT device affect engagement in a PA intervention?	- Seems to positively affect engagement by increasing motivation - Many people like exercising together with others, and the same people seem to like to plan the activities on Ludi - People are different: some prefer exercising alone
RQ 1.2: How can the use of prompting and different prompting mechanisms affect engagement in a PA intervention?	- Prompts could work if they are relevant to the user - Social prompts are more motivating than system-generated automatic prompts - In general people are sceptical to being prompted, because they receive a lot of messages they are not interested in
RQ 1.3: How can the users' empowerment affect participation in a PA intervention?	- People are motivated by being able to control their intervention - A planned course(less empowerment) was desired in the start of an intervention to get going

Bibliography

[1] Helsedirektoratet, "Statistikk om fysisk aktivitetsnivå og stillesitting," 2015. [Online]. Available: https://helsedirektoratet.no/folkehelse/fysisk-aktivitet/ statistikk-om-fysisk-aktivitetsniva-og-stillesitting

[2] WHO, "Physical Activity and Adults," 2016. [Online]. Available: http: //www.who.int/dietphysicalactivity/factsheet_adults/en/

[3] A. Isca, "The economic cost of physical inactivity in Europe Foreword and introduction from Mogens Kirkeby," no. June, 2015.

[4] F. W. Booth, C. K. Roberts, and M. J. Laye, "Lack of exercise is a major cause of chronic diseases," *Comprehensive Physiology*, vol. 2, no. 2, pp. 1143–1211, 2012. [Online]. Available: http://www.scopus.com/inward/record.url?eid=2-s2. 0-84862234497{&}partnerID=40{&}md5=523f30209f96d6c968ce62a5e0cf518d

[5] WHO, "Physical activity," 2016. [Online]. Available: http://www.who.int/topics/ physical_activity/en/

[6] J. Kruk, "Physical activity in the prevention of the most frequent chronic diseases: An analysis of the recent evidence," *Asian Pacific Journal of Cancer Prevention*, vol. 8, no. 3, pp. 325–338, 2007, cited By 88. [Online]. Available: https://www.scopus.com/inward/record.url?eid=2-s2.0-44449153693& partnerID=40&md5=f8d146b12df0e14c5a90aa2621172ee8

[7] NICE, "Behaviour change: general approaches. NICE guidelines [PH6]," no. October, 2007. [Online]. Available: https://www.nice.org.uk/guidance/ph6

[8] J. Fanning, S. Mullen, and E. McAuley, "Increasing Physical Activity With Mobile Devices: A Meta-Analysis," *Journal of Medical Internet Research*, pp. 1–10, 2012. [Online]. Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3514847/

[9] J. Stephens and J. Allen, "Mobile phone interventions to increase physical activity and reduce weight: a systematic review," *The Journal of cardiovascular nursing*, vol. 28, no. 4, p. 320, 2013.

[10] E. S. Andreas Næss, "A study of the use of mobile ICT to promote behavior change in physical activity," *http://www.ubicollab.org/publications*, 2015.

[11] F. E. Sallis JF, Owen N, "Social and Behavioral Theories," *Health Behavior and Health Education: Theory, Research, and Practice*, vol. 4th, pp. 465–486, 2008.

[12] A. Bandura, "Social foundations of thought and action: A social cognitive theory." Englewood Cliffs, NJ, US, pp. xiii, 617, 1986.

[13] J. O. Prochaska and C. C. DiClemente, "The transtheoretical approach," *Handbook of psychotherapy integration*, vol. 2, pp. 147–171, 2005.

[14] E. L. Deci and R. M. Ryan, *Intrinsic motivation and self-determination in human behavior.* Springer Science & Business Media, 1985.

[15] R. M. Ryan and E. L. Deci, "Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being." *American psychologist*, vol. 55, no. 1, p. 68, 2000.

[16] ——, "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions." *Contemporary educational psychology*, vol. 25, no. 1, pp. 54–67, 2000. [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/10620381

[17] B. A. V. Kenneth W. Thomas, "Cognitive elements of empowerment: An "interpretive" model of intrinsic task motivation," *The Academy of Management Review*, vol. 15, no. 4, pp. 666–681, 1990. [Online]. Available: http://www.jstor.org/stable/258687

[18] H. Du, G. M. Youngblood, and P. Pirolli, "Efficacy of a Smartphone System to Support Groups in Behavior Change Programs," in *Proceedings of the Wireless Health 2014 on National Institutes of Health - WH '14*. New York, New York, USA: ACM Press, 2014, pp. 1–8. [Online]. Available: http://www.scopus.com/inward/record.url?eid=2-s2.0-84919346642&partnerID=tZOtx3y1

[19] R. Hurling, M. Catt, M. De Boni, B. W. Fairley, T. Hurst, P. Murray, A. Richardson, J. S. Sodhi, M. D. Boni, B. W. Fairley, T. Hurst, P. Murray, A. Richardson, and J. S. Sodhi, "Using internet and mobile phone technology to deliver an automated physical activity program: Randomized controlled trial," *Journal of Medical Internet Research*, vol. 9, no. 2, pp. 1–13, 2007.

[20] C. Maher, M. Ferguson, C. Vandelanotte, R. Plotnikoff, I. De Bourdeaudhuij, S. Thomas, K. Nelson-Field, and T. Olds, "A Web-Based, Social Networking Physical Activity Intervention for Insufficiently Active Adults Delivered via Facebook App: Randomized Controlled Trial," *Journal of Medical Internet Research*, vol. 17, no. 7, p. e174, jan 2015. [Online]. Available: http://www.scopus.com/inward/record.url?eid=2-s2.0-84938587878&partnerID=tZOtx3y1

[21] A. C. King, E. B. Hekler, L. A. Grieco, S. J. Winter, J. L. Sheats, M. P. Buman, B. Banerjee, T. N. Robinson, and J. Cirimele, "Harnessing different motivational frames via mobile phones to promote daily physical activity and reduce sedentary behavior in aging adults." *PloS one*, vol. 8, no. 4, p. e62613,

jan 2013. [Online]. Available: http://www.scopus.com/inward/record.url?eid=2-s2.
0-84876714104&partnerID=tZOtx3y1

[22] B. S. Fjeldsoe, Y. D. Miller, and A. L. Marshall, "MobileMums: A Randomized Controlled Trial of an SMS-Based Physical Activity Intervention," *Annals of Behavioral Medicine*, vol. 39, no. 2, pp. 101–111, 2010. [Online]. Available: http://link.springer.com/10.1007/s12160-010-9170-z

[23] Facebook, "Facebook," 2016. [Online]. Available: https://www.facebook.com/

[24] Endomondo, "Endomondo," 2016. [Online]. Available: https://www.endomondo.com/

[25] AAL, "CO-LIVING," 2016. [Online]. Available: http://www.aal-europe.eu/co-living/

[26] Placeit, "Instant iPhone Mockups & Demo Videos," 2016. [Online]. Available: https://placeit.net/

[27] D. H. Schunk, J. R. Meece, and P. R. Pintrich, *Motivation in education: Theory, research, and applications*. Pearson Higher Ed, 2012.

[28] R. M. Ryan, V. Huta, and E. L. Deci, "Living well: A self-determination theory perspective on eudaimonia," *Journal of happiness studies*, vol. 9, no. 1, pp. 139–170, 2008.

[29] E. S. Andreas Næss, 2016. [Online]. Available: https://github.com/eirikst/master-backend

[30] A. Patricio, 2007. [Online]. Available: https://developer.jboss.org/wiki/SupportedDatabases2

[31] A. M. Project. [Online]. Available: https://maven.apache.org/download.cgi

[32] C. Gatsou, A. Politis, and D. Zevgolis, "Text vs visual metaphor in mobile interfaces for novice user interaction 1," vol. 31, no. 2011, pp. 271–279, 2012.

[33] S. Carmien and A. Garzo, "Elders Using Smartphones – a Set of Research Based Heuristic Guidelines for Designers."

[34] Usability.gov, "System Usability Scale (SUS)," 2016. [Online]. Available: http://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

[35] Stronglifts, 2016. [Online]. Available: http://stronglifts.com/apps/

[36] Samsung, 2016. [Online]. Available: http://shealth.samsung.com/

Appendix Design
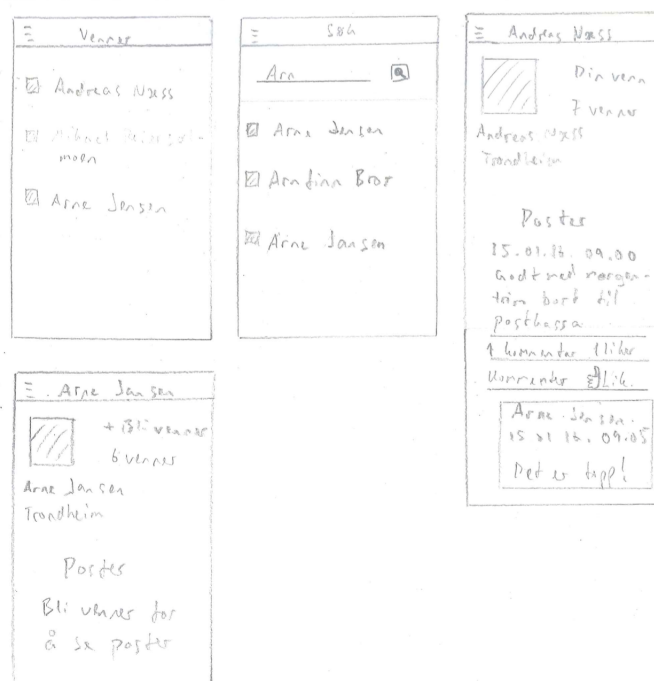
Figure A.1: Early paper prototypes
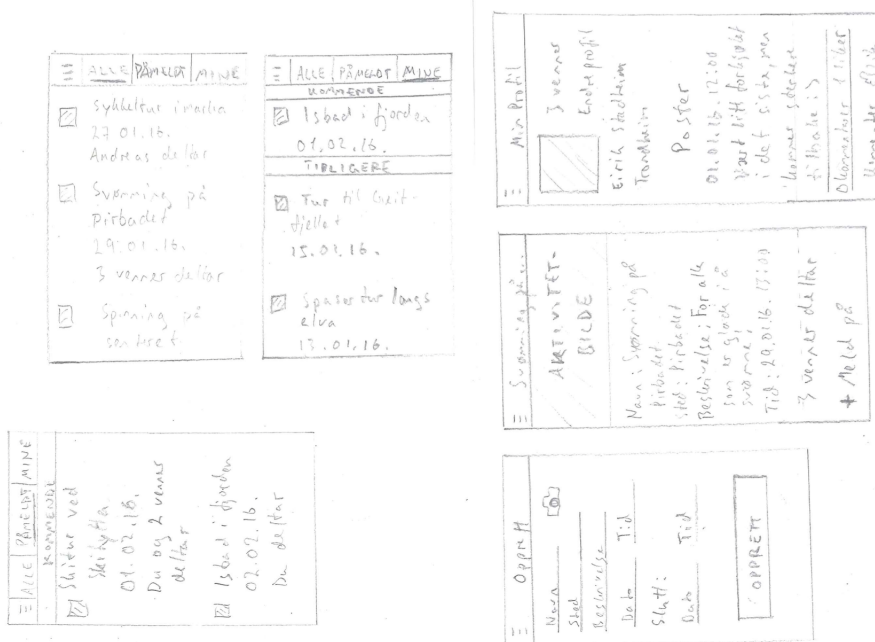
Figure A.2: Early paper prototypes

Appendix **B**

Usability Questionnaire

Ludi

Ludi er en mobil applikasjon og et sosialt nettverk. Målet med applikasjonen er at den skal skape økt fysisk aktivitet ved at folk engasjerer seg i sosiale fysiske aktiviteter. Dette gjøres ved at de selv oppretter, eller melder seg på andres aktiviteter. Aktivitetene er hendelser som skjer i et gitt tidsrom, og har forskjellig intensitet alt etter hvor fysisk krevende aktiviteten er. Typiske aktiviteter kan være gåturer, svømming på Pirbadet osv. Ludi er et sosialt nettverk, med fysisk aktivitet som hovedfokus.

* Required

Om deg

1. **1.1 Kjønn** *
   Mark only one oval.

   ◯ Mann

   ◯ Kvinne

2. **1.2 Alder** *
   Mark only one oval.

   ◯ Under 15

   ◯ 15-21

   ◯ 22-29

   ◯ 30-49

   ◯ 50-64

   ◯ 65-74

   ◯ Over 74

Generelt

Hvor enig er du i følgende utsagn, der 5 betyr veldig enig og 1 betyr veldig uenig. Du trenger ikke svare på utsagn du ikke har noen mening om.

Figure B.1: Questionnaire 1/9

3. **2.1 Jeg tror jeg ville brukt Ludi ofte**
   Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

4. **2.2 Jeg syntes Ludi var unødvendig komplekst**
   Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

5. **2.3 Jeg syntes Ludi var lett å bruke**
   Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

6. **2.4 Jeg tror at jeg ville trengt hjelp fra en teknisk kyndig person for å bruke Ludi**
   Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

7. **2.5 Jeg syntes de forskjellige funksjonene fungerer godt i Ludi**
   Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

8. **2.6 Jeg syntes Ludi var forvirrende**
   Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

Figure B.2: Questionnaire 2/9

81

9. **2.7 Jeg ville sett for meg at de fleste ville brukt kort tid på å lære seg å bruke Ludi**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

10. **2.8 Jeg syntes Ludi var knotete å bruke**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

11. **2.9 Jeg følte meg trygg da jeg brukte Ludi**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

12. **2.10 Jeg måtte lære meg mye før jeg kunne bruke Ludi**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

Aktiviteter

Hvor enig er du i følgende utsagn, der 5 betyr veldig enig og 1 betyr veldig uenig. Du trenger ikke svare på utsagn du ikke har noen mening om.

Aktivitetssiden

Figure B.3: Questionnaire 3/9
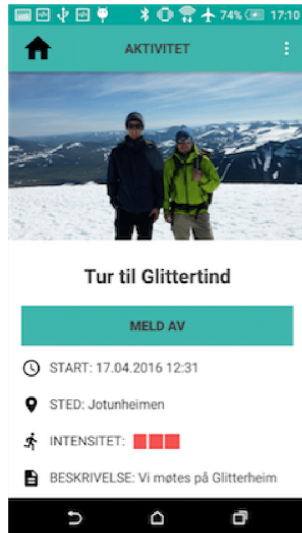
13. **3.1 Det var enkelt å melde seg av og på en aktivitet**
    Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

14. **3.2 Det var enkelt å opprette en aktivitet**
    Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

15. **3.3 Det var enkelt å forstå aktivitetene**
    Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

Figure B.4: Questionnaire 4/9

16. **3.4 Det var enkelt å finne deltakere på en aktivitet**
    Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

17. **3.5 Det var enkelt å finne folk man har vært på en aktivitet med**
    Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

18. **3.6 Hva syntes du om aktivitet-konseptet i Ludi?**

    ....

    ....

    ....

    ....

    ....

Profil

Hvor enig er du i følgende utsagn, der 5 betyr veldig enig og 1 betyr veldig uenig. Du trenger ikke svare på utsagn du ikke har noen mening om.

Profilsiden som viser informasjon om hver bruker

Figure B.5: Questionnaire 5/9

19. **4.1 Det var enkelt å opprette en profil**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

20. **4.2 Profilsiden var oversiktlig**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

21. **4.3 Det var nok informasjon om hver bruker på profilene deres**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

Figure B.6: Questionnaire 6/9

22. **4.4 Hva synes du om profilsiden?**

....

....

....

....

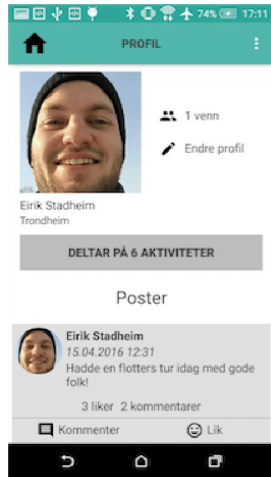..

Poster

Hvor enig er du i følgende utsagn, der 5 betyr veldig enig og 1 betyr veldig uenig. Du trenger ikke svare på utsagn du ikke har noen mening om.

Poster og kommentarer på aktivitetssiden

23. **5.1 Det var enkelt å skrive en post**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

24. **5.2 Det var enkelt å kommentere på en post**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

Figure B.7: Questionnaire 7/9

25. **5.3 Det var generelt enkelt å bruke kommentarsystemet**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

26. **5.4 Hva syntes du om poster og kommentarer?**

....

....

....

....

....
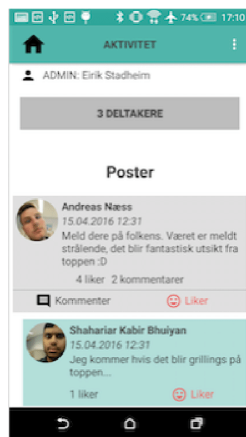
Til slutt

Hvor enig er du i følgende utsagn, der 5 betyr veldig enig og 1 betyr veldig uenig. Du trenger ikke
svare på utsagn du ikke har noen mening om.

27. **6.1 Det var enkelt å forstå ikonene som ble brukt**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

28. **6.2 Det var enkelt å finne andre brukeres profiler**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

29. **6.3 Det var enkelt å legge til venner**
Mark only one oval.

	1	2	3	4	5	
Uenig	◯	◯	◯	◯	◯	Enig

Figure B.8: Questionnaire 8/9

30. **6.4 Har du noen ytterligere kommentarer til Ludi?**

....

....

....

....

....

Powered by

Google Forms

Figure B.9: Questionnaire 9/9

Appendix C

Iteration 1: Bug Report and Proposed New Functionality

The bugs reported by the users in iteration 1 are summarized in Table C.1 and recommendations for new functionality is summarized in Table C.2. Green status text are items that have been resolved, whereas orange text indicates items that have not been resolved - either because they are not prioritized right now, or they are statements we have discussed and could not agree to.

Table C.1: Bug Summary

Bug	Status
E-mails that has spacing at the end of the line are not accepted. The app should remove trailing whitespace.	Fixed
The first time I'm asked to use the camera, I click OK and nothing happens. I have to click once more to take a photo.	Fixed
Activities that I create and attend are shown as recommended activities. These should not be in that list.	Fixed
Load more activities show two of the same activity.	Can be fixed at a later time. Not prioritized as it's not a big issue. It only happens if an event is created after you have loaded the list, but before it updates.
A user has added me as friend and I receive too many push notifications. I also cannot accept the request.	This happened because a user spammed friend requests. Should be fixed, but not yet prioritized.

Table C.2: Recommended Changes

Recommended change	Status
Friends are hidden. It's hard to get an overview of friends and what they do. Idea: Can instead of recommended activities, have latest news which shows news from friends and also recommended activities.	Implemented news feed, in addition to recommended activities.
Activities should have activity types. Tagging activities enables history tracking, and improved activity recommendations.	Activities are now tagged. Each activity now has its own symbol, indicating the activity type. Using the types for more complex functionality can be implemented at a later stage.
Inconsistent display of elements. Some are displayed as buttons, while others with text.	Implemented. Have also made it more clear what are buttons, and what are not. We keep some large buttons to make them distinct from clickable list elements.
I would like to see another color on the "Participate on X activities" button.	This button is now part of a button group together with "number of friends" and "change profile". They have all received a new look, and should now be more consistent and easier to understand.
You should be able to see the profile pictures of participants on the activity page.	You could see participants and their profile pictures, by clicking the participants button. We added them to the main activity page to make it more apparent.
Should include more sociality. The user search functionality should display a list of users before the search has been initialized.	This feature might be necessary with the user base is small. It might be hard to find other users. This feature has been implemented.
The "attend button" on your own activities should be updated. You can remove it or possibly assign a new admin, because you shouldn't be able to unattend your own activities. Also, instead of deleting an activity, it should be canceled.	We agree on this. The feature has been implemented.
If I search for people I do not know, it's too little information.	We don't provide more information about non-friends, as we want to maintain a certain user privacy. If a user want to see more information about another user, then they have to mutually agree to it, and befriend one another.
The app would be cooler with some motivational factors to show up during activities.	The motivation to participate lays in the sociality and the concept as a whole. We are not sure which motivational factors that would further improve participation.

Beneath location on the profile page, you could include country.	As of now, the location is just a text string. The users could input whatever they want. In a future release, we plan to have predefined locations.
You could include information about a user's age group.	We don't want to filter the users on age, but rather on activity intensity. Based on this, we think the users themselves can figure out which activities they can handle.
In the post and comment section, it was hard to click on e.g. "2 likes 1 comment" when I want to see who likes the post.	We don't think this part is any harder to click than any other part of the system. Most likely, the user has tried to click on the "1 comment"-part of "2 likes 1 comment". This will not work as only the "2 likes" part is clickable.
I would like my comments to be highlighted.	This can be implemented, but we think that name and profile picture is enough to make distinctions between your own posts and comments. There is already displayed a lot of information in the post/comment section, and we don't want to make this more complex than it already is.
The comments should be smaller, or have more indentation.	As the app runs on smartphones, where to screen already is quite small, then increased indentation would only increase the list length, and make it more messy. We have tried this before, and concluded that the current indentation gave the best readability. The comments cannot be shorter, as they depend on the text length.
There was no indication that there existed a "notifications" page in the top left of the main page, but I found it after a couple of clicks. Maybe it should be moved to the top right, and labeled with text.	We think the icon is sufficient to indicate this. If a new notification has arrived, the icon will be marked with a red number, showing how many notification the user has received. We don't see this as a problem as of now; when a user first receives a notification, we think he will notice it because of the red number.
I don't like the way comments are colored. I first thought the comments were my comments.	We have chosen to color the comments to make distinctions between posts and comments. As the feedback is not more concise than this, we don't know what we could have changed.
If a post has many comments, then they should be minimized behind a button. It's a lot of scrolling when all the comments are showing.	We initially agreed on this, but we chose to maintain a simple design for the elderly people. As a result, we don't want to include this functionality in the post and comment section, as it might be overwhelming with too many features.

Appendix D

Technical

Figure D.1 shows a package diagram of the frontend system. Figure D.2 is a package diagram of the backend system.
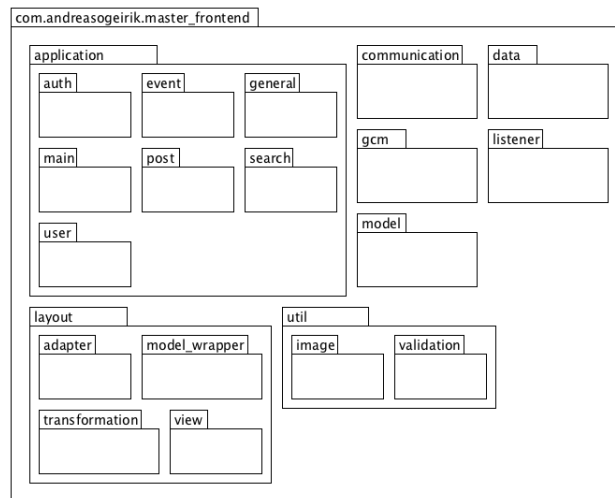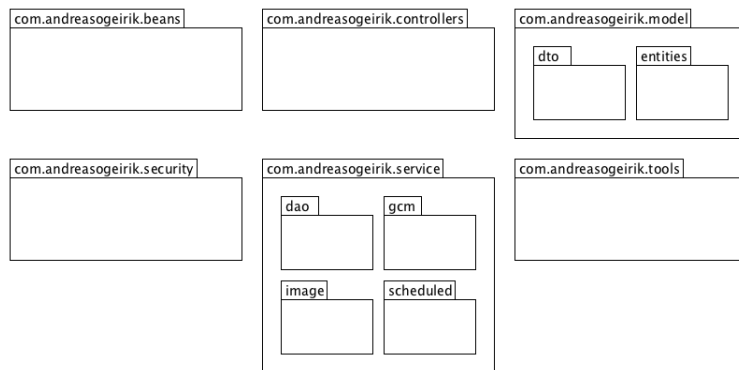

Figure D.1: Package diagram of the frontend

Figure D.2: Package diagram of the backend