NTNU - NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Fordypningsprosjekt

by

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A thesis submitted in partial fulfillment for the
degree of Master of Science
- Computer Science

in the
IME - Faculty of Information Technology, Mathematics and Electrical Engineering
IDI - Department of Computer and Information Science

October 2013

Declaration of Authorship

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"Gotta Catch 'Em All"

- Ash Ketchum

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Abstract

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The Thesis Abstract...

Keywords: *Asthma, Self-management, Gamification, Tangible Interfaces, Rasperry Pi*

Acknowledgements

We would like to thank Pieter Toussaint for excellent guidance and advice throughout the run of the project. We would like to thank Ole Andreas Alsos for advice, ideas and lending of his UX-skills to the project. Thanks to Elin H. Bergene, Marikken Høiseth and Jonas Å sheim. Thanks to Aaberg, Dahle and Svalestuen. Esben would like to thank: Aleks would like to thank:

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Abbreviations

NTNU	**N**orwegian **U**niversity of **S**cience and **T**echnology
BLOPP	**B**arns **L**egemiddel**OPP**levelser
CAPP	**C**hild **APP**lication
GAPP	**G**uardian **APP**lication
KAPP	**K**arotz **APP**lication
GUI	**G**raphical **U**ser **I**nterface
TUI	**T**angible **U**ser **I**nterface
NAAF	**N**orges **A**stma- og **A**llergi-**F**orbund

To Pikachu!

Chapter 1

Introduction

This chapter will give an introduction to the study. It will state the purpose, motivation, research questions and the research method for this study.

1.1 Purpose

The goal of this study is to evaluate the use of tangible user interfaces in the treatment of asthmatic children. The project is based on an application made by Aaberg, Aarseth, Dale, Gisvold and Svalestuen [**?**] in 2012. The evaluation will be done through usability testing, and diary studies of different versions of an application, augmenting the application from cycle to cycle.

We plan on using gamification as a motivational factor for the children. The goal of using gamification is not to research whether gamification is a suitable concept, rather than finding "the best" use of gamification in this setting.

1.2 Motivation

1.2.1 Asthma among children

According to NAAF, 20% [**?**] of the Norwegian population has or has had asthma at the age of 10, and 8% of the adult population suffers from asthma. Many of the children find it unpleasant to use their medicine as they often do not understand why the medicine must be taken. Research done by Å sheim [**?**] showed that children suffering from RS-virus were easily distracted and motivated to finish treatments when shown an non-interactive flash-video during the treatment. We aim to research whether

a tangible user interface may make the children more aware of their asthma and thus make them better understand why they must take their medicine on a daily basis.

1.2.2 Ways asthma affect the guardians

In an already hectic everyday life, remembering to give the children medicine may be cumbersome. Often the children do not enjoy taking their medicine, and the children may start an argument not wanting to finish their treatment. This may result in parents applying the medication incorrectly, applying the wrong treatment, or even forgetting to give the medicine to their children. We aim to find out if the use of a tangible user interface will make the task more enjoyable for the children and thus easier for the guardians.

1.3 Research Questions

The main goal for this study is to figure out ways technology can help children taking their medication. During the prephase, we will build upon the work of Aaberg, Gisvold et. al. [**?**]., trying to find problems with the system as it is today. The improved system will then undergo user testing over a longer period of time, in order with different concepts.

The objective has been composed into the following research questions:

RQ1: What are the usability problems of the current system?

RQ2: Is gamification a feasible solution for motivating children to take their asthma medicine?

RQ3: How will the presence of a Tangible User Interface affect children's medicational habits?

This evaluation should be done through user testing and feedback from potential users of the applications. Hopefully, thorough testing will give information on how the interaction between children and the system is, whether these systems helped during medication process, etc.

1.4 Research Method

This section will explain the methodology we plan to use during our research. The explanation is divided into the separate research questions.

1.4.1 RQ1

Finding usability problems with the current system will be a task of usability testing, which will be performed at a usability lab.

1.4.2 RQ2

We want to test the system on NUMBER children. In order to test this using a systematic approach, we plan to take the following steps, which will be explained in further detail below.

1. Give guardians a diary, where they take note of how things are working on a regular basis. Expected duration: 1 week.
2. Give guardians a mobile application which instructs children during their medication. This will be a simplified version of our final application. Expected duration: 1 week.
3. Give guardians a mobile application which has gamification elements to it, in addition to the instructions in Step 2. Expected duration 1 week.
4. Give the test persons a custom built TUI. Expected duration: 1 week.

During the testing phase, we want the guardians to fill out a diary, in addition to undergo an interview at the end of test period. Things we want to find out from the diary study, is whether the children like the idea of having a TUI at home or not. Do they like the idea of having a TUI in their home? How did they find the design?

The rationale for doing Step 1 is to create a foundation to build upon on the later steps. Having children taking their medicine under "normal" conditions gives us a set of control data which we may use for comparison in order to discover trends and how the application and TUI affected the children and guardians.

The rationale for doing Step 2 is to see if it is actually enough to have a minor avatar system who tells the child what to do, and when to do it. This might give some ideas for further research from BLOPP.

The rationale for doing Step 3 is to answer whether gamification have the motivational effect on children, i.e. motivating children to take their medicine on a continuous basis.

The rationale for doing Step 4 is to see if a relation artifact can give children proper motivation for taking their medicine. How do they react when seeing our TUI? Do they get reminded that they have not taken their medicine yet? Will they get excited?

A key point during all these steps is that guardians are actually on place, observing the children's behavior. We will not dive further into children's behavioural patterns or psychology, other than if they like it or not.

1.4.3 RQ3

Through the conducted studies we will evaluate and compare the usage and opinions the guardians and children had regarding use of our system. Through the data gathering in the diaries we will be able to directly compare how the children and guardians reacted to the arrival and use of a TUI. We will also conduct interviews to get feedback on how the use of the TUI affected the children. The interviews will mainly be conducted on the guardians, since small children may not give reliable data.

Chapter 2

Background

This chapter will give a brief introduction to the history behind the BLOPP project (2.1) and the CAPP, GAPP and Karotz applications. Section 2.3 gives an overview of some of the applications that are currently on the market, a brief look at some of them, in addition to an overview of an assessment that has been performed on the applications that are currently on the market. Section 2.4 will give an introduction to some of the current research that has been performed on mobile technology in combination with children and health.

2.1 BLOPP Project

Barns LegemiddelOPPlevelser (BLOPP) is a project group working for "Sykehusapotekene i Midt-Norge" (Hospital pharmacies in Mid-Norway). Their purpose is to create easier medical treatments for children through use of technology.

2.2 CAPP, KAPP and GAPP

In the autumn of 2012 Aaberg, Aarseth, Dale, Gisvold and Svalestuen were engaged by the BLOPP Project group through the course "TDT4290 - Customer Driven Project" [**?**] at NTNU. During the period of August 2012 to December 2012 they developed a prototype of a mobile information system consisting of two applications and a tangible user interface. One application was developed for guardians of a child (GAPP), and two applications were developed for children (CAPP and KAPP). In this section, we discuss them further in detail, while a full report of their work is available at [Insert Reference].

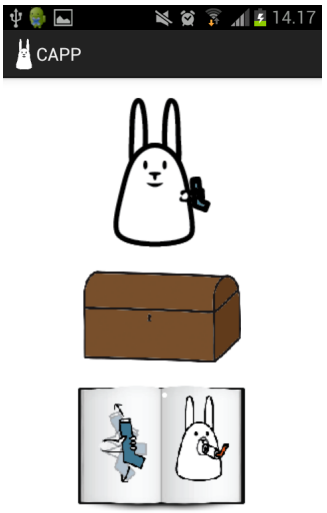

FIGURE 2.1: CAPP main menu

Their prototype is the foundation for our work in this project.[1]

2.2.1 CAPP

CAPP is an Android application targeted towards the children. It launches the alarms given by parents and guides children during their medication. When the alarm is launched, the medication process starts, where the child is taken through the process by an avatar in the application.

One of the objectives towards CAPP was to introduce a gamification experience to the process. Accordingly, the child gets a golden star in his/her treasure chest once the child is done, however, these stars were not useful for anything else but showing them off.

As the target group for the application is children below the age of 8 it is reasonable to assume that not all of them are able to read, this application consists mainly of pictures. Figure 2.1 shows a screen shot of the main page.

2.2.2 KAPP

KAPP is the other application targeted towards children. The application runs on a Karotz[**?**], which is a small robot bunny (see Figure 2.2). The purpose of the Karotz is similar to CAPP, namely to remind children when it is time to take their asthma medicine and give instructions during treatment. In order to interact with the Karotz, children may use either a Nanoz (a small bunny with an integrated RFID) or by pressing

[1]The applications have norwegian as their main language

FIGURE 2.2: Karotz

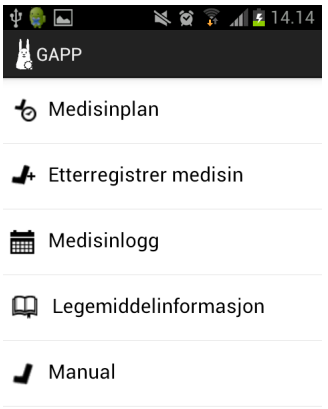

FIGURE 2.3: GAPP main menu

a button on the top of the Karotz' head. In addition, it is possible to interact through the Karotz' ears, but from our part, this has not been experimented with.

2.2.3 GAPP

GAPP is an Android application targeted towards the parents or guardians of the children. Currently, guardians are having problems with remembering how often their children have taken their medicine the last couple of days, when they should take them and how their child's desease has evolved the last couple of days. The purpose of GAPP is to let guardians monitor their child's medication usage the last couple of days, setting up reminders, etc.

Figure 2.3 shows a screenshot of the main menu of GAPP. The main functionality is separated into *Medical Plan*, *Register treatment*, *Medicine log*, *Medicine information* and *Manual*. Medical Plan gives parents the option to set up reminders at particular times.

The "Register treatment"-option gives parents possibility to register a treatment that is taken in case the child forgot to go through the process in CAPP or KAPP. This way, children will be rewarded with stars accordingly. "Medicine information" gives general information about different medicines, what they do, and what they help against. "Medicine log" shows how many times a child has taken their medicine the last couple of days. The manual is to help "newcomers" to medicate children. For instance, if an aunt is watching children with asthma, then they could use the application as a reference on how to do the process.

It's basic functionality is to view logs on how often a child needs medication, how the child has been feeling the last couple of days, according to the asthma traffic light system, and to set up alarms for the child. CAPP and GAPP work together as a pair, and thus the log will show the logged treatments of their child.

2.2.4 Known areas for improvement

As Aaberg et al. finished their work, they commented on several areas of potential improvement for CAPP/GAPP/KAPP. This document is reprinted in its entirety in Appendix B (after permission from Aaberg, Aarseth, Dale, Gisvold and Svalestuen). The main topics for improvement were

- Reward System
- Distraction sequence for children
- Web application
- Support for more children

Additionally, we want to use air quality data provided by Norwegian Institute for Air Research

These comments are used as a basis when we decide what to improve in this project.

2.3 Existing products

On the two largest application stores, Google Play and iOS AppStore, we have found a couple of applications similar to the one we have in mind. Among the ones we have looked into, is Huff and Puff [2], Asthma Logger [3], Kids Beating Asthma [4] and Asthma Monitor [5]. Common for all these applications is that they have one specific aim. For instance, Huff and Puff wants to teach children in general about asthma. Asthma Logger logs treatments, and Kids Beating Asthma have some game elements, but the games are not available for playing during treatment. For our product, we want to create a superset of these applications.

[2] Google Play : Huff And Puff
[3] Google Play : Asthma Logger
[4] Google Play : Kids Beating Asthma
[5] Google Play : Asthma Monitor

Application	**Positive**	**Negative**	**Target Audience**
Huff And Puff	• Relevant quizzes from introduction to more experienced users • Can play sounds if children cannot read • Has asthma-specific word games, puzzles, etc.	• Poor navigation models • Quiz is too generic, for instance asks what doctors call this and that. • The games are not exactly what we look for, as they cannot be played while undergoing a treatment	Children
Asthma Logger	• Possibility to send journal on email specified by user. May forward the journal to doctor. • Very intuitive application • Shows doses taken the last couple of days	• Only has one generic medicine (does not state which medicine, for instance Ventoline) or dosage (?)	Adults
Kids Beating Asthma	• Informative and simple	• Suffers from software bugs and crashes regularly	Children
Asthma Monitor	• Ability connect Peak Flow to activities • Thorough and "advanced" statistics • Can input symptoms like Cough, Sputum, Wheezing breath and Dyspnsea • Can send records via email	• Old fashioned GUI	Adults

TABLE 2.1: Evaluation of existing products on the market

2.3.1 Conclusion and evaluation

Asthma Monitor seems like a great application once you get used to it, and it is developed by researchers, which implies that they know what they're doing. However, it seems a bit too complex for the following reasons:

1. If an adult who have no other experience of asthma other than through his/her child, the application contains terminology which they might not be very used to
2. The user interface is not very appealing
3. Forcing information from a child regarding how much they cough once a day seems rather hard

As for the quiz, we have concluded that this is a great way to inform children. Namely by letting them playing around with the application and gathering knowledge on this basis.

2.3.2 Assessment of existing applications

In 2012, Huckvale et. al. [**?**] conducted an assesment on the existing applications on both Google Play and AppStore. They assessed 103 different apps with english as the native language. Out of these applications, *No apps for people with asthma combined reliable, comprehensive information about the condition with supportive tools for selfmanagement.*(Huckvale et. al., 2012). They concluded that doctors should be careful when recommending apps for people with the purpose of self management.

2.4 Existing Research

This section will give a foundation on some of the reserach performed on using technology in combination with deceases and children.

2.4.1 Monitoring your own decease with mobile technology

There exists some research on self-management of monitoring your asthma condition. A lot of this research does however work with SMS (Short Messaging System) technology. In 2009, Andhøj and Møldrup et. al.[**?**] did a feasability study to check how users would react to a SMS-reminder study. Their methodology were to send SMS a couple of times a day, and have the users respond to their peak flow and answer yes/no questions.

Users could then access a web page to see different statistics on peak flows, how they've felt the last couple of days, etc.

They concluded that SMS is a feasible solution for collecting asthma diary data, mainly because the SMS technology was a big part of the participant's everyday life. Although SMS is a great technology to be used for this purpose, few children in our target group are able to use this technology, for obvious reasons. According to *Senter for IKT i utdanningen*(Center for ICT in education), about 40% of norwegian children below the age of 3 years old have used a tablet, and 6 out of 10 children below the age of 6 have used a touch screen device [**?**]. Thus the technological background should be somewhat familiar for our target group.

2.4.2 Children and mobile devices

In 2013, babies.co.uk posted results on a poll they had posted on how many toddlers are using smartphones or tablets each day[**?**]. Over 1000 participants responded, and according to the survey, 14% of the responders allowed children to use smartphones or tablets more than 4 hours a day. Considering the normal awake time of a child between 9 and 12 months old is approximately 10 hours, they spend a considerable amount of their day on the smartphone. This relates to our research, because we don't necessarily want children to be spending a considerable amount of time playing around with the application. We need to figure out a gamification element that does not give this need to children.

2.4.3 Children and gestures

Abdul Aziz et. al. [**?**] made a study on what gestures children are able to comprehend when playing with an iPad. He/She tested 33 children's abililty to do gestures on a variety of applications suited for children. The children were in the range of 2-12 years old, 3 children per age. The study showed the following restrictions:

- 2 year old children have difficulties with pinching, and are unable to drag-and-drop, spread and rotation of the device, and are not able to focus on the application.
- 3 year old children have difficulties to drag & drop until they are told to do so, in addition to having problems with pinch and spread.
- 4 year old children have difficulties to drag and drop.

Children at age 5 and above are able to do all the normal gestures at a tablet. As CAPP is currently only available for mobile devices, this is reason for some discussion. The main part to notice is pinching and drag and drop. Now, are these difficulties only

problems regarding the tablet size, or do they also arise on mobile phones? An iPad is fairly large relative to the size of these children's hands.

Chapter 3

Usability

This chapter will give a brief definition of what usability is, and how user tests can help us improve it. Since the applications are targeted towards both children and adults, we will give a description of how the usability tests for these groups will differ. We will also explain how the user testing was performed at ...

3.1 What is usability?

There are many ways to describe usability.

The International Organization for Standardization(ISO) uses the following definition of the term usability [**?**]:

Extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

The same document defines the context of use as:

Users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used.

These definitions cover how the system is used, the user's thoughts about the use and the context of the system. This can be broken down further into several subgoals in order to achieve better usability, and to give a better insight as to what usability is. These subgoals are:

1. How precisely is the user able to perform a task by using the application?
2. How much resources(for example time, or number of tries) was used to perform the given task using the application?

3. How many errors occurred?
4. Did the user find the use satisfactory?

User-centered design is a way of designing with the user in mind. By using this technique these goals are achievable. User-centered design is about getting feedback from the users during the design and development process. Always thinking about how the user would solve this problem, and consolidate the users when in doubt is a fundamental part of user-centered design. The user's opinion is the measure of how good the system performs and the user's feedback defines how you score on usability. [Should have reference]

3.2 How to test usability

There are many ways to create a good user experience. Having knowledge of expert opinions is always a good idea, and using user-centered design techniques is also a wise way to go. According to SOME PERSON [Insert Reference] developers should get feedback from users by users tests at different stages of development. According to SOME PERSON [Insert reference], having a user-centered approach will help the developers to address the weakest parts of their system, and give feedback on design decisions.

A user-centered design can be done in many different ways and at different stages of the product life cycle [**?**], as shown in Table 3.1:

Method	**Purpose**	**Phase of the project life-cycle**
Background interviews and questionnaires	To collect data and to understand the user better	When starting the project
Focus groups	Discover design issues and receive feedback	At an early stage
On-site observation	To both collect information of the context the system will be used in, and find the primary problems the users may have	At an early stage
Role playing / simulations	Will give a broader understanding of what the user expects from the system	Early to mid stage of the project
Automated evaluation	Gives feedback on deviations from standards or best practices. This method excludes actual users, but is based on well tested principles	Mid to end of the project
Usability testing	To measure the usability of the system and provide feedback on very specific elements that are badly designed	Abras [**?**] says it should be at the end of the project while others [**?**] think it should be done in iterations throughout the project.
Interviews and questionnaires	Gives a qualitative measurement of how good or bad the system is	End of the project

TABLE 3.1: Methods of user-centered feedback

The purpose of this project is to test an existing system, improve the existing product and plan an extensive testing of the improved product. We will focus mainly on WHAT WHAT WHAT?

Usability Testing The purpose of usability testing is to increase the usability of a system. At the same time, performing these usability tests may save the developers some time and reduce the cost of the project by removing errors and poor design at an early stage [**?**].

The usability testing can be performed in different ways [**?**]. At the early stages of the project, low-fidelity prototypes are a good option since they will provide feedback and take proportionally little time to make, making it easier to have more iterations of testing. The different testing methods include a potential user of the system performing tasks to provide real data. Observing and recording each usability test may help the developers to analyze their system, and correct the flaws [**?**].

Before starting the usability tests, the developers should set goals planning what they want to know about the system [**?**]. This will ensure that the purpose of the test is fulfilled. The developers should then plan tasks according to the desired results. These tasks should allow the user to explore the system, or the parts the developers wish to test, giving the test person some time per task, in order to not stress the test person.

After being planned, the test should be run on a number of different test persons. From figure , you can see that as the number of participants increases, the number of undetected errors decrease.

Nielsen states that after five user tests, 85% of the errors have been found [**?**]. Molich[**?**] states that six test persons is the ultimate number. Faulkner [**?**] states that while six test persons may find 85 % of the errors, they may also find considerably less. In Faulkner's research, a number of five test users found between 55 % and 100 % of the errors, while 20 test persons found between 95 % and 100 % of the errors.

Testing environment The next thing to consider when performing usability testing is the testing environment. It should resemble the environment in which the system will be used. To make the most of the tests, it is wise to perform videotaping of the tests. This will help when reviewing the results from the test[insert references]. If the test are being recorded, a consent from the test person or his/hers guardian will be required.

Before the test persons arrive, a test leader should be chosen, in order to have a person to guide the test persons through the process. The test leader should be in charge of testing and act as an interviewer to help the participant to "think-aloud"[1]. The test leader should answer questions from the participant, but be careful not to give away information that may affect the results of the test.

After the tasks are done, it is necessary to gather loose ends and get answers to all the questions that might be unanswered. A system usability scale(SUS)[**?**] may be a good way to grade the usability of the system together with the observations made during the test. The SUS scale will reflect on how satisfying the usability is in the eyes of the users. Bangor et al [**?**] have made a scale based on the SUS-forms from different system

[1]Reference to Thinking aloud

usability tests, in order to make it possible to compare the mean score of a system with what is an acceptable level of usability. In our testing, we will make use of a Norwegian version, developed by Svanæs A.

3.3 How to test usability on children and toddlers

While usability testing on children and toddlers have the same basic approach as testing on adults, there are many more precautions to be followed. Hanna et al. [**?**] lays out some of these precautions. They recommend not using children that are skilled with computers since they may find the tasks too easy and will not produce useful data. Since children these days have a higher skill with computers thanks to the invasion of tablets and smart phones [insert reference?], this may not be as much of a concern.

Since our application is targeted towards children with Asthma, we want to test the system on children suffering from Asthma in addition to children from the same age group, not suffering from Asthma. These children will most likely have a different approach to the system and may give different feedback.

Hanna, Risden and Alexander also point out changed that should be made to the testing environment as mentioned in 3.2. They recommend making the testing environment more suitable for children by placing colourful posters on the walls. Children of young age may be afraid of "The Doctor's Office" and we will need to make adjustments to avoid frightening the children upon their arrival at the test lab.

As mentioned by Donker and Markopoulos [**?**] talk-aloud is very useful technique when doing usability testing with children. Talk-aloud is a technique were the children talk about what they are doing instead of what they are thinking.

3.4 Usability testing on mobile devices

We plan on doing usability testing in testing lab or quiet testing office. The application's main environment for use will be at the user's home, which may be noisier and more hectic than our testing lab. Kaikkonen et al [**?**] states that the similarity between testing environment and place of use is not too important, the test user will still be able to complete the tasks and find the same number of errors. This claim is supported by Beck et al [**?**] who discovered that the test persons found more usability problems when sitting down, in difference to when walking on the street.

Schusterich et al [**?**] published a guide on how to build the perfect infrastructure for usability testing on mobile devices, in 2007. They describe how generic infrastructure issues, mobile device-specific issues and usability study context issues should be taken into consideration. Shcusterich et al. recommends having a number of cameras recording from different angles in order to capture unbiased interaction patterns of the mobile device.

3.4.1 Emulator versus device

When developing for mobile devices such as Android, it is possible to run an emulator on a pc, instead of running the application on an Android device. The emulator emulates the use of a mobile device on screen. Input must be given by mouse-clicks on buttons/screen elements. The Android emulator emulates use of system resources corresponding to a given Android device, in order to not act faster or slower that a real device. While this may be true in theory, it is not always true in practice. The emulator is often much slower than an actual device, a claim supported by Lin et al[**?**], who found that native code will run up to 34.2% faster than on the emulator.

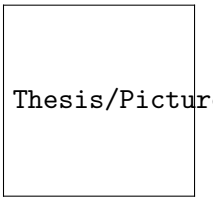

FIGURE 3.1: The Android Emulator running an emulation of Android 4.1

The question arises, should one do usability testing on an emulator or on a real device? Using the emulator allows for easier capture of the interaction with the device, since it allows screen recording of user input and easier capture of the user when interacting with the emulator. Using a computer as a test object may be more positively perceived by the test user rather than installing the test application on their device or having them doing tests on our device.

Using a real device has the benefit of being an actual device, and may lead to a more realistic interaction pattern when using the application. While there exists a number of screen recorders for Android devices, these require that the device is "rooted" [**?**], which is not an option for us. The use of a real device also allows the use of gestures, which is a benefit in contrast to the emulator which can simulate swiping.

Beitol and Cybis [**?**] compared doing usability testing on a tripod-mounted device to an emulator and having a in the field. They found that many users found the tripod-mounted device difficult and unnatural to operate. The users found 80% of the usability issues on the emulator, but Beitol and Cybis points out that use of an emulator may depend on the similarity between the emulator and the device.

Based on the research we have read we decided to do the usability testing on a real device.

Chapter 4

Tangible Interfaces

This chapter will introduce the reader to Tangible Interfaces, and elaborate on some existing research that has been done on the concept.

4.1 About tangible interfaces

In 1997, Ishii et. al. presented an article called "Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms". They established the term "Tangible User Interface" (TUI) as a way to move beyond the dominant model of Graphical User Interfaces. The objective of TUI was explained to *augment the real physical world by coupling digital information to everyday physical objects and environments* [**?**]. Thus, TUIs are about giving physical objects a digital meaning.

Additionally, combining augmented reality (AR) with objects have been proven to improve children's cognitive learning [**?**].

The Karotz is an example of a tangible user interface. It lets the user interact with a rabbit instead of a desktop or tablet, which contains digital information about whether it is time to take medicine, and can send digital information when a child has taken his/her medicine.

4.2 Usage

Using TUIs instead of GUIs have been proven to work in several different settings. In this section, we will give an overview on some of the domains in which the concept has been proven to work.

Learning Terrenghi et al. designed a cube for learning, giving children quizzes where answers had the shape of text or images [**?**]. Children could then rotate the cube in order to get the correct answer pointing upwards, sort of like a dice.

Collaborative learning Scarlatos et. al. created a system called TICLE (Tangible Interface in Collaborative Learning), which are used to help children solve a Tangram [**?**].

Interactive storytelling Zhou et. al. designed a cube for storytelling, using a head mounted display and a "Magic story cube" in order to let children explore the world while being told a story [**?**]. Stanton et. al. created a "Magic Carpet", giving children possiblity to influence a story in the classroom [**?**].

Social Context Marble Answering Machine is an invention by Durrell Bishop, dating back to 1992. The interface allows users to drop marbles into a play-back indent on the system, which plays a recorded message.

4.3 Effects of robots

In 2003, Wada et. al. conducted a study on how the introduction of robotics affected the elderly. [**?**]. They conducted a study at a day service center in Japan, where they placed a robotic seal, named Paro, together with the elderly. It had recently been found that animals have a positive effects on blood preassure, depression and loneliness. The problem is that animals are not allowed in a lot of hosiptals and care centers, because people may have allergic reactions, get scratch marks from the animal, etc. They placed a robotic seal in the care center, and analyzed the reactions from the elderly.

The results showed that their mood was better after interacting with Paro over five weeks, and became worse once Paro was no longer there. In addition, nurses burnout rate decreased during the experiment, which implied that the subjects had easier days whenever Paro was there. The study shows that their quality of life was improved after Paro was introduced.

4.4 Are Tangible Interfaces more fun?

In 2008, Xie et. al. performed a study on how children reacted using different interfaces in order to solve a jigsaw puzzle [**?**]. The different interfaces were a physical interface

(i.e. a standard jigsaw puzzle), a TUI and a GUI. Their findings were mainly that children enjoyed playing with the different interfaces similarly. However, the children were more likely to start a puzzle over again if the interface were physical or tangible, which implies that a repeated task is more likely to be performed if they're playing with a tangible or physical interface, while it becomes boring to do the same task over and over again on a graphical user interface. It is worth mentioning that the puzzles were being solved by groups of two, and considering the GUI was a computer with one mouse, they didn't get the same sharing experience as with the other interfaces.

This applies to our research because the medication process is a repetitive task, and we are dependent on children not getting bored during the process.

4.5 What is gamification?

"Gamification" as a term was first mentioned by Currier in 2008[**?**], but did not become a wide-spread term before 2010. Today gamification is a much used term both in programming and in the spoken language. Smartphone applications and manufacturers have helped make the term gamification a widespread notion. Examples of this is the application Foursquare, which is built around gamifying "checking in" at restaurants, historical sites and similar places [**?**]. Apple developed a Game Center for iOS in 2010, giving every iPhone/iPod and iPad user a hub for challenges, awards and other gamelike activities[**?**]. Lately there has been many games built singularily around gamification, such as Cookie Clicker [**?**] or Farmville [**?**]. Even consoles like PLAYSTATION 3 and XBOX contain gamification support per default, with their achievement/trophy systems [**?** **?**]. While there are many users of such games, they are often critiqued for using gamification to lure players into playing.

There are many different ways of describing gamification. Deterding, Dixon, Khaled and Nacke[**?**] defines Gamification as:

Gamification is the use of game design elements in non-game contexts.

Huotari and Hamari[**?**] defines gamification as:

Gamification is a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation.

Deterding, Dixon, Khaled and Nacke's definition often commonly referred to, because of it's simplicity and understandability for people who have little or no connection to traditional games or games consoles. Gamification is a much discussed theme, where there does not seem to be an agreement as to which gamification is a useful or not. Antin

and Churchill[**?**] argues that gamification may be used for goal setting or instruction. Goal setting challenge the users to meet the mark that is set for them, and is known to be an effective motivator [**?**].

Bogost goes as far as naming gamification as "marketing bullshit"[**?**], used as a way of moneytizing bad business.

McGonigal's studies[**?**] on how rewards are perceived over time show that:

After three hours of consecutive online play, gamers receive 50 percent fewer rewards (and half the fiero) for accomplishing the same amount of work.

Steinung[**?**] arguments for gamification not being powerful enough to make a task interesting. Simply adding points, badges, a leveling system or similiar, won't make a task interesting on its own. Since gamification is based on behavioural pshychology, poor design may be perceived as interesting, for a shorter period of time [**?**]. Zichermann makes a similar statement, saying gamification needs to take ethical precautions [**?**].

McGonigal's statement is central to our research, since we aim to research how [INSERT APPNAME] is perceived by children over a longer period of time. While McGonigal's research dives into how rewards are percieved when playing over a longer consecutive time, our goal is to make the users use the application for a short period of time, everyday.

In order to achieve a meaningful use of gamification Nicholson[**?**] suggests using a user-centered design approach[**?**] when developing system with elements of gamification.

4.6 Use of Gamification in [INSERT APPNAME]

Our hypothesis is that children need a motivating factor in order to take their medicine, as they do not necessarily understand why they take it, and gamifying their treatment might be a feasible motivation factor.

In [INSERT APPNAME] we aim to use gamification as a distraction and rewarding element for the children. Instead of putting a lot of predefined badges, rewards, experience points or other rewarding elements, we let the users choose their own rewards, which implies that users can decide what is best for themselves.

The children are rewarded with stars based on their health state. The reason for this is that the children may have to take more medicine when they have a cold or there is much pollen in the air. The guardians have access to a administrator menu where they may set new rewards for the children. The children will then be able to order the

rewards when they have earned enough stars. This way the guardians and their children create their own gamification environment, and the application do not force parents to do something that for some ethnographical or sociological reason. Examples on possible rewards could be to give their child an extra 10 kr. in weekly salary, taking them to football matches or even go to the local amusement park. It is an option where the only boundary is the imagination and how much effort guardians want to put into it.

The rewards will appear at a "milestone" basis. We do not want children to feel they lose something if they buy a reward, which some probably could feel if stars were taken away from them.

An overview of the screen shots, architecture and logic behind the gamification elements is found in Section [INSERT REFERENCE].

Chapter 5

Our intended solution

This chapter will give a brief introduction into the TUI we are planning to create.

5.1 Introduction

From our experiences with Karotz [**?**], we have found that we do not want to go any further with it. The thought behind Karotz is great, but these thoughts are, in our subjective opinion, poorly executed. If we were to test the concept at people's homes, we would need to preconfigure the units down to the smallest details. Just the fact that we would have to ask families for their WiFi-credentials before testing a system, should be reasons enough. Additionally, the Karotz API is only documented in french, which makes it considerable harder to develop for. The largest challenge by using Karotz is it's price. A Karotz starters kit costs $200, not including customs to Norway. Making such a large investment on a product parents have no experience with is going to be quite difficult from a commercial standpoint.

We have also taken a brief look into Arduino, which is an open source electronics prototyping platform [**?**]. We have seen some of the projects that have been done in Ardunio, and have found that they require competence and knowledge we simply do not have, i.e. digital design and circuit boards.

The idea we have found most exciting, both for ourselves and as a solution, is Rasperry Pi [**?**]. It is a cheap computer with the size of a credit card, with the original intention of teaching british school children about computer programming [**?**]. Since the release early in 2012, it has sold more than 1 million units, and is highly popular among computer enthusiasts [**?**].

5.2 What do we want to create?

On the highest level of abstraction, what we want to create here is a descrete artifact children can have at their rooms, which can remind them to take their medicine, and help them through the process. Our plan for the time being is basically to wrap the Rasperry Pi inside a toy, i.e. teddy bear, a doll, or some other popular, medium sized toy.

We consider the following as the minimum set of abilities for our TUI:

- Ability to connect to a network, either through ethernet or WiFi, though both are preferred.
- Play sounds through speakers
- Ability to read RFID-chips
- Display information about the color of the asthma medicine through LED-lights

5.2.1 A basic scenario

In order to get a basic understanding of what we are trying to achieve here, we have included a basic scenario below. Assume that we have our Rasperry Pi inside a teddy bear.

1. (Bear): Cough, cough. Come over here kiddo
2. (Kid approaches)
3. (Bear): I need my asthma medicine now. Could you please help me? The color of the medicine is displayed at my belly.
4. (Kid finds the medicine)
5. (When the child holds the medicine towards the mouth of the bear, the RFID chip on the medicine is read, which instructs the bear to continue).
6. (Bear): Thanks. Now it is your turn to take your medicine.
7. (Bear): Now, find your mask and put it over your nose and mouth. You need to press the button at the top of your medicine before you start breathing.
8. (Bear): (Counts for the amount of seconds needed)
9. (Bear): Great job!

The idea behind having a voice to the teddy bear is to establish a two-way communcation between children and the artifact. We want children to actually care for our product, which may be achieved through giving the artifact a sense of personality.

5.2.2 Components

RFID We will be using RFID-technology to let children interact with the TUI. Our initial vision is to attach an RFID-chip to each of the childrens' medicines, which in turn can be read by our TUI. For instance, during step 5 in the above scenario, a child can hold the medicine towards the mouth of the bear. The type of the medicine is read by the bear, who can notify the child if he/she is starting to take the wrong medicine.

Speakers The speakers will be used to play prerecorded messages from the teddybear.

Connect to network Ideally, we want to attach a wifi shield to our Rasperry Pi, making it able to connect wirelessly. The benefits of this is that it makes the TUI portable. However, this might include having to preconfigure the system as with Karotz as mentioned in section 5.1. This makes it a problem we will have to research further before deciding on a solution for our prototype. Information we want to send through the network consists mainly of alarm notifications set by parents, i.e. when the toy should giving signals that it needs medication.

LED-lights Through LED-lights, we intend to show the color of the medicine that is to be taken. As we cannot assume children are able to read, or to remember the name of the medicine, Aaberg et. al. have found that showing the color is a feasible solution to showing which medicine should be taken [**?**].

5.3 Programming our Rasperry Pi

Rasperry Pi's main programming language is C. As we are not especially good at programming in C, we will use Pi4J as a bridge between Java and the Rasperry Pi's native libraries, which makes us able to manipulate IO-channels [**?**].

Chapter 6

Usability Tests

This chapter will describe the purpose of the tests and how they were executed. Finally it will cover the observations and results of these tests.

6.1 Purpose

The usability tests were performed in order to provide usability feedback on the application. These tests were created to test and discover the usability problems in the at that time current version of [INSERT APPNAME]. The tasks given to the participants were created with routine use of the application in mind. User tests were performed on participants with no prior knowledge of the application. These participants where chosen in order to get valuable feedback on usability problems with the current design and structure, and to prevent invalid feedback from users who already knew how to perform the tasks. In addition, this situation mirrors everyday life of the users.

6.2 Research Method

The execution of the usability tests was based on the theory described in Section 3.2 and Section 3.3. We choose to not do usability testing exclusively on our target group, parents with children suffering from asthma. Main reason for this was time concern, and the goal of our application being suited and having good usability for all users, disregarding their knowledge of asthma. Our test persons were mainly students selected from Bachelor or Master students at NTNU, with none computer science subjects. The computer science students were excluded due to the fact that they are more used to

graphical user interfaces and applications at a "beta stage", which may have given invalid data. The tests were run in XXX iterations on 5-6 test persons on each iteration.

Before of each usability test, we performed a quick-and-dirty pilot test in order to discover critical errors that could make an impact on the result.

To ensure that the participants had the wanted background, they were asked to fill in two forms when registering for the usability tests. These are added in [INSERT REFERENCE].

The participants were placed at a table and given an Android mobile device to perform the tasks on. The different tasks were given one by one in order to complete. The participants were introduced to the "think-aloud"-method, and were told to ask questions during the process, even though the test leader was not allowed to answers these questions during the test. The main reason for gathering questions was for discussion afterwards or to facilitate the "think-aloud"-method.

Upon finishing the tasks, the participants were asked to answer the forms in [INSERT REFERENCE] and A. The test leader finished the test by asking questions regarding what the participants thought of the system and answered the questions that may have occurred during the test.

The result was later analyzed to work out the improvements needed to be done to the system. The errors was rated after level of severity [**?**].

- Critical (Level 1) - Prevents the participant from completing the task.
- Siginificant (Level 2) - Generates significant problems when trying to complete the task.
- Minor (Level 3) - Have minor effect on the usability of the application.
- Non-essential (Level 4) - Enchancements to the system. When a participant states that "it would be nice to have this".

6.3 Participants

Table **??** shows the answers to the forms in [INSERT REFERENCE], which covers information about them and the knowledge they had with computer usage and asthma.

Table **??** contains answers the users wrote down after completing the test.

Participant	P1	P2	P3	P4	P5	P6
Gender						
Age						
Education						
Experience with computers						
Access to internet						
Time spent online per day						
Has a smartphone						
SMS Usage						
Has facebook account						
Uses electronic reminders (calendar, to-do list etc)						

TABLE 6.1: Participants' experience with IT solutions

Participant	P1	P2	P3	P4	P5	P6
What was difficult?						
Why was it difficult?						
Have you used similar systems?						

TABLE 6.2: Participants's opinions upon finishing the test

6.3.1 Scenario and tasks given to the users

Since both the system and the test users spoke Norwegian, the scenario and tasks were given in Norwegian. The exact scenario and tasks handed to the participants can be found in Appendix E, but for convenience the next paragraph gives a short summary of the scenario and tasks.

The scenario explained that the user was a guardian of a 4-year-old child with asthma. They have recently been to the doctor's office, and will now have to set up treatment plans according to advice given by the specialist. Since they have little experience with asthma, they would have to look up information about the medicines and how the treatment will be done. In order to motivate the child to continue taking his/hers medicine, they will have to add a reward via the application menu. Finally, they would have to look through the calendar log in order to find correlations between the child's health state and use of medicines.

6.4 Observations and Results

As described in Section 3.1, usability can be a combination of effectiveness, efficiency and satisfaction. The sections 6.4.1, 6.4.2 and 6.4.3 will give answers to how well the system performed compared to these components. The most interesting observations are summarized in Section 6.4.4.

6.4.1 Effectiveness

6.4.2 Efficiency

6.4.3 Satisfaction

The participants satisfaction when using the application was adressed through the System Usability Scale-forms. The Table [INSERT REFERENCE] shows the result from the participants SUS-forms after calculating the scores.

Participant	P1	P2	P3	P4	P5	P6	Mean
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
Score							

6.4.4 Specific problems

Chapter 7

Description of [APPNAME]

This chapter will give a description of [APPNAME], through textual description and screen shots. Please note that the main language of the application is Norwegian, and we have translated parts of it where it seems appropriate.

7.1 Basic System Architecture

Figure 7.1 shows an overview of the architecture we intend to use for our solution. We will build upon the architecture used by Aaberg et. al. [**?**].

We have access to a MySQL-server hosted at NTNU, which we will access by a PHP-server hosted at NTNU. The main reason we have to access the database through a server layer, is that it is quite cumbersome to connect to the database if a device is not connected at NTNU's network. In addition, by having a webservice do some of the work for us, it becomes easier to parse results from the database through JSON.

The downside by having this approach is that scalability suffers from this architectural choice. However, we consider these problems as outside the scope of our thesis, and will continue using this approach.

7.2 Child partition

The child partition of our application consists mainly out of four parts. When Aaberg et. al. created the original application, they wanted a conceptual look and feel throughout the applications. They used images of Karotz in the application in order to introduce

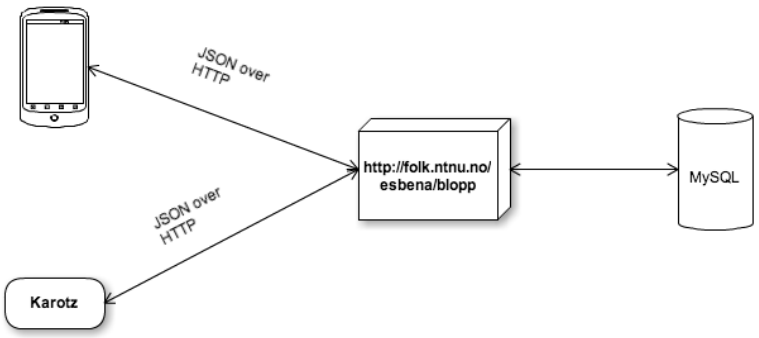

FIGURE 7.1: Basic architecture of our system

a sense of completeness, i.e. the Karotz bound CAPP, GAPP and KAPP together. [TODO: Vi burde bytte ut Karotz-bilder med eget produkt imo].

7.2.1 Treatment

Figure 7.2 shows a screenshot for the application when the child starts their treatment. Starting this sequence can come from one out of two events: (i) *The child reacts to an alarm set in the guardian partition*, and (ii) *The child needs to take their medicine by need*. If (ii) is the case, the child is instructed to pick the medicine from a list shown by the application. If (i) is the case, the medicine is chosen beforehand. When a child has started their treatment, they are taken through an animated sequence, which reacts when a child interacts with the device. In addition, they are being told what to do through the comforting voice of Yngve Svalestuen.

7.2.2 Showing rewards

Figure **??** shows a screenshot for the application when the child wants to review how many stars he/she has received, based on the amount of medicine they have taken. We have made two design decisions for our reward system. First, we never want stars to be removed. We dont́ want children to feel that credits are being removed from them. Second, we cant́ assume children are able to read, and thus we have made it countable, and hopefully they can comprehend how many stars they've actually got. In addition, we provide some help to those who are able to read numbers, by showing the amount of stars a child has on the top. The downside here comes when a child has been given a huge number of treatment, such as 200 treatments or more. This will obscure the view.

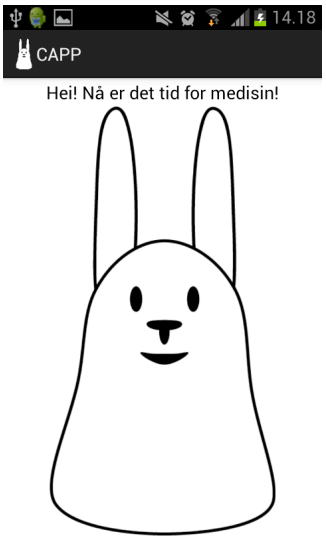

FIGURE 7.2: Starting a treatment

FIGURE 7.3: SHOULD BE A SHOP

7.2.3 Shop

In the shop, children are allowed to buy rewards from parents [Insert Reference]. Figure 7.3 shows a inside-view of our shop. Children can buy an activity by pressing the selected activity. Due to time constraints, we have not been able to implement voice over, so the children will have to find a parent who can read it if they are not able to [TODO: 1: Bryter med linjen over. 2: Implementasjon av voice over med norsk som sprk er vanskelig].

7.2.4 Treatment instructions

The treatment instructions is a book-styled instruction set which shows generically how to take a medicine. The following steps are included in instructions:

1. Shake the inhaler such that the particles loosen up.
2. Take the cap of the inhaler
3. Attach the inhaler to the inhaling chamber [TODO: Korrekt bruk av chamber?]
4. Put the inhaler onto the face of the child
5. Press the inhaler until you hear a sound
6. Let the child breathe calmly 10 times in and out
7. Let the child wash his/her mouth

FIGURE 7.4: Instructions 1

FIGURE 7.5: Instructions 2

FIGURE 7.6: Instructions 3

FIGURE 7.7: Instructions 4

FIGURE 7.8: Instructions 5

FIGURE 7.9: Instructions 6

FIGURE 7.10: Instructions 7

7.3 Guardian partition

This section will take you through the Guardian partition of [INSERT APPNAME].

7.3.1 Menu

Figure 7.11 shows the main menu of the guardian partition. It has six options (norwegian translation in paranthesis):

1. Medicine Plan (*Medisinplan*)
2. Register Medicine Afterwards (*Etterregistrer medisin*)
3. Medicine Log (*Medisinlogg*)
4. Medicine Information (*Legemiddelinformasjon*)
5. Manual (*Manual*)
6. Rewards (*Premier*)

7.3.2 Medicine plan

Creating a medicine plan for asthma treatment is highly connected to the Traffic Light System [INSERT REFERENCE]. Users can have three different plans, depending on which health state they are currently in. As we are targeting children, we can not assume that they are aware of which category they are currently in, and as a result, we let their guardians control it. Figure 7.13 and [INSERT REFERENCE TO EDIT PLAN] shows the view in which one may the change medicine plan their child are currently on, in addition to setting alarms where appropriate. For instance, one might set an alarm at 07:00, which makes the user aware before it is time to leave for school. Changing medicine plan is done by selecting the checkbox at the left side of the panel.

7.3.3 Register medicine

What happens if a child need their medicine, but the application or our TUI is not nearby? They would probably be mad because they did not get their star, and did not make any progress as far as the rewards go. Fortunately, it is possible to register a medicine that has been taken afterwards, which entitle the child the amount of stars they should have gotten. *Register Medicine Afterwards* allows parents to register the medicine, at any given day prior to current time (See Figure 7.12).

7.3.4 Medicine log

The *Medicine log* can be used by parents to show how many times a child has taken their medicine. One of the main reasons that children does not take their medicine is lack of communication between parents. Having an option to show medicine log, give parents the ability to check and see whether they have taken the necessary amount at a given day.

Figure [INSERT REFERENCE] shows the calendar view of the application. The view is a bit complicated, and an explanation is in it's place. We'll start out by the cells in the calendar. They obviously show any given day of a month. In addition, there is a top bar in the view. The top bar indicates which health state (or health plan) the child was in at a given day. At the bottom of the screen, there are three panels. The left one shows which medicine that has been taken at a selected day. The middle one shows the air quality in Trondheim. The right shows the pollen distribution of the 6 most common pollen types. The idea behind this is that asthma symptoms can often be the same as allergy symptoms, and if guardians are able to recongize a pattern between health state and pollen distribution, they might want to take their child to a hospital.

7.3.5 Medicine information

Figures 7.14 and 7.15 shows the application's medicine information functionality. The information part of the application is a part that is somewhat down-prioritized. At the time being, it contains a lightweight description of what it is, what it is used for, important information and how you apply it.

7.3.6 Manual

The manual contains excactly the same information as shown in Section 7.2.4. [TODO: Beskrive hvorfor dette er to steder i appen?]

7.3.7 Reward

Figure 7.16 shows the list of possible rewards a child might receive. They are added by parents through emphAdd reward. The idea of having guardians set their children's rewards is to specify rewards according to children's interest [TODO: Referanse til hvor vi har sagt dette fr]. Figure 7.17 shows how one may add an activity. Users inserts a description, then either take a photo or select one out of our standard images. It is

possible to set a reward on “Repeat”, which will make the reward repeating with twice the amount of stars [TODO: Omformuler]. When the user press “Lagre” (Save), the reward is added and children have the possibility to buy it.

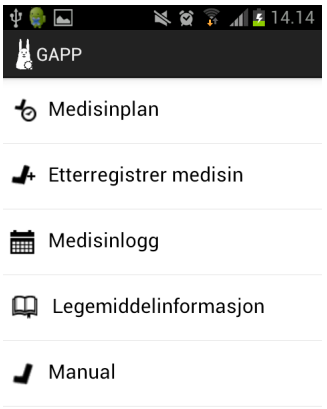

FIGURE 7.11: Menu in guardian partition

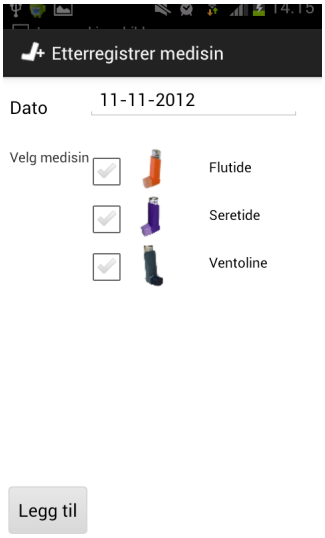

FIGURE 7.12: Register treatment

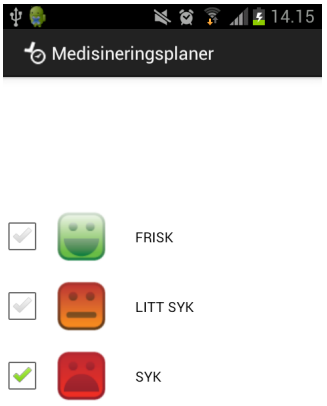

FIGURE 7.13: View plans

FIGURE 7.14: Information 1

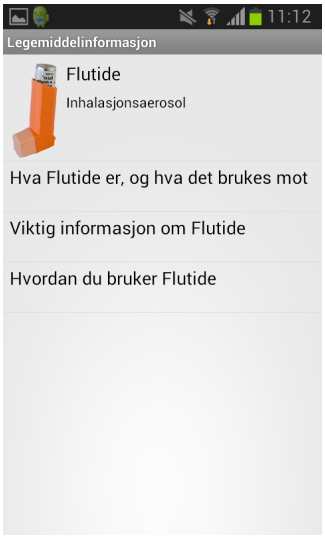

FIGURE 7.15: Information 2

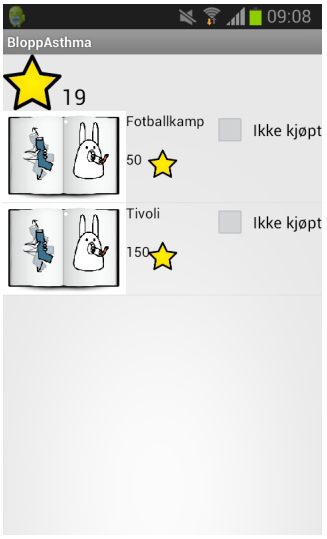

FIGURE 7.16: Reward list

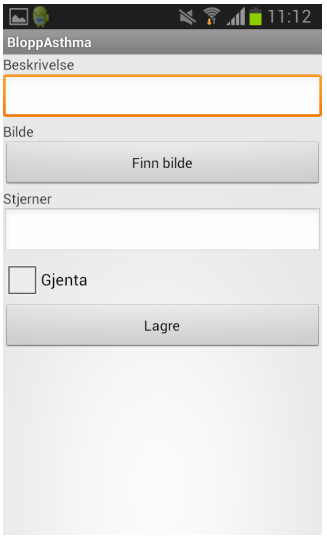

FIGURE 7.17: Add reward

Chapter 8

Results and Discussion

This chapter will go through the findings from this study and summarize the results to answer the research questions from Section 1.3

8.1 Evaluation

8.2 Research Method

Chapter 9

Conclusions

Appendix A

Norwegian SUS form

This Norwegian version of the SUS form was developed by Svanæs, D. in 2006.

Noen spørsmål om systemet du har brukt.

Vennligst sett kryss i kun en rute pr. spørsmål.

	Sterkt uenig				Sterkt enig
1. Jeg kunne tenke meg å bruke dette systemet ofte.	1	2	3	4	5
2. Jeg synes systemet var unødvendig komplisert.	1	2	3	4	5
3. Jeg synes systemet var lett å bruke.	1	2	3	4	5
4. Jeg tror jeg vil måtte trenge hjelp fra en person med teknisk kunnskap for å kunne bruke dette systemet.	1	2	3	4	5
5. Jeg syntes at de forskjellige delene av systemet hang godt sammen.	1	2	3	4	5
6. Jeg syntes det var for mye inkonsistens i systemet. (Det virket “ulogisk”)	1	2	3	4	5
7. Jeg vil anta at folk flest kan lære seg dette systemet veldig raskt.	1	2	3	4	5
8. Jeg synes systemet var veldig vanskelig å bruke	1	2	3	4	5
9. Jeg følte meg sikker da jeg brukte systemet.	1	2	3	4	5
10. Jeg trenger å lære meg mye før jeg kan komme i gang med å bruke dette systemet på egen hånd.	1	2	3	4	5

|

SUS
Norsk versjon ved Dag Svanæs
NTNU 2006

Appendix B

Further Work

This chapter gives an overview of some of the ideas both the customer and the developers had for further development of the application. This includes a description of further development, analysis of the user groups and work towards NAAF and the health department. The main part of the work to be done after the end of this project is connected to requirements that has been taken out of this project due to limitation of time and resources. Other issues remaining is connected to the security and privacy of the patient's treatment log and storing sensitive information. Section **??** lists the overall requirements that have not been implemented during the project. These requirements has either been requested early in the process of have been brought up during discussions and meetings with the stakeholders.

B.1 Improvements

The following sections describes the ideas we had for future improvements to the applications. It is parted into subsections for improvements in the fields of database records, the reward system, the distraction and the web application.

B.1.1 Rewardsystem

The children's application (CAPP) is all about changing the children's view of medication to something positive. It shall be a motivation for the children to take their medication. It is therefore an important task to entertain them and give them some form of reward when they take their medication. As for now, we have given stars to the child after completed medication. The stars are in a treasure chest where the child can

see how many stars he or she has. This is a simple reward, but worked fairly well during the user tests. However, it may be boring over time.

The initial idea was to have a shop where the children could buy clothes and other items to their avatar. The stars earned from finishing treatments would serve as credits in the shop. This was not implemented due to time restrictions. It is also possible to take this to the real world, e.g. that the child gets a lollipop for every 10th star, but this would have to be supervised by the parents.

There is an endless line of opportunities for this reward system, and we chose the simplest implementation, so we would have something to test.

B.1.2 Distraction sequence for children

During our workshop, we came up with a lot of ideas for distractions for the children. These would range from simple animation sequences, like what we decided to implement, to more complex things like games that would not require a lot of movement and could therefore help during longer treatments.

The distraction sequence is one of the fields were we feel it has more or less never ending possibilities for improvement, and as more research into what children finds distracting, but not to the point where they can't take their medicine, this distraction sequence can be evolved.

B.1.3 User testing of the guardian application

GAPP has not yet been user tested on actual parents of asthmatic children. This has to be done to get an understanding of how they interact with the system, and to get knowledge about what they think of an application of this type. This is a system to make it easier for the guardians to give their children medications. While it is important that the children likes the system, it is also important that the parents feel it helps them give their children their medicines, without it being a big time waster.

B.1.4 Web application

There is a possibility of making this application as a web application, as a whole. By extracting the functionality and running it on a web service it would make it easier for people to use it across platforms. Done right, it may run on all devices with an internet connection. This may also give an easier integration with external information such as

air pollution forecast, pollen forecast, temperatures, etc. Since our application is written in Java, using Android SDK, it will not run on an internet server as is. Making a web application will require an almost complete refactoring of the source code.

B.1.5 Support for more children

Currently, the application only use one child, but there are implemented support for using more children. Each child has its own id (childId), and support for more children can be implemented without much change of the existing code. There should also be concidered using accounts for the guardians connected to the children, in case of the guardians having more than one asthmatic child.

B.2 Ideas and minor improvements

Webinterface The doctors may prefer to set up the users medication plans through a web interface on their computers. This part may be integrated into existing systems.

Other devices The application are fitted for a phone running the Android operating system. For the future it should also be scalable to tablets. There may be more interesting for a child to work on a tablet than a phone. There will also be much more space for content. This extra space gives greater potential of the reward system. It should also be available on other operating systems than Android, e.g. iOS or Windows Phone. This will improve the availability for the users, not limiting them to Android phones.

Overall graphical design The priorities have been to make the major functionality work. We have used lots of time making the applications understandable and easy to use, but there is still a great potential in making the applications interaction design better.

Personalize the system The application may be more personalized. E.g. "It's time to take medication" could be "It's time to take medication, Eric". By involving the users name more in the system, they may feel more appreciated.

Integration of external elements The distraction part of the application may be integrated with a story or other external elements. I. eg. a story where the children will need to take medicine in order to get the next part of the story.

Appendix C

Questionnaire. Demographics

Vennligst besvar sprsmle under, før vi begynner testen.

Kjønn
Alder
Utdanning
Yrke

Appendix D

Interview conducted before usability testing

Experience with computers
Access to internet
Time spent online per day
Has a smartphone
SMS Usage
Has facebook account
Uses electronic reminders (calendar, to-do list etc)

Appendix E

Scenario and tasks

Du er verge til et barn på 4 år. Dere har nylig vært hos en lege med spesialkompetanse på barnesykdommer. Barnet har fått diagnostisert astma. For å enklere holde orden på at medisinene blir tatt til riktig tid, på riktig måte, har du lastet ned applikasjonen [SETT INN APPNAVN]. Systemet har ikke behov for at du registrerer navn eller lignende, for du ønsker ikke at slik informasjon kommer på avveie. For at du best mulig skal kunne benytte deg av [APPNAVN], er det nødvendig at du gjennomfører noen oppgaver.

Oppgave 1: Du skal sette opp en medisineringsplan i henhold til anbefaling fra legen. For enkelhets skyld skal du kun endre medisineringsplanen for barnet når det er helt friskt. Legg til en varsel for "Flutide" kl 13:37 og en varsel for "Seretide" kl 18:30. Velg deretter å følge denne medisineringsplanen.

Oppgave 2: Barnet ditt tok allerede en dose med medisin da dere var hos legen. Du ønsker å starte loggføringen med en gang. Etterrigstrer bruk av Seretide kl 12:51 i dag.

Oppgave 3: Du ønsker å motivere barnet ditt til å ta medisinene sine uten at det skal bli en krangel hver gang. Lag en premie barnet ditt kan få dersom hun/han har fulgt medisineringsplanen sin. Som premiebilde kan du ta et bilde med kameraet pélefonen, og premietekst og antall stjerner velger du selv.

Oppgave 4: Se hvordan barnet ditt ligger an i forhold til målet du satte i forrige oppgave?

Oppgave 5: Det er nå gått to uker, og du ønsker å se hvordan du og ditt barn har fulgt medisineringsplanen. Let gjennom loggen for å se om dere har gjort jobben på en god nok måte.

Du har nå gjennomført testen. Vennligst fyll inn skjemaene for å forklare hvordan du oppfattet bruken av applikasjonen.