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by

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"Gotta Catch 'Em All"

- Ash Ketchum

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Abstract

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The Thesis Abstract...

Keywords: *BLOPP, Asthma*

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We 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
GUI	**G**raphical **U**ser **I**nterface
PCHR	**P**ersonally **C**ontrolled **H**ealth **R**ecord
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 CAPP, GAPP and Karotz Applications created by Aaberg, Aarseth, Dale, Gisvold and Svalestuen [1]. The evaluation will be done through usability testing carried out on all three applications. The results of these initial tests will thereafter be used to improve the applications for a newer version. We will also plan a thorough testing of the applications.

1.2 Motivation

According to NAAF, 20% [2] 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 [Should have a reference]. This may result in parents applying the medication incorrectly, applying the wrong treatment, or even forgetting to give the medicine to their children.

1.3 Research Questions

The main goal for this study is to evaluate the CAPP, GAPP and Karotz application, and identify the usability problems in these systems. Structuring the goal into different

research questions will help this study with the evaluation of the goal. The goal has been composed into these questions:

RQ1: How will guardians of a child react on having a Karotz constantly "watching" over their child?

RQ2: What are the usability problems of the current system?

RQ3: Will the physicians benefit from having detailed logs and information sent by email?

This evaluation should be done through user testing and feedback from future users of the applications. The testing will give information on how well the ...

1.4 Research Method

Chapter 2

Background

This chapter will give a brief introduction to the history behind the BLOPP project [insert reference] and the CAPP, GAPP and Karotz applications.

2.1 BLOPP Project

Barns LegemiddelOPPlevelser is a project group ...

2.2 CAPP/GAPP/KAPP

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" [3] at NTNU. During the period of August 2012 to December 2012 they developed a prototype of a mobile information system consisting of three applications. One application were 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].

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

(Sidenote: The applications have norwegian as their main language)

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

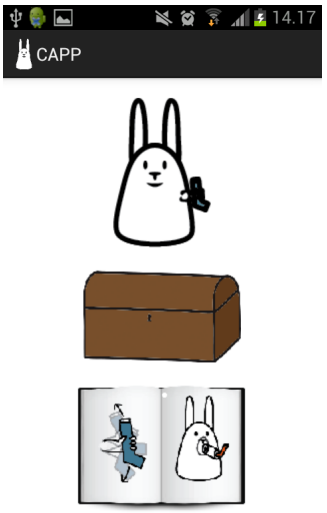

FIGURE 2.1: CAPP main menu

launched, the medication process starts, where the child is taken through the process by a Karotz on 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.

As the target group for the application is children below the age where it is reasonable to assume that they 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[4], 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 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 (yet).

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

FIGURE 2.2: Karotz

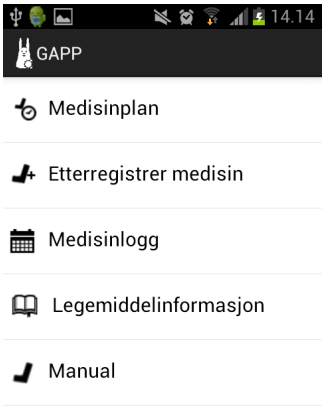

FIGURE 2.3: GAPP main menu

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 medicine*, *Medicine log*, *Medicine information* and *Manual*. Medical Plan gives parents the option to set up reminders at particular times.

The Register medicine-option gives parents possibility to register a medicine that is taken in case the child forgot to go through the process in CAPP or KAPP. This way, children gets their stars in the treasure chest. 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.

Its 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, so a child may only have one parent and vice versa.

2.2.4 Known areas for improvement

As Aaberg, Aarseth, Dale, Gisvold and Svalestuen 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

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

2.3 Existing products

On the two biggest 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 [1] , Asthma Logger [2] , Kids Beating Asthma [3] and Asthma Monitor [4] . 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.

2.3.1 Conclusion and evaluation

The main ideas we want to take further in our application are the email-sending system of Asthma Logger and the quiz-aspect of Huff And Puff. In general, it is a good idea to be able to send your journal on email, for instance to yourself. If we combine this

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

Application	Positive	Negative	Target Audience
Huff And Puff	• Relecant quizes 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

with possibility to send the journal to a doctor, we have a great time saving tool. To give an example: Ole has been feeling ill for a while, and has been keeping a journal for when he has taken his medicine. He can then schedule an appointment with his doctor, and send his journal on email to the doctor. When he arrives to his appointment, the doctor already knows how many times he has taken his medicine the last days and can give advice based upon these facts.

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. [5] 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 103, *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

2.4.1 Monitoring your own decease

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.[6] 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.

Whether the system actually improved the user's awareness of their decease was unanswered (TLDR?)..

Although SMS is a great technology to be used for this purpose, few children in our target group are able to use this technology.

2.4.2 Children and gestures

Abdul Aziz et. al. [7] 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 is 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 [8]:

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 [9], 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 [9] says it should be at the end of the project while others [10] 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 [11].

The usability testing can be performed in different ways [10]. 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 [11].

Before starting the usability tests, the developers should set goals planning what they want to know about the system [12]. 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 [13]. Molich[14] states that six test persons is the ultimate number.

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)[15] 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 [16] have made a scale based on the SUS-forms from different system 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 Svans A.

[1] Reference to Thinking aloud

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. [17] 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 [18] 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 NSEP Usability Lab

This section will describe some of the features in the NSEP Usability Lab, used by NTNU to perform usability testing.

3.4.1 The Facility

I made this section Justin Case.

Chapter 4

Security Requirements

This chapter will give a brief explanation of the security requirements enforced upon systems and applications that store medical information on Norwegian inhabitants.

4.1 Norwegian Law

Norway has specific laws for storing of medical information. The most significant law is "The Health Register Act[1]"[19]. This law regulates who is allowed to store health records and how they store the records.

The most significant consequences are that we will need permission from "The Norwegian Data Protection Authority" [2] n order to store medical records in the application, and that the information has to be stored on servers on Norwegian soil. This eliminates the option of using cloud-based storage[3].

4.2 Measures for Anonymization

Pursuant to section 16 of the Health Register Act [19] all information that may identify a person, must be encrypted[4].

Since we have no interest in the data values or the personal information of the test persons we made the following measurements to completely anonymize the data:

[1] Lov om helseregistre og behandling av helseopplysninger
[2] http://www.datatilsynet.no/
[3] Such as Amazon EC2 or Windows Azure
[4] There is no notion as of what level of encryption is required

Encryption In order to identify children, we have a few problems. First, it should not be possible to identify children by gaining access to the database. Second, we need a way that uniquely identifies the children, as both CAPP, GAPP and KAPP relies on uniquely identifying them.

We propose the following level of encrypting a child's identity: First, we will make use of the Android UUID (Unique Unit IDentifier). We will let the guardian type in the children's names. Then we will concatenate these values, and hash them using SHA-1[20]. By including the Android UUID, we will get a one-way encryption function, which should be acceptable for storage.

4.3 Personalized Access Control for a Personally Controlled Health Record

One of the most wanted features for CAPP/GAPP/KAPP was to be able to share the treatment history recorded in the application with the doctor's office. Keeping a medical journal is no revolution, but sharing detailed information about treatment history in the way done in CAPP/GAPP/KAPP is not done today. The guardians and physician's opinion about this sharing of information is one of the central questions we aim to answer, as mentioned in 1.3.

The idea of a complete Patient/Personally Controlled Health Record was presented by Mandl et al.[21] in 2001. The idea is to assemble the complete health history of the patient in one place. Røstad and Nytrø[22] made a list of security requirements for PCHR, one of which is "The patient is the administrator of access to his/her information. The patient decides what permissions to assign to who". This specific requirement and other requirements[22] have been taken into consideration when developing CAPP/GAPP/KAPP.

Nasjonal Kjernejournal

4.4 Basic security

HTTPS vs HTTP If the application is to be published by NAAF, there are some requirements towards sending data over HTTPS. However, in order to get HTTPS certificate, we have to pay a set fee (REFERANSE)[5]. In addition, the communication

[5] A small number of companies are allowed to sell HTTPS certificates. One of them is Symantec - http://www.symantec.com/verisign/ssl-certificates

will run more slowly, since data must be encrypted and decrypted. For demonstration value and early usability testing, we want to make sure that communication towards the database runs as smoothly as possible. As a consequence, we will not use HTTPS during the usability testing.

Passwords We will allow the user to create a password in order to protect medication records. These will be encrypted and stored securly in our database.

Chapter 5

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

5.1 Evaluation

5.2 Research Method

Chapter 6

Conclusions

Appendix A

Norwegian SUS form

This Norwegian version of the SUS form was developed by Svans, 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.

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