Makings of a Relationship: Perceived Qualities of Type 1 Diabetes Self-management Applications

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Abstract

Diabetes self-management applications can provide functions facilitating the management of the disease. Having better self-management can lead to better glycemic control and even decrease inpatient care costs through preventing complications. Therefore, it is important to have an application that is pleasant to use and has the features needed to support self-management.

This Master’s thesis is a qualitative research of the topic “Makings of a Relationship: Perceived Qualities of Type 1 Diabetes Self-management Applications”. This research analyses love- and break-up letters and date-adverts from 33 respondents by using grounded theory as a method. The goal of this thesis is to reveal which elements or qualities of type 1 diabetes self-management applications affect the user experience of these applications. Moreover, this research analyses answers from a questionnaire in the aim of finding what persuasive features have the biggest effect on those experiences.

Based on the results, the most important elements or qualities in self-management applications are automatic data transfer, visualization, dose calculation, pleasant outlook, ease of use, and connection with health care personnel. The persuasive features having positive effects on user experience are reminders, tailoring/personalisation, similarity, liking, social role, self-monitoring, and trustworthiness/expertise. In this research, competition, social comparison and recognition were strongly rejected as being possibly harming features in diabetes self-management.

Keywords
type 1 diabetes, diabetes self-management, information systems, mobile applications, grounded theory

Supervisor
PhD Piaastina Tikka
Foreword

First of all, I would like to thank all the members in the Ykköstyypin diabetes aikuiset - Facebook group, for allowing me to utilize the group for this research.

I will always be greatly thankful for my supervisor, PhD Piaistiiina Tikka, without whose guidance and great insights this thesis might have never been finished. You gave me valuable ideas and comments, and helped me to overcome obstacles. I would also like to give my deepest thanks for Dr. Kaisu Juntunen, who was in an important role in the beginning of this work: without you the transfer from a foggy idea into executable one would have been painful.

The work with this thesis did not proceed as systematically as I would have liked to. There were times when I was incapable of working with this, followed with times when I could spend the whole day and night with this. Due to that, I will always be grateful for my beloved one. Without your care our home would have been a mess and I would have forgotten to eat. Thank you for being understanding and supporting me when it was difficult, and giving me space when I needed it to work with this thesis.

Miia Laitinen

Oulu, May 5, 2018
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1. Introduction

For people who have type 1 diabetes, there are multiple different mobile applications available to be taken in use for self-managing the disease. The aim of this thesis is to survey how people with type 1 diabetes experience using different mobile applications and what do they wish from the applications. The thesis also aims at distinguishing persuasive features in such mobile applications that affect the said experiences.

In this thesis, the focus is on type 1 diabetes (T1D). Type 2 diabetes, which despite its name, differs from type 1 diabetes especially as regards its causes and treatment, will not be discussed in large. People who have T1D have problem with their pancreas: its beta cells are destroyed, which causes the person’s with T1D pancreas not to produce insulin (American Diabetes Association, 2017a), meanwhile in type 2 diabetes the body is not able to use the produced insulin properly (American Diabetes Association, 2017b). In T1D a person needs to check his/her blood sugar regularly and based on glucose level and carbohydrates he or she eats, inject a dose of insulin (American Diabetes Association, 2017c). In type 2 diabetes, on the other hand, it is possible to control blood glucose levels with active lifestyle and healthy eating, without injecting insulin (American Diabetes Association, 2017b), which is not possible in T1D. In T1D it can sometimes be difficult to maintain blood glucose in balance even if a person with T1D tries his or her best. In these cases, using diabetes related application to help in self-management may be useful in noticing the problematic issues.

The problem is that there are several applications in the market, and they have multiple different features and functions in them. But do they have what people with type 1 diabetes need for a good self-management and balanced blood glucose levels? Trying to do one’s best and still failing can be very exhausting. Tracking the disease often helps in managing it. Today, when it is more common to use an electric device than pen and paper, it is increasingly likely that people use a mobile application in tracking, rather than other, more traditional ways, such as pen and paper.

With good self-management, it is possible to avoid diabetes related complications. As the treatment of diabetes is expensive – and even more expensive with complications – the main focus should be on preventing complications and encouraging self-management. In UK, the annual inpatient care costs were estimated to be between £1,800 and £2,500 per patient, while annual outpatient costs were estimated to be between £300 and £370 per patient (Diabetes.co.uk, 2017a). In Finland, it is estimated that annual diabetes treatment without complications costs approximately €1,300 per patient, while annual costs with complications costs approximately €5,700 per patient (Terveyden ja hyvinvoinnin laitos, 2016).

When evaluating the treatment of T1D, glycohemoglobin (HbA1c) value is used as one of the tools. HbA1c-test gives a picture about how in last 2–3 months one’s blood glucose has varied. Based on the result, it can be seen whether the treatment works or if it needs to be changed. (American Diabetes Association, 2017d.) HbA1c represents average blood glucose level, and does not tell how much it varies (Suomen Diabetesliitto ry, 2018). That is, HbA1c does not necessarily show the truth: it is possible that one’s blood glucose varies a lot from hypoglycaemia (too low blood glucose) to hyperglycaemia (too high blood glucose) leaving the average blood glucose
value to be within target level and causing the HbA1c-value also to be on optimal level. As the glucose adherence is slow, the blood glucose value of a single day does not affect the value of HbA1c practically at all (Eskelinen, 2016). For a person with type 1 diabetes, high variance and high blood glucose level can cause harm. Hyperglycaemia can, over time, damage blood vessels, cause neuropathy, retinopathy, and cardiovascular diseases (e.g. Diabetes.co.uk, 2017b). That also is why it is important to keep log on blood glucose levels: with gathered data, it is possible for both the person with T1D him- or herself and health care personnel to fix treatment to obtain more stable levels of blood glucose.

As can be seen from above, self-oriented treatment is cheaper than inpatient treatment, and treating diabetes without complications is cheaper than treating these complications. Both of these refer to the importance of successful self-management. In the aim of encouraging people with T1D for self-managing the disease, there should be applications to help them in that. Derived from that, the motivation for this thesis is to find out how people with type 1 diabetes experience using self-management applications and what they wish and expect from them. There are multiple applications available to be used, but there is neither similar research made concerning the experience of using those applications nor concerning the features affecting the experience. However, McCarthy, Rodriguez Ramírez and Robinson (2017) have conducted a research regarding medical devices used in treating T1D. That research is the base of this Master’s thesis: this thesis will survey experiences and preferences regarding the usage of self-management applications using grounded theory similarly as in McCarthy et al.’s research. This thesis will widen McCarthy et al.’s research from medical devices to applications. Previous research is more precisely presented in chapter two.

The main research question in this thesis is “How people with type 1 diabetes experience using self-management applications?”. To understand this better, the present thesis approaches the question through the following subquestions:

- Which elements or qualities of type 1 diabetes self-management applications affect the user experience of these applications?
- What persuasive features have the biggest effect on those experiences?

This thesis is predominantly qualitative research. The letter-part, discussed in chapters three and four, utilizes grounded theory similarly as McCarthy et al. (2017) in their research. After revealing the user preferences and wishes, they are supplemented with persuasive feature analysis utilizing PSD model (see chapters three and five).

In this thesis, the structure is as followed: in chapter two, prior research is covered. Chapter three focuses on research method used when conducting this research, including developing questionnaires and analysing the results. After that, in chapter four, received letters are analysed, after which in chapter five the persuasive features are analysed. Then, in chapter six the findings are discussed, which is followed by discussion in chapter seven. Finally, in chapter eight, there are conclusions.
2. Prior research

Existing literature is presented in this chapter. At first, the procedure of searching the literature is described. Then, the results are presented, after which is a short summary.

2.1 Procedure

Existing literature on the research topic was studied using a systematic literature review approach as a guideline. In systematic literature review the research question is formed at first, and after that literature will be reviewed to find answer for the question (Kitchenham, Budgen, Turner, & Khalil, 2007). Instead of following systematic literature review precisely, this research utilizes systematic literature review approach in defining keywords, with which it was possible to systematically find the most relevant papers. In this thesis, peer reviewed papers from journals and conferences were accepted.

Google Scholar and Scopus were first priority databases when looking for articles. Keywords “type 1 diabetes”, “self-management”, “experience” and “mobile applications” and their combinations were used, and each relevant article’s journal was also scanned with the aim of finding more relevant articles. Records from the following journals have been scanned for this review: Journal of Diabetes Science and Technology, Journal of Medical Internet Research, including JMIR Diabetes and JMIR mHealth and uHealth, and Journal of Human Nutrition and Dietetics. Beside journals, from Google Scholar also two conference papers were found: Chomutare, Tatara, Årsand and Hartvigsen (2013), and McCarthy, Rodriguez Ramirez and Robinson (2017), the source of this thesis’ method.

Since the first issue of Journal of Diabetes Science and Technology is not later than 2007, and has only six issues per year, all the issues of this journal were scanned on title level between volumes 1 and 11. There were several articles focusing on application usage in diabetes treatment for health care personnel (see e.g. Janssen, Portalatin, Wallace, Zhong, & Parkes, 2007; Jhaveri & Lee, 2007), but since the viewpoint was opposite to this thesis, those articles were excluded. From this journal, altogether six articles are included in this thesis.

As the Journal of Medical Internet Research has more articles than Journal of Diabetes Science and Technology, it was not scanned thoroughly. Instead, the keywords "type 1 diabetes" AND "self-management" AND "mobile applications" were used, and from the 14 articles found with this research, only two were accepted for this thesis. Rest of the 14 articles were rejected due to their focus only on physical activity and/or weight management (e.g. Mateo, Granado-Font, Ferré-Grau, & Montaña-Carreras, 2015), focus on overall mobile applications instead of diabetes self-management mobile application (e.g. Zhao, Freeman, & Li, 2016), or otherwise being irrelevant for this topic.

After changing the keywords to "type 1 diabetes" AND "self-management" AND "application", 48 results were gained, which were scanned at title level. From these results, one more relevant article was found and included in this study.
In JMIR Diabetes, keywords "type 1 diabetes" AND "self-management" were used, since when added "application", only 9 results were found. From the 17 results, four were found relevant and included in this thesis. Others were excluded, due to irrelevancy for this topic. In JMIR mHealth and uHealth, however, keywords "type 1 diabetes" AND "self-management" AND "application" were used, and from 48 results 8 were included as relevant ones.

The last journal, Journal of Human Nutrition and Dietetics, got 21 articles as a result for "type 1 diabetes" AND "self-management" AND "application". From these, the majority focused on obesity and nutrition, and no more than the one, found from pre-search, was included in this research from this journal.

2.2 Results of literature survey

The literature search did not identify a precisely similar earlier research on the topic of the present thesis. However, there is some relevant research concerning features themselves in diabetes self-management applications: for example, Chomutare, Fernandes-Luque, Årsand and Hartvigsen (2011) conducted a study in which they searched 137 applications found from online vendor markets, journal databases and grey literature. Their research’s results reveal that four most prevalent features in applications are insulin and medication recording, data export and communication, diet recording, and weight management. Similarly, El-Gayar, Timsina, Nawar and Eid (2013) reviewed self-management applications in Apple App store and some published articles finding that available applications support different tasks, such as insulin dosage and blood glucose testing, and also alerts were possible to use in some of the applications. In their research, they found out that decision support was available only in 12/71 applications, meanwhile 59/71 applications had a possibility to transfer input data for the health care personnel. Self-management education was available in 13/71 applications, and only one application had its security features explained. (El-Gayar et al., 2013.) Martinez et al. (2017) got similar results in their research when analysing 15 diabetes-related applications available for Apple-devices: the most used ones are simple, but they have a possibility to expand to cover more features. Williams and Schroeder (2015), on the other hand, reviewed 20 applications in Apple and Google Store, and searched for the most common features in them. According to their study, the most common features are blood glucose recording and activity logs. Also, data exportation via email was possible in majority of the applications. (Williams & Schroeder, 2015.)

Boyle, Grainger, Hall and Krebs (2017) conducted surveys in the aim of establishing, whether patients in New Zealand use diabetes self-management applications and evaluate the desirable features in applications. As a result, they found out that recording blood glucose values was the most liked feature, and there was also interest in having an insulin dose calculator. However, as they also surveyed whether health care personnel recommend applications for people with diabetes or not, they revealed a need for more assessment of the quality and safety of self-management applications, since health care personnel was unconfident to recommend applications. (Boyle, Grainger, Hall, & Krebs, 2017.)

Frøisland, Årsand and Skåderud (2012) in their research evaluated adolescent patients’ experiences with two different mobile applications and found out that the most wanted and/or needed features in diabetes self-management applications are visualization, access and software changes. The researchers interviewed all the 12 participants to get
the results from 3 months intervention period, during which at least three days before consultation it was mandatory for the participants to record data on the application. Drion et al. (2015), on the other hand, found in their research that usage of Diabetes Under Control -mobile phone application did not improve the quality of diabetics’ lives compared to traditional pen-and-paper -diary. However, Osborn et al. (2017) found in their research that using One Drop | Mobile app decreased HbA1c value, and when also food intakes were recorded, the value reduced even more. Similarly, Wu et al. (2017) and Bonoto et al. (2017) in their researches found out that mobile application interventions can improve glycemic control and improve the control of HbA1c.

Cafazzo, Casselman, Hamming, Katzman and Palmert (2012) interviewed six adolescents with type 1 diabetes to gather information, based in which they developed a mobile application and pilot tested it in 12-week period with 20 adolescents. In their study, they found out that gamification incentives in diabetes self-management application increases the frequency of blood-glucose monitoring within adolescents with type 1 diabetes. As Cafazzo et al. (2012), also Thompson (2012) studied gamification, or more precisely, serious video games. According to Thompson, serious games can provide information, personal mastery experiences, tailoring, and entertainment, which all can have effects on behaviour change and lead to better self-management (Thompson, 2012). Similarly, Goyal et al. (2017) developed a diabetes self-management application and tested it with 46 users, meanwhile a control group of 46 people did not use the application. They found out that the group using the application self-monitored their blood glucose more often, which led to improvement of their HbA1c-values.

In year 2013, Chomutare, Tatara, Årsand and Hartzvigsen used design science method and got promising results from incorporating persuasive elements (for instance blood glucose tracking and visualization) and social media access straight from the application, which supports Årsand et al. (2012) research’s results: in the future, automatic data transfer, visual user interface, considerable health benefits, dynamic usage, and context sensitivity will be important elements. However, it should be noted that Chomutare et al. (2013) focused on type 2 diabetes in their research. Due to persuasiveness in their research, the article was accepted for this research even though it is about type 2 diabetes.

Hoppe, Cade and Carter (2017) studied diabetes targeted apps for Android smartphones aiming to evaluate their content, functions and behaviour change techniques. They used Google Play Store to search the apps, and tested and evaluated in total 40 apps in their research. In the research, they counted the number of features and behaviour change techniques in each of the applications, and noted that the most common functions in the applications are possibility to enter blood glucose values in the application, and exporting data to smartphone from it (even though not automatically). Most common behaviour change techniques are among self-regulatory techniques: to prompt self-monitoring of behaviour and to prompt intention formation. Based on the research, optimal combination of behaviour change techniques (“prompt self-monitoring of behaviour” with one or more of the following self-regulatory techniques: “prompt intention formation”, “provide feedback on performance”, “prompt specific goal setting”, and “prompt review of behavioural goals”). They found out that diabetes applications include only few functions or behaviour change techniques, even though applications with more functions and behaviour change techniques would give them higher ratings.
Holtz et al. (2017) used patient-centred research methods to further develop their diabetes application, MyT1DHero. In their research, they focused on parent-child view, and how diabetes is managed between them. From interviews they found out, that an application could help in transferring responsibility for diabetes management from the parent to the child itself. To keep on using an application, customization, interactivity, and tangible rewards were mentioned as important motivators. (Holtz et al., 2017.) Similarly, Castensøe-Seidenfaden et al. (2017) used participatory design in their research, in which they created a diabetes self-management application “Young with Diabetes”. As a result, they noticed and recommend that before creating and finishing expensive applications, it is crucial to prolong the prototype/testing phase, and include end users in all phases of the development. (Castensøe-Seidenfaden et al., 2017.)

Clements and Staggs (2017) have researched the impact of synchronizing glucometer data to a mobile application by analysing retrospective data on 81 youth with type 1 diabetes. The results of the study show that a glucometer-connected mobile application may increase the number of self-monitoring of blood glucose. However, as there has not been longitudinal research about the topic, it remains to be determined whether this kind of application can improve glycaemic control or not.

Beside applications, McCarthy, Rodriguez Ramirez and Robinson (2017) carried out a study, in which they surveyed adolescents’ experiences and preferences regarding the usage of medical devices. In their study, they tried a new letter writing method for defining user requirements female adolescents have for their medical devices. The method had not been used either for documenting or informing the design of persuasive medical devices and/or technologies before. In the research, they researched six females who have type 1 diabetes. McCarthy et al. gave all the participants a culture probe kit in which was instructions and other needed material for writing a love letter, a break-up letter, or both of them. The task for the participants was to think about a device or other piece of medical equipment they loved or hated, and to write it a letter based on their emotion. After receiving the letter, the researchers conducted interviews with the participants for gaining further information.

From the letters, the researchers were able to construct four different categories: acquiring and changing medical devices, requiring convenience and practicality for everyday contexts, collecting and using data, and corresponding with preferences and values (McCarthy et al., 2017). In the first category, they revealed a wish to use some device, such as FreeStyle Libre, but incapability to use it because of the costs. Similarly with syringe holder, a noise it made when using it caused negative feelings against it, and as the participant got a possibility to switch it, she did. In the second category, it was found out that devices needed to be usable in everyday contexts: for example, a blood glucose meter without in-built light was difficult to use at night. Also, different devices, such as blood glucose meters and insulin pens and pumps, were criticized for being “chunky” and “uncomfortable” to carry along everywhere. From the third category, need for accurate results from blood glucose meters was highlighted alongside with a desire to get translated data. That is, one participant wished blood glucose meter to visualise the results into graphs, from which it would be easier to point out the trends. Also, a possibility to share data with parents and/or health professionals was wished.

The last category focused on preferences and values. For example, a pleasant outlook of devices was mentioned, as the devices are used every day in many contexts. Also, a possibility for silent functioning was valued, since there are situations where extra attention is not wanted. Beside aesthetics, also environmental values were thought: one participant decided to replace disposable insulin pens with reusable ones. McCarthy,
Rodriguez Ramírez and Robinson (2017) pointed out that when medical technology matches with user’s needs and wishes, there can be also positive experiences when using them.

As writing letters in participant’s own peace can help him or her provide more personal information (Thoring, Luippold, & Mueller, 2013), the activity of writing letters was utilized in this research. Writing letters can help in organizing one’s thoughts and gives a possibility to be creative. Instead of only giving participants options from which to choose their opinion, in letter writing there are no limitations. Also, writing a letter can arouse new ideas, and due to that from letters it is possible to gain more information for this research than from a structured questionnaire. Also, as McCarthy et al. (2017) found in their study the method enjoyable, the same method was taken into use in this thesis.

McCarthy et al. (2017) revealed also some suggestions and needs for medical devices that could be noted when developing them. This thesis aims at doing the same for type 1 diabetes related mobile applications.

2.3 Summary of methods and features

In most of the studies conducted so far, interviews and questionnaires (e.g. Frøisland, Årsand, & Skåderud, 2012; Dobson et al., 2017), systematic reviews (e.g. Chomutare, Fernandes-Luque, Årsand, & Hartvigsen, 2011; Klonoff, 2013) and design science (e.g. Chomutare, Tataara, Årsand, & Hartvigsen, 2013; Pulman, Taylor, Galvin, & Masding, 2013) have been the applied research methods. With grounded theory, only McCarthy, Rodriguez Ramirez and Robinson (2017) have conducted a research on this topic. Similarly with grounded theory, only Clements and Staggs (2017) conducted a research on this topic using retrospective data analysis.

The most important features in diabetes-related applications, based on previous researches, are a diary for recording blood glucose levels, insulin doses and eaten carbohydrates (e.g. Chomutare et al., 2011; Dobson et al., 2017). Beside only recording data, also a possibility to determine suitable doses of insulin and/or carbohydrates was found useful (Pulman et al., 2013; Dobson et al., 2017).

Data visualization has been found as a helpful function, when aiming at getting benefit from an application. For example, a graph from diabetic’s blood glucose levels is one form of data visualization. (Frøisland, Årsand, & Skåderud, 2012; Klonoff, 2013.) Beside visualization, also gamification was found beneficial: Cafazza, Casselman, Hamming, Katzman and Palmert (2012) created and pilot tested a new application in their research and found out that adolescents with type 1 diabetes checked their blood glucose levels more often when there were gamification style incentives in the application. Similarly, Shapira, Yodfat, HaCohen, Feigin and Rubin (2010) found that their test group (n=30) preferred a bolus guide that had carbohydrate values in a range list, instead of estimating exact values.

One not-yet-widely-existing feature mentioned in many of the previous studies is automatic data transfer from blood glucose meter to a mobile application (Årsand et al., 2012; Clements & Staggs, 2017; Lithgow, Edwards, & Rabi, 2017). Clements and Staggs (2017) conducted a study, which revealed that this automation can lead to checking one’s blood glucose levels more often than with glucose meters which do not send the results automatically to an application.
3. Research method

In this chapter, the research method is presented. At first, grounded theory and Persuasive System Design model are presented. Then, data collection method is presented, followed by pre-questionnaire and actual questionnaire.

3.1 Grounded theory and applying it in the present study

The basic method for analysing the letters in this thesis was Grounded Theory (GT). During the analysing process, Cathy Urquhart’s (2013) guide was utilized.

Grounded theory has its roots in a movement that is known as symbolic interactionism, in the mid-1800s. Symbolic interactionism was refined by Glaser and Strauss, who defined a systematic procedure for both collecting and analysing qualitative data. In GT, one of the basic principles is that a research shall not have any hypotheses and presupposes regarding the topic, people and society under research – instead, all the results should emerge from the gathered data. The ultimate goal of utilizing GT is that researcher could develop a new theory. (Goulding, 2008, pp. 38–43.)

The first step of analysing the results in this research was to code the love- and break-up letters as well the date-adverts. During this process, the letters were copied from Webropol to Word in which the letters were divided in pieces, sentence by sentence. After dividing a letter, it was open coded one sentence at a time first in a short descriptive form and right after that to an analytical form. That is, as Urquhart (2013) puts it, “-- with open coding, to break open the data to begin with, it often pays simply to summarise the data in a descriptive fashion. -- Finally […] my analysis, using the first two [descriptive] codes, leads me to think that this is what he [Obama] may be attempting to do in that first sentence.” (Urquhart, 2013, pp. 81). Following Urquhart’s guidance, every sentence in the letters received was open coded in one to three descriptive code, and based on these, in one analytical code. See tables 1 and 2 for examples.
Table 1. Example coding of a break-up letter.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Descriptive codes and analytical code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making notes afterwards is painful,</td>
<td>- Difficult to add notes afterwards</td>
</tr>
<tr>
<td></td>
<td>- No always time to make notes immediately</td>
</tr>
<tr>
<td></td>
<td>⇒ Usage takes too much time and is difficult</td>
</tr>
<tr>
<td>although it is good to make notes in real time,</td>
<td>- It would be better to make notes immediately</td>
</tr>
<tr>
<td></td>
<td>- No time for that</td>
</tr>
<tr>
<td></td>
<td>⇒ Usage takes too much time</td>
</tr>
<tr>
<td>but there is no always time to make notes,</td>
<td>- No always time</td>
</tr>
<tr>
<td></td>
<td>- Other things are more important</td>
</tr>
<tr>
<td></td>
<td>⇒ Usage takes too much time, the application should be more flexible</td>
</tr>
<tr>
<td>and sometimes making them afterwards is really difficult.</td>
<td>- Difficult to add notes afterwards</td>
</tr>
<tr>
<td></td>
<td>- Adds notes afterwards</td>
</tr>
<tr>
<td></td>
<td>⇒ Wants to benefit from the application</td>
</tr>
</tbody>
</table>

Table 2. Example coding of a break-up letter.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Descriptive codes and analytical code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dear Glimp,</td>
<td>- Calling the application with name</td>
</tr>
<tr>
<td></td>
<td>⇒ Has some feelings with the application</td>
</tr>
<tr>
<td>I tried to start a relationship with you</td>
<td>- Tried to start</td>
</tr>
<tr>
<td></td>
<td>- Failure</td>
</tr>
<tr>
<td></td>
<td>⇒ Problems in the beginning</td>
</tr>
<tr>
<td>when I got Libre and noticed that my phone has the needed NFC-feature.</td>
<td>- Got more modern blood glucose monitoring system</td>
</tr>
<tr>
<td></td>
<td>- The phone included needed (modern) features</td>
</tr>
<tr>
<td></td>
<td>- Uses phone instead of Libre’s own reader device</td>
</tr>
<tr>
<td></td>
<td>⇒ Wants to be up-to-date and use modern technology</td>
</tr>
<tr>
<td>I would have wanted to write down my life with Libre’s values,</td>
<td>- Would have wanted to use the application with Libre</td>
</tr>
<tr>
<td></td>
<td>- Did not succeed</td>
</tr>
<tr>
<td></td>
<td>⇒ Would have been modern</td>
</tr>
<tr>
<td>but you made it too difficult.</td>
<td>- Problems in using the application</td>
</tr>
<tr>
<td></td>
<td>⇒ Wants ease-of-use</td>
</tr>
<tr>
<td>I didn’t even have the strength to properly try,</td>
<td>- Quited quite soon</td>
</tr>
<tr>
<td></td>
<td>⇒ The application is too complex to use</td>
</tr>
<tr>
<td>because you were so complicated and demanding.</td>
<td>- Application is complicated and demanding</td>
</tr>
<tr>
<td></td>
<td>- Application is too inconvenient</td>
</tr>
<tr>
<td></td>
<td>⇒ Wants more simple and easier to use</td>
</tr>
<tr>
<td>Sentence</td>
<td>Descriptive codes and analytical code</td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------</td>
</tr>
</tbody>
</table>
| Even Old John can’t take that, especially in the beginning of the relationship. | - Metaphor  
- A beginner in the use of the application  
⇒ Too difficult to understand the application thoroughly |
| The beginning should be easy and smooth, so that we can get to know each other and benefit from each other. | - Wishes for start  
- Better guidance is needed  
⇒ Ease-of-use |
| But no, you weren’t flexible, instead you were demanding and wanted to know every single detail. | - Statement  
- The application did not meet the expectations  
⇒ Too difficult to use |
| And your Americanness did not fit in my straightforward Finnishness, so I had no choice but to find another, easier partner. | - The application wanted detailed information  
⇒ Hinders the beginning  
- Application language is English  
- Language barrier  
⇒ Need for Finnish (mother language) application |
| I hope you find other people. | - Changing to another application  
- Need for easier one  
⇒ Not satisfied with current, complex application  
⇒ Wish, that other people will use the application  
⇒ Hopes that some people will find the application pleasant |
| I leave you. | - Saying good bye  
⇒ Quitting the usage |

After open coding was finished, the selective coding began. In selective coding, open codes are put in groups based on their similarities, and a possible selective code is given. After grouping, it should be considered whether some of the selective codes can also be grouped together, if one selective code is an attribute of another, if a selective code is actually a relationship, and, is the given name truly representative. (Urquhart, 2013, e.g. pp. 88–89.)

In this thesis, selective coding was a little bit longer process than in Urquhart’s (2013) examples, because unlike in examples, in this thesis there were not one but 33 letters to be finally coded in together. Instead of completing only one selective coding, in this thesis there were at first 33 selective codings, which were later combined to become one in each category (love, break-up and date).
From the examples (see tables 1 and 2), following summaries can be derived: for table 1 ”Adding notes to the application should be fast, and it should be easy to do even afterwards”, and for table 2 “Modern technology is important. An application should be simple and easy to use. With this application, problems were difficult start and complex usage. Also, it would be better if available in mother language”. From these, among other break-up letters, one category can be derived: “Lack of fluency in use”.

### 3.2 Persuasive Systems Design model

Persuasive Systems Design (PSD) model is developed by Oinas-Kukkonen and Harjumaa (2009). There have been guidelines for creating systems to motivate their users for healthier life style (see e.g. Intille, 2004), but in their previous research in 2007 Harjumaa and Oinas-Kukkonen found out, that a framework developed by Fogg (2002) is not comprehensive enough to be applied to persuasive system development (Harjumaa & Oinas-Kukkonen, 2007).

The PSD model concentrates both on the postulates behind persuasive systems and the importance of the persuasion context. The seven postulates are key issues behind persuasive systems, and they are needed to be thought thoroughly when designing persuasive systems. (Oinas-Kukkonen & Harjumaa, 2009.) See table 3 for a summary of the postulates and Oinas-Kukkonen and Harjumaa (2009) for more detailed information.

#### Table 3. Postulates behind persuasive systems (Oinas-Kukkonen & Harjumaa, 2009).

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Information technology is never neutral</td>
</tr>
<tr>
<td>2.</td>
<td>People like their views about the world to be organized and consistent</td>
</tr>
<tr>
<td>3.</td>
<td>Direct and indirect routes are key persuasion strategies</td>
</tr>
<tr>
<td>4.</td>
<td>Persuasion is often incremental</td>
</tr>
<tr>
<td>5.</td>
<td>Persuasion through persuasive systems should always be open</td>
</tr>
<tr>
<td>6.</td>
<td>Persuasive systems should aim at unobtrusiveness</td>
</tr>
<tr>
<td>7.</td>
<td>Persuasive systems should aim at being both useful and easy to use</td>
</tr>
</tbody>
</table>

The persuasion context needs to be analyzed and understood in the aim of succeeding in persuasion. The context consists of three pieces: the intent, the event, and the strategy. The first one focuses on who is the persuader, and what is the change type. The second one focuses on the use context and the user context, meanwhile the last one has its focus on the message and the route to reach the user. (Oinas-Kukkonen & Harjumaa, 2009).

When following the PSD model in persuasive system development, the most important phases (e.g. discovering requirements) are covered. Similarly, the seven postulates cover aspects, such as ease of use and positive user experience, needed to be recognized when designing a persuasive system. However, it has to be noted that requirements for software qualities do not belong under the PSD model, and they are needed to be communicated with software engineers. Nevertheless, when analysing the persuasion context and selecting the persuasive design principles, followed with the processes of defining requirements for software qualities and implementing them, the results should cover behaviour and/or attitude change. (Oinas-Kukkonen & Harjumaa, 2009.)
The PSD model is selected to be used in this research for a few reasons. First of all, finding out the most important features in diabetes self-management applications can help in designing and developing them. When succeeding in creating persuasive system that affects its users by changing their behaviour and/or attitude, helping them to manage their diabetes better, there is a chance to decrease the costs occurring from inpatient care.

As Hoppe, Cade and Carter (2017) found out, in current applications there are not many functions or behaviour change techniques, even though they would make the applications rated higher. Using PSD model in this research can give us insight into this topic: by analysing the results following PSD model we can see which persuasive principles are the ones that are considered important.

Persuasive features can be divided into four different categories: social support, dialogue support, primary task support and system credibility support (Oinas-Kukkonen & Harjumaa, 2009). See tables 4a-d for these categories, principles, and explanations.

<table>
<thead>
<tr>
<th>Category</th>
<th>Principle</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social support</td>
<td>Social learning</td>
<td>Looking for what others do and then copying the behaviour</td>
</tr>
<tr>
<td></td>
<td>Social comparison</td>
<td>Comparing own behaviour with others</td>
</tr>
<tr>
<td></td>
<td>Social facilitation</td>
<td>Seeing others conducting a behaviour</td>
</tr>
<tr>
<td></td>
<td>Normative influence</td>
<td>Norms and peer pressure affecting behaviour</td>
</tr>
<tr>
<td></td>
<td>Cooperation</td>
<td>Working together in the aim of achieving a goal</td>
</tr>
<tr>
<td></td>
<td>Competition</td>
<td>Competing with other users</td>
</tr>
<tr>
<td></td>
<td>Recognition</td>
<td>Having a public mention from success</td>
</tr>
</tbody>
</table>
Table 4b. Dialogue support (Oinas-Kukkonen & Harjumaa, 2009).

<table>
<thead>
<tr>
<th>Category</th>
<th>Principle</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialogue support</td>
<td>Praise</td>
<td>Praises shown for user after achieving a goal</td>
</tr>
<tr>
<td></td>
<td>Rewards</td>
<td>Like praises, but instead of only textual praises, rewards are most often virtual trophies</td>
</tr>
<tr>
<td></td>
<td>Reminders</td>
<td>Recalling the users to behave in a certain way</td>
</tr>
<tr>
<td></td>
<td>Suggestion</td>
<td>Getting suggestions for what to do</td>
</tr>
<tr>
<td></td>
<td>Similarity</td>
<td>The system and the user have something in common, for example language</td>
</tr>
<tr>
<td></td>
<td>Liking</td>
<td>The system is visually attractive</td>
</tr>
<tr>
<td></td>
<td>Social role</td>
<td>For example a virtual specialist to assist communication</td>
</tr>
</tbody>
</table>

Table 4c. Primary task support (Oinas-Kukkonen & Harjumaa, 2009).

<table>
<thead>
<tr>
<th>Category</th>
<th>Principle</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary task support</td>
<td>Reduction</td>
<td>Reducing complex task into smaller pieces that are easier to accomplish</td>
</tr>
<tr>
<td></td>
<td>Tunneling</td>
<td>Guiding the user through a process</td>
</tr>
<tr>
<td></td>
<td>Tailoring</td>
<td>Having functions important and useful for a specific group of people</td>
</tr>
<tr>
<td></td>
<td>Personalisation</td>
<td>Matching the content and functions for a single user</td>
</tr>
<tr>
<td></td>
<td>Self-monitoring</td>
<td>Keeping track on a user’s performance</td>
</tr>
<tr>
<td></td>
<td>Simulation</td>
<td>Simulating the outcome</td>
</tr>
<tr>
<td></td>
<td>Rehearsal</td>
<td>Getting advised on how to do a task</td>
</tr>
</tbody>
</table>
### Table 4d. System credibility support (Oinas-Kukkonen & Harjumaa, 2009).

<table>
<thead>
<tr>
<th>Category</th>
<th>Principle</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>System credibility support</td>
<td>Trustworthiness</td>
<td>Offering genuine information</td>
</tr>
<tr>
<td></td>
<td>Expertise</td>
<td>The product comes from expert base</td>
</tr>
<tr>
<td></td>
<td>Surface credibility</td>
<td>Having a competent look</td>
</tr>
<tr>
<td></td>
<td>Real-world feel</td>
<td>Providing information about the real people and world behind the system</td>
</tr>
<tr>
<td></td>
<td>Authority</td>
<td>Having professional source</td>
</tr>
<tr>
<td></td>
<td>Third party endorsements</td>
<td>Respect sources showed in the system</td>
</tr>
<tr>
<td></td>
<td>Verifiability</td>
<td>Information is supported by referencing</td>
</tr>
</tbody>
</table>

### 3.3 Letter writing as data collection method

Writing letters, diaries, cards, etc. is a common part of Cultural Probe kits. In Cultural Probes, there is a collection of different items to be used by a participant on his or her own, creating data to be analysed later by researchers. Using Cultural Probes as a method has advantages, one of the biggest of them being that researcher does not need to be present while participant is accomplishing tasks. Similarly, participant does not feel observed and through that may be capable to provide more personal information. (Thoring, Luippold, & Mueller, 2013.)

Like in Cultural Probes, also in this data collection method the aim was to get personal experiences and opinions. As McCarthy et al. (2017) found out, some of their participants enjoyed the activity of writing a letter, and from them with a follow-up interview information about experiences with medical devices was revealed. Also, as McCarthy et al. (2017) notices, writing letters can contribute the development of different themes and goals. McCarthy et al. also suggests that designers and suppliers of medical devices should consider this combination of methods (letters and interviews) to get more precise information of user requirements.

As proven by Thoring et al. (2013) and McCarthy et al. (2017), from letters it is possible to gain insight of a specific topic. As this thesis is aimed to cover a variety of people with type 1 diabetes, regardless where they live in Finland, no interviews were arranged. Similarly, since the aim was to get information about experiences of using self-management applications, or what kind of features they wish a self-management application to have, delivering other items would have been superfluous.
3.4 Materials and procedure

In this chapter, at first the pre-questionnaire is presented, after which we will take a look at the actual questionnaire.

3.4.1 Pre-questionnaire

During the process, members in a Finnish Facebook group called “Ykköstyyppin diabetes aikuiset” (Eng. “Type one diabetes adults”, researcher’s own translation) has been used as a target group. While considering the topic of the thesis, and where to find people to answer the research questions, a pre-questionnaire was made and sent to the abovementioned group. The pre-questionnaire was created in the group using Facebook’s own “create poll” -option. The pre-questionnaire asked which mobile application the group members are using for self-managing diabetes, giving them few possible options and a possibility to add their own options in the poll. From these answers it was first possible to check if there are enough application users for research, and secondly to get an overview of which applications are used. The answers from the poll are to be seen in table 5.

Table 5. Answers from the pre-questionnaire.

<table>
<thead>
<tr>
<th>Application</th>
<th># Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don’t use any application</td>
<td>123</td>
</tr>
<tr>
<td>LibreLink</td>
<td>12</td>
</tr>
<tr>
<td>Contour Diabetes app</td>
<td>10</td>
</tr>
<tr>
<td>mySugr</td>
<td>8</td>
</tr>
<tr>
<td>Diabetes:M</td>
<td>7</td>
</tr>
<tr>
<td>Dottli</td>
<td>3</td>
</tr>
<tr>
<td>DiabetesConnect</td>
<td>2</td>
</tr>
<tr>
<td>Balansio</td>
<td>2</td>
</tr>
<tr>
<td>Rapid Calc</td>
<td>1</td>
</tr>
<tr>
<td>OnTrack Diabetes</td>
<td>1</td>
</tr>
</tbody>
</table>

From the pre-questionnaire, it was found that many of the group members are not using any mobile applications for self-managing their diabetes (table 5). Based on that information it was decided to add a date-advert among love- and break-up-letters. By doing so it was possible to get more answers and points of view of mobile applications as regards desired features and functionalities.

3.4.2 Questionnaire

The actual questionnaire (see Appendix A for Finnish and B for English version) included two parts: first, letter-part, is based on McCarthy et al. (2017), extended with date-advert, and second, persuasive features in multiple-choice part, is based on Oinas-Kukkonen and Harjumaa (2009).
The letter-part follows McCarthy et al. (2017) tightly, asking participants to write either love letter or break-up letter or both, based on their feelings about the application they are using. Participants were instructed in the questionnaire as follows: “Next we ask you to think about your relationship with diabetes self-management mobile application. In the next pages, write either love- or break-up letter, or both, based on how you feel about your relationship with the application. From below, choose if you would like to write love- or break-up letter, or both”. When choosing the love letter -option, the participant was moved on another page with instructions “Write below a love letter for the mobile application, you use in self-management. Give concrete examples on which are the issues you like in your application and why you want to continue your relationship with the application. Otherwise the style and length of your letter are free!”.

Instructions for break-up letter are inversely identical with love letter, and in case participant wanted to write both of the letters, the instructions included both of them united.

Before instructing on writing love- and/or break-up letter, the questionnaire asked whether respondent used any mobile application at all, and if “yes”, which application she or he used. In case the responded did not use any mobile application, she or he was moved on a page, on which date-advert was to be written. Date-advert was instructed as follows: “In this part we ask you to think, what kind of mobile application would fit best for you to support your diabetes self-management. Write a date-advert, with which you are looking for The One mobile application. Please, give concrete examples on what kind of features you would like to get with your advert, and what kind of features the one answering to your advert must not have. Otherwise the style of the advert is free!”

The persuasive feature part was based on Oinas-Kukkonen and Harjumaa (2009). In here, there were four pages – one persuasive feature category per page –, in which respondents choose the best fitting answer from 1 to 6, where 1 stands for “not important at all” and 5 “very important”. Option 6 stands for “I cannot say”. Number of questions on each of the categories varied based on the content of each persuasive category and the suitability of them regarding self-management applications. For example, in system credibility support -category “trustworthiness” and “expertise” were combined, as it was found unnecessary to keep them separated.

The questionnaire was published in the beginning of June 2017, and it stated that the last day to give answer would be the last day of June. On the publishing day of the questionnaire, there were 1798 members in the Facebook group. In first three days eight answers were received, after which the questionnaire-post was lifted up on the Facebook wall by commenting it by the researcher. The lift-up, however, did not have any effect, and there were no new answers received during the week. After that, the researcher wrote a new post on the Facebook group’s wall reminding group members about the questionnaire with the link to the survey. During the weekend, the number of answers rose from eight to 20 answers.

Later again, the researcher commented the last post to lift it up. During the week, there were some new answers given, in total being 24 answers. At that time, a new post was written and sent on the wall to get more answers for the questionnaire.

On the last day of June, which was planned to be the last day for the questionnaire, there were 32 answers received. During the day, the last written post was lifted up three times. However, there were no new answers given during that day. Desiring to get more answers, the researcher left the questionnaire open for five more days, during which one more answer was received. In the beginning of July, the questionnaire was closed.
4. Results

In this chapter, basic demographic about the respondents is provided, followed with description of the eight applications mentioned later in the letters. After that the letters – love letters, break-up letters, and date-adverts – are processed.

4.1 Respondents

There were 33 respondents in the questionnaire. Most of the respondents were female (29/33), leaving 3/33 to be male and 1/33 to be other. Most of the respondents were aged between 26-30 years (8/33). There were no respondents under 16 years old. See figure 1.

![Bar chart showing age distribution of respondents](image)

**Figure 1.** Respondents’ age and number.

From respondents, 20 have graduated from University or University of Applied Sciences, meanwhile the rest 13 have graduated from high school or vocational school.

4.2 Applications

In the letters, eight different applications were mentioned: Diabetes:M, mySugr, Novo Nordisk Hiiari (Eng. Novo Nordisk Carb, researcher’s own translation), Balansio, Contour Diabetes app, Sokeriseuranta (Eng. Gluco-tracking, researcher’s own translation), Diabetes Connect, and Glimp. Here, we will take a look at these applications.

**Diabetes:M** (fig. 2) has eight main features: clean logbook, food database, bolus calculator, detailed graph, analytical charts, various reports, data import/export, and reminders system. If a user pays for use, it is possible to remove ads, have two
additional profiles, expand food database, get pattern analysis, add additional lab results, have automatic synchronization with (multiple) devices, get reports in different formats, and import/export data in XLS format. (Diabetes:M, 2018.)

Diabetes:M is developed by diabetics, and was first published in 2013. The application is designed for smartphones and tablets, and it provides detailed statistics that can be shared with healthcare personnel through e-mail. In Diabetes:M, it is possible to import data from different devices, such as glucometers and insulin pumps, and the application can analyse the imported data. Diabetes:M is available for both, Android and iPhone. (Diabetes:M, 2018.)

**mySugr** (fig. 3) has also a free of charge and a paid version available. In the basic version of the application, it is possible to get analysis and CSV-reports from the data inputted in the application. Also, a limited number of challenges and tags are available, and in European Union, also a limited usage of an insulin calculator. With pro version, reports are available also on PDF and Excel -forms, challenges and tags have no limitation, as well as insulin calculator. Compared to basic version, pro has also possibility to add photos and pictures, use smart search, set blood sugar reminders, have basal rates (for insulin pump users), get multi-device-syncing, have priority support, and get bonus pro-challenges and -tags. The application is available for both, Android and iPhone, and can be connected with Google Fit. (mySugr, 2018a.)

mySugr is developed by diabetics, and was first published in 2012. mySugr has their own diabetes coaches, who are certified as diabetes educators, and have diabetes themselves. (mySugr, 2018b.)
Novo Nordisk Hiilari (Novo Nordisk Carb, researcher’s own translation) (fig. 4) is a digital carbohydrate guide that could be downloaded on a mobile phone. The application does not have possibility to add any information in it; instead, it is only a tool to check estimated carbohydrates in example foods.

It should be noted that after receiving the answers for this research, Novo Nordisk Hiilari was updated, and is no longer available as such. The new version, Mobiilihiilihydraattikäsikirja (Engl. Mobile carbohydrate handbook) (fig. 5), was published on November 20th, 2017, and can be downloaded for both, Android and iPhone. The new application is capable of calculating the carbohydrates from number of products selected to be eaten at a time, alongside showing the carbohydrates per a product. (Novo Nordisk, 2018.)

Balansio (fig. 6) has a possibility to automatically transfer data from blood glucose meters (CareSens Dual, CareSens N Premies, and Diabeto devices) to the application. Balansio also has bolus calculator, and can automatically use activity data either from Health app (iPhone) or Google Fit (Android). With Balansio, it is possible to share data with health care personnel, and get their advices without meeting them in person. (Balansio, 2017.)

From the applications that are presented here, only Balansio has a possibility to use other smart equipment than mobile phones and tablets: with an Android Wear watch it is possible to add new data to the application, get bolus proposals and the amount of active insulin, and also see previously added data. Balansio is available for both, Android and iPhone. (Balansio, 2017.)
Contour Diabetes app (fig. 7) is an application created to work together with Contour Next One -blood glucose meter. From the meter, the data can be automatically synced and logged with the application via Bluetooth connection. The blood glucose meter uses colours to simplify the understanding of the results (green = within target, amber = above target, and red = below target). With the application, it is possible to add extra information within the results, such as activity, and add notes or vocal memos within the results. The results can be shared with health care personnel from the application. Contour Diabetes app is available for both, Android and iPhone. (Ascensia Diabetes Care, 2018.)

Figure 6. Balansio. Figure 7. Contour Diabetes app.

Sokeriseuranta (Eng. Gluco-tracking) (fig. 8) is a Finnish website, in which it is possible to keep track on daily blood glucose levels, insulin doses, carbohydrates and activities. Beside these basic information, one can add notes about travelling, having stress or being sick, and find out how these affect blood glucose levels. From the results, it is possible to see how self-management has succeeded. (Sokeriseuranta, 2018a.)

In 2015, Sokeriseuranta was updated to communicate with following applications: Moves, Strava, RunKeeper, and Nightscout. People with diabetes using insulin pump, can send information from the pump to Sokeriseuranta by using Excel-file brought from Diasend. (Sokeriseuranta, 2015.)

After signing in, CSV-files can be send to the website from sensor or blood glucose meter. Sokeriseuranta supports the following sources: Accu-Check, Diasend, CareSens, Contour Next USB, and Medtronic. From Diasend, blood glucose levels taken from a finger or from a sensor (connected to insulin pump), insulin boluses, and eaten
carbohydrates can be sent to the website. From Accu-Check and CareSens, only blood glucose levels can be sent, meanwhile from Contour Next USB blood glucose levels, insulin doses, carbohydrates, and own comments can be sent. From Medtronic, sensor values and calibrations can be sent. (Sokeriseuranta, 2018b.)

Figure 8. Sokeriseuranta.

**Diabetes Connect** (fig. 9) is an application created by diabetics and suitable for both type 1 and type 2 diabetics. In Diabetes Connect, one can input there a lot of information, such as blood glucose levels, taken insulins, activity, blood pressure and pulse. Meals can be put in either as bread units, carbohydrate units, or directly carbohydrates. The application offers graphical analysis of blood glucose and meal data, and can export data in PDF and CVS formats. Also, statistics are presented, and it can be synchronized with other devices. Diabetes Connect is available for both, Android and iPhone. (Diabetes Connect, 2018.)

The last application, **Glimp** (fig. 10), is an Abbott FreeStyle Libre-blood glucose sensor reading application (Glimp, 2017). FreeStyle Libre-blood glucose sensor differs from traditional blood glucose meters in the sense that it does not require fingerpricks. Instead, it continuously monitors glucose levels through a small sensor. (FreeStyle Libre, 2018.) With Glimp, it is possible to read the sensor by using a smartphone that has NFC-capability. One can add eaten carbohydrates and taken insulin doses in the application. Unlike Abbott FreeStyle Libre reader, Glimp can be manually calibrated by adding manually blood glucose levels in the application. (Glimp, 2017.)

Glimp can also be connected to Dropbox, in the aim of accessing the blood glucose values remotely. Similarly, Nightscout can also be connected with the application. From
Glimp, it is also possible to transfer data to Diabetes:M, and to use the application as a continuous glucose monitoring system, if held in an armband above the sensor. (Glimp, 2017.)

Figure 9. Diabetes Connect.  
Figure 10. Glimp.

4.3 Letters

In this chapter, the results from the letters received for this thesis are introduced. In here, the different letter-categories are processed individually, presenting the most important findings from them.

It should be noted that some of the applications got both love- and break-up letters from same users, but in this thesis the letters are divided only based on their class without paying attention whether there are both or only one kind of letter for them.

All the received letters are not presented here, since there were similarities between their content. In here, the most representational ones are cited.

4.3.1 Love letters

Love letters were written for six different applications: Diabetes:M, mySugr, Novo Nordisk Hiilari, Balansio, Contour Diabetes app and Sokeriseuranta, altogether nine letters: mySugr got three love letters, Diabetes:M two, and the rest got one love letter each.

Based on grounded theory, three different major categories were found from love letters. These are “having a fluent user experience”, “having automation” and “having a modern application”.
In the first category, having a fluent user experience, especially the ease-of-use was present in many of the letters. Unfortunately, in most of cases there was no explanation what user meant by telling the application to be “easy to use”, so with certainty it cannot be said what it actually means. In the fluent user experience, also versatility, accuracy, visual design and a possibility to get reports and/or summaries received positive feedback. For example, one love letter to mySugr shows the versatility of the application (letter translated by researcher):

(Female, aged 26-30):

Dear mySugr-monster!

I like you, because you make my life easier. Without you, having a recently diagnosed diabetes, I should carry a notebook for my blood glucose and carbohydrate notes everywhere with me. Because of you, I can see precise times when I have eaten, taken my insulin shots and measured my blood glucose. You even give me a possibility to make notes if I have hypoglycaemia, hyperglycaemia, or some other feelings that I have. You are one of the most important equipment in the aim of getting a good glycaemic control! Sure, I have thought about betraying you and trying some new applications... Nevertheless, I’m so pleased with you that I don’t think I would fully betray you!

In the second category, having automation, one major reason for being satisfied with the currently used application is that the application can whether communicate with other applications (for example some sports-application) or directly with glucometer. Especially Balansio and Contour Diabetes app got praise from their users because of the automatic data-transfer from glucometer to application. Below are love letters for Balansio and Contour Diabetes app (translated by researcher):

(Female, aged 31-35):

Balansio:

Bluetooth connection with my glucometer is irreplaceable, there is no need to note down the numbers anywhere else anymore.

(Female, aged 16-20):

Contour Diabetes app:

Dear Contour Diabetes app,

I like you, because I can see possible graphs about how my glucose has been. There is no need to use pen and paper to write down how my blood glucose has been, because connecting the glucometer to my mobile by Bluetooth I can get all the information into the application.
The third category, having a modern application, is a mix-up of current applications and wishes that application users’ have. Modern application can be seen both in the above showed letters to Balansio and Contour Diabetes app (above), but also in other letters, which highlight the importance of updates. For example, one love letter to Diabetes:M mentions both of these (letter translated by researcher):

(Male, aged 36-40):  

As a person with lately diagnosed diabetes, this application has hugely helped me with orientation in this new life. The application has also developed nicely fast and in a good direction. In this short, approximately 3 months of usage, the application has e.g. got www-based user interface, in which the information typed in the application is easy to survey. If there is something I wish to be in this Diabetes:M application, it would be a capability to read my glucometer’s (Contour Next One) measured values wirelessly, without needing to write down the values in to the application by hand.

4.3.2 Break-up letters

Altogether five break-up letters were received for five different applications: Diabetes:M, mySugr, Diabetes Connect, Glimp and Sokerisauranta. All the applications got one break-up letter each.

From the codings of break-up letters, two different categories were found: lack of automation and modern technology, and lack of fluency in use.

In the first category, lack of automation and modern technology, the main reason for being unsatisfied with the application is that the application cannot receive data straight from the glucometer or -sensor, or that the application does not automatically calculate right parameters for the user regarding insulin doses. One user also has wishes for technology that does not exist yet; this can be read from break-up letter to Diabetes Connect below (translated by researcher):

(Female, aged 36-40):

Hi,

It would be nice, and especially would make my life easier, if you got data straight from the glucometer or sensor. And from insulin pen and carbohydrates from a picture. That would make you easier to use. This applies to all applications, so this break-up is not your fault. <3
The second category, lack of fluency in use, is a major theme in two of the break-up letters: one for Sokeriseuranta and one for Glimp. In Sokeriseuranta, the user felt annoyed because it is difficult to make notes in the application afterwards, meanwhile in Glimp already the start of using caused problems. See the letters below (translated by researcher):

(Female, aged 50+):

Sokeriseuranta:

Making notes afterwards is painful, although it is good to make notes in real time, but there is no always time to make notes, and sometimes making them afterwards is really difficult.

(Female, aged 46-50):

Glimp:

Dear Glimp,

I tried to start a relationship with you when I got Libre and noticed that my phone has the needed NFC-feature. I would have wanted to write down my life with Libre’s values, but you made it too difficult. I didn’t even have the strength to properly try, because you were so complicated and demanding. Even Old John can’t take that, especially in the beginning of the relationship. The beginning should be easy and smooth, so that we can get to know each other and benefit from each other. But no, you weren’t flexible, instead you were demanding and wanted to know every single detail. And your Americaness did not fit in my straightforward Finnishness, so I had no choice but to find another, easier partner.

I hope you find other people. I leave you.

4.3.3 Date-adverts

From altogether 33 letters, 22 were date-adverts. From these 22 letters, one had to be excluded because it did not contain any text. From included 21 date-adverts, three main categories were found: being modern, being pleasant to use, and creating certainty. Like in love letters, also in date-adverts automatic data transfer from glucometer to application was wanted. Beside transferring data from glucometer to application, there were also wishes that application could both read sensor and insulin pump, and be used as a remote controller for insulin pump. Also transferring responsibility from person to application was wanted in this first category: application should count carbohydrates and based on that, tell the user how many units insulin he/she should take, or the application should give advice based on previous data. Below are some example-sentences regarding responsibility transfer from date-adverts (translated by researcher):
(Female, aged 21-25):

*I wish to find an application that counts automatically my food portion’s carbs and based on that knows, how many units I should take insulin* ---

(Female, aged 26-30):

*It would be more than great if the application communicates with sensor, reminds me to check my blood sugar and take insulin shots, counts carbohydrates and insulin doses.*

(Female, aged 26-30):

--- *The application should [...] learn it’s user’s habits (offers by default the same breakfast that the user always eats or right amount of insulin for a work-out day etc.)* ---

(Female, aged 21-25):

--- *I wish, I could tell you everything: my blood sugar, insulin shots, eatings, exercises and other things affecting my blood sugar. You should be wise and create graphics or lists, from which I could see what goes well/what is wrong.* ---

---

In the next category, being pleasant to use, like in previous letter-types, also here in many letters the writers mentioned wanting an application to be easy to use. In one letter, easy-to-use was linked with clear usage, but neither of them were more precisely explained. Another letter mentioned that in an application there should not be any extra functions that have nothing to do with diabetes. Also in one letter, fast and effortless usage, meaning that writing down or searching information should be easy, was discussed among the wish for application to be easy to use.

Other discussed topics in this category were that application should be versatile and modifiable, visual, fast and to be in mother language. For example, one respondent wrote in her letter:

(Female, aged 31-35):

*Hey you, in time blood glucose-values showing diabetes-application, who speaks Finnish and uses unit that are used in Finland!*  

*Here misses you a diabetic, who respects ease of use, and for whom analysing own blood sugar-values is important. In this especially visual, clear outfit is a remarkable issue.* ---

---

In the last category, creating certainty, topics such as application coming from reliable source, information sending to other people, application not having any diabetes unrelated functions, and application giving support and encourage to better self-management, being as a “health care taker”, were found. It was noticed from the date-adverts that people answering the questionnaire mainly did not want the application to have extra-functions, especially ones that do not have anything to do with diabetes.
5. **Persuasive system features**

In this chapter, the PSD model categories are presented in the context of this research and received answers.

5.1 **Social support**

People respond to computer products socially, and that has significant implications when considering persuasion. Especially non-commercial domains, like healthcare and fitness, are suitable targets for behaviour change administered by persuasive technology. (Fogg, 2002.) With social support is meant different forms of communication between people to help them in their behaviour change. Social network and different online communities can help in communication. (Ploderer, Reitberger, Oinas-Kukkonen, & van Gemert-Pijnen, 2014.) According to social cognitive theory, presented by Bandura (1978, 1986), behaviour effects persistent interaction with both environmental and personal conditions, and is also affected by them. Similarly, seeing other people performing a behaviour can affect to an individual, and make him or her also perform the same behaviour (Bandura, 1986).

When in the questionnaire asked, how important competing with other application users would be in a diabetes self-management application, most of the respondents (30/33) said it is not important at all. Most of the respondents (25/33) also choose “not important at all”, when asking how important it would be to see all the application users’ results rated in an application. In the end of the questionnaire, there was an open field, in which the respondents had a possibility to write anything they may have in mind (see Appendix A), four respondents wrote about competitive features, and how they absolutely do not want an application to have that kind of features. Below are two answers from the optional answer-field (translated by researcher):

(Female, aged 16-20):

*From the previous form, it came out a possible competitive part of the application, and that is something I absolutely don’t want. Sure, competing is fun if you do it playfully and only a limited time. But I know that it is easy to get hooked in applications and this competition can change to be too rough. Even the winner gets health with good balance, I don’t think that diabetes itself is a “meaning of life”, and I myself treat it only as much as needed to stay healthy. If one focuses too much in managing it, it is possible to forget to live a life.*
(Female, aged 26-30):

Absolutely no competitions or rewards for success. It dejects them, who already does their best and still fail. I would feel really stupid to publish my own values as a “status update”, and I definitely don’t want an application to be a “game” or otherwise try to be funny, because I can’t stand that. I hope that diabetes stays under control, and I don’t want to spend any more time on it than I have to. I can only imagine the number of curse-words, when I’m trying quickly to do something with the application, and it starts announcing that you got a trophy! Or asking “do you want to share your week’s average to your friends?” I hope support for managing my diabetes, not make it as my whole life. If someone want’s support in the application, then I hope that it can also be turned off.

Other questions and answers in the social support -category can be seen in table 6.

Table 6. Answers in the Social support -category.

<table>
<thead>
<tr>
<th></th>
<th>Not important at all</th>
<th>A little important</th>
<th>Neutral</th>
<th>Important</th>
<th>Very important</th>
<th>I can not say</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>The data put in the application, like the averages of the daily measures’ result’s or diagrams, can be shared with other application users [Social learning]</td>
<td>13</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>33</td>
<td>2.55</td>
</tr>
<tr>
<td>The application shows the users’ result’s ranked [Social comparison]</td>
<td>25</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>1.39</td>
</tr>
<tr>
<td>Via the application, it is possible to find and contact users similar to yourself [Social facilitation / Normative influence]</td>
<td>15</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>33</td>
<td>2.27</td>
</tr>
<tr>
<td>In the application, there can be formed user groups, which together work to achieve a goal (for example to decrease HbA1c-value under 8%) [Cooperation]</td>
<td>14</td>
<td>3</td>
<td>6</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>33</td>
<td>2.42</td>
</tr>
<tr>
<td>In the application, it is possible to compete with other users [Competition]</td>
<td>30</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>1.21</td>
</tr>
<tr>
<td>The application gives honourable mention, which other users can see, for example for the person with best blood glucose levels of the month [Recognition]</td>
<td>24</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>33</td>
<td>1.61</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>121</strong></td>
<td><strong>16</strong></td>
<td><strong>30</strong></td>
<td><strong>21</strong></td>
<td><strong>9</strong></td>
<td><strong>1</strong></td>
<td><strong>198</strong></td>
<td><strong>1.91</strong></td>
</tr>
</tbody>
</table>
As can be seen from table 6, social support principles are not rated high when thinking about type 1 diabetes related applications. Social facilitation and cooperation are the only social support principles that have some noticeable importance among the sample: former have 7/33 respondents naming it as “important”, meanwhile latter have 8/33. Also these strengthen the common results about that there is no competition wanted – instead, working together to reach a goal (like better HbA1C-level) or being able to discuss with other users, similar to yourself, are possible functions that are approved by the respondents. That shows that instead of trying to be better than other, among the respondents it is more important to support each other.

Online support has been found useful also by Maloney-Krichmar and Preece (2005), who in their study noticed that online support has a positive effect on participants’ health. How the support is given in an online environment depends on the stage, in which participants currently are: based on Ploderer, Smith, Howard, Pearce and Borland (2012), who studied smoking cessation in Facebook, majority of supportive comments come from users, who are already at later stages of a change. In practice, in the view of this research, it would mean that in a group which would work together to reach a common goal, there is a need to have people in different stages for social support.

5.2 Dialogue support

The internet and devices connected to the internet can be used as a media to provide feedback and mimic interpersonal communication. An interactive cycle of feedback and response can facilitate a person’s progress in persuasive process. (Cassell, Jackson, & Cheuvront, 1998.) For example reminders that are one part of dialogue support, are found useful and proven to have a positive effect for example by Lee, Tsai, Griswold, Raab and Patrick (2006), who studied effects of a mobile phone application for monitoring caloric balance.

Incremental persuasion, meaning that there are series of suggestions instead of a one-time consolidated suggestion, is found to be an effective method (Mathew, 2005). That is, the behaviour change should be supported step by step to reach positive effects.

From the answers, it is found that the respondents do not want a self-management application to be any game, but instead it should be supportive and give, for example, reminders and suggestions for self-management. Also 22 of 33 respondents said that it is at least important, if not very important, that health care personnel could see the results in the application without meeting the patient in person. That correlates well with the letters: many of the respondents wished for some kind of automation, and that the application would give advice and notice the problematic situations, tell what to do better in self-management. Based on the answers, it does not seem to matter whether the advices come from the application itself or the health care personnel.

Like in social support, where competition was not wanted, in dialogue support the respondents said that they do not want rewards or praise in the application: in rewards, only 11 of 33 respondents said that they are important or very important; 10 said rewards not to be important at all. For 5 respondent rewards were a little important, meanwhile 7 of them had neutral attitude towards rewards. When asking about praise, 13 of 33 respondents said it to be at least important, meanwhile 8 had neutral attitude and 11 a little important at maximum.
Instead of having any competition or game-like application, in dialogue support reminders, suggestions, mother language, pleasant visuality and connection with health care personnel were at least important for most of the respondents. For more precise distribution of the answers, see table 7.

Table 7. Answers in the Dialogue support -category.

<table>
<thead>
<tr>
<th></th>
<th>Not important at all</th>
<th>A little important</th>
<th>Neutral</th>
<th>Important</th>
<th>Very important</th>
<th>I can not say</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>The application gives praise, if I have for example checked my blood sugar many times enough</td>
<td>9</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>33</td>
<td>3.06</td>
</tr>
<tr>
<td>[Praise]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There will be a picture of a reward in the application, if I have had my blood sugar within limits for a day, for example</td>
<td>10</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>33</td>
<td>2.76</td>
</tr>
<tr>
<td>[Rewards]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The application gives reminders</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>9</td>
<td>0</td>
<td>33</td>
<td>3.45</td>
</tr>
<tr>
<td>[Reminders]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The application gives suggestions</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>12</td>
<td>11</td>
<td>0</td>
<td>33</td>
<td>3.82</td>
</tr>
<tr>
<td>[Suggestion]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The application is possible to get in your mother language</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>21</td>
<td>0</td>
<td>33</td>
<td>4.21</td>
</tr>
<tr>
<td>[Similarity]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The application looks pleasant</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>15</td>
<td>0</td>
<td>33</td>
<td>3.91</td>
</tr>
<tr>
<td>[Liking]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health care personnel can see the information you put in the application, and can comment your self-management without meeting you in person</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>7</td>
<td>15</td>
<td>0</td>
<td>33</td>
<td>3.73</td>
</tr>
<tr>
<td>[Social role]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>20</td>
<td>38</td>
<td>53</td>
<td>83</td>
<td>1</td>
<td>231</td>
<td>3.56</td>
</tr>
</tbody>
</table>

In total, praises and rewards are not wanted in dialogue support -category, but all the rest – reminders, suggestions, similarity (in language), liking (the outlook) and social role (health care personnel) are found at least important. From this can be derived that instead of getting praised and/or rewarded for succeeding in self-management, the respondents prefer other, more practical supports, such as reminders and suggestions. Instead of getting clapped on a shoulder, there is a wish to be able to understand the reasons for success and continue the same way. Beside that, it is also found important that using an application would be fluent and pleasant, meaning it should be in mother language and look pleasant. Since the application would be used in everyday life, it is easy to understand, why it should be so. However, it should be noted here that in research group, mother language, pleasant outlook and a possibility for health care personnel to see and comment the results was important mainly for females – with males, the highest rate was “important”.

Whether having health care personnel to see and comment the results without meeting in person is thought as a replacement for actual meetings with personnel or only extra advice between the meeting cannot be said based in this research, as it was not more precisely asked. However, there seems to be need for more flexible and perhaps also more frequent counselling with health care personnel. It can also be thought as if the health care personnel could see the results in the application, they can get better overall view and based on that, give precise advices or recommendations. This kind of action is called computer-mediated persuasion; that is, in this case, health care personnel can persuade the user through the application (Oinas-Kukkonen, 2013).

5.3 Primary task support

In overall, features included in primary task support -category are thought at least as “important”. Especially the importance is noticed in targeting the application to people with T1D, and creating different kinds of diagrams. Visual demonstration and giving information in visual form were also mentioned in letters – both in love letters (four mentions) and in date-advert (three mentions). Similar to McCarthy et al. (2017), where visuality was a wished function in medical devices, like in blood glucose meter, it is the same in mobile applications.

In primary task support -category, only simulation and rehearsal were thought as to be either relatively evenly distributed or focused more on “not important” than on “important” head of the line (see table 8). Giving demonstrations about future and guiding in technique may either be thought as extra-functions, which was found in date-advert to be unwanted, or issues that are talked about when meeting health care personnel, when there is no need for the application to tell the same. Since in the questionnaire there was no question about how long a respondent has had diabetes, it cannot be told whether guiding is important for newly diagnosed and not important for people, who have had diabetes for a long time, and vice versa for demonstrating, or if the answers are divided evenly between the newly and long time ago diagnosed or based on some other factor.
Table 8. Answers in the Primary task support -category.

<table>
<thead>
<tr>
<th>Feature Description</th>
<th>Not important at all</th>
<th>A little important</th>
<th>Neutral</th>
<th>Important</th>
<th>Very important</th>
<th>I can not say</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>The application guides how to use it [Tunneling / Reduction]</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>33</td>
<td>4</td>
</tr>
<tr>
<td>The application is specifically targeted to people with type 1 diabetes [Tailoring / Personalisation]</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>26</td>
<td>0</td>
<td>33</td>
<td>4.52</td>
</tr>
<tr>
<td>The application creates diagrams from information it gets, for example from blood sugar levels [Self-monitoring]</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>21</td>
<td>0</td>
<td>33</td>
<td>4.33</td>
</tr>
<tr>
<td>The application demonstrates with pictures what happens, if for example blood sugar levels varies too much or is too high [Simulation]</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>8</td>
<td>1</td>
<td>33</td>
<td>3.15</td>
</tr>
<tr>
<td>The application guides and gives advices for example in technique how to check blood sugar [Rehearsal]</td>
<td>11</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>33</td>
<td>2.64</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>14</td>
<td>20</td>
<td>35</td>
<td>64</td>
<td>7</td>
<td>165</td>
<td>3.73</td>
</tr>
</tbody>
</table>

Here, demonstration with pictures divides the respondents based on their gender: most of the males (2/3) says it is very important, when most of the females (8/29) considers it as “neutral”. Answers within females were, however, more divided, and a bigger respondent group could have another opinion.

5.4 System credibility support

Oinas-Kukkonen and Harjumaa (2009) defined seven postulates to be addressed when evaluating or designing persuasive systems. The fifth postulate highlights the importance of transparency; that is, the information of the people behind the system is needed to be visible. In case the information remains unclear, it is possible that the system’s persuasiveness might be lost, or it could mislead users. (Oinas-Kukkonen & Harjumaa, 2009.)

As can be seen from table 9, most of the features in the system credibility support -category are either important or very important for the respondents. Similar to McCarthy et al. (2017), where medical devices needed to be reliable, here it is found very important that an application comes from a reliable source. Unlike other features that have disintegration between the level of importance, reliability is one feature that has no answers on importance level less than “neutral”.

Source credibility is one important issue in persuading a user: if the persuasive message given to user is strong, sources that have high credibility affected more on users’
confidence in their thoughts than sources with low credibility. But what is interesting, is that if the persuasive message given to user is weak, then sources with low credibility affected the confidence more than sources with high credibility. (Tormala, Briñol, & Petty, 2005.) These results are worth considering when developing an application and informing the user who is behind the application, in case the target of the application is to persuade users to carry out better self-management.

### Table 9. Answers in the System credibility support -category.

<table>
<thead>
<tr>
<th></th>
<th>Not important at all</th>
<th>A little important</th>
<th>Neutral</th>
<th>Important</th>
<th>Very important</th>
<th>I can not say</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>The application comes from a reliable, professional source [Trustworthiness / Expertise]</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>23</td>
<td>1</td>
<td>33</td>
<td>4.73</td>
</tr>
<tr>
<td>The application’s outfit is official [Surface credibility]</td>
<td>3</td>
<td>2</td>
<td>12</td>
<td>12</td>
<td>1</td>
<td>3</td>
<td>33</td>
<td>3.45</td>
</tr>
<tr>
<td>Developers’ contact information can be found in the application [Real-world feel]</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>13</td>
<td>2</td>
<td>33</td>
<td>3.91</td>
</tr>
<tr>
<td>Hints to support self-management can be found in the application [Authority]</td>
<td>4</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td>11</td>
<td>0</td>
<td>33</td>
<td>3.7</td>
</tr>
<tr>
<td>The application can be linked with other applications [Third party endorsements / Verifiability]</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>7</td>
<td>15</td>
<td>0</td>
<td>33</td>
<td>3.88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>13</td>
<td>8</td>
<td>31</td>
<td>44</td>
<td>63</td>
<td>6</td>
<td>165</td>
<td>3.93</td>
</tr>
</tbody>
</table>
6. Findings

From the results it can be seen that there is a wish for automation. In all of the letter-types (love- and break-up letters and date adverts) there are mentions about automatic data-transfer from blood glucose meter to application, and in one love letter also communication with other applications. In one date-advert, also a possibility to read sensor and/or insulin pump with an application, and even using the application as a remote controller for insulin pump was on a wish list. Missing automatic data-transfer from blood glucose meter to an application is also one reason for breaking up with the application.

Previous research has revealed this similar wish, such as Årsand et al. (2012), Clements and Staggs (2017) and Lithgow, Edwards and Rabi (2017). From this can be derived that modernization and automation is a trend that needs to be answered. In one break-up letter, there was a mention that automatic transfer from insulin pen to an application would be helpful, and as an answer for that, there should be shortly coming at least one type of insulin pens that do send information automatically to the application via Bluetooth (Companion Medical, 2017). That is, new technologies are continuously being developed to help people with diabetes in their everyday life.

Similarly to Frøisland, Årsand and Skåderud (2012) and Klonoff (2013), visualization was also mentioned in the results of this research. Based on the letters, it is important to be able to see graphs revealing patterns in blood glucose levels. Also, when asked about the wanted features, creating diagrams was mainly thought as “very important”.

However, what is noticeable, Cafazzo, Casselman, Hamming, Katzman and Palmert (2012) found out that gamification incentives would support adolescents with type 1 diabetes in checking blood glucose levels more often. In this research, especially competition was refuted, and as one respondent wrote in an open field: “-- and I definitely don’t want an application to be a “game” or otherwise try to be funny, because I can’t stand that”. There are of course differences between individuals, and in future it is important to study further, whether the differences found here are to do with individual preferences, or if they are, perhaps, cultural.

Based on the results gained in this research, there is a need for an application that would communicate at least with a blood glucose meter, and would either calculate or help in calculating appropriate doses of insulin and carbohydrates, would give reminders about taking medicines, draws graphs from results it obtains, which is designed and developed especially for managing type 1 diabetes, has pleasant outlook and is easy to use, and which offers a possibility for health care personnel to see the results and remotely comment on them. Most of the wishes reference to a requirement that an application would help in self-managing diabetes as good as possible, when at the same time making it faster and easier. Also, a demand for developing technology is shown, the greatest in a wish to get automatic data-transfer.

The biggest flaws in current applications, as seen from the break-up letters, are the lack of automation, complexity of adding notes afterwards, and difficult start. Also, in one break-up letter, there was a mention that since the respondent got FreeStyle Libre, there
is no more use for the application, and since there is not enough space available in the phone, the application was deleted. From this answer, it is not possible to say whether the self-management application demands much of the memory and was deleted because of that, or if other applications use much memory and the self-management application was deleted only since it was not used anymore. However, from this answer it can be derived that self-management applications should not demand excessive resource from the mobile device.

According to Oinas-Kukkonen and Harjumaa (2009), unobtrusiveness plays a high role: an application is not supposed to disturb the user, when he or she is conducting other tasks. If an application interrupts its user often, it is possible that the wanted persuasive outcome may be even opposite (Oinas-Kukkonen & Harjumaa, 2009). Another topic close to unobtrusiveness is kairos. Kairos is about timing, and is defined as an opportune moment to persuade (Fogg, 2009). When thinking about the automatic data transfer, wanted in the letters, a number of questions arise: is the automation wanted only in the aim of making life easier, or is there some hints of technostress behind? Technostress is a disease caused by inability to manage with computer technology in a healthy way, and it has two linings: (1) struggle to accept computer technology itself, and (2) overidentification with computer technology (Brod, 1984). In this thesis, technostress is not further studied, and it leaves a need to study it in the view of self-management applications.

Between genders, there were no major differences found. However, since there were only three males participating in this research, it is not possible to say, whether there are differences in preferences or not. This should be further studied in the future.

Mobile phone applications have also some good elements compared to traditional pen-and-paper: Collins, Kashdan and Gollnisch (2003) studied traditional self-monitoring and cellular phone monitoring when collecting data on alcohol use, and noticed that cellular phone monitoring was more reliable, due to date and time stamping on data, was easily integrated into daily life, and it made it possible to entry the given data instantaneously into a central database. In diabetes self-management, these benefits are similarly accurate: the input data has date and time stamping, which can make it possible to find problems caused, for example, two insulin shots taken too closely to each other; mobile phone application can be more easily integrated into daily life than pen and paper; and it could be possible to entry the data instantaneously into a central database, from which it could be possible for health care personnel to see them.

Hoppe, Cade and Carter (2017) in their research found out that there are not many functions or behaviour change techniques implemented in current self-management applications, even though they would rate applications higher. When considering categories in PSD model, it is seen that based on this research, features in system credibility support, dialogue support, and primary task support are the most important ones. In those categories, percentage of the features being at least important, based on the answers, are 64,8%, 58,9%, and 60%, respectively. The features in social support category, on the other hand, were thought at least important by only 15% of the respondents; 61% of them thought them to be “not important at all”.

To take a closer look at the PSD categories, it can be seen that in social support -category especially social comparison, competition and recognition were unwanted principles. Instead of trying to be better than others, the respondents in this research highlighted the need to do one’s own best, not to defeat everyone else. To support that, also praise and rewards in dialogue support -category were rated more as “not important
at all” than important ones. However, praise and rewards were not as strongly rejected as social comparison, competition and recognition, and there were 5 to 7 people considering them at least as “important” meanwhile in social support, only 1 to 2 thought those principles to be at least “important”. All in all, principles in social support -category were not thought as important, excluding social facilitation and cooperation, which got 9 and 10 respondents to keep them at least as “important”, respectively.

Unlike principles in social support -category, which received more negative than positive attitudes, principles in dialogue support -category were received more in disperse, emphasising more on positive attitude, meanwhile in primary task support -category the answers are even more divided, having still its emphasis on the “important”-end of the scale. Principles in system credibility support -category were also mainly held as at least “important”.

From above, and more precisely from chapter 5, can be seen that excluding social support -category all the categories were thought more as important than unimportant. In dialogue support -category, especially similarity, liking and social role received more answers on important than unimportant end of the scale. In primary task support -category, tailoring/personalisation and self-monitoring were the most important principles, meanwhile in system credibility support -category trustworthiness/expertise received most of the answers on the important -end of the scale.
7. Discussion

This research has revealed some points regarding type 1 diabetes related self-management mobile applications. For application developers, this research is useful, since there are positive and negative features exposed and wishes, how new applications should be. Also, as (medical) technology is developing rapidly, this study gives some examples that could be developed for making self-managing type 1 diabetes easier and more efficient.

As McCarthy et al. (2017) in their research found out, the practicality in everyday context is important when discussing about medical devices. This research found similarities with McCarthy et al.: when in McCarthy et al.’s (2017) research there is a demand for “convenience and practicality for everyday contexts”, in this research there is a demand for fluent user experience, pleasant usage, and certainty. That is, there is need for both medical devices and self-management mobile applications that can be easily included in everyday life. Similarly, when in McCarthy et al.’s research “acquiring and changing medical devices” was one of the categories, in this research “having a modern application” and “being modern” are categories derived from love-letters and date-adverts, respectively. When in McCarthy et al.’s research some of the respondents wished to get FreeStyle Libre, one of the modern ways of checking blood glucose levels, in this research some of the respondents wished to get an application that could read FreeStyle Libre or automatically transfer the data from a blood glucose meter to an application. In both of these researches technological development was found important.

As McCarthy et al. found a need for “collecting and using data”, including the reliability of blood glucose results, this research reveals need for expert source for an application. In both of these, it was found important that the device/application could be trusted. In addition to these, also the last category in McCarthy et al.’s research, “corresponding with preferences and values”, have similarities in this research: for a self-management application to meet user’s requirements, there are for example need for features such as reminders and/or automatic data-transfer, and a possibility to hide or set up some of the features can help in providing good user experience for a variety of users.

This research can be exploited by health care system, since the costs of managing diabetes is high. Self-managing diabetes is cheaper than inpatient care (Terveyden ja hyvinvoinninlaitos, 2016), which could push also health care system to recommend self-management applications for people with diabetes. Since there are no strictly limited features and functions that self-management application should have, there is a great variety of them. This may also make it impossible for health care personnel to recommend any of them. However, if there was a medically approved application, it could be exploited and recommended also by health care system, and health care personnel could encourage people with type 1 diabetes to use it in the aim of executing better self-management.

Since this research focuses only on type 1 diabetes, these results cannot be straightly exploited in developing a self-management application for people with type 2 diabetes. Also, as the research group for this research is relevantly small and the respondents are gathered from one place only, there is no guarantee that the results are generalizable, at
least to other countries and cultures. However, considering the explorative nature of the present study, the sample (N=33) should be adequate in providing good insight into the research topic. Besides, as there were similar features mentioned in the letters, the number of respondents can be thought as sufficient. Also, for more reliable results, there should be more males included in a research. However, this research presents a good basis for further studies, and points out some relevant features and functions that could be considered when developing a self-management application for people with type 1 diabetes in Finland.

In this research, the results show wishes for getting advice from health care personnel remotely. Telemedicine have been proved to be useful in diabetes management: using a telemedicine platform has decreased the level of HbA1c and allowed better glycaemic control with type 1 diabetics who are using insulin pumps (Rigla et al., 2007). Also, when added telemedicine to the usage of continuous glucose monitoring system (CGMS), health care personnel can give advice and through that result to decreased HbA1c (Salzsieder et al., 2007). All in all, having more contact with health care personnel by providing them data virtually to be commented, can improve glycaemic control (Grady, Cameron, Levy, & Katz, 2016).

However, as Malasanos already in 2008 in her analysis criticized, as long as input is user driven, there is a possibility that user fakes the values. Or, in case the values are too high, the user may choose not to send the data. (Malasanos, 2008.) It is true that some people with diabetes may feel pressure to get the data, shown to health care personnel, look perfect. In Finland, doctoral visits are agreed individually between person with diabetes and his or her doctor, but most commonly doctoral visits are every 6 months or once a year (Diabetes: Käypä hoito-suositus, 2018). In case there are no contact with health care personnel between the meetings, all the management of the disease is left for the diabetic him- or herself, and he or she may feel like a failure in case the goals, agreed with last time met with health care personnel, are not reached. However, as abovementioned articles show, it is possible for health care personnel to remotely advice their patient, and that was also wished in the results of this research. Derived from this, I suggest giving attention to this possibility when developing self-management mobile applications to people with type 1 diabetes.

In the aim of finding the flaws, analysing patterns plays an important role. Even though HbA1c-level is important in assessing long-term blood glucose levels, it does not provide overview of the reality – from HbA1c, it is not possible to see how blood glucose levels vary from day to day. In this, self-monitoring blood glucose levels shows its value, and from these results, pattern analysis can be done. For analysing patterns, computer-based programs are efficient, and can provide valuable information for health care personnel. (Parkin & Davidson, 2009.) From the results, it was possible to find that the respondents found it important to get graphs from the input data. Similarly, hints to support self-management was found important. These can be interpreted to mean that people with type 1 diabetes wish to get different kind of guidance and analysis of their disease, to support them in their self-management.

When considering the persuasive principles, it was found out that no comparison, competition and/or recognition was wanted in a diabetes related self-management application. However, in dialogue support category, praise and rewards divided opinions more evenly. From this can be derived, that there might be market for an application that has a possibility to give praises and/or rewards for its user, in case the user wants them. This supports the results found by Martinez et al. (2017), where the
analysis revealed that the most used applications are simple with a possibility to expand to cover more features.

What then are the features wanted in self-management applications? From principles in PSD model, praise and rewards are in grey area, but social facilitation, cooperation, similarity, liking, social role, tailoring/personalisation, self-monitoring, and trustworthiness/expertise are considered as important. Even though it might be easily thought that there is strength in a group and principles in social support -category would be the most wanted ones, the results show it opposite. In this research, it is impossible to say whether it is Finnish individual-focused culture that makes the respondents to dislike the principles in social support -category, or is it about a view of managing diabetes individually, or what is the reason behind that. Nevertheless, for Finnish people with type 1 diabetes the most important issues in a diabetes self-management application are similarity (e.g. a possibility to get the application in Finnish), tailoring/personalisation (i.e. the application is designed for people with type 1 diabetes), self-monitoring (e.g. visual diagrams to help finding problems), and trustworthiness/expertise (i.e. the application comes from a reliable, professional source).

However, an application with suitable features is not enough to assist in self-management – not at least then, when there is a need to change one’s behaviour towards more positive and comprehensive way of managing the self. As Clements and Staggs (2017) found out, automatic data transfer from a blood glucose meter to a self-management application can result in checking blood glucose levels more often compared to meters which do not have automatic data transfer. This can be easily understood: ease of checking blood glucose levels without needing to write them down, and still benefitting from the check either as proof that self-management is being successful or as a possibility to quickly see from an application how many units of insulin is needed to take or how many grams of carbohydrates to be eaten in the aim of balancing the situation. When the data is transferred automatically from a meter to an application, and if the application has a possibility to suggest needed actions, the process becomes very unobtrusive – there is no need for a user to stop his / her work to think and calculate. However, what could become problematic with this is that in case the responsibility of the management of diabetes is transferred completely from a diabetic to an application, self-reflection will remain unimplemented. In case a blood glucose meter or a sensor will send data automatically to an application, which will do the calculations and give the user suggestions of actions (and maybe even calculate carbohydrates from a picture: see Zhang, Yu, Siddique, Divakaran, & Sawhney, 2015), there will be no reflection and learning for the user him-/herself. This can cause problems for example in a situation, when the application is not available or functioning for some reason.
8. Conclusions

There are several diabetes related self-management mobile applications available in Google store and for iPhones. With good self-management, it could be possible to prevent expensive complications from occurring. In this, self-management mobile applications can be helpful, if they have the needed features.

This thesis utilized grounded theory in analysing letters, following similar type of a research conducted by McCarthy et al. (2017). In this thesis, 33 respondents from a Finnish Facebook group called “Ykköstyypin diabetes aikuiset” (Eng. “Type one diabetes adults”, researcher’s own translation) wrote love- and/or break-up letters, or date-adverts, for a mobile diabetes self-management application that they currently use or wish to use. After letters there was a questionnaire regarding persuasive elements in application. In questionnaire, PSD model was utilized.

This research had two questions: 1) Which elements or qualities of type 1 diabetes self-management applications affect the user experience of these applications? 2) What persuasive features have the biggest effect on those experiences? As an answer for the first question, it is possible to derive from the letters that automatic data transfer from a blood glucose meter or sensor to the application would be one of the biggest wishes for the application. For fluent and extensive use, visualization, i.e. drawing graphs from the data, insulin and/or carbohydrate dose calculation, pleasant outlook, ease of use, and a possibility to share the data with health care personnel and get comments from them are in an important role in affecting the user experience. As an answer for the second question, it can be seen from the questionnaire that reminders, similarity, liking, social role, tailoring/personalisation, self-monitoring, and trustworthiness/expertise are the principles affecting the most. What needs to be noticed here is that competition, social comparison and recognition were strongly rejected by the respondents in this research.

There still remains aspects to be studied. For example, this study rejects competition strongly, which is opposite to what Cafazzo et al. (2012) found. This could be further studied in the aim of finding if there are specific elements in gamification/competition that are repelled, or is the whole gamification/competition inappropriate in a self-management application. Also technostress regarding self-management applications, and differences in preferences regarding self-management applications between genders should be studied in the future. In addition to these, it is needed to study what is meant with the wanted “ease of use” in mobile self-management applications.
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Appendix A. Questionnaire (Finnish)

1-tyyppin diabeetikoiden kokemuksia ja toiveita diabeteksen omahoidon tukemiseen tarkoitettujen mobiilisovellusten käytöstä

Tervetuloa vastaamaan 1-tyyppin diabeteksen omahoidon tukemiseen tarkoitettujen mobiilisovellusten käyttöä koskevaan kyselyyn!

Kysely on osa Oulun yliopiston tietojenkäsittelytieteiden opiskelijan Miia Laitisen maisteritutkintoa. Kaikki kyselyn vastaukset käsitetään luottamuksellisesti, eikä vastaajan henkilölisyyys paljastu missään vaiheessa. Vastaamalla kyselyyn suostut siihen, että antamiasi tietoja hyödynnetään anonyymisti tutkimuksessa.

Kyselyn tarkoituksena on selvittää diabeetikon kokemuksia omahoidon tueksi tarkoitettujen mobiilisovellusten käytöstä, sekä mikä vaikuttaa käyttökokemuksiin. Voit vastata kyselyyn, vaikka et käyttäisi mitään mobiilisovellusta omahoitosi tukena.

Halutessasi lisätietoja tai sinulla on ongelmia kyselyn täyttämisessä, ota yhteyttä kyselyn tekijään: miia.laitinen@student.oulu.fi

Halutessasi voit keksiä itsellesi tunnuksen (voi sisältää kirjaimia, numeroita ja/tai erikoismerkkejä). Tunnuksen avulla voit pyytää antamiesi vastauksien poisvetämistä tutkimuksesta 30.6.2017 asti lähettämällä sähköpostia osoitteeseen miia.laitinen@student.oulu.fi ja kertomalla viestissä tunnuksesesi sekä halusi poistaa vastauksesi tutkimuksesta. Otathan keksimäsi tunnuksen itsellesi talteen!

**Tunnus**

Tunnus [____]
Taustatiedot

Ikä *
○ Alle 16
○ 16-20
○ 21-25
○ 26-30
○ 31-35
○ 36-40
○ 41-45
○ 46-50
○ Yli 50

Sukupuoli *
○ Mies
○ Nainen
○ Muu

Korkein koulutus *
○ Peruskoulu
○ Toinen aste (lukio, ammattikoulu)
○ Korkeakoulu (yliopisto, ammattikorkeakoulu)

Käytätkö jotain mobiilisovellusta diabeteksen omahoidon tukena? *
○ Kyllä
○ En

Mitä mobiilisovellusta käytät pääsääntöisesti? *
○ Balansio
○ Contour Diabetes App
○ Diabetes Connect
○ Diabetes:M
○ Dottli
○ Glucose Buddy
○ LibreLink
○ mySugr
Rakkaus- tai erokirje

Seuraavaksi pyydämme sinua miettimään suhdettasi käyttämääsi diabeteksen omahoitoa tukevan mobiilisovellukseen. Kirjoita seuraaville sivuille varattuihin tiloihin joko rakkaus- tai erokirje, tai molemmat, sen mukaan miltä suhteesi sovellukseen tuntuu.

Valitse alta, haluatko kirjoittaa rakkaus- vai erokirjeen, vai molemmat.

**Haluan kirjoittaa *  **

- Rakkauskirjeen
- Erokirjeen
- Molemmat

**Rakkauskirje**

Kirjoita alla olevaan kenttään rakkauskirje diabeteksen omahoidon tueksi käyttämälesi mobiilisovelluksesta. Anna konkreettisia esimerkkejä siitä, mistä pidät sovelluksessasi ja miksi haluat jatkaa suhdettasi käyttämäsi sovelluksen kanssa. Muutoin kirjeesi tyyli on vapaa, ja voit kirjoittaa niin pitkän kirjeen kuin haluat!

**Rakkauskirje *  **
Erokirje

Kirjoita alla olevaan kenttään erokirje diabeteksen omahoidon tueksi käyttämällesi mobiilisovellukselle. Anna konkreettisia esimerkkejä siitä, mistä et pidä sovelluksessasi ja miksi et halua jatkaa suhdettasi käyttämäsi sovelluksen kanssa. Muutoin kirjeesi tyyli on vapaa, ja voit kirjoittaa niin pitkän kirjeen kuin haluat!

Rakkaus- ja erokirje

Kirjoita alla oleviin kenttään rakkaus- ja erokirje diabeteksen omahoidon tueksi käyttämällesi mobiilisovellukselle. Anna konkreettisia esimerkkejä siitä, mistä pidät/et pidä sovelluksessasi ja miksi haluat/et halua jatkaa suhdettasi käyttämäsi sovelluksen kanssa. Muutoin kirjeesi tyyli on vapaa, ja voit kirjoittaa niin pitkän kirjeen kuin haluat!
Tässä osassa pyydämme sinua miettimään, millainen mobiilisovellus toimisi parhaiten diabeteksesi omahoidon tukena.  

Kirjoita treffi-ilmoitus, jolla haet itsellesi Sitä Oikeaa mobiilisovellusta. Annathan konkreettisia esimerkkejä siitä, millaisia ominaisuuksia haluat ilmoituksellasi saada, ja millaisia ominaisuuksia ilmoitukseesi vastaajalla ei saa olla. Muutoin ilmoituksen tyyli on vapaa!
### Sovellus

Sovellus ohjaa itsensä käyttöä

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Sovellus on suunnattu erityisesti 1-typin diabeetikoille

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Sovellus ohjeistaa ja neuvoo esimerkkejä verensokerin mittaustekniikassa

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Sovellus kehuu esimerkkejä riittävän tahtoista verensokerin mittauksesta

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Sovellus antaa muistutuksia

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovellus antaa muistutuksia</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Sovellus antaa ehdotuksia

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovellus antaa ehdotuksia</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Sovellus on mahdollista saada äidinkielelläsi

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovellus on mahdollista saada äidinkielelläsi</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Sovellus on ulkoasultaan miellyttävä

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovellus on ulkoasultaan miellyttävä</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Hoitoihinklädikunta näkee sovellukseen antamasi tiedot ja voi kommentoida niiden perusteella hoitoasi tapaamatta sinua kasvotusten

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoitoihinklädikunta näkee sovellukseen antamasi tiedot ja voi kommentoida niiden perusteella hoitoasi tapaamatta sinua kasvotusten</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

### Sovellus

Sovellus tulee luotettavasta, asiantuntuvasta lähteestä

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovellus tulee luotettavasta, asiantuntuvasta lähteestä</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Sovelluksen ulkoasu on virallisena näköinen

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovelluksen ulkoasu on virallisena näköinen</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Sovelluksesta löytyy sen kehittäjien yhteystiedot

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovelluksesta löytyy sen kehittäjien yhteystiedot</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Sovelluksesta löytyy vinkkejä omahoidon tueksi

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovelluksesta löytyy vinkkejä omahoidon tueksi</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Sovelluksen voi liittää muihin sovelluksiin

<table>
<thead>
<tr>
<th>Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovelluksen voi liittää muihin sovelluksiin</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Arvioi, kuinka tärkeitä seuraavat ominaisuudet ovat sinulle *

<table>
<thead>
<tr>
<th>Sovellukseen syötettävät tiedot, kuten päivän mittautulosten keskiarvot tai kaaviot, on mahdollista jakaa muiden sovelluksen käyttäjien kanssa</th>
<th>Ei lainkaan tärkeä</th>
<th>Hieman tärkeä</th>
<th>Neutraali</th>
<th>Tärkeä</th>
<th>Erittäin tärkeä</th>
<th>En osaa sanoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sovellus näyttää käyttäjien tulokset paremmuusjärjestysessä</td>
<td>Ei lainkaan tärkeä</td>
<td>Hieman tärkeä</td>
<td>Neutraali</td>
<td>Tärkeä</td>
<td>Erittäin tärkeä</td>
<td>En osaa sanoa</td>
</tr>
<tr>
<td>Sovelluksen kautta on mahdollista löytää ja ottaa yhteyttä itsensä kanssa samanlaisiin käyttäjiin</td>
<td>Ei lainkaan tärkeä</td>
<td>Hieman tärkeä</td>
<td>Neutraali</td>
<td>Tärkeä</td>
<td>Erittäin tärkeä</td>
<td>En osaa sanoa</td>
</tr>
<tr>
<td>Sovelluksen voidaan perustaa käyttäjäryhmä, jotka yhdessä pyrkivät pääsemään tavoitteeseen (esimerkiksi laskemaan HbA1c-arvon alle 8%:iin)</td>
<td>Ei lainkaan tärkeä</td>
<td>Hieman tärkeä</td>
<td>Neutraali</td>
<td>Tärkeä</td>
<td>Erittäin tärkeä</td>
<td>En osaa sanoa</td>
</tr>
<tr>
<td>Sovelluksessa on mahdollista kilpailua muiden käyttäjien kanssa</td>
<td>Ei lainkaan tärkeä</td>
<td>Hieman tärkeä</td>
<td>Neutraali</td>
<td>Tärkeä</td>
<td>Erittäin tärkeä</td>
<td>En osaa sanoa</td>
</tr>
<tr>
<td>Sovellus antaa kunniamaininnan, joka näkyy myös muille käyttäjille, esimerkiksi kuukauden parhaimmasta verensokeritasapainosta</td>
<td>Ei lainkaan tärkeä</td>
<td>Hieman tärkeä</td>
<td>Neutraali</td>
<td>Tärkeä</td>
<td>Erittäin tärkeä</td>
<td>En osaa sanoa</td>
</tr>
</tbody>
</table>

Halutessasi voit kertoa tähän vielä muita mobiilisovellukseen liittyviä toiveita tai asioita, jotka vaikuttavat sovelluksesi käyttöön ja siihen, miltä sen käyttäminen tuntuu.
Appendix B. Questionnaire (English)

NOTE! This appendix is created only for reporting purposes. The questionnaire was not available in English during the research.

Welcome to answer in a questionnaire, which created to study the usage of type 1 diabetes self-management mobile applications!

This questionnaire is a part of Miia Laitinen’s Master studies in faculty of Information Processing Science. All the answers in the questionnaire are handled with care, and respondent’s identity will not be revealed in any point of the study. By answering in the questionnaire, you agree that the information you give can be used in the study.

The target of this questionnaire is to survey experiences of the usage of diabetes self-management applications and to find out, which are the components affecting user experiences. You can answer this questionnaire even if you don’t use any mobile application to support your self-management.

In case you need more information or have problems in filling the questionnaire, please contact the author of the questionnaire: miia.laitinen@student.oulu.fi

If you would like to, you can create yourself an ID (can include letters, numbers and/or special characters). With ID, you can ask for withdrawal of the answers you have given until June 30, 2017, by sending email to miia.laitinen@student.oulu.fi and mentioning your will to withdraw the answer and telling your ID. Please, save your ID!
Background information

Age *
- Under 16
- 16-20
- 21-25
- 26-30
- 31-35
- 36-40
- 41-45
- 46-50
- Over 50

Gender *
- Male
- Female
- Other

Highest education *
- Primary school
- Second degree (high school, vocational school)
- University (university, university of applied sciences)

Do you use any mobile application in your diabetes self-management? *
- Yes
- No

Which mobile application you use to most? *
- Balansio
- Contour Diabetes App
- Diabetes Connect
- Diabetes:M
- Dottli
- Glucose Buddy
- LibreLink
Next we ask you to think about your relationship with diabetes self-management mobile application. In the next pages, write either love- or break-up letter, or both, based on how you feel about your relationship with the application.

From below, choose if you would like to write a love- or break-up letter, or both.

**I would like to write** *

- A love letter
- A break-up letter
- Both of them

**Love letter**

Write below a love letter for the mobile application, you use in self-management. Give concrete examples on which are the issues you like in your application and why you want to continue your relationship with the application. Otherwise the style and length of your letter are free!

**Love letter** *
Break-up letter

Write below a break-up letter for the mobile application, you use in self-management. Give concrete examples on which are the issues you do not like in your application and why you do not want to continue your relationship with the application. Otherwise the style and length of your letter are free!

Break-up letter *

Love- and break-up letter

Write below a love- and break-up letters for the mobile application, you use in self-management. Give concrete examples on which are the issues you (do not) like in your application and why you (do not) want to continue your relationship with the application. Otherwise the style and length of your letter are free!

Love letter *
In this part we ask you to think, what kind of mobile application would fit best for you to support your diabetes self-management.

Write a date-advert, with which you are looking for for The One mobile application. Please, give concrete examples on what kind of features you would like to get with your advert, and what kind of features the one answering to your advert must not have. Otherwise the style of the advert is free!
<table>
<thead>
<tr>
<th>Feature</th>
<th>Not important at all</th>
<th>A little important</th>
<th>Important</th>
<th>Very important</th>
<th>I can not say</th>
</tr>
</thead>
<tbody>
<tr>
<td>The application guides how to use it</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application is specifically targeted to people with type 1 diabetes</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application creates diagrams from information it gets, for example from blood sugar levels</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application demonstrates with pictures what happens, if for example blood sugar levels varies too much or is too high</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application guides and gives advices for example in technique how to check blood sugar</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application gives praise, if I have for example checked my blood sugar many times enough</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>There will be a picture of a reward in the application, if I have had my blood sugar within limits for a day, for example</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application gives reminders</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application gives suggestions</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application is possible to get in your mother language</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The application looks pleasant</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Health care personnel can see the information you put in the application, and can comment your self-management without meeting you in person</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Estimate, how important the following features are for you*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Not important at all</th>
<th>A little important</th>
<th>Neutral</th>
<th>Important</th>
<th>Very important</th>
<th>I can not say</th>
</tr>
</thead>
<tbody>
<tr>
<td>The application comes from a reliable, professional source</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The application’s outfit is official</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Developers’ contact information can be found in the application</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Hints to support self-management can be found in the application</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The application can be linked with other applications</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The data put in the application, like the averages of the daily measures’ result’s or diagrams, can be shared with other application users</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The application shows the users’ result’s ranked</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Via the application, it is possible to find and contact users similar to yourself</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>In the application, there can be formed user groups, which together work to achieve a goal (for example to decrease HbA1c-value under 8%)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>In the application, it is possible to compete with other users</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The application gives honourable mention, which other users can see, for example for the person with best blood glucose levels of the month</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
If you would like to, here you can tell other issues and wishes regarding mobile application, its usage, and how it feels to use it.