BACHELOR THESIS

A multi-layered interface for older adults
*a study into the learnability and user experience
of an introduction layer for a mobile application*

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Abstract

Background: Almost everyone uses a smartphone nowadays. Younger generations are used to the fact that computers and smartphones play a large role in their lives, and it often comes as second nature to use these technologies. For older adults it can be more challenging, especially combined with declining cognitive functions. To improve the process of learning to use a new application a multi-layered interface shows promising results. This way, users are presented with a simplified version to introduce them to an application in a stepwise manner. This study will use the mobile application Activity Coach, which guides people maintaining a healthy lifestyle. A simple introduction layer is added where advanced functions, settings and notifications are left out.

Purpose: The aim of this study is to investigate the multi-layered approach in a mobile context. Central are whether it results in a better learnability and usability for older adults, as well as recording the attitudes and experiences of the users through a mainly qualitative approach.

Methods: An interactive mock-up has been used to test an introduction layer. By means of a survey and in-depth interviews participants who used the introduction layer were compared with participants who used the application without the extra layer, and their experiences were analysed.

Conclusions: Most users had a positive attitude toward using a multi-layered interface. Some reported it improved the task performance, but for the other half it did not. Many users would prefer if there was additional information about the functionalities of the application, such as an overview page of what you can do with the application. For some users, more guidance in the introduction layer is preferred, such as guiding text next to buttons to support in navigating.

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1. Introduction

The number of mobile applications has been growing ever since the use of smartphones has been widely adopted. There have not only emerged apps for entertainment purposes or to connect with others, but also to improve healthy behaviour, to maintain a schedule or to improve mental health. Younger users that have grown up with technology generally accept and find their way with a new application rather quickly. For older users, however, it can be challenging to learn how to use new application. According to Kim, Gajos, Muller & Grosz (2016), the perceived ease of learning given by a combination of design elements could be a critical variable that influences the acceptance of technology. A high learnability, meaning an interface is easy to learn for new users, is important. Usability is the broader concept of how usable and easy it is to use a product or interface.

There have been many recommendations proposed in research to help older adults learn using a new computer technology. These include minimizing working memory demands, providing cues and aids, not overloading older learners with too much information, and not requiring learners to make complex inferences or fill in gaps of missing information (Fisk, Rogers, Charness, Czaja & Sharit, 2009). A multi-layered interface to improve initial learnability is in line with most of these recommendations. Multi-layered interfaces refer to an interface with a simplified version to introduce a user to an application in a stepwise manner (Kang, Plaisant & Shneiderman, 2003). Stated by Leung et al. (2010) "Multi-Layered interfaces can be designed to support learning such that novices first learn to perform basic tasks by working in a reduced-functionality, simplified layer (version) of the interface. Once users have mastered this layer or require more advanced functionality, they can transition to increasingly complex layers and learn to perform more advanced tasks."

Few research has been done however on multi-layered interfaces in a mobile context and for older users, and mostly on a small scale. Also, these have mainly been concerning usability and task performance only, and the user's attitude toward and experiences of using a multi-layered interface have not been central. Therefore, with this research, the aim is to inquire how a multi-layered app design is evaluated by users and if it is beneficial for improving the learnability for older adults. It intends to get a more qualitative insight in multi-layered interfaces by also including in-depth interviews about the user's experiences. The results of this study can be useful for developing applications targeted for older adults, but also when targeted at a general audience to make it more user-friendly and easier to learn for older users.

The central question in this research is as followed: *Does a multi-layered interface improve the initial learnability and user experience of a health application?*
User experience refers to the entire experience of using an interface, including how usable and satisfactory it is. In this study, mainly the attitude towards using an introduction layer of an application is studied. The research will be done with a health application that is still in development, the Activity Coach App. An interactive mock-up is used by the participants as a prototype of the

application. Prototyping is the process of building low- or high-quality mock-ups of your application's design to have something tangible to test with users. As mentioned by Lowdermilk (2013) "Prototyping is a powerful way to help your users visualize what you intend to deliver through your application". This research will be conducted for Roessingh Research & Development, a scientific research centre where multiple disciplines work on current and future innovations in rehabilitation and chronic care. The eHealth cluster aims at realizing innovative solutions for healthcare delivery through ICT. One of the focus points are evaluating eHealth technology on usability and user experience and applying user-centered design for developing and improving new technology.

To conduct this study, the Activity Coach app from Roessingh will be used. The target group of the application are older adults (55+) who want to improve their health in their everyday life. This version of the application is still a work in progress and focuses next to physical activity on other domains such as sleep and mental health. Per domain, the user can set goals and view his or her progress. In addition, the user can choose to be supported by a virtual coach. The virtual coach provides feedback and notifications. The application is not yet finished, thus this study also aims to improve the usability in this early stage of the design process. Figures 1.1 and 1.2 depict some screens of the mock-up application to provide a better picture of the context in which this research takes place. Additional screens can be found in Appendix D.

Figure 1.1. Home screen

Figure 1.2. Step counting

After introducing the subject and aim of this study in chapter 1, this report continues with a review of relevant literature about usability, user experience and user design for elderly, as well as other studies into multi-layered interfaces in chapter 2. Chapter 3 describes the method and instruments used in this study. Thereafter, the results of this study are presented and examined in chapter 4. In chapter 5 the results are interpreted and wrapped up in a conclusion, and the limitations of this study as well as recommendations for further research will be discussed.

2. Theoretical framework

In this chapter relevant literature will be explored. This includes user experience, usability, user design for elderly and multi-layered interfaces.

2.1 User experience, usability, and learnability

User experience (UX) has been defined as "the combined experience of what a user feels, perceives, thinks, and physically and mentally reacts to before and during the use of a product or service" (International Organization for Standardization). User experience is a term often used to summarize the whole experience of using a software product or interface. It does not only concern the functionality, but also the engagement and how pleasant an application is to use. "An application's UX is greater than the sum of its parts" (Lowdermilk, 2013). Important for creating a good user experience is placing the future users of a software product central, the so-called user centered design principle. Wallach and Scholz (2012) highlight that user centered design is based on involving the users at different stages in this procedure of designing. A study into user experience evaluation methods by Vermeeren, Roto, Obrist, Hoonhout, Vaananen-Vainio-Matilla (2010) found that there were 96 user experience evaluation methods found in literature, with their own advantaged and disadvantages. Some of these consist of extensive questionnaires or more visual ways in which users can show their experiences through drawing or selecting faces with emotional responses.

The concept of usability relates to the functional use of an interface or product, and how 'usable' it is. The International Standard ISO 9241-11 (2018) has defined usability as the capability of the product to be understood, learned, operated, and its ease of use to users in order to achieve certain goals with effectiveness, efficiency, and satisfaction. It can be seen as a component of user experience, as being able to understand and use an interface is important for creating an overall good experience. Stated by Nayebi, F., Desharnais, J.-M., & Abran, A. (2012), the usability of a product must consider three aspects:

Efficiency: little time or efforts to complete a particular tasks.

Easy to learn: operations can be done and learned by observing the object.

User satisfaction: meets user expectations and objectives.

In the context of this study with the Activity Coach application, the efficiency and easy to learn aspects are most relevant. User satisfaction is less applicable, since the app is not yet finished and the participants who will test the application are not already existing users, thus they might not have specific expectations or objectives for using the app. The first two aspects both relate to learnability, a component of usability. This research will study this aspect, namely whether implementing an

introduction layer in an application makes it easier for people to learn the application. There are several additional usability criteria mentioned in literature, such as: effectiveness, efficiency, satisfaction, safety (error tolerance), utility, learnability, memorability, and engagement (Rogers, Preece & Sharp, 2007). Some usability criteria are task-centered, where specific tasks are measured and quantified in usability testing (Lazar, Feng, & Hochheiser, 2010). For example, it can be measured how much time it costs to complete a task, which is an indicator for efficiency. Learnability can be measured by the time it takes to learn a task. Ease of learning describes how fast and how easily a user can learn to use a new application or complete a new task. The retention rate describes how long they retain the learned skills (Feng et al., 2005). Lazar, et al. (2010) also mention that some usability criteria cannot be measured using only quantitative measurements, as they are subjective. It can involve human emotions, such as engagement and satisfaction. "Subjective satisfaction describes the user's perceived satisfaction with the interaction experience."

Data is usually collected using Likert scale ratings (e.g., numeric scales from 1 to 5) in questionnaires. Henderson compared four different user-based evaluation methods and found that the usability testing with think-aloud generates most usability problems (Henderson et. al., 1995). Also, later research on this method confirmed it is a good method for usability testing, for example according to Kokil & Scott (2017), the think-aloud method enhances the ability to analyse the data.

It is important to also take user experience into account, however the focus of this study will be mainly on usability. Especially the effect of multi-layering an interface on the learnability, since the multi-layered interface approach has potential to make it easier for user to learn and master using an interface. As for user experience, mainly the experience of using an introduction layer to the application and users' attitude towards this approach is studied.

2.3 User design for elderly

According to research, elderly have different requirements for user interfaces than younger users, and solutions that meet these requirements require some level of participatory or human-centred design. (Dodd, Athauda & Adam, 2017). Many studies have researched how user interfaces can be optimized to fit the needs of older adults who have less affinity with technology. For example, Li & Luximon (2019) have provided certain guidelines regarding navigation and menu buttons. De Barros, Leitao & Ribeiro (2014) have done recommendations on navigation, interaction and visual design in mobile user interfaces targeted for older adults.

Glisky (2007) identified three main cognitive issues as a result of ageing, namely attention, long term memory, and working memory, all of which affect users' interaction with information systems. Older users are also less likely to be able to recall a chain of events without any prompting (Granata et al., 2013). The ability to remember and learning new techniques is also reducing with age. Elderly in some studies for example encountered problems with understanding the menu because the

design was too complex.

When it comes to attention, both divided attention, which manages multiple tasks or information sources at once, and selective attention, which deals with filtering stimuli in the environment of the user, are both affected by ageing (Glisky, 2007). Balakrishnan et al. (2012) did a case study with a website and found that it can be hard for older users to focus on the desired content once it has been identified due to distractions like flashing ads in some interfaces. Granata et al. (2013) found that older users can have trouble keeping track of the actions required to complete a task. The more steps or layers of complexity are added to the chain, the greater the chance that the user will lose track or make mistakes.

Through a systematic literature review Dodd et al. (2017) found that there is a lack of solutions addressing these cognitive issues in the domain of mobile user interfaces. One proposed solution to improve the usability and learnability of mobile applications for elderly is by implementing a multi-layered interface, which is explored in the next section.

2.4 Multi-layered interfaces

The multi-layered approach, initially called level-structured approach (Shneiderman, 1998), advocates the use of two or more interfaces each containing a pre-determined set of features of growing complexity. The idea of a Multi-Layered interface is that before users directly use a full-functionality application, they will use a simplified version. It reduces an application's complexity (functions and/or content) during the learning process and enables users to focus on the most important elements to learn tasks. One of the core benefits is that the simplified layer places fewer demands on the user's working memory, which makes it particularly valuable for older users. The study by Kang et al. (2003) investigated two approaches, the multi-layered approach, and an integrated initial guidance approach. The second refers to the implementation of 'sticky notes' inside the interface which highlight the most important functions and provide some information about the features. They experimented with integrated initial guidance with a single layer version of an online map tool, and with a multiple-layer version. The qualitative study collected the users' experiences and comments on both of the interfaces but did not study the learnability. Most users indicated that they preferred using the multi-layered interface to the interface that included all features at once.

Leung et al. (2010) suggests that a reduced functionality layer helps users to master a set of basic tasks compared to people who only use a fully functional application. Quantitative performance measures were taken to assess the learnability of the two interfaces. These included the total number of attempts before mastery, the number of steps (i.e., button presses) to perform a task, and task completion times. The multi-layered interface had more benefits for older participants than for younger participants in terms of task completion time during initial learning, perceived complexity,

and preference. However, when users transitioned from the Reduced-Functionality to the Full-Functionality interface, their performance on the previously learned tasks was negatively affected. There was no negative impact on learning new, advanced tasks in the application.

The study of Leung et al. (2010) divided the features based on complexity, however there are multiple ways to design a multi-layered interface. On, Wong, Mendenhall, Skubic & Enayati (2014) did a comparison of layering the interface by functionality and complexity. Their research suggested that layering by functionality had better results than layering by complexity, however, the sample size was too small to offer any statistical evidence. They created two versions of a multi-layered interface. In the first version the features were sorted into layers based on complexity, and in the other one based on functionality. In the complexity version, the first layers consisted of features that were judged to be easy to understand and use. In the functionality version, all features were categorized in two groups: navigation and graph manipulation. In the first layer users could access all the pages in the menu, however no graphs were displayed when data was submitted. The interface allowed the user to familiarise with navigating the application before being able to view, customize and interpret graphs. While with both these versions the goal is to make the simple layer less complex, the main difference is that by sorting by functionality the 'frame' of the application is intact, e.g. from the home screen all pages of the application are accessible, while in the case of sorting by complexity a certain feature that is deemed more complex would be left out of the home screen.

Taking this into account, for designing the introduction layer for the application it is decided to design two layers based on their functionality. First of all, it was suggested to have slightly better results in the study from Leung et al. (2010). This way, users can learn to navigate through the application with the essential features without many distractions and additional features.

3. Method

A user-centered, mainly qualitative method is used, with a quantitative element. The first part consists of a usability test, and the second part of a short survey and semi structured interviews with the participants.

3.1 Research design

First of all, a user test is conducted, in which the participants used a mock-up of the Activity Coach application and performed a set of tasks. One group of participants received a simplified version of the same application, and then used the full version to perform the tasks. The other group immediately used the regular interface of the application. The introducing participant message of the survey and the task list can be found in Appendix A. Afterwards, the participants were interviewed in-depth about their experience with a semi-structured approach via an online (video) call. Questions include how easy or difficult it was to navigate the application, whether the two layered interface has any added value or made it easier, and whether they would prefer to use it in 'real life'.

Measurements

To get an idea of what usability issues participants encountered during the use of the mock-up, participants filled in a survey using a Likert-scale. The survey questions can be found in Appendix C. The survey includes rating the difficulty of each task on a scale of 1 (easy) to 5 (hard). Some questions are taken from the Mobile Application Rating Scale (MARS), such as questions regarding the navigability of the application. Also, statements regarding user experience were presented, such as: by first using the simple version of the app it was later on easier to perform the tasks. There was not made use of an existing user experience evaluation method since those have an extensive amount of questions which would take quite some time. Users could elaborate on their experience with the application in the interviews. These measures form a basis for the interview and help the participants to evaluate their experience, which they elaborated on in the interviews. It also provides with some quantitative data from the survey to compare the two groups.

A comparison is made between the participants who first had the simplified version and the participants who immediately used the full version in how easy or hard they found performing the tasks in the full interface. There are however not enough participants to make any hard claims concerning whether a multi-layered interface decreases the rating in difficulty of the tasks. Therefore, the qualitative data that is gathered is important to find out whether a multi-layered interface has added value in terms of the user's experience.

3.2 Research participants

The participants selected are in the target group for the health application Activity Coach. The main factor is age, all participants are 50 years and older. They are gathered through the network of the researcher. Educational background or other factors are not of relevance. Five participants tested the multi-layered interface, and five tested he regular interface. Some participants had problems with opening the survey or app mock-up, this was solved by contacting the researcher. The participants are all familiar with using a smartphone, however the frequency they use it varies per participant, between 10 times and 45 times a day. The demographics of the research participants can be found in table 3.1.

Table 3.1

Demographics research participants

	Group 1	Group 2
Age	52, F	51, M
Male (M) or Female (F)	54, M	56, F
	57, F	56, F
	60, F	58, M
	65, M	62, F

3.3 Pre-test

To ensure that the research trajectory went smoothly, and everything was clear to the participants, a pre-test with one participant was conducted. This participant went through all the stages of the research, doing tasks in the mock-up, and going through the survey and interview questions while thinking aloud so any unclear questions or answer possibilities could be identified and altered. No major changes were made, however the information about the procedure in the questionnaire was elaborated on more and the language was made more concise and comprehendible.

3.4 Data collection procedure

The procedure of the data collection went as followed. The researcher made an appointment with the participant for the interview at a set time. The participant was instructed to perform the tasks in the mock-up application and answer the survey questions an hour before the interview. The survey started with asking for the consent of the participant and an explanation of the procedure. Then they received the task list and the link to the mock-up, which they were instructed to open on their smartphone. They were instructed to fill in the survey on a laptop or computer, so they did not have to switch on their smartphone between the task list and the mock-up. After performing the tasks, they returned to the survey to answer the questions. The link to the survey was sent to the participant on relatively

short notice before the interview, so the mock-up application could not be used by participants beforehand. The researcher randomly provided participants with either the survey which included the simplified version of the application or the survey which only contained the regular version.

Although this research was done in the context of a health-application, no large issues arose related to sensitive information concerning health. The goal is to study the interface of the application, and participants did not need to give any information concerning their health. All participants were asked for their full consent. Only some relevant personal data was collected, such as age and affiliation with technology. The interviews that were held were recorded, the recordings were handled with caution and not stored online. The research proposal of this study was reviewed and approved by the Ethics Committee of the University of Twente.

Research Materials

In figures 3.1 and 3.2 a comparison can be seen between the full-functionality version of the application and the introduction layer. It is chosen to still display a basic graph as well in the simple version, because the Activity Coach App is designed in a way where one of the three main pages provides an overview in a graph of the past days or weeks. If the graph is removed the page looks very different, whereas the goal of the simple layer is to let the user get used to the basic outlay of the application. The options that are usually available to change graph settings are left out.

Figure 3.1

Full-functionality version

Figure 3.2

Introduction layer

Additional screenshots of the application can be found in Appendix E.

When opening the Activity Coach application, you first encounter a welcome page, then a login page, and then you can select a virtual coach figure. Thereafter you see the home screen. From there, in the simplified layer you can navigate to all screens, but certain features are left out. In table 3.2 an overview can be found of the differences between the two layers of the application.

Table 3.2

Overview layering application

Layer 1	Layer 2
Coach automatically selected	Selecting coach
No settings	Settings available
No evaluations	Evaluation available
No notifications	Notification on home screen
Graph without options	Graph with options

3.5 Data analysis

The results of the survey were analysed and differences between the group who used the introduction version and the group who did not were compared. In order to analyse the interviews of the participants they were first transcribed. Afterwards, the transcriptions were coded with the software Atlas.ti using a codebook. The codes were developed inductively by the researcher going through the data. An inductive approach to content analysis allows for a truthful description of the content and the categories and provides a deep understanding of the material without bias as a result of preconceptions of the researcher (Mayring, 2015).

The goal of coding the interviews is to get insights in the differences between the experiences of participants who used the introduction layer and those who did not, as well as what parts of the application were seen as positive and which as negative. The sub codes positive, negative as well as neutral were chosen to label statements by the participants. The code learnability in this case refers to how participants mentioned the app as a whole, whether it is easy or more difficult to use. Ease-of-navigation is used for cases when it is mentioned if a feature or page in the application is difficult or easy to find. The code comprehensibility refers to aspects of the application, such as buttons, that are mentioned as unclear or clear. The code layout is used when the placing or order of certain features or pages in the app is discussed. The codes also overlapped in some cases. The codebook including example quotes from participants can be found in table 3.3.

The data collection methods were standardised to ensure the quality of the research. The same survey and task list were given to the participants, apart from the purposeful differences between the

two groups. The interviews were semi-structured, which ensure the same topics were discussed while still leaving room for flexibility in follow-up questions. In order to establish that the outcomes of the research are reliable, the codebook was analysed by calculating Cohen's Kappa. In total there were 304 quotations coded. Over 10% of the transcripts were used, in this case one interview of average length. A second encoder used the same codebook to code the transcript, which were later compared. The Cohen's Kappa for the codebook is 0,73. This is sufficient, thus no changes were made to the codebook.

Table 3.3

Codebook

Code group	Nr	Main code	Sub code	Example
Introduction version	1	Would make use of introduction version	Positive	"Yes, I think if it were offered to me when I download an app I would use it"
			Negative	"I would probably go directly to the full application"
			Neutral	""Because this app is relatively simple, I don't think it would be necessary"."
	2	Changes/suggestions		"I would be nice if there was something next to the buttons"
General app	3	Ease of navigation	Positive	"I could easily find the settings"
			Negative	"For the exercise of the day I didn't know where I had to be directly"
	4	Comprehensibility	Positive	"The home button is very clear"
			Negative	"I didn't see the evaluation immediately"
	5	Learnability	Positive	"I didn't find the app that complicated"
			Negative	"I found the overview… I didn't immediately get it"
	6	Layout	Positive	"I think it's a good way with the buttons on the bottom which stay the whole time"
			Negative	"I would find it more logical if the evaluation would come after the exercise and not directly on the home screen"

4. Results

First of all, the survey results will be presented to give an overview of how participants rated the tasks and other various aspects of the application. The two groups are compared to see if there are any notable differences, and also the frequency of the smartphone use of the participants is taken into account. It continues with the analysis of the interviews by means of the codes from the codebook.

4.1 Comparison multi-layered and regular interface

Difficulty of tasks

Task 3 (select Kristina as a coach) was rated as the easiest for both groups, and task 5 (go to the exercise of the day) and 6 (fill in the evaluation of the day) as the most difficult. An overview of the rating of each task can be found in figure 4.1. Overall, group 2 who used the introduction version rated the tasks on average slightly easier than group 1.

Figure 4.1

Difficulty of tasks
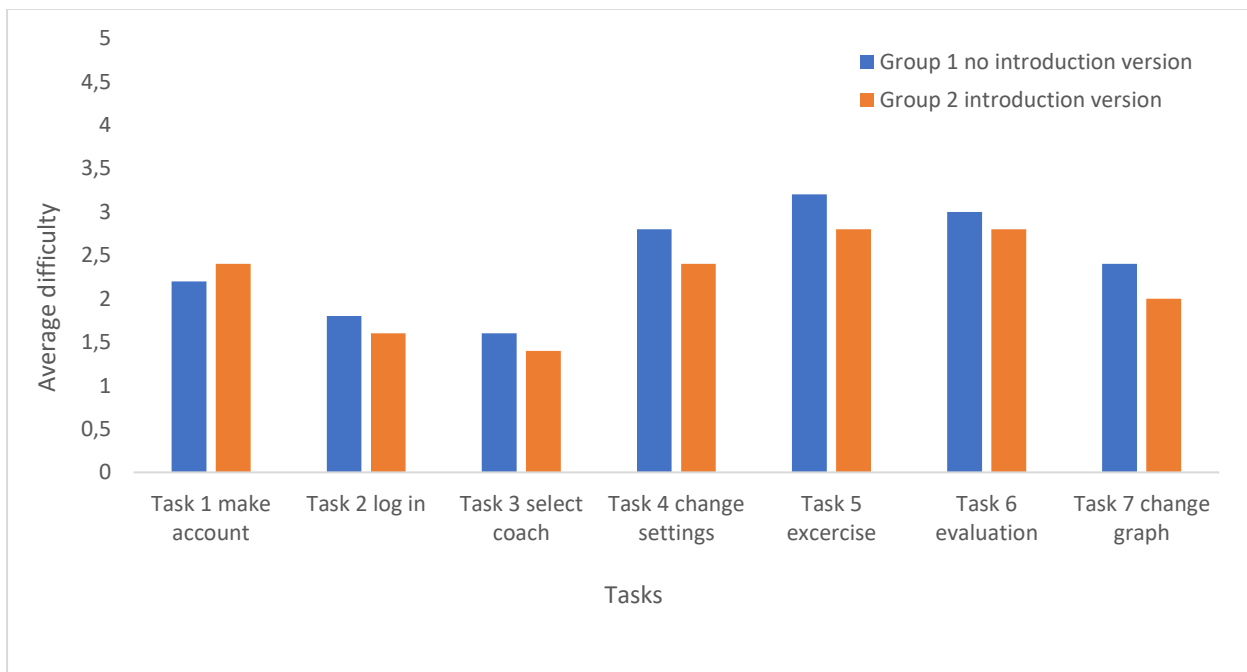
Note. Rating of the tasks, 1 being easy and 5 being hard

For the other six questions, the largest difference in results between the groups was with the statement "I feel like I have mastered using the app". A comparison of the two groups between the average outcomes of the survey questions can be found in table 4.1. On the scale of 1 being fully agree and 5 fully disagree, group 2 who used the introduction version had an average of 2.8, for the other group it

was 3.4. The application was also rated slightly easier to learn according to participants from group 2. The average of group 1 was 3 and for group 2 it was 2,6. Looking at the questions regarding user experience, there were no large difference to the question "The activity coach app is pleasant to use". Group 1 had an average of 2,4 and group 2 of 2,2.

Table 4.1

Comparison averages survey results between group 1 and 2

Survey questions	Average group 1 no introduction version	Average group 2 introduction version
Using the app was easy (1) to hard (5)	3	2,4
The 3 main buttons were clear (1) to unclear (5)	3,2	3
The screens of the app were linked together in a way that made sense	2,4	2,6
I feel like I have mastered using the app. Agree (1) to disagree (5)	3,4	2,8
The app is easy to learn. Agree (1) to disagree (5)	3	2,6
The app is pleasant to use. Agree (1) to disagree (5)	2,4	2,2
By using the introduction version it was easier to do the tasks later on. Agree (1) to disagree (5)	-	3,2

For the question "by using the introduction version it was easier to do the tasks later on" the results varied. On a scale of 1 being fully agree and 5 fully disagree, the average was 3.2. One participant agreed nor disagreed, two agreed with the statement and two disagreed. In the interview section 4.2 it will be explored why participants think the introduction value has added value or not by analysing the interviews.

Smartphone use participants

In the interviews, participants were asked how often they used their smartphone. This turned out to be between 10 times and 45 times per day. To compare this to the survey results, participants are divided

in 3 categories: using a smartphone 10 to 25 times, between 26 and 35 times and 36 to 45 times. In table 4.2 the average rating of the difficulty of using the application are shown per category. It shows that for these 10 participants, on average the ones that use their smartphone more find it easier to use the application. The number of participants from group 2, who used the introduction version, are also shown. They are not overrepresented in any of the categories, thus it appears that the earlier found differences in task-rating between the two groups are not caused by a difference in frequency of smartphone usage. The differences for "the app is easy to learn" are less apparent.

Table 4.2

Frequency smartphone usage compared to difficulty app rating

	10-25 times per day	26-35 times per day	36-45 times per day
Total number of participants	2	5	3
Participants from group 2 (introduction layer)	1	3	1
Average of "using the app is easy (1) to hard (5)"	3,2	2,7	2,5
Average of "The app is easy to learn." Agree (1) to disagree (5)	3	2,8	2,6

It needs to be emphasized that there is only a small number of participants in this research, thus the aim is not to have quantifiable results. Therefore, the statistically significance is not taken into account. The results provide possible outcomes and insights to look into further but are not generalisable.

4.2 Interviews

This section is divided by parts concerning the introduction layer and parts about the general application. The interview questions can be found in Appendix B.

4.2.1 Introduction layer

The code group introduction layer was used to label all the parts of the interviews that discussed the introduction layer of the application. It consist of the main codes 'would make use of introduction layer' and 'changes and suggestions'. Only participants from group 2 have talked about the introduction layer, however in the interviews it is talked about a lot, resulting in still quite high

number of quotations, 39 times for 'would make use of introduction layer' and 34 times for 'changes and suggestions'.

Would make use of introduction layer

Some participants found it complicated having to open 2 different links to the introduction version and the general application, and thus were negative at this form of the introduction layer. However, when it would be an option that can be turned on and off in the same application, they were more positive about it. Participant 8: *"if it would be an option when you first open the app, I would probably use it".* Out of five participants, three said they would use the introduction version when it was presented to them in a new application, one would maybe use it and one participant would not use it. Participant 9: *"I usually just go on with it and get to using the app immediately, so I would probably skip the introduction".* Two participants mentioned that for a complicated app a simpler introduction version would be helpful, but for the test application they used it would not be necessary. Participant 5: *"Because this app is relatively simple, I don't think it would be necessary".* Three out of five participants mentioned they were positive about the fact that you can click though and use the introduction version. Participant 7: *"because you can go through all screens you can already learn a bit where everything is".*

Changes and suggestions

Several suggestions were made by participants to change the introduction version. Mostly mentioned was adding information in some form, which was mentioned by 4 out of 5 participants. Participant 10: *"it would be nice if you got an overview of what you can do with the app."* Two out of five participants from group 2 said they would like more information on what you can do and what kind of functions the application has. Two participants of group 1 also mentioned this, although they did not use or know about the introduction version. Participant 3 (group 1): *"for example, I wasn't sure how the step counting worked and what else could be done with the smartwatch, I would like to have some more information about what you can do".* Two participants would have liked more guidance and information in the introduction version. For example, participant 6 said: *"I would like it if there was something next to the buttons, just like sometimes on the computer when you hover over something a text appears".* Participant 5 said they would prefer it if there were no things left out in the introduction. *"I'm someone who likes to have an overview so I would prefer if there were not things left out".* They did suggest some more guidance within the app, including its functions.

4.2.2 General application

The code group general application was used to label all the parts of the interviews that discussed the application in general, and not the introduction layer. It consist of ease-of-navigation, comprehensibility, learnability, and layout.

Ease of navigation

Ease of navigation is coded 42 times, and in general slightly more negative (61%) than positive (49%). In group 1 the ease-of-navigation was mentioned more negative (68%) than in group 2 (54%), which used the introduction version of the application. Participant 1 (group 1): *"I couldn't always immediately find where I had to be"*. Participant 3 mentioned: *"I could easily find the settings."* One participant mentioned they did not know at first where to go for the evaluation of the day (task 6), because they did not immediately see the notification on the home screen. Two participants stated that navigating the app was not that difficult since there were not that many screens.

Comprehensibility

As for the comprehensibility, there was no notable difference between the two groups. Overall, it was mentioned around equally positive (48%) and negative (62%) of 39 quotations. Participant 8 mentioned: *"I didn't know how the weekly program worked"*. Another participant also mentioned this, saying that you could not go to the daily exercise from there which was confusing, which is related to the ease-of-navigation. Mentioned multiple times in a positive way was understanding the graph and changing things in the settings. Participant 4: *"I immediately understood how to change the graph"*. Three participants also mentioned the buttons on the bottom of the application, which was also asked about in the survey. The home button was thought of as clear, but the other two less so. For example, participant 6 mentioned: *"the one on the left, it looked kind of like a landmine. I didn't think it was very clear"*. Participant 9 said that *"the overview of exercises that was on the left I would expect more under the right button. That one looks like an overview or calendar"*. This also links to ease-of-navigation, for users who find the buttons less clear it could be more difficult to easily navigate.

Learnability

Most comments about the learnability were positive (40%) or neutral (30%) out of 42 quotations, which corresponds with the results of the survey (see table 4.1). There was no large difference between the two groups. Six participants mentioned positive statements regarding learnability, two participants had negative and three participants neutral statements. Participant 7 said: *"Overall I didn't think the app to be complicated"*. In some cases, the learnability relates to the ease-of-navigation, for example with participant 1: *"I couldn't always immediately find where I had to be",*

*w*hich is also mentioned in the section ease-of-navigation. One other participants also indicated that it sometimes took a while to find something in the application, and it was not that easy to learn. Two participants mentioned that because of a lack of overview it was not that easy to learn to use the application. Participant 2 said*: "I find the overview… you don't get it that fast".*

Lay-out

The layout was not mentioned that much compared to other codes, 16 times in total. These were more negative (71%) than positive (29%). A negative example is of participant 5: *"I think it would be more logical if the evaluation would come after the exercise and is not immediately on the home screen".* In two cases, the layout was linked to ease-of-navigation, for example with participant 2: *"It would be easier to find things in the app if you could go there from the homepage".* Participant 4 positively mentioned: *"I thinks it's a good way to have the buttons on the bottom which stay the whole time".*

5. Discussion

5.1 interpretation of results

The aim of this study was to inquire how a multi-layered app design is evaluated by users and if it is beneficial for improving the learnability and user experience for older adults. Existing literature shows that there is a lack of solutions addressing cognitive issues in the domain of mobile user interfaces. Helping new users to learn their way in an application an introduction layer is a promising way for older adults. Based on user tests with an application mock-up and by analysing the resulting survey and interview data, several insights arise from the study.

First of all, most participants who used the introduction version would also choose to use it for another new application and had a relatively positive attitude towards it. They are mostly positive about the concept of having an introduction layer for an application. There were no indications that implementing an introduction version led to a more positive or negative user experience. Some users said the learnability was improved by the introduction layer, but others indicated that it did not necessarily make performing tasks in the application easier. Thus, for some it can improve the learnability, but not for everyone. Users who first went through the introduction layer did feel more like they had mastered using the application. Whether or not they felt like they had mastered the application more was mainly because they also found it easier to use or if using the introduction could also in general lead to feeling like mastering the app cannot be concluded.

People who used the introduction version rated the tasks slightly easier, indicating as well that it might make using the application easier and increase the learnability. Ease-of- navigation was also mentioned more positively by users who made use of the multi-layered application. These indications regarding learnability are in line with the study of Leung et al. (2010), where users were better able to master tasks when first using an introduction layer. In his research users had to perform tasks in both layers, which is a slightly different approach. When transitioning to the full interface the previously learned tasks were however negatively affected. More information regarding the functionalities of each layer might be helpful, what participants of this study also suggested. About this negative outcome this research does not provide any results however, since users only performed tasks in the full-functionality version of the application.

Another relevant insight is that relatively many users preferred having more information regarding the functionalities and use of the application. In both groups, whether they used the introduction layer or not, there were people who would like to have more information regarding the functionalities and what you can do with the application. Next to information about the functionalities of the application, some users of the multi-layered approach would prefer more guiding information in the application. This relates to the study by Kang et al. (2003), which investigated both the multi-layered approach, and an integrated initial guidance approach. The integrated guidance

approach, which provides 'sticky notes' in an interface with some information, can help users to navigate. The outcome of this study suggests that some users would prefer to use an interface which also has this integrated initial guidance approach.

5.2 practical implications

The findings of this study are relevant when designing an application for older adults or to improve an existing application for older users. Several practical recommendations can be made when designing an interface for older users. First of all, it also becomes clear that some older adults prefer having more information regarding the applications functions. This can be provided before downloading the app, but it would also be beneficial to provide this information when first using the app, or to have an overview page in the application with all functionalities.

For some users it is also beneficial to provide more guidance information within the introduction layer. When using an introduction layer for an application it should be possible to skip it, as some users might want to get using the fully functional application immediately. Since this study was performed with an application mock-up and not a functioning application, the simplified layer was presented as an interactive introduction to get to know the application. In a working application this approach can also be taken, but it could also be a functional layer in which information is saved and the changes that a user makes are kept when transitioning to the full-functionality interface. The appropriate parts of the interface could be added with animated transitions, to help users see what is changing. Also, the Activity Coach application is as of yet not very complex. A multi-layered approach can especially add value for complex interfaces with many or complicated functions.

This study provides more insights in the use of a multi-layered interface approach. By using a qualitative method, it gives an interesting insight in how people perceive an introduction layer and what reasons they might have to perceive it in a positive or negative way. It also contributes a first insight in this approach in a mobile context.

For the Activity Coach application in general there also some practical recommendations for improvement to be concluded from this study, next to the previously mentioned implications. It is recommended to provide an overview screen to go to the different function, for example on the home screen. Also, the evaluation of the day could be placed automatically after doing the exercise. The icon of the button on the left was found unclear and should be changed into a more general icon that found clear by users. The icon on the right is suggested to be used for the exercise overview. Additional information about the application should be provided, especially for the step counting and on how to use and connect to a smartwatch.

5.3 research limitations

One of the limitations of this research is the fact that the participants interacted with the test application on their own without the researcher being present. Although the interviews took place almost directly after participants used the application, it is possible that participants might have already forgotten certain problems they encountered when using the application. The think-aloud method would have been better in this case since it eliminates the possibility of participants forgetting to mention certain things. The think-aloud method was however in this study not usable due to the circumstances of the COVID-19 outbreak. The option of using video calling with screen sharing for 'observing' the tasks and letting participants think aloud was not deemed suitable for this study, since it makes the whole process a lot more complex. Participants would have to share their screen and at the same time perform tasks. Especially for older adults this may have been too much and would have hindered the study.

Secondly, the research participant might not be representative of the population. All participants were older adults, but there were no measures taken to make sure they had diverse backgrounds, such as education. Also, the test application was not fully finished. Therefore, less screens were available, and it was less extensive than a finished application would be. Especially because the multi-layered approach mainly benefits learning to navigate an application, in this case multi-layering might not have been studied to its full extent. A limitation of the survey is that there are not enough participants to provide reliable results that are generalisable for older adults as a whole.

5.4 recommendations for further research

As is one of the outcome suggestions of this research, more research should be conducted into a multi-layered interface with additional information to guide users in the introduction layer. A comparison between those two would provide valuable insights. Also, there has not been done any larger scale research into this topic. A large-scale survey that measures the usability and user experience would provide more quantitative data for this topic. Preferably after a qualitative study designing an introduction layer to an application taking feedback from users into account. A more complex interface could be used where a multi-layered approach can add more value, and it could also be compared to a less complex interface. It is also advised to do more research into the user experience of multi-layered interface, which is as of yet understudied compared to usability, which also had more of a focus in this research.

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Appendix A: Participant message and task list

Groep 1:

Bedankt dat u wilt meewerken aan dit onderzoek! U kunt op elk moment stoppen met het onderzoek, en hoeft geen uitleg te geven waarom u bent gestopt en er zullen ook geen consequenties zijn.

Het onderzoek betreft het gebruiken een mobiele app ter bevordering van een gezonde levensstijl. U krijgt een link naar de testversie van de app, waarin u een aantal taken moet uitvoeren. De app hoeft u dus niet te downloaden. U hoeft ook geen eigen gegevens in te vullen omdat het geen echt werkende app is.

Deze vragenlijst maakt u op een computer of laptop, en de link naar de app opent u op uw smartphone. Zo kunt u tegelijkertijd de app gebruiken en deze vragenlijst invullen.

U krijgt straks telkens een taak om uit te voeren in de app, en daarna een vraag hoe makkelijk of moeilijk dit ging. Na het invullen van alle vragen volgt het interview dat van tevoren afgesproken is. Het interview zal worden opgenomen om de uitkomsten te verwerken, de opname zal daarna verwijderd worden.

Het doel van het onderzoek is om de app te testen en te verbeteren, en niet hoe handig u met een smartphone bent.

vervolg

De Activity Coach app heeft als doel een gezonde levensstijl te bevorderen, onder andere door lichamelijke oefeningen aan te bieden. De app kan verbonden worden met een slim horloge om bijvoorbeeld het aantal stappen te tellen. In de app zit een virtuele coach voor ondersteuning.

De link naar de testversie van de Activity Coach app vindt u onderaan.

Deze opent u op uw smartphone. Hiervoor opent u deze vragenlijst die u via de mail heeft gekregen ook op uw smartphone en klikt door tot u bij dit scherm komt met de link.

De app is nog in ontwikkeling, in deze testversie kunt u doorklikken zoals in een echte app. De meeste onderdelen werken, maar bij een aantal dingen kunt u merken dat u niet door kunt klikken, deze zijn nog niet ontwikkeld. De taken die gegeven worden zijn wel allemaal uitvoerbaar.

Het is niet mogelijk om dingen in te typen. In sommige gevallen, zoals bij het inloggen, moet u iets intypen in een tekstvakje. Als u op het tekstvakje klikt zal er automatisch tekst verschijnen.

Indien u vragen heeft of er iets niet lukt met bijvoorbeeld het openen van de testapp, aarzel niet om contact op te nemen met de onderzoeker. Het is niet erg als er een taak niet lukt of als u iets niet kunt

vinden in de app. Dit onderzoek is juist bedoeld om onduidelijkheden te verbeteren, dit kunt u later toelichten in het interview.

Groep 2:

Bedankt dat u wilt meewerken aan dit onderzoek! U kunt op elk moment stoppen met het onderzoek, en hoeft geen uitleg te geven waarom u bent gestopt en er zullen ook geen consequenties zijn.

Het onderzoek betreft het gebruiken een mobiele app ter bevordering van een gezonde levensstijl. Eerst krijgt u een introductieversie van de app, waarin u even rondkijkt om de app te leren kennen.

Daarna krijgt u de volledige testversie van de app, waarin u een aantal taken moet uitvoeren. Deze hoeft u beide niet te downloaden, u ontvangt een link. U hoeft ook geen eigen gegevens in te vullen omdat het geen echt werkende app is.

Na het invullen van deze vragenlijst volgt het interview dat van tevoren afgesproken is. Het interview zal worden opgenomen om de uitkomsten te verwerken, de opname zal daarna verwijderd worden.

Het doel van het onderzoek is om de app te testen en te verbeteren, en niet hoe handig u met een smartphone bent.

Vervolg

De Activity Coach app heeft als doel een gezonde levensstijl te bevorderen, onder andere door lichamelijke oefeningen aan te bieden. De app kan verbonden worden met een slim horloge om bijvoorbeeld het aantal stappen te tellen. In de app zit een virtuele coach voor ondersteuning.

De link naar de introductieversie van de Activity Coach app vindt u onderaan.

Deze opent u op uw smartphone. Hiervoor opent u deze vragenlijst die u via de mail heeft gekregen ook op uw smartphone en klikt door tot u bij dit scherm komt met de link.

De app is nog in ontwikkeling, in deze testversie kunt u doorklikken zoals in een echte app. Het is niet mogelijk om dingen in te typen. In sommige gevallen, zoals bij het inloggen moet

u iets intypen in een tekstvakje. Als u op het tekstvakje klikt zal er automatisch tekst verschijnen.

Als u de link opent moet u eerst inloggen, bij klikken verschijnt er een naam en wachtwoord. Neem dan een paar minuten (maximaal 5) om door de app te navigeren en de app te leren kennen. Hierna kunt u doorgaan naar het volgende scherm van deze vragenlijst.

Vervolg

De introductieversie van de app kunt u nu afsluiten, u hebt deze niet meer nodig.

Als volgende krijgt u de uitgebreide testversie van de app, de link is onderaan te vinden.

U krijgt straks telkens een taak om uit te voeren in de app, en daarna een vraag hoe makkelijk of moeilijk dit ging.

Voor deze testversie geldt hetzelfde als de vorige, u kunt doorklikken zoals in een echte app, maar geen dingen intypen. Als u op een tekstvakje klikt zal er automatisch tekst verschijnen. De app is nog in ontwikkeling.

De meeste onderdelen werken, maar bij een aantal dingen kunt u merken dat u niet door kunt klikken, deze zijn nog niet ontwikkeld. De taken die gegeven worden zijn wel allemaal uitvoerbaar.

Indien u vragen heeft of er iets niet lukt met bijvoorbeeld het openen van de testapp, aarzel niet om contact op te nemen met de onderzoeker. Het is niet erg als er een taak niet lukt of als u iets niet kunt vinden in de app. Dit onderzoek is juist bedoeld om onduidelijkheden te verbeteren, dit kunt u later toelichten in het interview.

Taken:

1. Maak een account aan
2. Log in bij de Activity Coach app
3. Kies als coach Kristina
4. Verander in de instellingen het geslacht en wis de geboortedatum
5. Ga naar de oefening voor vandaag en 'voltooi' deze
6. Voltooi de evaluatie van deze dag
7. Verander de weergave van de grafiek van het stappentellen naar wekelijks

Appendix B: Interview question list

Achtergrondvragen voor alle deelnemers:

- Heeft u een smartphone?
    - o Waar gebruikt u deze voor, en hoe vaak per dag?
- Installeert u weleens nieuwe apps op uw telefoon?
    - o Vind u het dan weleens lastig om deze te leren gebruiken?

Vragen beide groepen:

- Hoe ging het uitvoeren van de taken?
    - o Liep u ergens vast of kwam u problemen tegen?
- Kon u alles makkelijk vinden in de app?
- Heeft u verbeteringen voor de app?

Vragen groep (1/2):

- Vind u dat de simpele versie toegevoegde waarde heeft om de app te leren kennen? (schaal van 1 tot …?)
- Wat vond u van de simpele versie?
- Zou u iets weggelaten of toegevoegd hebben aan de simpele versie?
- Zou u als u een nieuwe onbekende app installeert gebruik maken van een simpele versie om de app makkelijker te leren gebruiken?

Appendix C: Survey questions

- Taak 1: Maak een account aan
- Taak 2: Log in bij de Activity Coach app
- Taak 3: Kies als coach Kristina
- Taak 4: Verander in de instellingen het geslacht en wis de geboortedatum
- Taak 5: Ga naar de oefening voor vandaag en 'voltooi' deze
- Taak 6: Voltooi de evaluatie van deze dag
- Taak 7: Verander de weergave van de grafiek van het stappentellen naar wekelijks

Deze taak vond ik:

Makkelijk   O   O   O   O   O   Moeilijk

Het gebruiken van de app vond ik:

Makkelijk   O   O   O   O   O   Moeilijk

De drie hoofdknoppen (onderaan) vond ik:

Duidelijk   O   O   O   O   O   Onduidelijk

De schermen van de app waren logisch met elkaar verbonden

Helemaal mee eens   O   O   O   O   O   Helemaal mee oneens

In hoeverre bent u het eens met de volgende uitspraken?

Ik heb het gevoel dat ik het gebruiken van de app onder controle heb

Helemaal mee eens   O   O   O   O   O   Helemaal mee oneens

De Activity Coach app is makkelijk om te leren gebruiken

Helemaal mee eens   O   O   O   O   O   Helemaal mee oneens

De Activity Coach app is fijn in gebruik

Helemaal mee eens   O   O   O   O   O   Helemaal mee oneens

Aanvullende vraag groep 2:

Door de simpele versie van de app eerst te gebruiken was het makkelijker om later de taken uit te voeren

Helemaal mee eens   O   O   O   O   O   Helemaal mee oneens

Appendix D: Screens activity coach application

WELKOM BIJ DE
ACTIVITY COACH!

INLOGGEN

Nog geen account?

MAAK ACCOUNT

VANDAAG, 21 APR 2020

Kristina:
Er wacht een nieuwe evaluatie!
Wil je de vragenlijst nu beginnen?

LEES MEER

| M 20 | D 21 | W 22 | D 23 | V 24 | Z 25 | Z 26 | M 27 |

Oefeningen
3 / 12

TIP!
Doe de oefeningen op een vast moment
van de dag, bijvoorbeeld na het opstaan
of voor je gaat slapen. Hierdoor bouw je
een ritme op.

BEGIN MET OEFENEN

Selecteer je coach
Met wie wil je aan je gezondheid werken?

Kristina   Johan   Marga

Karel   Laura   Thomas

GA VERDER

**6-WEEKS
OEFENPROGRAMMA**

Week 1: Warmlopen

• Training A	21 feb 2020	✓
• Training B	28 feb 2020	✓
• Training C	29 feb 2020	✓

Week 2: Op stoom

• Training A	21 feb 2020	✓
• Training B	28 feb 2020	✓
• Training C	29 feb 2020	✓

Week 3:

◀ VANDAAG, 21 APR 2020

Stappen
5 000 / 10 000

⚙ VERANDER DOEL

Overzicht:
21.04.2020

PER DAG ▾

6 000 stappen

TOTAAL: 5 000

4 000

2 000

06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00 02:00 04:00
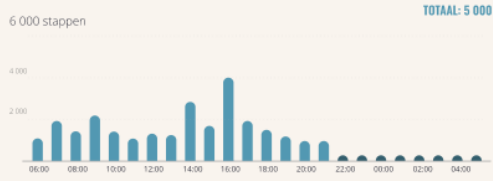
○ Dag   ○ Nacht   ● 24 uur

⏱   🏠   📅

← **⚙ Instellingen**   🔔

| 👤 | Persoonlijke gegevens
C. De Vries | ▶ |

| 👣 | Stappen tellen | ▶ |

| ⚖ | Gewicht | ▶ |

| ✏ | Vragenlijst | ▶ |

| 🔔 | Notificaties | ▶ |

⏱   🏠   📅

Appendix E: Literature study log

1. Research questions literature study

- What is usability?
- What is user experience?
- What is important in user design for elderly?
- What are multi-layered interface and what did other studies find in this subject?

2. Criteria preferred materials

The preferred materials for this literature study were scientific books and articles, preferably in English. More recent studies were preferred, but also some older research was used.

3. Selected databases

The databases that were used are Scopus, Google Scholar and Web of Science. These all provide multi-disciplinary research and give a broad overview global scientific research.

4. Relevant terms

Concepts	Related terms	Smaller terms	Broader term
Usability	Usage, ease-of-use, ease-of-navigation	Learnability	User experience
User experience	Attitude, perception	Satisfaction	
Multi-layered interface	Mobile interface, application, layering	Multi-layered interface	User design
Elderly	Older users	Older adults	Users

Search actions

	Date	Database	Search action + search technique	Total hits
1	27-02-20	Scopus	TITLE-ABS-KEY (usability AND mobile AND interface) Limited subject area to social sciences	301
2	02-03-20	Scopus	TITLE-ABS-KEY (usability AND mobile AND interface AND elderly)	128

3	06-03-20	Google Scholar	multi-layered AND interface AND elderly	9710
4	06-03-20	Web of Science	TOPIC: (user AND design AND elderly)	479
5	13-03-20	Scopus	TITLE-ABS-KEY (usability AND elderly AND "literature review")	30
6	19-03-20	Scopus	TITLE-ABS-KEY ("user experience" AND mobile AND application) Limited to subject area social sciences	271
7	21-03-20	Scopus	TITLE-ABS-KEY (mobile AND usability AND evaluation AND testing AND method)	221
8	26-03-20	Scopus	TITLE-ABS-KEY (usability AND issues AND mobile AND user AND interface)	419
9	02-04-20	Google Scholar	Mobile AND application AND user AND design AND elderly	136.000
10	15-04-20	Scopus	TITLE-ABS-KEY (learnability AND mobile AND interface AND elderly)	11

5. Reflection

I started broader with different search terms to find relevant search terms and to orient myself on the research subject. This was helpful in specifying my searches more later on. On some occasions I limited the subject area to social sciences because there were a lot of results from other field, when filtering those out I did find relevant literature. When I found relevant articles, I looked a lot at their reference list and related articles from Scopus and used this 'snowballing' technique to find other sources. Especially for the quite specific topic of multi-layered interfaces this is how I found most articles. I also received some literature articles from my supervisor Silke ter Stal about user interfaces and research methods, which was helpful. The literature searching could have been more structured, in the future I would bring more structure and try more different search strings.