Developing a Life-Storybook-Application for people with dementia

Bachelor thesis
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Abstract

This thesis investigates on a specific tool for people with dementia that can help them to preserve memories. This tool is called life storybook and is similar to a photo album. More particularly, in this thesis it is tried to find out whether making a life storybook digital can enhance its user experience for people with dementia. At first it might seem rather contradictory that making a book digital for people who struggle with little daily-life-activities and are not used to technology can achieve an improvement in any way. Research however shows that technology is going to play an important role in dementia care in the future. That is because recent developments like our ageing society and elderly wanting to live longer at home require health care to adapt to these changes. The main pillar in this restructuring process is technology due to its possibilities. Additionally, these possibilities offer new ways to dementia treatment methods, in particular to the ones that include multi sensory stimulations which have been found to be especially effective. Subsequently, a digital life storybook could stimulate more senses of the user than only a book. If this and what else contributes to a better user experience was investigated by designing and developing a 'life-storybook-application'.

This process happened in two steps. First a LoFi-prototype was created and tested. In this phase the prototype was not fully functional yet, which is why the testing was aimed at its usability. Next to that, an interview was conducted collecting information about people with dementia in general. With the results of both, the testing and the interview, the first part of the answer to the research question could be formulated: for the life-storybook-application to be able to enhance the user experience it has to be usable by elderly. This concretely means that its design has to be simple, intuitive and consistent. Furthermore it was found that it should preferably be designed as book. It is important, that buttons and the font size are big enough and it should always be clear what the user can do, i.e. if something is clickable or not. In general, it is crucial to limit the options.

In the second step the prototype was realized by being programmed as complete and functional application, which was then evaluated in a second user test. This time, the focus was put on its functionality and content. The content included screens showing photos with a voice recording, a video and photos with a song. The main goals were to find out which combination of media is considered to be most stimulating and whether the participant is able to perform a basic interaction with the application, which is to add content to it. Answers to these questions were obtained by observing the participant testing the application and through an interview, that was meant to clarify, testify and complement the observations. Additional information was collected with a questionnaire providing quantitative data and therefore another perspective to the results. The main findings were that participants struggled with adding content to the application and that all combinations of media were considered to be stimulating with the remark that for voice recordings that is only the case if the voice is familiar. That way, it is shown that with multimedia, more ways of stimulating can be provided as with a conventional life storybook. In conclusion, digitising a life storybook enhances its user experience due to the different combinations of media that can be included, given that it is user friendly for people with dementia.

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1 Introduction

Dementia is a widely spread and well-known disease. Characterized by the deterioration of cognitive functions affecting the memory, thinking, orientation, comprehension etc., dementia is a progressive disease accompanied by neuropsychiatric symptoms like depression and anxiety (Huang et al., 2015 and Elfrink et al., 2017). The effects of dementia cause a lot of difficulties and challenges, especially in an ageing society. Worldwide, around 50 million people are affected by dementia, where 60 to 70 percent of the cases is Alzheimer, the most common form of dementia (World Health Organisation, 2015).

1.1 Motivation

Dementia leads to dramatic changes not only in the affected person's life but also in the lives of their relatives. The deterioration of cognitive functions strongly affects the ability to communicate and with it the capacity to maintain relationships. This can cause frustration and complications on both sides (Crispi & Heitner, 2008). The person with dementia feels disempowered and side-lined and their family is heartbroken from the loss of the person the patient used to be and struggles from the burden that comes with taking care of the patient. Even given poor interactions with a lot of effort and little success, the family usually stays motivated to be in contact with and care for the person. This shows, how much there is a need for methods or programs that assist family members trying to maintain a good relationship with the person with dementia and to maximize the well-being of everyone involved. This issue does not only exist between the person with dementia and their relatives, but also between demented people and their caregivers. According to Bruce and Schweitzer (2008), in current care situations, there can sometimes be observed a 'malignant social psychology', which means the caregivers' tendency to depersonalize and disempower people with dementia. This does not happen out of malice, but because they unconsciously neglect the patients' needs or feelings. These circumstances are described in more detail by the four personal detractions: outpacing, infantilization, treachery and ignorance (Bruce and Schweitzer, 2008). On the other side, Brooker (2004) presents his 'VIPS framework', that has the opposite effect and helps counteracting the 'malignant social psychology'. VIPS abbreviates the principles Valuing people, treating them as Individuals, looking at the world from their Perspective and setting up a supportive Social environment. These build the core of a person-centred health care approach and are the reason why this approach is so essential. It enables high quality care since its focus is on the personhood of the patient. Therefore, recent developments go towards a person-centered, individual health care approach (Edvardsson, Winblad & Sandman, 2008).

1.2 Goal

Considering the question how to treat dementia, one of the methods that corresponds to the person-centred care approach is a psychosocial and cognitive based intervention called reminiscence therapy. The reason for this is that this therapy focuses on the individual and their personal history by also taking into account their emotions and relationships. That way, the person behind the patient becomes apparent and is taken care of. Reminiscence therapy is only

one of many existing interventions. They have to be differentiated between drug- and non-drug-treatments. The latter are treating people with dementia with all kinds of therapies, e.g. Cognitive Stimulation Therapy, Speech therapy, music therapy or aromatherapy. They will be elaborated on in more detail in the following chapter.

In reminiscence therapy memories are triggered by discussing the past of a person and using tangibles prompts like photos or items (Subramaniam and Woods, 2012). Part of the type of reminiscence therapy that focuses on the individual's life with specific memory triggers is a method called 'Life Review process'. As the name suggests, it works through an individual's personal history in chronological order, while the goal is to get the participant involved into conversations about their lives with caregivers and relatives. This process can result in producing a Life storybook, that captures the discussed memories and makes them easy to recall whenever desired. It includes the history of an individual in chronological order with pictures, captions and personal memorabilia. The use of such Life storybooks has been evaluated in many earlier studies and there has been found evidence of their beneficial effects on demented people (Subramaniam & Woods, 2012; Pieper, 2017; Mohamed, 2017; Elfrink et al, 2017).

Since this technique works well and there will be a need for more and more various solutions to dementia treatment in the future, new improved ways based on Life storybooks are being explored. Considering the advances of technology and its increasing acceptance among the elderly, the idea comes up to integrate technology into Life storybooks. Fields in information and communication technology (ICT) are becoming increasingly more popular and also the older generation starts to feel comfortable and motivated using technological devices (Abu Hashim, et al., 2015). Another reason for making the step of digitising the conventional life storybook is the great potential a digital version brings with itself, like multimedia, interaction and easier usage. Goal of this research is to evaluate the combination of ICT and life storybooks in more detail. In order to do so, first a general overview over existing treatment methods will be given and then the technique of creating a Life storybook will be investigated. Finally, digital life storybooks will be introduced and it will be presented in what way they are advantageous over the conventional versions.

The research question is, how the digitalisation of a life storybook can enhance its user experience for people with dementia. It will be answered by realizing and testing a new type of digital life storybook in form of an application.

2 Background

2.1 State of the Art

2.1.1 Non-pharmacological treatment methods

As already pointed out, dementia can be treated in several ways. Pharmacological treatments are commonly applied, however, they can cause unwanted side effects and have limitations. These limitations come from the fact, that drugs can only address the biological dimensions of dementia, while social and emotional needs remain unattended. Considering that non-drug treatments can meet these needs and also the demand for alternative ways of treating dementia, they establish an attractive opportunity to restructure the care of demented people. The range of non-pharmacological methods is rather large. The Cognitive Stimulation Therapy targets the cognitive and social functions by triggering the participants to generate opinions and to create new semantic links. This has positive effects on the word list memory and resulted in an increased ability to make oneself understood (Orrell & Woods, 2010). Furthermore, it has been found that the participation in cognitive leisure activities like reading, writing, doing crossword puzzles or playing an instrument can reduce the risk of dementia (Verghese et al, 2003).

Non-pharmacological sessions also sometimes include speech therapy or physiotherapy, which stabilize behavioral symptoms (Jost et al, 2007). A therapy that addresses, opposed to the already presented methods, a side effect of dementia, which is agitation, is aromatherapy. Lavender is used to alleviate agitated and disturbing behaviour and to promote sleep (Wan-ki Lin et al, 2007). Music therapy improves the performance on speech content and fluency dimension of spontaneous speech (Brotons & Koger, 2000). As part of music therapy, an instrument has been developed similar to a harp, that is supposed to spread healing vibrations and deliver pleasant experiences to the user. It promotes non-verbal communication and that way it can have an effect on people even with severe dementia. Besides instruments, there are also other tools available that combine multiple senses, like for example the ‘Tovertafel’, which is a box projecting visual effects on the surface of a table including sound (Tovertafel, 2018). The goal is to have patients respond to that, to integrate them into social interaction and to stimulate physical and cognitive activity. A similar product is the ‘BelevenisTafel’ that wants participants to be engaged together with others in games or tasks (Belevenistafel.nl, 2018).

Figure 1:
top left: music therapy,
top right: the 'Tovertafel',
bottom: the 'BelevenisTafel'

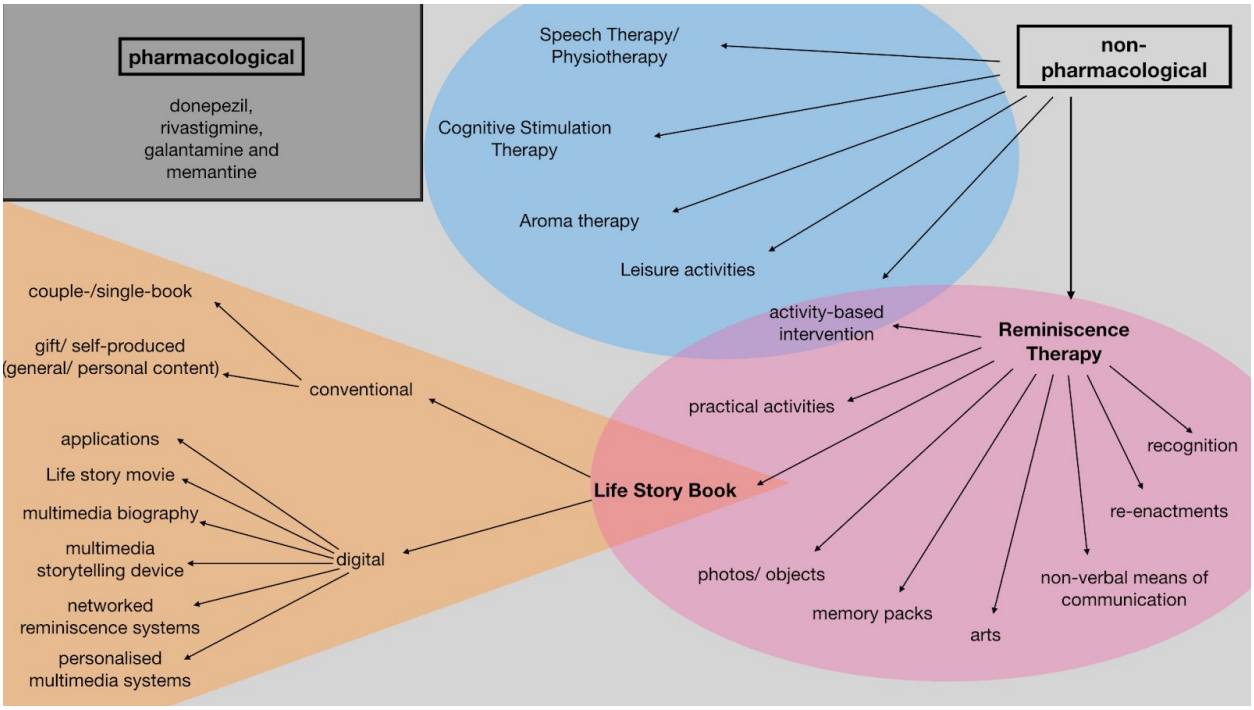


Figure 2: overview over treatment methods for dementia

2.1.2. Reminiscence Therapy

Another kind of non-pharmacological treatment is the Reminiscence therapy. As already mentioned earlier, Reminiscence therapy involves the process of recalling the past using artifacts to trigger memories and conversations. It is aimed at the autobiographical memory and supposed to encourage conversations in individual sessions or groups. The reasoning behind this idea is the fact that demented people's autobiographical memory system stays intact for a relatively long time and in reminiscence therapy it is used to recover and maintain as many memories as possible (Caddell L & Clare L., 2010). Other beneficial effects are the preservation of self-esteem, improved well-being, mood, social interaction and cognitive functions as well as reduced depressive symptoms (Subramaniam & Woods, 2012).

As previously stated, Reminiscence Therapy suits a person-centred health care approach, but in what way is Reminiscence Therapy predominating over other strategies? One of the main issues with dementia is to keep a good relationship to the person with dementia. Fundamental requirements to achieve that are understanding and respect - two conditions that are most effectively promoted by Reminiscence Therapy. Furthermore, with its multiple variations it can be used with people with varying levels of cognition (Lazar et al, 2014).There are different ways to carry out reminiscence therapy. It can be based on sharing memories with others using general memory triggers. This option serves more a narrative and informative purpose, while another type of reminiscence work focuses on the individual's life with the help of specific memory triggers and has an integrative function (Subramaniam & Woods, 2012).

2.1.3 Methods and tools in Reminiscence Therapy

Memory triggers can not only be photographs or personal belongings from the past, but also objects like products, posters or packaging from back in the days can also serve this purpose. This idea was picked up by Nestlè, who created a 'Reminiscence pack' including historical packaging like tin labels, chocolate boxes and posters. Similar to that, there are various types of packs online, that consist of material according to different themes, e.g. the '1960s pack' which has model cars, collector styled cards, Action Man etc. in it or the 'DIY pack' meant to bring back memories about everyday activities. Something special among these packs is the 'geur box', that instead of products includes typical smells from back in the days, like apple pie or green soap. These smells can be used to evoke memories and initiate a conversation. A rather simple idea is the 'Conversation Card' suggesting various conversation topics.

An important aspect that has to be kept in mind when doing reminiscence work is the fact that people with dementia might remember, but are not able to express themselves in words. In that case, different means have to be found in order for the memories to not get lost. One way is to invite them to show how something was done or what it was like (Schweitzer and Bruce, 2008). In general, the idea is to address as many senses as possible. If the patient is confronted with a familiar object, it does not only see its shape, but can feel its weight and texture. An interesting observation has been made by Schweitzer and Bruce (2008) who found that one patient was not able to explain how to operate a typing machine, however, had no troubles using it when having direct access to one. This suggest, that the body has its own memory, which should be made use of whenever possible, by providing the patients with the

according settings. Similarly, memories can be evoked by re-enactments of for example a wedding. By creating an environment that represents the corresponding event from the past and pretending it happened again in the here and now, patients are set back to the point in time of the actual event and might be reminded of what it was like. A reminiscence approach that also does not solely focus on conversations is to perform physical activities together, like singing, dancing or cooking (Schweitzer & Bruce, 2008).

2.1.4 Reminiscence Therapy and arts

Another powerful component in Reminiscence Therapy can be the use of arts. The theory that motivates arts based interventions is explained by Kitwood (1997). According to him, there is a conflict between the fragmentary, confused and emotive language that characterizes dementia and the structured talk that occurs most frequently in care institutions. Arts can bridge that gap by offering an alternative way of self-expression.

With respect to reminiscence, poetry can be particularly useful. Gregory (2011) describes how a poet can work together with a person with dementia to encourage conversations and trigger memories. In the first step of the session, the poet tries to get the patient to talk as much as possible about their experiences or past events and takes notes. Later, the poet transforms these notes into a poem, that he then performs in front of the patient. By listening to their own stories, the patient feels confirmed and their imagination is encouraged.

Next to poetry, also other forms of arts can be used, not only within reminiscence therapy. Music, dance and visual arts offer more than engaging patients into actions and conversations. They enable more options for self-expression and that way can give patients feelings of empowerment and control. That, in return, restores their dignity and personhood and makes them experience an identity next to that of the patient (Gregory, 2011).

2.1.5 The ‘Life Review Process’

Going back to Reminiscence Therapy, its fundamental idea which is recalling the past is reflected in the already presented method called ‘Life Review Process’. By going through the patient’s life in chronological order, conversations can be stimulated and memories evoked. As a result of this process, a Life storybook can be created, which is a visualized version capturing the most important scenes of the person’s life (Subramaniam & Woods, 2012). More detailed information about Life story books will be given in the following chapter.

2.2 Life storybooks

2.2.1 Content and production

A popular strategy in reminiscence therapy is the production of a life storybook, which is obtained as the result of the life review process. It represents a personal, illustrated record of an individual’s history. Its content consists of pictures, captions and memorabilia like cards, newspaper clippings or wedding vows (Ingersoll-Dayton et al., 2013). There is no limit set to the range of items the content could include, however, according to Haight et al. (2003) it should be something that the participant, that is the person with dementia, approves. Determining what is

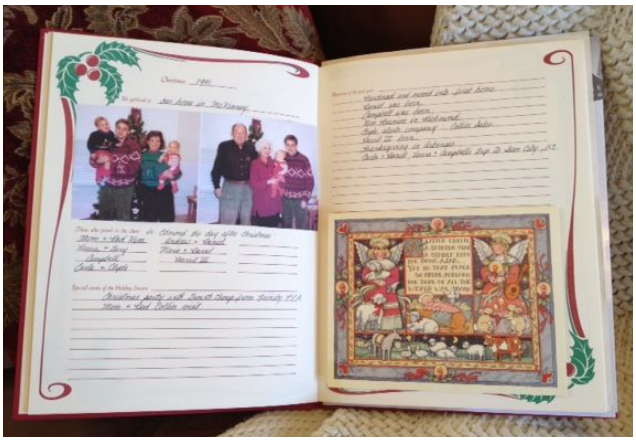


Figure 3: a conventional life storybook

going to be part of the life storybook refers to its development, which can be approached in two different ways. Subramaniam and Woods (2016) present the participatory design, which means the participation of the demented person either in the complete process or only in selected steps. Opposed to that, the other way of developing a life storybook is independent of the demented person and executed by care staff or relatives, who then present the book as a gift to the patient. While Subramaniam, Woods, & Whitaker (2013) came to the conclusion that either of the two different pathways have benefits, Haight et al. (2003) point out that the participatory design gives better results since it is crucial for its effectiveness to create the life storybook as the patient's own story, which can be more easily achieved having them involved in the development. In that case, caregivers and family members take on a guiding and assisting role throughout the process. From that, the need for training, supervision and education of the staff follows (Pieper, 2017).

2.2.2 Motivation (goal)

Hence, what makes a life storybook attractive? A more abstract reason for its popularity is the fact that it meets the recent changes in the care system: the trend goes towards patients staying longer at their home, instead of moving into nursing homes. Health care should be adapted to this change by shifting it towards a person-centred care, that focuses on the individual's unique life story (Pieper, 2017). Exactly these requirements are covered by the production of a life storybook. However, to actually value its utility, its effects have to be addressed. Before listing those, the types of measures used for interpreting the results of a life storybook correctly, will be presented.

2.2.3 Measures

Part of the research on life storybooks was also dedicated to what ways of measuring their effects are there. This can be challenging since the effects are often so called 'soft measurements' meaning that they refer to data that cannot easily be expressed in number, e.g. emotions. The following will give a short overview over methods that have been used by other studies.

In general, data can be gathered with the help of questionnaires, follow-up assessments, feedback and observations. Apart from that, according to Subramanian and Woods (2016) measures can be divided into qualitative and quantitative ones. Latter are mostly expressed by scales indicating the person's state with respect to different factors of well-being, like the quality of life (QOL-AD), the personal semantic schedule (PSS) and autobiographical incident schedule (AIS) concerning the autobiographical memory interview (AMI), the geriatric depression scale (GDS-12R) and the quality of caregiving relationship questionnaire (QCPR). Qualitative

measures, on the other hand are established through open-ended questions or verbal interviews. For this project, data will be collected mostly through verbal interviews. This measure was chosen over the quantitative measures since these require people with dementia who will not be recruited for this study for ethical reasons. Instead, interviews will be held with caregivers, experts and volunteers.

2.2.4 Effects

The effects of a life storybook have to be differentiated depending on the party affected by them. There are three different parties involved in the process of creating a life storybook: the demented person, referred to as participant, their family members and care staff. A mutual effect, that applies to everyone concerned, is the improvement of the relationships among them (Pieper, 2017). For the participants, this can be derived from the fact that a life storybook encourages them to more conversations and interactions. This goes along with positive changes in their behaviour (Lazar et al, 2014).

The most highlighted effect for participants, however, is the improvement of their autobiographical memory (Subramaniam & Woods, 2012). That, in turn, entails a better well-being in general, since participants are more content about and feel proud of their lives and feel strengthened in their identity (Woods et al., 2005). Also connected to that, is the increase of cognitive functions. Overall, this results in an improved quality of life because of these positive emotions and feelings of being understood, integrated and valued.

Furthermore, which could be referred to as one of the main goals, life storybooks make it possible to delay institutionalization (Haight et al., 2003). This refers back to the current trend in dementia care of patients being taken care of at home instead of in care institutions. The treatment method including life story books match with this change since it can be applied by family members and is geared towards an individual one-on-one therapy. As a result, people with dementia can stay at their home longer before having to move into nursing homes.

Next to these positive effects, life storybooks can also evoke sadness since some memories might not be pleasant (Mohamed, 2017). The caregivers on the other side, can provide a more individualized care, because they can see the person behind the patient, which helps them to uphold the patients' personhood, understand them better and to enhance communication (Woods et al., 2005). Similar effects can be noticed on the relatives' side. They also profit from the effects a life storybook has on the participants since it makes it easier for them to understand and communicate. Next to that, they also experience positive emotions just by witnessing the participant's improvements (Subramaniam & Woods, 2016).

2.2.5 Drawbacks

From what has been presented up until now, one might suggest that the creation of life storybooks only comes with benefits. By investigating further, however, it becomes clear that this assumption does not hold true. There are multiple issues arising, e.g. private unwanted disclosure as a result of dealing with very personal information (Mckeown et al, 2013). Another drawback, indicated by Haight (2006) and Subramaniam & Woods (2012), lies within the complexity of this process. It is explained how due to the patients' cognitive impairment, running through a life storybook process can be very demanding.

Furthermore, Morgan and Woods (2010) also point out that the process might lack flexibility, that is needed since not every patient is able to proceed at the same speed. Subramaniam and Woods (2012) support that assumption by finding that the degree of success of a life storybook can be varying according to the participant's condition. The complexity of the process does not only affect the participants, but also the caregivers. Therefore, Pieper (2017) suggests that special training and supervision by the staff is required. In addition to that, Subramaniam and Woods (2012) mention that the life storybook process can be very time-consuming and needs a lot of planning and organization. As a consequence of this, a requirement is, that only people with mild to moderate dementia are able to participate and and their family members should be involved as well.

2.2.6 Introducing Digital Life story books

Now, that conventional life storybooks have been presented, their 'next generation' is going to be introduced, the digital life storybook. Digital life storybooks exist in all kinds of forms, e.g. as multimedia biography, storytelling device, networked reminiscence system, life stories using lifelogging entities or simply as movies (Subramaniam and Woods, 2016). Whatever type is chosen, the basis is usually established by the conventional life storybook. Then it is up to the individual approach, whether the life storybook is simply turned into a digital photo album with additional sound and video clips as it has been done in Pieper's study (2017) or a movie is made out of the life storybook, which was the case for Subramaniam and Woods (2016).

In earlier studies, Subramaniam and Woods (2012) present two ways of integrating technology into life storybooks: CIRCA, which is short for Computer Interactive Reminiscence and Conversation Aid, and the use of ICT (Information and Communication Technology). In most cases, the digital versions are implemented as an application.

There is for example the 'Dementie en Herinneringen - app' that gives access to photos, videos and songs and provides a structure by suggesting different topics the content can be assigned to (Dementie-winkel.nl, 2018). The system 'ReMe' creates an online Profile of the individual with content gathered from the internet according to the user's characteristics, experiences and interests (Remindmecare.com, 2018). It is operated remotely, so that everyone who got access can contribute to the profile. Since the content includes content themes, users are encouraged to join in on discussions, which promotes group engagement. A slightly different approach is taken by an app called 'Dementia Citizens Beta', which serves more the purpose to connect people affected by dementia with researchers to explore new methods for dementia care (Anon, 2018). More specifically, these methods included creating a life storybook or a personal playlist with the goal to improve users' wellbeing and get a better understanding of issues with dementia from the collected data. Another example is the 'GreyMatters' app, which is an interactive life storybook combined with music and games to share and maintain memories (GreyMatters App, 2018). Next to personalized content, the app also offers packs including general themes like 'culture from the 1930s'. Similarly, the 'My Life Story' app, a photo album memory tool, lets users record their life stories and memories for the purpose of reminiscing, understanding and education (Aged Care Guide, 2018).

The app 'Alzheimer Assitent' on the other hand, is more of a counselor, providing advice and information for relatives of people affected by dementia (Alzheimerassistent.nl, 2018). Not

an adviser- but a manager-functionality is offered by the 'MiessAgenda' app, that can help organizing appointments and events of people with dementia (Miessagenda.nl, 2018).

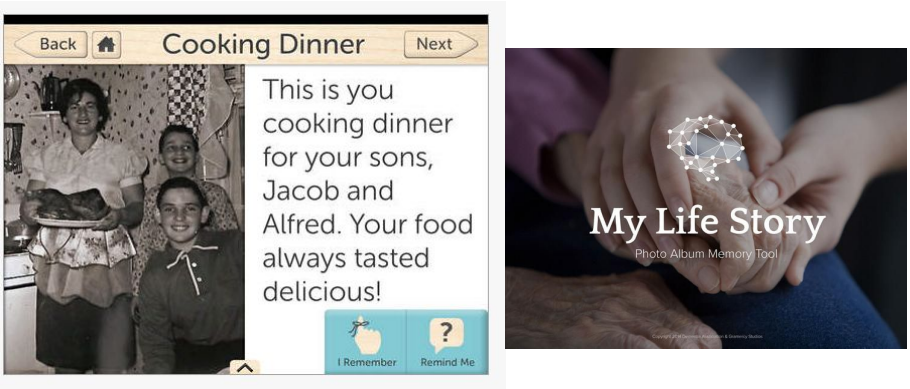


Figure 4: the 'GreyMatters' app (left) and the 'My Life Story' app (right)

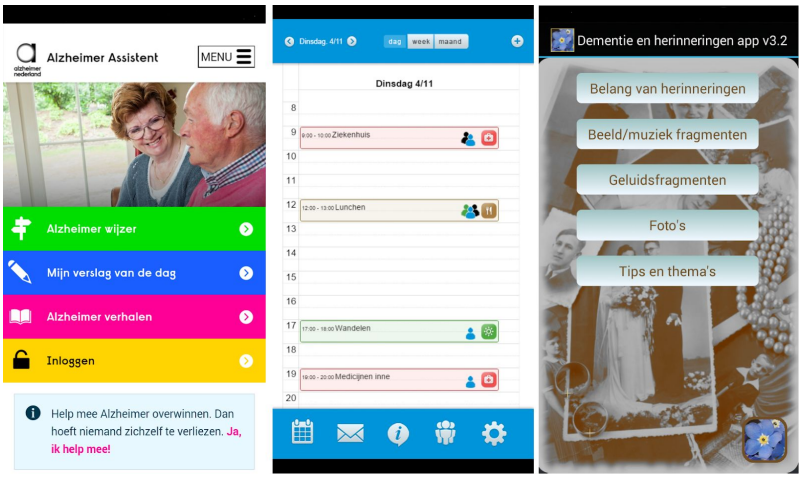


Figure 5: the 'Alzheimer Assistent' app (left), the 'MiessAgenda' app (middle) and the 'Dementie en herinneringen' app (right)

2.2.7 Added value of Digital Life story books

While there are multiple ways of implementing such a digital version, what most of the studies present in the same way are the additional features, that technology offers. The one feature at hand, is the inclusion of multimedia like background music, songs, videos or radio. These additions provide extra options for stimulations and present memory triggers and the content in a new and more vibrant way, so that patients can engage with the topics on another level (Pieper, 2017). A concrete example that supports this statement is given by Subramaniam and Wood (2016), who observed how an old song made one of the participants sing, which she had not done in years. This can address the issue of the life storybook process being too demanding for cognitive impaired people, since with the use of multimedia a bigger and possibly more attractive range of options is offered, which might trigger more intense reactions more easily.

Elfrink et al. (2017) takes this finding one step further by stating that digital life storybook are also usable for people with dementia in later stages. This is explained by the fact that at some point verbal stimuli might not be enough anymore to trigger a response and for that case, multimedia can provide alternatives, like touch, videos or music.

Another feature coming with technology, that turns out to be very advantageous, is the possibility of interacting with the system (Lazar et al., 2014). Not only can directly involved parties add something to the book, but multiple people, present or not, can contribute to and profit from the digital life storybook at the same time. That way, its quality can be increased and next to that, this mechanism relieves family members and caregivers. Recalling that for a conventional life storybook, a lot of time, organization and training was required, with digital life storybooks these obstacles are removed.

Another advantage highlighted by Hashim et al. (2015) is the easy and broad access provided by the integration of technology. Once the digital version is online, it can be accessed whenever, wherever. Furthermore, Elfrink et al. (2017) points out, that content is easier documented and retrieved. This allows digital life storybooks to be flexible in a way, that conventional life storybooks cannot be. The process can be more adapted to the patient's individual condition, which leads to an increasing efficacy of the digital life storybooks.

2.3 Related work

Before coming up with ideas for the 'life-storybook-application' of this project, it is useful to get another overview over what concretely already existing applications implemented. With this overview it can later more easily be retraced where the inspiration came from. The systems presented in the following have already been mentioned previously, but will now be investigated in more detail in order to extract the features that seem useful for the 'life-storybook-application' of this project.

Firstly, the 'Dementie en Herinneringen'-app will be looked into (Dementie-winkel.nl, 2018). This app is set up quite simply, but includes more than it seems at first. In the menu, the user can choose from five different options, of which three of them are the typical themes 'Photos', 'Music' and 'Sound'. The photos are assigned to themes like childhood, sports or jobs, while the content they show can be general as well as personal. In the music section there are songs but also movies from different genres or video clips about different topics. By clicking on the sound option you get to choose from various radio stations and also from audio recordings of sounds that occur in all kinds of areas, e.g. nature or household. The other two of the five options from the menu provide the user with general information about memories, dementia and reminiscence and give advice and suggestions for activities.

Figure 6: the 'Dementie en herinneringen' app

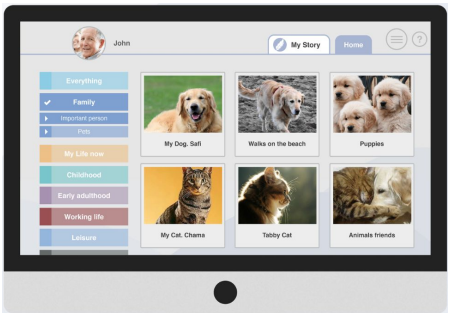


Figure 7: the 'RemindMeCare' service

With the online care service 'RemindMeCare', users can participate in a digitised process of establishing a life story (Remindmecare.com, 2018). It can involve personal content and content from the internet. The process is supposed to be stimulated by asking the user questions about what they have done or what they like. What is special about this is, that the individual who the life story is created for is always in the centrum. To support this approach, 'RemindMeCare' creates a profile for that person that consists of internet content according to the individual's experiences and interests. Next to that, it offers a wide range of other features: in the entertainment section, radio, TV and movies are offered, the music category lets the user choose from ready-made playlists or create one themselves. Under the theme 'Games and Activities' there are tutorial videos on physical exercise, meditation and yoga and games like quizzes. Another feature is the calendar that gives reminders or guidance videos on how to manage the day. There are also functionalities meant to enhance the communication between users like messaging and video calls. Lastly, 'RemindMeCare' collects and gives information on the user's health. They can give feedback on their well-being by answering questions which the service turns into graphics that give the user an overview over their current and past health situation. In general, what distinguishes 'RemindMeCare' from others is that they connect the users while placing the person with dementia in the centre. That way, it is possible to share content and involve different people like caregivers and family members at the same time.

Another system that was an influence to this project is a platform for dementia research called 'Dementia Citizens' (Anon, 2018). It includes two applications, one called 'Book of you' and the other one called 'Playlist for Life'. The research of this platform evolved around the question whether these applications could improve the well-being of people with dementia. 'Book of you' is a multi-media app that can capture moments of an individual's life using photos, music and movie. The idea is for people with dementia to share their life story with family, friends and caregivers. The 'Playlist for Life' on the other hand, solely includes music. Its principle is to detect the songs that have a special meaning to the person with dementia and put them together into one playlist to create their personal 'soundtrack of life'. The researchers found that especially songs that a person with dementia connects something with, can have a surprisingly big impact on them. Only by letting them listen to this one specific song, caregivers managed to evoke a reaction in them even if they usually would not give any response.

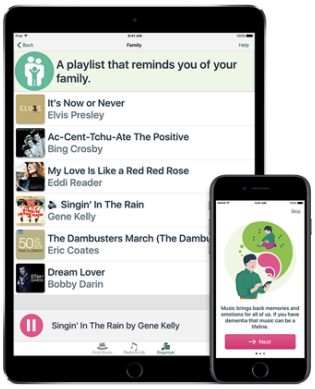


Figure 8: the 'Playlist for Life'

Finally, there is the interactive life storybook app called 'greymatters' (GreyMatters App, 2018). The main functionality is the life storybook including photos, text and voice narration. Furthermore, it allows the user to record a video and share it with others. Similar to 'RemindMeCare', there is also the functionality of reminding the user of appointment or their surroundings with the help of audiovisual effects. While viewing their story, the user can choose

to listen to a playlist. Other than the life storybook there are also other activities like the ‘game of memory cards’. A special feature of this app are the so called universal content packs consisting of entries from the life storybook according to themes like politics or culture. The design of the app was chosen with the goal to make it as accessible and simple as possible.

Figure 9: three screens of the ‘GreyMatters’ app

Having investigated some of the existing implementations of a life storybook, it has become apparent that there are much more other options than solely documenting and visualizing an individual’s life, which is the basic concept of a life storybook. The question now is, which of the presented functionalities should be taken on to the ‘life-storybook-application’ of this project and which ones can be dropped because they are not needed or too complex. To better evaluate on this, the following graphic gives an overview over all the possibilities for features that have been found:

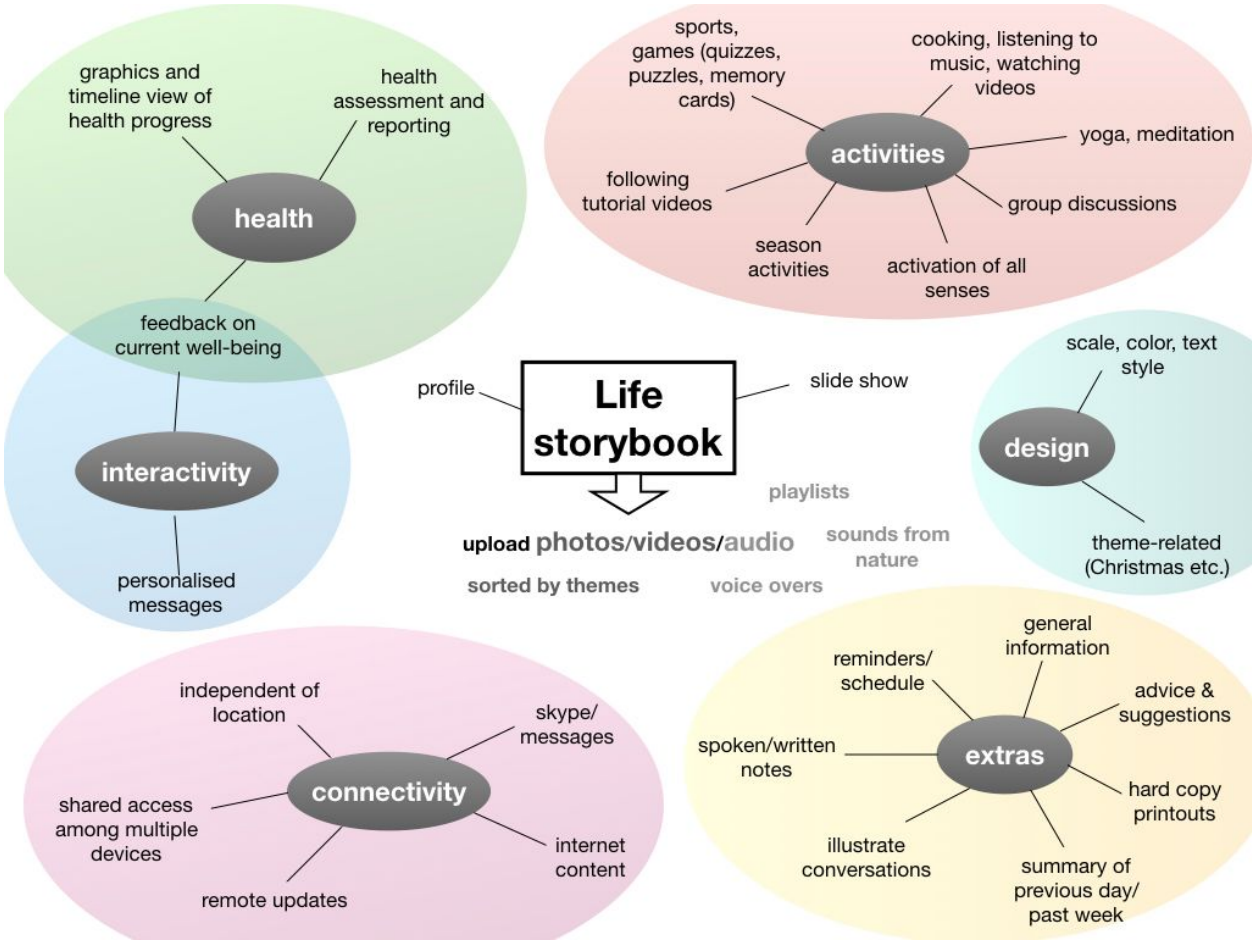


Figure 10: overview over all possible functionalities of a life-storybook-application gathered by researching existing work

2.4 A profile-centred approach

In this section, the online health care system ‘RemindMeCare’ will be presented in more detail as it was considered particularly useful for this project. The special feature of ‘RemindMeCare’ is its profile functionality. It is meant to reflect the interests, beliefs and experiences of the person with dementia, or in other words, everything that makes them them. The theory of ‘RemindMeCare’ around connecting the person with dementia to themselves and strengthening their personality involves multiple aspects (Remindmecare.com, 2018). Firstly, there is a need for identity, which can be supported by setting up the care service in a continuite and narrative way. Next to that, the need for occupation is important meaning that the focus should be on the abilities and powers of the person with dementia. Furthermore, recognition plays an essential role. The user feels recognized by seeing their name, which relates to the idea of personalized messages, and by having the feeling of being listened to. Another aspect similar to that is

involvement, which can be achieved by consulting the person with dementia about their wishes and needs. However, they do not only have to be involved, but also be made aware of the collaboration they are part of since the care process is shared among multiple people. Lastly, it is important to provide facilitation in order to assist the person with dementia to avoid frustration.

3 Methods and Techniques

In this chapter, an overview will be given over the the guidelines that determined the course of this project. These guidelines are specified in the Creative Technology Design Process, which will be presented in the following chapter. Next to that, also all the methods used throughout this project will be explained.

3.1 Creative Technology Design Process

As elaborated by Mader and Eggink (2014) the design process for Creative Technology contains four phases: Ideation, Specification, Reaslistion and Evaluation. Its starting point is the research question and it is meant to be gone through in an iterative way. The steps included in each phase will be explained in the following.

3.1.1 Ideation phase

As already mentioned, the initial input for the ideation phase is provided by the research question. Based on this, divergence techniques are meant to be applied in order to explore related fields. The divergence technique used in this project is brainstorming and researching existing work, that is relevant to the research question. In doing so it is important to keep in mind the stakeholders of this project. Therefore, they are identified in a stakeholder analysis. At this point, the ideas obtained from the brainstorm and research have to be shortened and that is achieved by testing them on their feasibility. In order to do so, feedback from the supervisors is collected in a so called expert review and an iPact analysis is conducted. Finally, this results in being able to formulate preliminary requirements the product, which is in this case an application.

3.1.2 Specification phase

The product idea obtained from the ideation phase is then supposed to be specified further. In this project, this is done by elaborating the system architecture of the application. It is specified in more detail by determining the most important functionality of the application, which is the life storybook. At this point of the project, it is possible to create a first prototype. This prototype is iterated once before it is evaluated in a user test. The results of this user test help to reposition focus points and to redefine the requirements stated at the end of the ideation phase.

3.1.3 Realisation phase

The goal of this phase is to realize what has been specified in the previous phase. More specifically, this is done by first splitting the product into components which are then realized separately before being connected back together. In case of the application, it is divided into two components, one that incorporates the life storybook and one that includes the remaining

functionality. The first part is then integrated into the second part so that a complete and working prototype is obtained. Its functionality is visualized in an activity diagram.

3.1.4 Evaluation phase

Finally, the prototype from the realisation phase is evaluated. This is done by checking whether the requirements and the stakeholders' expectations are matched. It is therefore necessary, to conduct a user test with the stakeholders. In this project, the prototype of the application is tested with caregivers and volunteers. The obtained results lead to one last iteration of the requirements and eventually to an answer to the research question.

3.2 Brainstorm

According to Alex Faickney Osborn (1948), who first came up with the expression, brainstorm means to use your brain to storm a creative problem. Originally, brainstorming was meant to be done in a group who comes up with as many ideas as possible while following four rules (Osborn, 1948): no criticism, quantity is important, crazy ideas are welcome, combining ideas is good. However, since for this project no complex problem has to solved, which is when a group brainstorm can be advantageous, but it is about generating a list of ideas, an individual brainstorm is done. Concretely, the goal of the individual brainstorm is to come up with ideas for functionalities that the application could have. The information collected in the literature research serves as inspiration.

3.3 Expert review

The expression 'expert review' refers to the process of collecting feedback from an expert. In this case, the experts are the supervisors of this project, who are approached to get their opinion on which functionalities should be included in the life-storybook-application. This is an important step because that way the collected ideas can be considered from another person's perspective rather from the one who created them. Finally, with the result from the expert review, a decision can be made on which ideas are feasible and which ones are not.

3.4 Stakeholder analysis

A stakeholder is defined as follows: "individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion" (Project Management Institute (PMI), 1996). The first step of the stakeholder analysis is to identify the stakeholders. In this project, the stakeholders are divided into four groups: the users, developers, legislators and decision-makers. Per group, it is important to name every member specifically, to make sure

that no stakeholder is forgotten as this can have negative effects on the success of the project. Next, the interests of every stakeholder are assessed. The challenge here is, to keep in mind that their interest is different from the one who is analysing them and that they might also change over time. Additionally, the true interests of stakeholders might not be what they claim to be interested in (Smith, 2000). To the stakeholders of this project, this difficulty is not likely to apply. What is relevant for this project, however, is to figure out the level of impact of every stakeholder. The level of impact can be determined by thinking about what the effect would be if an interest of a stakeholder was not met. For the level of interest and impact a differentiation is made between high, medium and low expressed on a scale from 1 to 10 (Smith, 2000). The outcome of the stakeholder analysis shows who and what to pay most attention to when developing the product, in this case the application, or in other words, influences its requirements.

3.5 iPACT

The abbreviation ‘iPACT’ stands for intention, people, activities, context and technologies and is derived from the more commonly known PACT analysis, that is used to analyse situations in interactive systems (Konstandinos, 2016). It is based on the assumption that “**P**eople use **T**echnologies to undertake **A**ctivities in **C**ontexts” (Benyon et al., 2005). The goal of this analysis is to understand the correlation between these elements and what each of them contains. By taking all elements into account, it can be better identified what the system, that is the application, is aimed to do. This can get even clearer by coming up with use scenarios, which describe possible stories in which the application could be used. From this information, requirements can be derived.

3.6 Requirements

As already mentioned in the previous two chapters, the requirements arise from identifying the stakeholders and the relation between intention, people, activities and context of the project. The requirements can be prioritized depending on how important they are for the project by conducting a MoSCoW analysis, which will be explained in the next chapter. Furthermore, they can be divided into function and non-functional requirements. The difference will be described in 3.6.2.

3.6.1 MoSCoW

Since not all requirements identified for the product have the same priority, they can be ranked with the help of the MoSCoW method. MoSCoW stand for must have, should have, could have and won’t have (Mulder, 2017). By assigning these attributes to each of the requirements, it is clear where to start with the project and its chance of being a success can be increased. A Must-have-requirement is essential to the project and in case it is not met, the project has failed. If the requirement is under the category ‘should-have’ it has still a high priority but the product is

still usable if it not fulfilled. Could-have-requirements should only be considered if there is more than enough time left since it does not have any negative influence on the project if they are not met. Finally, Won't-have-requirements are impossible to realise within the scope of the project because there might not be enough time or money.

3.6.2 Functional and non-functional requirements

According to Stockdale (2017), the difference between functional and non-functional requirements is that the functional ones specify what the system is supposed to do, while the non-functional ones determine how well the system is supposed to do it within the design and resource constraints. In other words: functional requirements refer to the behavior and execution of the system and non-functional requirements describe the performance and usability of the system. Accordingly, for instance that after the setting menu item is clicked, the setting page has to load is functional, and that the settings page has a matching appearance to the rest of the interface is non-functional.

3.7 System architecture

The system architecture is the structural design of a system (Spacey, 2018). It is based on the idea to separate the system into different components. By doing so, its complexity gets reduced and the single components are more approachable. The level of the system architecture determines how detailed the components are that the system is broken down to. For this project, analysing the system architecture is not necessary, since there are not many components involved.

3.8 Activity Diagram

As explained by Ericsson (2004), an activity diagram illustrates what happens in a workflow and is supposed to clarify the order of activities throughout this workflow. Activity diagrams are created in UML (Unified Modeling Language) and its basic notation is explained in the following: there is a start node and an end node and everything in between mostly consists of activity states, symbolized by boxes with rounded edges, decision branches that are split by a route leading to multiple alternative branches and synchronisation bars where branches can come together.

3.9 Evaluation

In the evaluation the developed prototype is tested according to certain goals. In this project this happens twice: first after the LoFi-prototype is created and then after the development of the HoFi-prototype. While the first evaluation is more about the usability of the application and about

collecting information about its users, the second evaluation focuses on the functionality of the application. Furthermore, to obtain multiple kinds of data, different evaluation methods are used, which are described in the following.

3.9.1 Interviews

In this project, interviews are part of the evaluation process for two reasons: in the first evaluation to gather information about people with dementia in general and in the second evaluation to verify, clarify and complement the results of the prototype testing. Accordingly, the type of data that is wanted to be gathered is qualitative. There are three kinds of interviews that are aimed at collecting qualitative data: structured, semi-structured and narrative interviews (Stuckey, 2013). In a structured interview, there is a predetermined set of questions that only allow for a limited range of answers. The interviewer sticks to a script and the interview is therefore consistent and standardized. The semi-structured interview, opposed to that, follows a rough outline, but leaves space for the interviewee to determine the direction. Therefore, typical questions in an semi-structured interview are open-ended. In a narrative interview there are no questions involved but consists of the interviewee telling their story and perspective to a certain event or experience. The form of interview used for this project is a mixture between a structured and semi-structured interview since the questions are determined in beforehand but most of them are open-ended.

3.9.2 Prototype testing

The goal of prototype testing is to evaluate a basic version of the product before developing it. According to Naji (2016), in order to run a prototype testing, four parties are required: sample users, an interactive prototype, a facilitator and observers. Who is suitable as sample user can be understood from the stakeholder analysis. Furthermore, it should be taken into consideration that the way of communicating with the sample user during the testing can have a big influence on the test results. For instance, a descriptive instruction like “you want to buy a sweater” can be more effective than a prescriptive instruction, that tells the user exactly where to go and what to click. Regarding the prototype, its prerequisite is to have at least the test relevant features ready. It should also incorporate a realistic interaction and realistic content for the user to be able to properly experience the prototype. A facilitator is someone who knows the users and their habits and can therefore estimate how to avoid conflicts. Lastly, the observers are usually the ones who also designed and developed the prototype since they are the ones who will process the user reactions. In this project, the facilitator and observer is the same person since there are no aspects involved that are likely to cause conflict.

3.9.3 Questionnaire

A questionnaire is a research instrument consisting of a series of questions meant to gather information from the respondents, as described by McLeod (2018). The questions can be of two types: closed or open. Closed questions only offer pre-defined options as answer. These options can be defined so that nominal or ordinal data is obtained. An example for nominal data is ‘yes’ or ‘no’ and ordinal data is often achieved through rating scales. Open questions, as the name suggests, allow the respondent to give any kind of answer they like. Furthermore there

are a couple of factors that have an influence on the success of a questionnaire: how well the questions match with the aims of the research, the length of the questionnaire, the way it is presented, the terminology it includes and the order of the questions. It can also be helpful to gather feedback on the questionnaire before delivering it to the real respondents. In this project, closed questions, which give quantitative results, are chosen for the questionnaire since there is already a large amount of qualitative data from the interviews and various kinds of results can reveal more information.

4 Ideation phase

4.1 Brainstorm

With this information about already existing applications in mind, the focus can be put on the ‘life-storybook-application’ of this project. The previously described features of what has already been made serves as inspiration, but beyond that it is necessary to create new ideas. A good method for doing so is brainstorming. In the following, the process and outcome of this brainstorm will be presented.

It started off with the question what the basic functionality that is needed for the ‘life-storybook-application’ should be. This question lead to the realization that the app has to at least provide the following two options: to upload pictures to the app and to view the uploaded content. More specifically, this content can be selected from the library of the device or directly taken via the camera. Given these two features, a simple ‘life-storybook-application’ can be established.

However, there are way more implementation possibilities which are explored in an extended brainstorm. Its starting point was the mindmap of all features that were collected from already existing work shown in figure X. For the life-storybook-application of this project it has been decided to focus on the Life storybook, interactivity, activities, health and some extras, which are therefore highlighted in figure X. The domains connectivity and design have been left out because the design is going to be considered at a later stage of the app development and connectivity is not relevant for this application since for simplicity reasons it will not have access to the internet. For the brainstorm, two domains have been chosen that leave a lot of room for creativity and are also most most closely related to the life storybook: the interactivity and possible activities. In the following, the ideas that have been brainstormed under these themes will be presented.

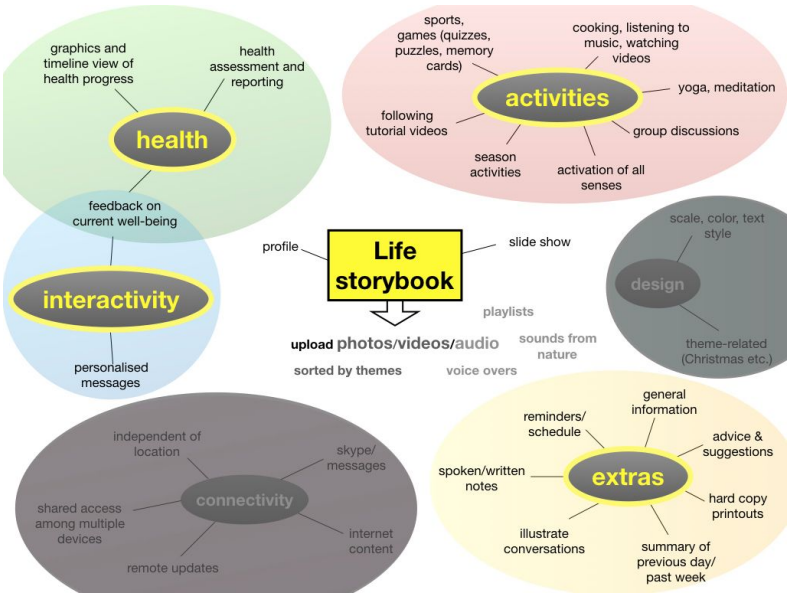


Figure 11: overview over all possible functionalities collected from existing work with the ones highlighted that are relevant for this project

4.1.1 Brainstorm on interactivity

4.1.1.1 Interactive photos

For this round of ideas generation, the focus is put on the interactivity of the app. That is because, as described in Chapter 2.2.7, one of the main benefits of a digital life storybook as compared to conventional ones is the fact that it can interact with the user. Interactivity can for example be implemented in the uploaded photos by making information appear after the user tabbed on the picture. This information could be the names of the people shown in the photo or the location it was taken at. Another option is to make an audio that is related to the content of the picture start playing once the corresponding button is clicked.

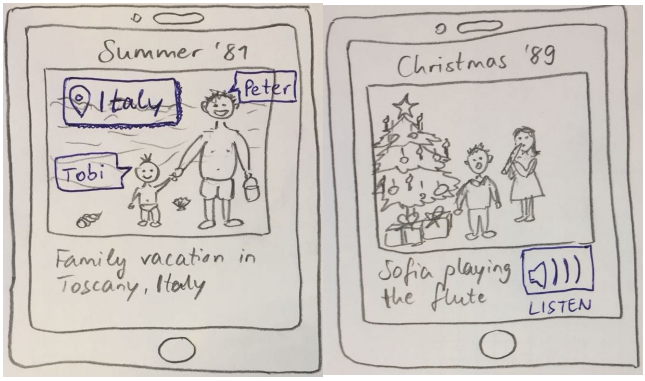


Figure 12: sketches of the idea to make additional information pop up after the photo has been tabbed on

This idea, however, would require a change of the upload functionality as well, since then the photos would not only be uploaded but attached to the according information or audio in beforehand. Developing this idea further, the photos could also get connected to other kinds of data, e.g. 'keywords' which could be similar to hashtag in social networks like instagram. With this feature, users who have troubles finding the right words, which is a common symptom of dementia, can be assisted and encouraged to start or be part of a conversation. Another type of data that could be attached to content before uploading it is its rating or category. The user can be asked about the emotions they connect this specific memory with. That way the content of the life storybook can be organized according to different kinds of moods. Another way of categorizing them is to simply assign them to a certain phase of life or to a theme like 'work' or 'holidays'. The advantage of sorting memories is that subcollections like 'My top 5 favorite memories' can be created and a search functionality can be implemented, that for example outputs all the 'happy' memories.

Figure 13: the 8 dimensions of well-being

4.1.1.2 Interactivity by giving feedback on well-being

Taking this concept even further, the idea came up to use this information about the uploaded content to create customized collections of memories that correspond to the user's current condition. To make

that possible, the user has to be able to give feedback about their mood and physical condition. For the assessment of the well-being of the user, that is the person with dementia, the question is how to get feedback in a simple but precise way that is not intrusive. This can only be answered with a clear understanding of what defines our well-being. Therefore, some research was done on well-being in general and the findings were that there are eight dimensions of well-being as visualized in figure 13 (Bellin.org, 2018). Furthermore, commonly used measures for well-being are life satisfaction, worthwhile, happiness and anxiety (Tinkler, 2015).

Physical health
in pain?
active?
tired?
appetite?
physical limitation?

Table 1: questions about physical health

Mental health	
emotional	Happy?
	Anxious, worried, down?
social	Connected, supported?
	Excluded, dependent?
	Relationships, trust, safety, affiliation feeling?
spiritual	Purpose, satisfaction, acknowledgements?
intellectual	Achievements, recognized abilities, challenges?

Table 2: questions about mental health

With this knowledge, different kinds of questions were thought of and assigned to either one of the two categories, mental health or physical health. These questions revolve around the central question ‘How are you feeling?’. Tables 1 and 2 give an overview over the two categories.

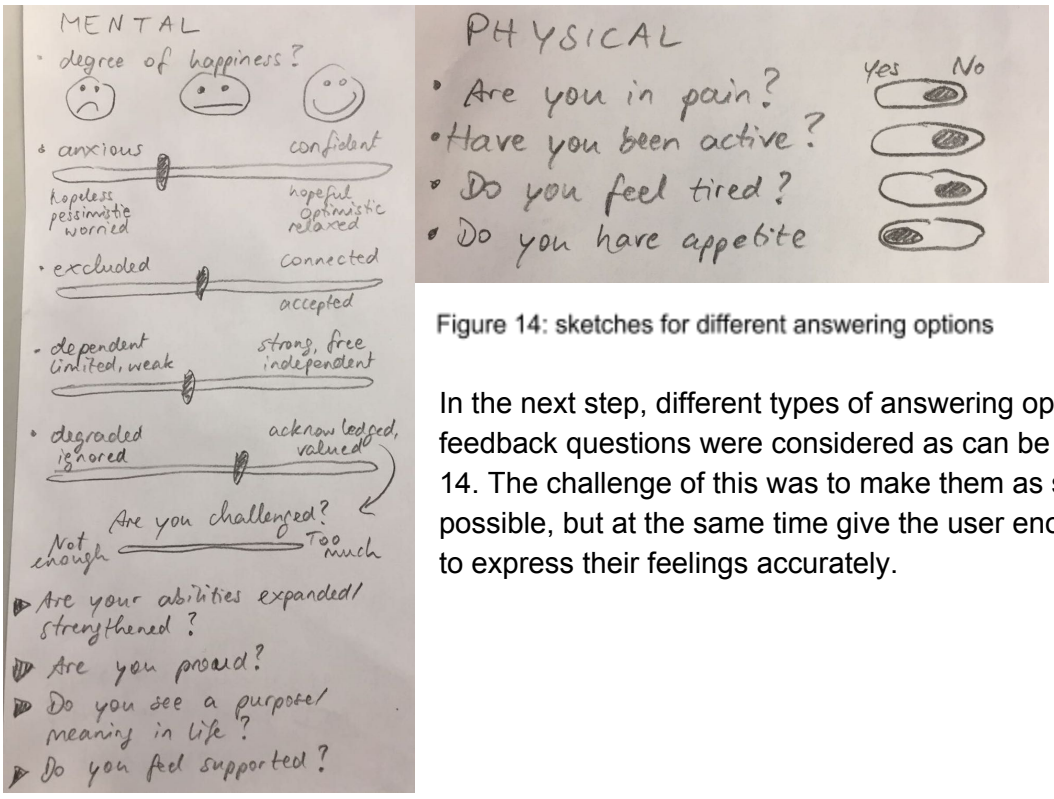


Figure 14: sketches for different answering options

In the next step, different types of answering options for the feedback questions were considered as can be seen in figure 14. The challenge of this was to make them as simple as possible, but at the same time give the user enough freedom to express their feelings accurately.

Coming back to the purpose of this well-being assessment, which is to present memory-collections to the user according to their current condition, the question now is how the gathered feedback can be used. The goal is to create this memory-collection in such a way, that any negative emotions or states that the user has indicated are stimulated to reverse or diminish. This is tried to be achieved by selecting those memories that were rated or categorized accordingly and arranging them to a type of collage. Since it is meant to address the mood of the observer, it can also be called moodboard. Next to the memories, further visual effects can be used to enhance its impact. Since colors are known to be great influencers on the mood of a person, there was the idea to include them into the moodboard. For that reason, a small excurs was done into colortherapy, also called chromotherapy, and its outcome is presented in the following (Verywell Mind, 2018):

Figure 15: colors and their effects

This knowledge can be used to choose for example the background color of the moodboard accordingly to support the mood that is expressed by the selected memories. To enhance this effect even more, content from the internet could be included matching the atmosphere of the moodboard. Since this approach appears quite complicated to realize, a simpler alternative would be to only apply this method to the background color of an uploaded photo.

4.1.1.3 Interactivity through the camera

In search for more ways of integrating interactivity in the ‘life-storybook-app’, the idea came up to make it interact with the surroundings through the camera. Strictly speaking, this is already happening when the user takes a photo or video to upload it to the app, but there are more possibilities for interactions with the real world. One option to make the app respond to real objects is by attaching qr-codes to them. It scans the specific code and then displays content affiliated with the object. As stated in chapter 2.2.1, memorabilia like newspaper articles or wedding vows or even more tangible objects like an old packaging of the favorite brand of chocolate cookies play an important role in reminiscence therapy as they are often connected to strong memories. These memories can be intensified by showing the person with dementia digital content connected to it. Depending on the object, the content could include a wedding

photo, a video clip of the news about the same topic as the newspaper article or a recipe for recreating the chocolate cookies.

4.1.1.4 Interactivity through messages

Putting the camera related interaction aside, there is another simple way of interacting with the user which has not been mentioned yet. A common way of interacting with a digital device is simply to react to notifications that show up in situations when the opinion of the user is required. This method can be applied to the 'life-storybook-application' as well. Personalized messages to the user can be used to inspire them in the process of creating the life storybook by for example asking if they have travelled or what kind of music they like. What turns out to be most beneficial about personalized messages is the way they directly speak to the user, who is the person with dementia. This is an important aspect considering that one of the main purposes of the 'life-storybook-application' is the reconnect the person with dementia to themselves and their history. For this process of strengthening their identity to work out, it is necessary that they see themselves in the centre of it and feel concerned. If this can not be granted, not only is it difficult for them to feel reaffirmed, but also to find the motivation to use the app. Including personalized messages can be a good way of ensuring that the person with dementia feels encouraged to get active and at the same time is made aware of their identity.

4.1.1.5 Interactivity including a tangible book

Figure 16: visualization of the idea of combining the life-storybook-application with a tangible book

Another additional idea was to let the interaction with the application happen through a real book. For that, the application would be integrated into the book and respond to the pages of the book being turned. In order to achieve that, an arduino is necessary that senses whether a page has been turned and sends this information to the application that can then display the according content. That way the person with dementia can interact with the application by using a book, which is what they are used to and familiar with. With the book-application-combination the disadvantage of not knowing how to deal with the application gets removed, but at the same time, the user can still enjoy all the benefits that come with a digital version of the life storybook.

4.1.2 Brainstorm on activities

Finally, one part of the brainstorm was dedicated to activities that could be included into the life-storybook-application. As already described in chapter 2.3, an app gives room for more activities rather than only uploading and viewing content of the life storybook.

4.1.2.1 The 'journey into the past'

Taking the suggestions of the already existing work, like games and sports, as starting point, more ideas were generated. One of them is to integrate a functionality in the app that is similar to the concept of a 'phantasy travel'. This method of relaxation includes somebody stimulating someone else's imagination by slowly reading instructions to them on what to think while they have their eyes closed. Originally, these instructions encourage the listener to imaginarily move to a very enjoyable place, e.g. the beach. This principle could be transferred to the 'life-storybook-application' by turning it into a 'journey into the past' and not only using voice as stimulation, but also media. Something similar to a slide-show could be created, accompanied by matching sounds and voices, that takes the person with dementia step by step back to certain events of their life. However, since this idea seems visually costly, its practicability is questionable.

4.1.2.2 Suggestions for activities based on well-being

Besides the 'journey into the past', one other general idea came up concerning activities, which is to connect them to the output that is gained from the feedback functionality that was presented earlier. This could be realized by generating suggestions for activities depending on the current state of the person with dementia. If they indicate for example, that they feel tired and excluded, a game could be proposed that is played with multiple people and requires the participants to get active. This concept might be problematic however, since it cannot be guaranteed to what extent these suggestion are reliable.

4.1.3 Summary of the brainstorm

To conclude this chapter, the complete output of the brainstorm is summarized and visualized in the figure 17.

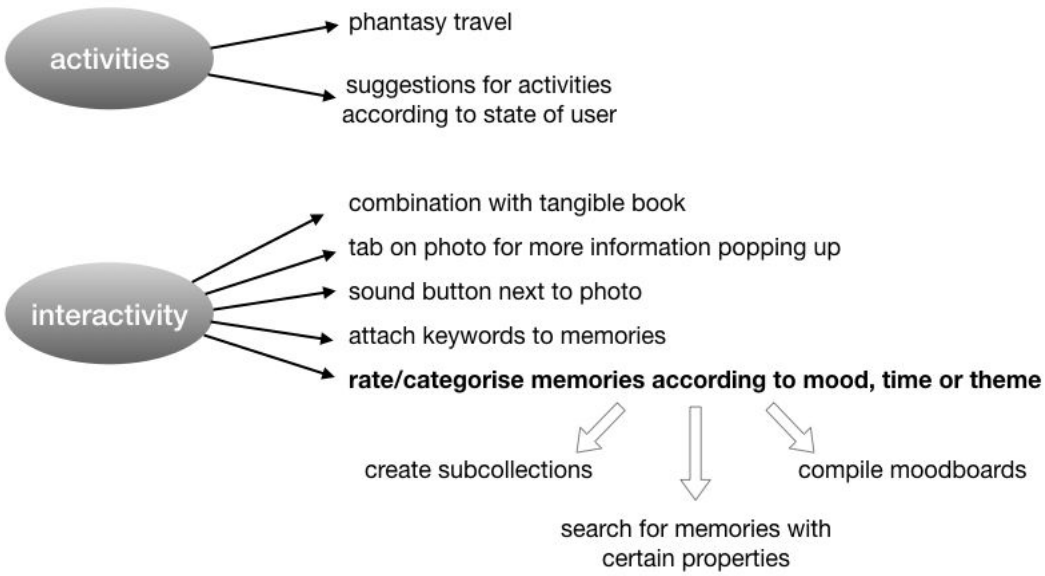


Figure 17: summary of the brainstorm

4.2 Stakeholder analysis

In this chapter, the stakeholders of this project are going to be identified since some of them will play a role in the following chapter, when the brainstormed ideas are tested on their feasibility. Firstly, all stakeholders will be described and then they will be summarized in a table showing an overview over their characteristics.

Users: four different types of people using the life-storybook-application can be identified: the person with dementia, the family members of the person with dementia, his or her caregiver and the volunteer. The last two are similar with the difference that for caregivers, taking care of a person is their main job while volunteers usually take over the care job for a limited amount of time and without being specifically educated for it. The one, that should always be included in the usage is the person with dementia. Whether the other three types of users are involved or not, depends on the situation, but there has to be at least one more, since the person with dementia is not meant and not able to use the application by themselves. In a situation where the person with dementia is still living at home, it is more likely that mostly family members or volunteers will be the co-users, whereas in an institution, caregivers will be using the application together with the person with dementia. All four types of user have the intention of counteracting the consequences of dementia: for the person with dementia that is to keep and regain memories, for the family members to stay connected to the person with dementia and to integrate his or her in their lives and the caregivers are also interested in a strong connection to their patient since this is the base of good quality care. They all have high interest

in using the application, but the person with dementia a little less, since he or she might at first not be open towards trying out something new. Regarding their level of impact, it is similar: all four of them have a high level of impact, but the family members, caregivers and volunteers more since they can estimate better what is usable. Among these three, the caregivers can be given even higher impact since in the end it is up to them whether the application will be used in a large scale or not.

Developers: the developer within this project is the developer of the application. In this category, there are no further people involved and therefore, the interest and impact of the app developer are both high.

Legislators: people who set up the guidelines for this project are experts and care institutions. Due to the experts' knowledge and expertise and the care institution's requirements, they both have a big influence on the project and therefore a high level of impact. However, since the result of this project will not be ready for a large-scale-use, the interest of care institutions is rather small. The experts' interest is even smaller since they are not the ones actually using the application.

Decision-makers: the decisions in this project are made by the clients and the developer. While the clients decided on the course of the project meaning what has to be done by when, the developer made design-decisions, which were however also influenced by the clients. Also as decision-maker, the developer has a high power and interest because of its sole responsibility. The clients' high interest comes from the fact that they would like the application to be developed so it can carry out research and they have high power as well since many decisions are made by them.

Stakeholder	**Type**	**Interest**	**Impact**
Person with dementia	User	7	7
Family members	User	8	8
Caregivers	User	8	9
Volunteers	User	8	8
App-developer	Developer	10	10
Expert	Legislator	3	8
Care institution	Legislator	5	8
Clients	Decision-maker	9	9
App-developer	Decision-maker	10	10

Table 3: Stakeholder analysis

4.3 Feasibility

4.3.1 Feasibility testing by revisiting the State of the Art

After having created a wide range of options that could be implemented in the 'life-storybook-app', now it has to be considered which of these are necessary and suitable and which ones can be dropped. To make this decision, chapter 2.2.7 will be revisited, that describes the benefits of a digital life storybook. By checking whether the collected options are part of these benefits, it can be decided, if they will be included into the life-storybook-application or not.

The range of ideas that are considered, consists of the ones obtained through the brainstorm as presented in section 4.1.3 in figure X and the ones collected from already existing work, which are visualized as mindmap at the end of chapter 2.3 in figure X. For a better overview, all these ideas are summarized in the following table:

INTERACTIVITY
- Feedback on well-being
- Personalised messages
- Tabbable photos
- Sound buttons
- Keywords attached to memories
- Categorisation of memories: moodboards, search function, subcollections
- Combination with a tangible book
ACTIVITIES
- Phantasy travel
- Suggested activities according to state of user
- Sports, games, cooking, meditation, etc.
EXTRAS
- Reminders/ schedule
- Summary of previous day/ week

Table 4: list of ideas resulting from brainstorm and existing work

Recalling section 2.2.7, the main benefits that come with a digital life storybook compared to a conventional one, are the multimedia aspect and multisensory stimulation and that it is interactive, flexible and adaptable. The list of ideas above can now be shortened according to which ideas contribute to the desired benefits the most. Since multimedia and multisensory stimulation are one of the main advantages of the digital version of a life storybook, sound should definitely be included, which is why the idea of sound buttons will be kept. Furthermore, the app should be made as interactive as possible. Several ideas have been collected regarding interactivity, but some of them were decided to be dropped: to make the photos tabbable and to attach keywords to the entries. Making additional information pop up after tabbing on a photo can be interesting but it could be challenging to implement without creating confusion. Also the keywords, at this stage of the app development, would be too complicated to implement and therefore, for simplicity reasons, these ideas will be left out. Same goes for the idea of combining the application with a tangible book, since it would require too much time to implement it. However, what will be kept is the idea of creating moodboards. That is because it can be nicely linked to giving feedback on the user's wellbeing, which contributes a lot to the app's interactivity. Another easy and effective way of making the application more interactive is by letting it 'talk'. Therefore, the idea of including personalized messages will also be taken on. Subsequently, the list of ideas can be reduced as follows:

INTERACTIVITY
- Feedback on well-being
- Personalised messages
- Sound buttons
- Categorization of memories: moodboards
ACTIVITIES
- Phantasy travel
- Suggested activities according to state of user
- Sports, games, cooking, meditation etc.
EXTRAS
- Reminders / schedule

Table 5: reduced list of ideas resulting from the brainstorm and existing work; the domains have different colors so it can be recognized where they are implemented in the prototype shown in the sketches below

Figure 18: three different versions of homescreens including functionalities that correspond to the ideas in the list above as can be recognized by the matching colors (blue = interactivity, red = activities, yellow = extras)

The next step is to transfer these ideas to the prototype of the life-storybook-application, which requires a decision on which ideas to include and how. The prototype is approached by first creating its homescreen since this is the first one to appear and can give an overview over all functionalities that are included in the application. By determining what is shown on the homescreen, it is determined which ideas are included and which ones are not.

Three different versions of homescreens have been created as can be seen in the sketches in figure 18. The purpose of the colors in the homescreens is to show which ideas from the previous list they include. Accordingly, the fields on the homescreen have the same color as the idea they refer to. This means that the homescreen in the middle incorporates all three categories of the list, interactivity, activities and extras. More specifically, there is a personalized message, visualized as the speech bubble (blue), which is supposed to grab the user's attention and connect them to the app. The questions below refer to activities (red), feedback on well-being (blue), and a reminder and schedule (yellow). The reason why these functionalities are formulated as questions is to make the user curious and pick them up from whatever kind of situation they are in when starting the app. The first two questions are 'What do you feel like doing?', referring to the activities, what the life storybook is part of, and 'How are you feeling?' that leads to a screen enabling the user to give feedback on their well-being and thereafter to the created moodboard. Furthermore there are the functionalities from the 'extras' category, which are described by the questions 'What is going to happen today?' and 'What happened yesterday?'. These last two questions are what differentiates the middle version from the right version, since they are not included there. However, everything else in the right homescreen is the same as the middle one.

A completely different approach has been taken with the left homescreen: it shows a simple rather impersonal login screen. The idea behind this is to make the further development of the app dependent on who logged in, the caregiver or the person with dementia. Accordingly, the app would take on different kinds of styles and display different content and options.

4.3.2 Feasibility testing through feedback by the supervisors

Similarly to when the list of ideas had to be reduced, now it has to be decided which version of the homescreen should be kept. Again, in order to do so, the three versions will be checked on their feasibility. This time, this will be done through feedback by the supervisors.
The first homescreen, the login screen, was discarded because in a discussion with the supervisors it was recalled that the person with dementia is not meant to use the application on their own. The function of having different versions of the application depending on who logged in is therefore not necessary. That leaves the choice between the second and third launch screen. Since at this point, the project is still an early stage and it is easier to drop features than to reintegrate them, it has been decided to choose the second homescreen that includes more options. Recalling these options, they are expressed by the questions ‘What do you feel like doing?’, ‘How are you feeling?’, ‘What is going to happen today?’ and ‘What happened yesterday?’. The first one leads to activities that the user could do. At this point, the only activity, that is specified and certainly included is using the life storybook. All the other possible activities are still kept open since they are not that essential for the application. The second question takes the user to the feedback functionality which, as a result, shows a moodboard. For the other two questions no details are specified yet only that they will incorporate a reminder and a schedule in some way.

4.4 iPact analysis

Now, that the life-storybook-application has started to take on shape, it is a good moment to reflect on the system as a whole including its users and how they will interact with. This will be done via an iPact analysis as described in chapter 3.5.

Intention (goal of the system, what it is aimed to do)
Primarily, for the person with dementia the intention of the life-storybook-application to keep and regain memories with the help of technology that allows for multisensory stimulation. As a consequence, the person with dementia stays socially active and in better contact with relatives, caregivers and volunteers meaning that the life-storybook-application also has a positive effect on them. The end goal of the life-storybook-application for the person with dementia is to increase their well-being, for the relatives to strengthen their relationship to the person with dementia and for the caregivers to support them to provide good quality care.

People (who will use the system, personas)
George (78 years) has recently been diagnosed with dementia. His grandchildren worry about him and research the internet for therapy options, which is how they come across the life-storybook-application. They encourage George to give it a try, who agrees, since his wife is still fit and open for new things and can therefore use the app with him together.

Lucie (32 years) works in a care institution for people with dementia. She likes her job, but sometimes she struggles with understanding her patients’ behaviour and wishes she could get

to know more about them to be able to deal with them better. From a colleague, she heard about the life-storybook-application. Since it is not a big investment, she decides to get the application and integrate it into her job.

Tina (63 years) has volunteered in a project for elderly with dementia. In this project, she created a life storybook in form of a photo album for and with a person with dementia. Now she gets asked to participate in another project that includes working with the life-storybook-application instead of a physical album. Since she has already experienced the creation of a photo album, she finds the idea of making a digital version of it interesting and is willing to be part of the project.

Activities (situations in which product will be used)
The person with dementia can use the life-storybook-application together with a relative, a caregiver or a volunteer. Using the application includes several different activities: filling the life-storybook with content, viewing its content or doing one of the additional activities offered by the application, e.g. editing the profile. Depending on the stage of dementia, it should be decided how much the person with dementia is included into using the application. In early stages, the person with dementia could also participate in uploading content to the application, however, as the disease proceeds, he or she might only be able to passively view the content with the help of another person.

Context (environment or location)
The life-storybook-application can technically be used anywhere, but the two main locations are at home or in a care institution, depending on where the person with dementia lives.

Technology (technologies used by the product)
Technologies that are part of the life-storybook-application are the application itself, a tablet, which the app runs on and the camera of the tablet. The reason why the app will only be developed for tablets is its bigger screen size which makes it more usable for elderly.

Use scenario
George is in an early stage of dementia and living at home together with his wife. He uses the life-storybook-application whenever his wife or other relatives are available. Initially, they used the application a lot since it took some time to gather material like photos and videos and to upload them to the application. Throughout this process, George was not actively using the application, but rather his relatives. They could add content collectively and independent of where they were. Next to uploaded photos, they could also add a caption and a description. They integrated George into this process by asking him for his opinion on which material should be uploaded. Now, that the life-storybook-application is filled with content, George often sits together with his wife, children or grandchildren, looks through the entries and talks about them. By constantly recalling old memories with content that does not only include photos but also song, voices and videos, they stay vivid in George’s mind and he even remembers events he

had forgotten. His relatives enjoy listening to his stories and they can imagine better what had happened because they have the media to look at.

Lucie works in a care institution for people with dementia. One of her patients, Tom, and his relatives agreed on trying out the life-storybook-application. The relatives uploaded material to the application that was then also visible to Lucie and Tom. The life-storybook-application is now available to Lucie whenever she has some extra time or to Tom's family when they come to visit him. Looking through the content of the life-storybook-application together with Tom enables Lucie to get to know Tom and his history a lot better. Since Tom moved into the care institution he has always had troubles falling asleep. Sometimes Lucie struggled with this behaviour because it costed her a lot of time and she didn't know what to do about it. Through the life-storybook-application, Lucie learnt that Tom started living together with his wife directly after he moved out of his parents' house which means that he had never slept alone in a room. Now she understands where Tom's sleeping issues come from and can better react to it. The application made it easy for Lucie to get an insight into Tom's life since his relatives could simply share all kinds of media with her. Furthermore, family members can use the application while visiting Tom in the care institution as a tool to start conversations to avoid awkward moments in which nobody knows what to say.

With this information about who will use the application, where, how and for what reasons, it can be better understood what is necessary for the app to have. Furthermore, it can be estimated which features of the application are most important and which ones are minor. Subsequently, with this knowledge from the iPact analysis, requirements with different priorities for the app can be formulated, which will be presented in the next section.

4.5 Preliminary requirements

Based on the iPact analysis and the use scenarios, a first set of preliminary requirements can be derived. They are categorized according the the MoSCoW method as described in section 3.6.1 and divided into functional and non-functional requirements, which were explained in 3.6.2.

FR1	The app **must** allow the user to add content chosen from the library to the life-storybook-application
FR2	The app **must** allow the user to view the added content
FR3	The app **must** be able to show different kinds of media, i.e. photos, videos and audio

FR4	The app **should** allow the user to add captions and text fields to added media
FR5	The app **should** allow the user to take a photo and then add it
FR6	The app **should** allow the user to change added content
FR7	The app **should** show an overview over the content
FR8	The app **could** have a profile
FR9	The app **could** offer other activities and services
FR10	The app **won't** be connected to the internet.
NFR1	The app **must** have an interface that is usable by elderly
NFR2	The app **must** work without lagging
NFR3	The app **must** (only) be suitable for tablets

Table 6: list of preliminary requirements sorted according to MoSCoW and functional/non-functional

5 Specification

5.1 System architecture

Before the development of a first mockup of the life-storybook-application is going to be described, an overview will be given over the whole system with its components and how they are connected to one another.

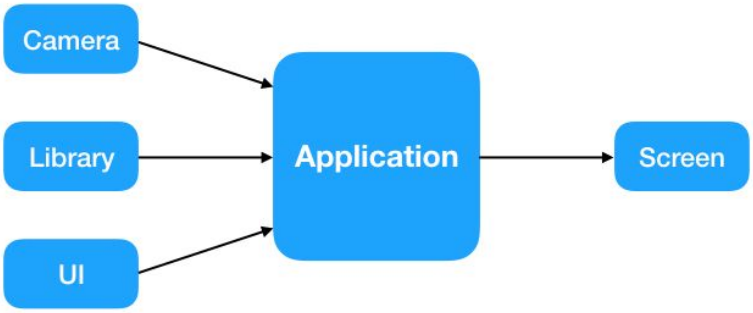


Figure 19: the system architecture of the application

As specified in the functional requirements 1 and 4 till 6, there are three different ways a user can input data into the application: by taking a photo with the camera of the tablet, by choosing a photo from the library of the tablet, or through the user interface by changing content or by entering text into the text fields. Next to entered text or changed content, the user interface also takes in the information about which buttons have been clicked and which user actions, e.g. swiping, have been executed. If the user chooses a photo from the library to be shown in the application, it is saved in a variable and then displayed on the screen. In case the user would like to input a photo from the camera, there are a couple of more steps before it can be displayed on the screen since the taken image first has to be given a name and saved to the internal storage of the tablet. In order to show it on the screen, it can then be loaded from the storage by accessing it through its name and path to where it was stored.

5.2 The Life storybook

In order to start developing a LoFi-prototype of the application, first the functionality of the most important part of the application has been worked out, which is the life-storybook. With the must-have and should-have functional requirements listed in table 6 in mind, an overview has been created over all actions related to the life-storybook shown in figure 20.

Firstly, a differentiation has to be made between viewing the life storybook and editing it. In case the user chooses to view the life storybook, there are multiple options: the user can start from the beginning of the book and then flick through the pages or directly jump to a specific entry by using a search functionality. The user can also get an overview over all entries of the life storybook. The most obvious way to arrange this overview is as a timeline. The timeline can be oriented in landscape or portrait mode. Editing the content of the life storybook can be done in two ways: new content can be added or already added content can be changed.

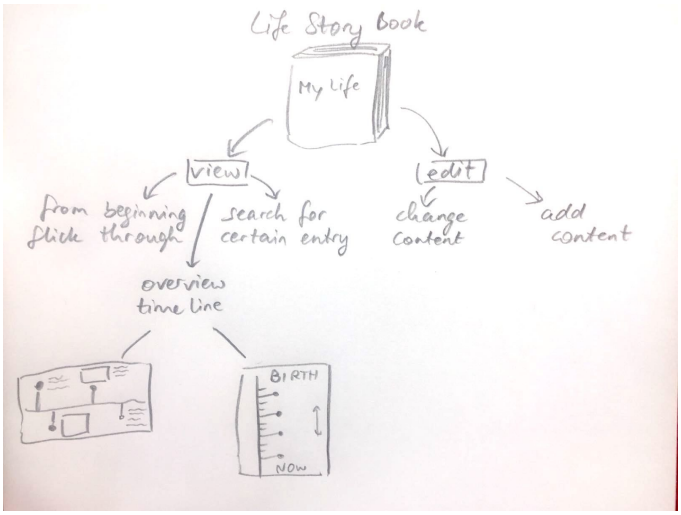


Figure 20: all possible actions related to the life storybook

5.3 The LoFi prototype, 1st iteration

Figure 21: the homescreen that the prototype was based on

In this chapter, the creation of the LoFi prototype will be described. It was made on a prototyping platform called Proto.io. The starting point was the homescreen that has been decided on in chapter 4.5 and is shown in figure 21. The graphic below shows the transition from the sketch to the prototype. It can be noted that the last question, has not been transferred. That is because, when putting together the launch screen in proto.io, also a header and a tab bar were included. That way, showing all four questions, would have appeared too crowded, which is why the last one was left out. The tab bar correlates to the questions, which can also be recognized by the matching icons. At this level of prototyping, only the most important feature, the life storybook, has been worked out in proto.io. The way the user gets to the life storybook is shown below. After clicking on ‘What would you like to do?’ an overview over everything the user could do is shown. They can reminisce about their life, get involved into activities like playing a game or get entertained by watching one of their favorite old TV series. If the user chooses ‘My Life’, they will again have multiple options. These are the options that have been worked out in the previous chapter based on the functional requirements 1 to 8 and include viewing the life storybook, editing it or searching for a certain entry. Since this is the first version of the LoFi prototype, only the options ‘view’ has been developed further. By clicking on it, the user gets to the cover page of the life storybook. After ‘opening’ it, a page showing pictures from the childhood with dates is displayed.

Prior to the iteration of this prototype, feedback was obtained from the client. They found that the idea of including a schedule for the upcoming day might be useful, but is too far away from the original idea of a ‘life-storybook-application’. Therefore, this feature was dropped. Furthermore, the supervisors emphasized that the most important functionality is the life storybook and that features which support or are connected to the life storybook should be given priority.

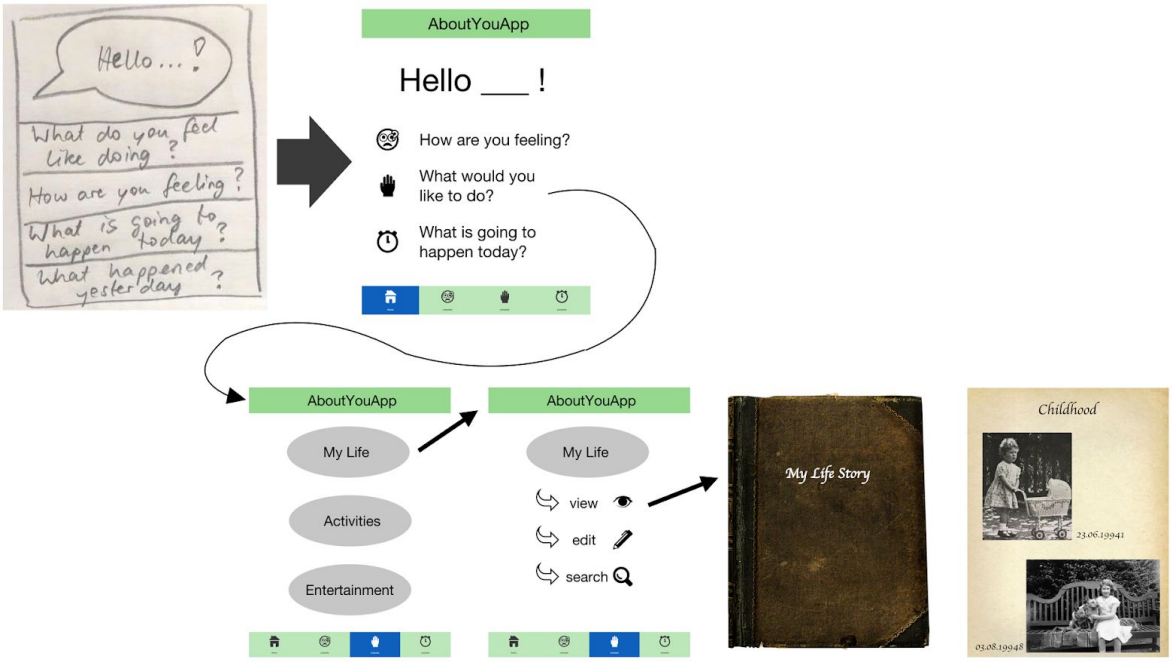


Figure 22: the transition from the sketch to the prototype plus its flow of screens

5.4 The LoFi prototype, 2nd iteration

In the next iteration of the LoFi prototype, instead of the question ‘What is going to happen today?’, another option was included, the profile. This decision was made to realize the supervisors’ feedback of only focussing on features that are directly related to the life storybook. A profile can support one of the purposes of a life storybook which is to help redefining the identity of the person with dementia. For a person with dementia, it is important to reconnect to themselves and everything that characterizes them as this is the fundament of reminiscing about their life. In order to do that, a profile can be an effective tool. This idea was derived from the ‘profile-centred approach’, described in chapter 2.4. The profile can also help to put the person with dementia into the centrum, which is important since the life storybook is about them. According to this principle, the life-storybook-application was names ‘AboutYouApp’.
Below the transition is shown from the first LoFi prototype to its iterated version.

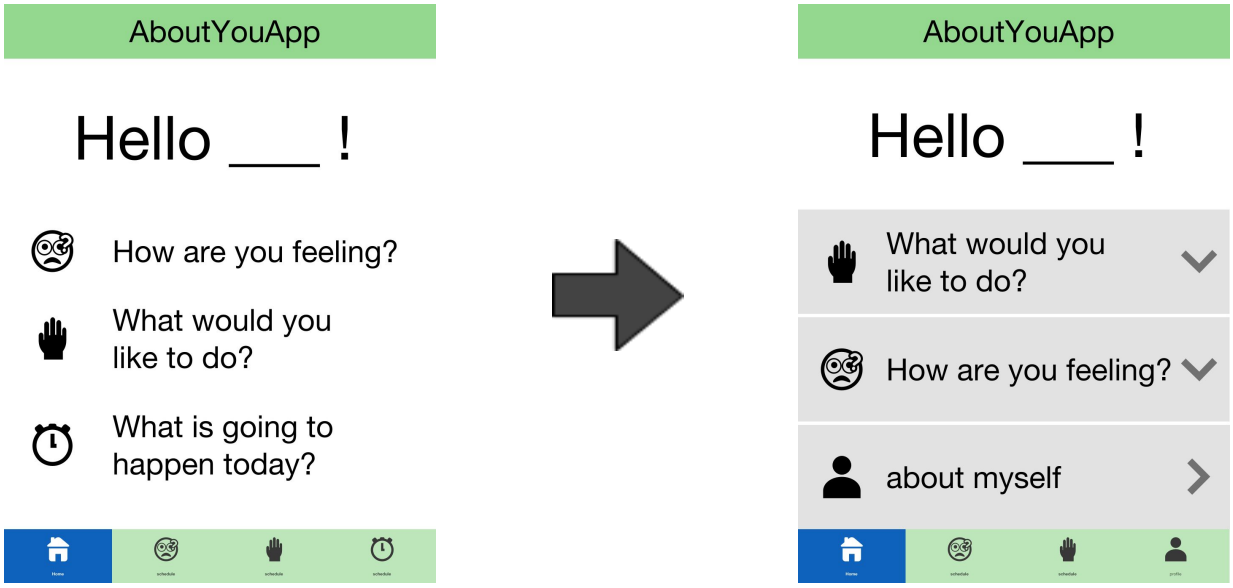


Figure 23: the transition from the homescreen of the first LoFi-prototype to the homescreen of the second LoFi-prototype

This version has almost fully been implemented in proto.io. The flow between the different screens can be comprehended in the following graphic. In the following, this flow will be explained.

Compared to the first prototype, the way of visualizing the options has changed. After clicking on one of the questions in screen 1, a drop down menu appears. The reason for using a drop down menu instead of displaying a whole new screen is to make the navigation easier and clearer. The options under 'My Life' in screen 3 are visualized as buttons and positioned in a group instead of on top of each other. That way it is supposed to be more obvious that they are clickable. Now, also the screens for editing and searching the life storybook have been implemented. Additionally, the user cannot only search for a specific entry but also overview all entries with the timeline shown in screen 6. By clicking on one of the events on the timeline, the user gets directed to the according page showing photos and information about the clicked event. The search bar on top of the timeline gives quick access to a certain entry. Otherwise, if the option 'view' has been chosen, the user gets to the front page of the book and can skip through it page by page like through an actual book. The third option on screen 3 is 'edit' and allows the user to upload new content to the life storybook. The beginning of the uploading process, which is selecting a photo, is shows in screen 8.

The feedback functionality had completely been skipped in the previous prototype, but is now included. After clicking on 'How are you feeling?', an information bubble is displayed explaining the idea behind giving feedback on the user's well-being and a drop down menu will appear that gives the options 'physically' and 'mentally', referring to the user's state. Respectively, the user is taken to screen 10 or 11 where they can answer questions on their

current physical or mental condition. Once they are done, they can save this information and a moodboard with content generated according the information obtained through the feedback appears. Finally, the last option on screen 1 takes the user to their profile including some details and a photo of themselves.

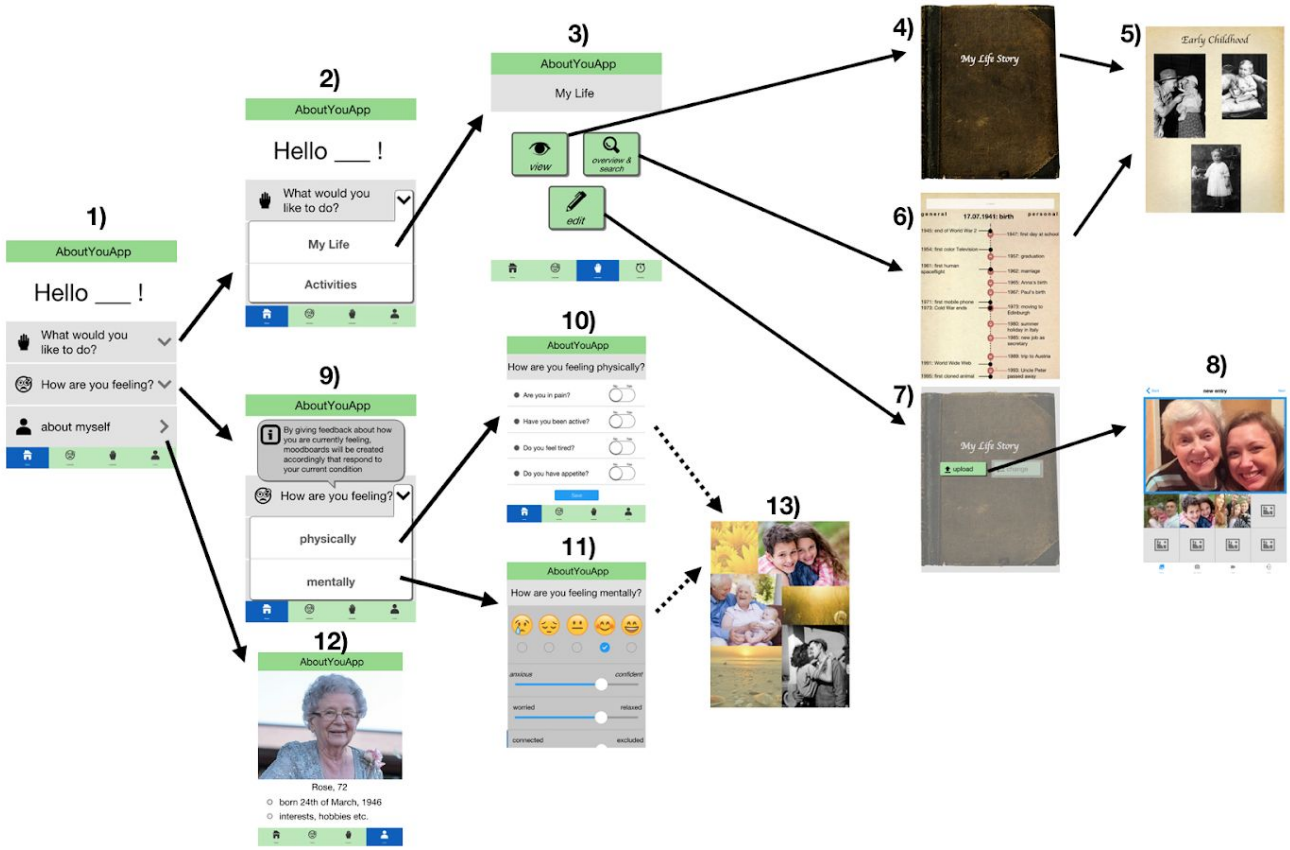


Figure 24: the flow of screens for the second LoFi-prototype

5.5 User testing and interviews

Since the second iteration of the LoFi-prototype is fully implemented, it is ready to be evaluated through a user testing combined with an interview. The purpose, method and results of this study will be presented in the following sections.

5.5.1 The purpose

At this point, the LoFi-prototype does only fulfill requirements that do not include the interactivity of the application, meaning for example that content cannot actually be added, but only the process of doing so can be followed. For this reason, conducting user tests with the LoFi-prototype is aimed at checking it on its usability and user experience. The goal of the interviews is to collect more information about dementia in general and what people affected by

it are like, especially with regards to technology. Ideally, this information would be obtained by including people with dementia into the study themselves, however, due to ethical concerns this was not possible within this project.

5.5.2 The method

5.5.2.1 The measures

In order to obtain meaningful results, a way has to be determined how the data collected throughout the interview and user testing is going to be measured. In an interview, the question itself is a measure since its type influences the answer and how it can be interpreted. In total, one interview consisted of 23 questions, which were divided into three themes: people with dementia, the work with people with dementia and people with dementia using technology. Most of the questions were formulated as open questions to not restrict the interviewee with his or her answer. Furthermore, there were three multiple choice questions and three questions that asked for an answer on a rating scale. The multiple choice questions referred to possible design options and to different types of media and user actions. The questions with a rating scale asked about the chance of the app causing discouragement, about the willingness of people with dementia to use the app and about the extent to which a person with dementia should be included into using the app. To be able to offer an alternative to participants who might not be able to come to the interview and user testing in person, an online survey has been created. A few questions extracted from this survey are shown below:

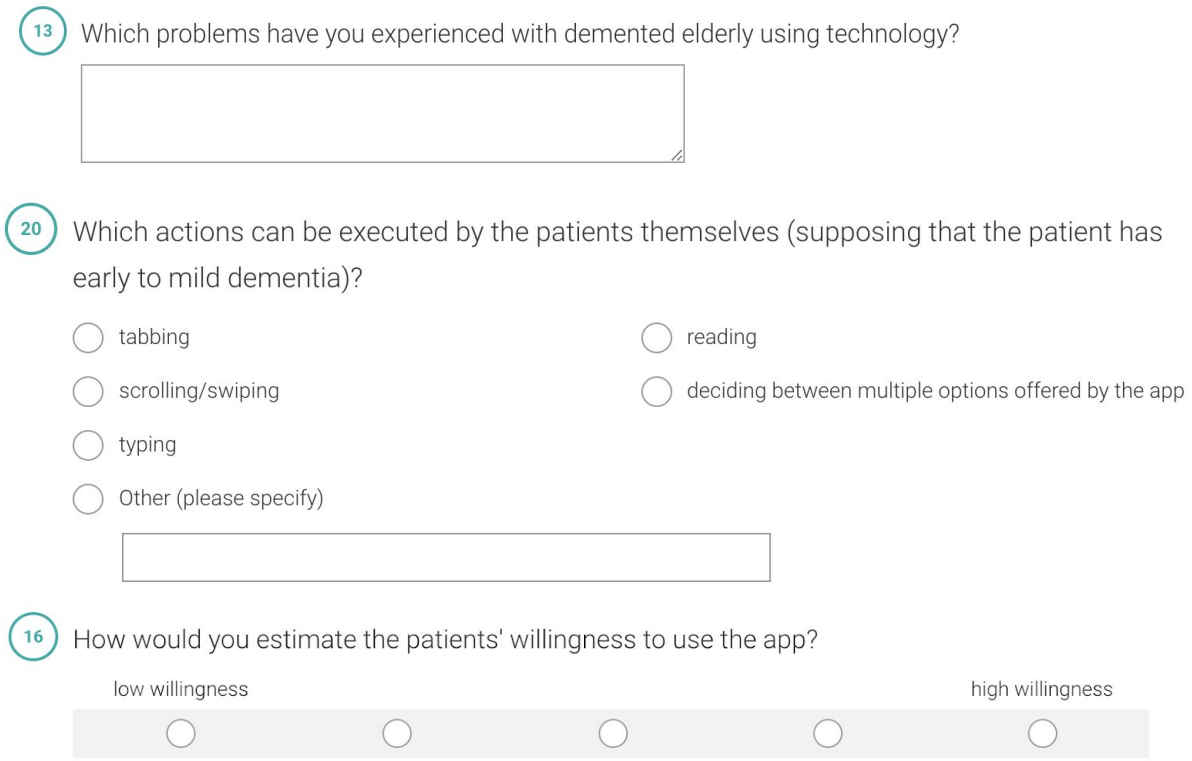


Figure 25: example questions from the survey

The user test was conducted by asking the participant to fulfill several different tasks with the application. The data collected during the user testing was measured according to the following three categories: success rate, the time required for fulfilling a task in the application, and the participant's satisfaction. In order to better analyse the observations made during the user testing, it was followed by a quick discussion in which the participant was asked a couple of questions on their experience with the application.

5.5.2.2 The participants

There were three types of participants: expert, caregiver and volunteer. As described in chapter 4.2, experts are involved in this project as legislators and caregivers and volunteers as users. In total, four people could get recruited, two experts, one caregiver and one volunteer. One of them is male, the rest is female and their range of age is between 28 and 45 years. The experts are researchers in the field psychology who have previously conducted a study on 'Narrative Technology for Health and Care' including an 'Online Levensalbum'. The caregiver works as nurse in the care centre 'Livio' in Enschede and the volunteer has been working with people with dementia on the creation of an online life storybook.

5.5.2.3 The procedure

In the preparation phase, the questions were formulated and the online survey was created. Next, a request for approval of the study was submitted to the ethical committee. After it got approved by them, emails were sent out to potential participants to invite them to the interview and user test. Finally, appointments with four participants, who were described in the previous chapter, have been established. Two of them took place on the UT campus, one at Saxion and one at the care centre 'Livio'. Every session was held in English and took around one hour. The data was collected by recording a video that did not include faces. During the interview it was only meant to capture the audio and during the user test the camera was directed onto the tablet so that it could film the interaction of the participant with the application. Accordingly, the equipment needed was a camera with tripod and a tablet with the prototype of the application on it. One session consisted of the following steps:

First the participant got introduced to the project and was asked if he or she has any questions about it. Then they were told what was going to happen. The most important detail here was to let them know that they will be video-recorded but without including their faces. Subsequently they were handed a consent form that stated all the discussed information on paper. They were asked to read and sign it if they agreed with everything. After that, the camera was positioned so that it was pointing towards the table and the recording was started. In the following, the actual interview was conducted consisting of the questions described in chapter 5.5.2.1.

Once all questions have been discussed, the participant was handed the tablet with the prototype on it, showing the homescreen of the application. The camera was repositioned so that it was filming the screen of the tablet. Firstly, the participant was given some time to explore the app by themselves without interference by the interviewer. Thereafter, the participant was asked to execute the following tasks:

- Look through the content of the life storybook
- Upload a new photo to the life storybook
- Give feedback on your mental condition

The procedure was finished up by another discussion in which the participant was asked about his or her opinion on the prototype and how he or she experienced using it. The questions were aimed at finding out whether the participant found something confusing or missing and whether the functions of the application appeared clear and useful to him or her.

5.5.3 Results

In order to be able to present meaningful results from the collected data, it first has to be analysed. This was done by listening to the audio and watching the video of the recording and transcribing everything that has been said or done. Just like the goals of the interview and the user test are different, also their results are. Therefore, the results are separated depending on whether they were obtained from the interview or from the user test. To recall, the objective of the interview was to find out more about people with dementia, the work with them and how they react to technology, while the user test was aimed at checking the LoFi-prototype on its usability and user experience. Accordingly, three categories of results emerged:

firstly, throughout the interview, the participants pointed out issues concerning dementia care, people with dementia and the life-storybook-application. Secondly, there was the information on what a person with dementia and working with them is like obtained from the interview. With this knowledge, it was possible to formulate requirements that the person with dementia and the people around them should fulfill if they want to use the application. Finally, what was obtained from the user test and also partly from the interview, is information on what the life-storybook-application should be like or in other words, how to make it usable and user friendly. The results of all three categories will be presented in the following sections.

5.5.3.1 Issues concerning the life-storybook-application and dementia care in general

The answers collected through the interview pointed out issues that are existing within dementia care and especially with regard to the life-storybook-application. Firstly, there are general issues with the current care situation. Next to that, there are more specific problems arising from applying reminiscence therapy and therapy with life-storybook-applications.

Concerning the current care situation, the interviewees mentioned challenges, that also already have been stated in chapter 1 and 2. There is the trend of people with dementia, or elderly in general, continuing to live longer at home instead of moving into a care institution. Next to that, there are the two common issues that come with dementia: how can the quality of life of the person with dementia be improved and how can the family members be relieved. All three of these problems are tackled by using the life-storybook-application. It is suitable for a therapy at home, is aimed to improve the memories and with that the social activeness and well-being of the person with dementia and facilitates the relationship between the person with dementia and their relatives. However, as already mentioned, also reminiscence therapy and the life-storybook-applications bring challenges. In general, effects or improvements caused by reminiscence therapy are difficult to determine since they are hard to measure. That is because its effects often concern soft measurements like emotions, which are very subjective and

therefore hard to prove or generalize. The problem with determining improvements is that dementia itself is a deterioration process, which is why an improvement is technically impossible, only a slowed down deterioration can occur.

Regarding the therapy with life-storybook-applications, the most obvious issue is the fact that people with dementia are not used to dealing with technology. They want to stick to what they know, which is a physical book. Everything that is new or unknown to them creates scepsis and discomfort. They could therefore not be open towards and interested in using an application. For that reason and due to the lack of technical skills of the person with dementia, it can also be difficult to integrate them into the usage of the application. Furthermore, it can be very exhausting for them to use it, which is why the life-storybook-application could be perceived more as a burden rather than a help. The interviewees also reported that often it was the case that the application has not been used anymore after it was filled with content. Another issue arises when trying to integrate it into daily-life-care: there might not be enough time and money to do so. Finally, one last well-known problem that has been mentioned is the fact that there are always also negative memories, which cannot be excluded but should also not be part of the life-storybook-application since it is not foreseeable what they will cause.

In the following, all the described problems are summarized in a table. For every problem a solution in form of a requirement for the life-storybook-application has been thought of. Some requirements are written in red because they are a solution to multiple problems.

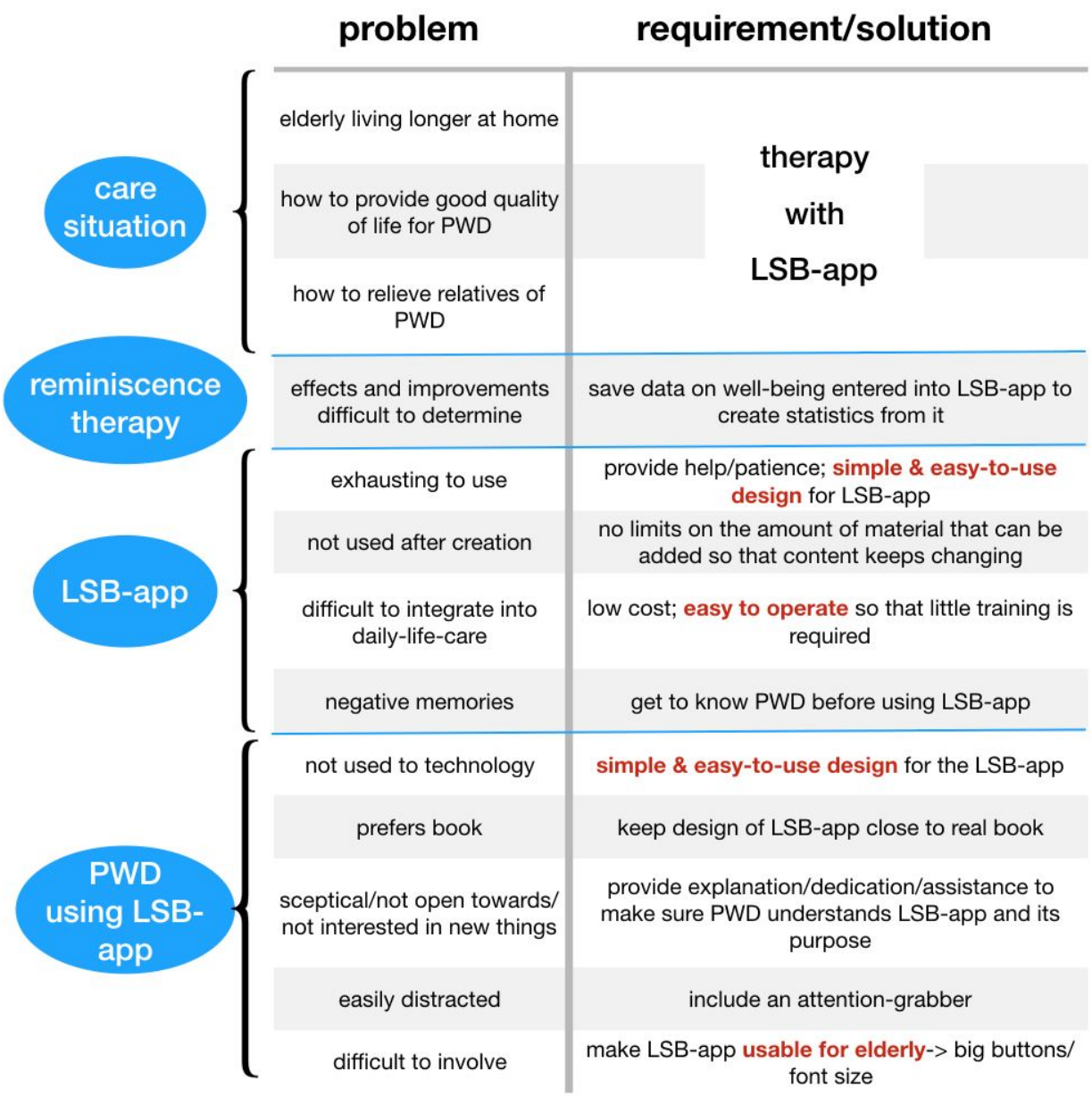


Figure 26: overview over issues mentioned in the interview with their corresponding requirements
abbreviations: LSB = life storybook; PWD = person with dementia

5.6.3.2 Requirements for the person with dementia and people around them using the life-storybook-application

There are two parties involved in the interaction with the application: the person with dementia and the assistance, that are the family members, volunteers and caregivers. In order to use the life-storybook-application, both parties are needed and they correlate to each other. This correlation between them and the application is visualized as triangle in figure 27. This clarifies that in order to make the interaction with the life-storybook-application work, not only the app itself has to fulfill certain criteria, but also the person with dementia and their assistance are required to meet some characteristics. What these characteristics should be was found through the information obtained in the interview about people with dementia and the work with them.

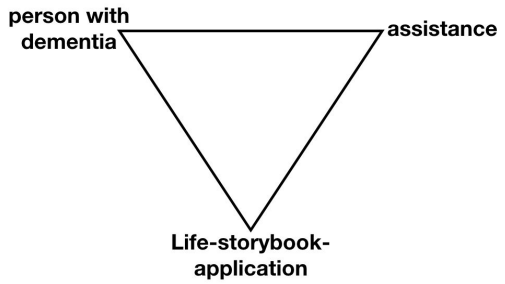


Figure 27: the 'interaction triangle'

Starting with the person with dementia, for them in order to use the life-storybook-application, it is advised that they should not have a trauma. Regarding the stage of dementia that the person with dementia should be in so that they can use the app, there were disagreements among the participants. One said, that people in all stages of dementia could use the application and one said only a person with early dementia is suitable. The other two participants were unsure about this. Another requirement for the person with dementia is that they have to be willing to work with the app and they should be informed in beforehand about its purpose and procedure to make sure they understand the it and are actively integrated. Furthermore they should not only be integrated, but also have the control over the process, e.g. decide which material to include into the application. This is important because the life-storybook-application is about the person with dementia and he or she should therefore be put in the centre of the intervention.

Moving on to the second party, the assistance consisting of the relatives, caregivers and volunteers, their most important requirement is to have time. Using the life-storybook-application can only be effective if they are available to spend company and participate in conversations with the person with dementia. In order to establish a good connection between the assistant and the person with dementia, it is necessary that the assistant makes sure he or she gets to know the person with dementia and understands them. Next to that, caregivers, relatives or volunteers are also required to remember and motivate the person with dementia to use the application. It is also their responsibility to make sure that the person with dementia received enough explanation about the intervention and understands what is going on. Due to their role as assistant it is good for the relatives, caregivers or volunteers to have some knowledge about how to use a tablet and in case they do not, they should consider undergoing a training. Furthermore, they should all contribute something to the application and collaborate among each other.

5.6.3.3 Requirements for the life-storybook-application

Having worked out the criteria that the person with dementia and their assistance should fulfill in order to achieve an effective interaction with the life-storybook-application, the information that is still missing is what the app itself should be like. The characteristics of the application can be divided into three groups: the design, functionality and content. Functionality in this context means the user actions that are necessary to interact with the application.
Information for the first group, the design, was collected from observations made during the user test, which was aimed at usability and user experience. The user test could also give results for the second group, the functionality. To verify and widen these results, participants were also asked about the design and user actions in the interview after the user test specifically in two multiple-choice-questions:

A) Which design option for the application do you prefer: a design close the an actual book or a design that makes use of typical digital design decisions?
B) Which action can the person with dementia execute themselves: tabbing, swiping, scrolling, typing, reading?

Finally, information about the third group, the content, or more specifically about the types of media within the application, could only be found out through a question in the interview since the LoFi-prototype does not include multiple types of media. This question was formulated as follows:

C) Which type of media triggers the most response: photos, videos, songs or voice recordings?

The results for each of the three groups are presented in the following.

Design: Firstly, general expressions describing what the application should be like were extracted from answers given in the interview after the user test. The most frequent ones were: simple, intuitive, personal, user-centred, without delay. Further, the participants indicated, that an important property of the design of the life-storybook-application is consistency. An information that was found through the observations from the user test was the importance of visibility: buttons and the font size should be big and icons should be recognizable. It cannot be taken for granted that elderly find commonly used icons clear. Therefore, icons should be used with caution. Next to these qualitative statements, one quantitative outcome was obtained through question A. The participants had to choose between a life-storybook-application being designed as book or one that featured typical digital design choices including user action like scrolling and swiping. Two participants indicated that the first option would be better and two said that both are possible. This distribution shows that the life-storybook-application should be designed so that it looks like a book.

User actions: In question B asking about which actions can be done by the person with dementia, the participants had five actions to consider: tabbing, swiping, scrolling, typing and reading. All of them were confident that a person with dementia is able to tab, one participant agreed that they could swipe and one that they could scroll. Another participant indicated a ‘maybe’ for scrolling and also typing and reading got one ‘maybe’ each. Interestingly, throughout the prototype testing, it was observed that in most of the cases, when swiping was needed, the participants intuitively swiped. A frequent general remark in the interview afterwards was that it is important to limit the options to for example only tabbing. It was also emphasized that it

should be indicated what kind of user action is needed. It should be clear which fields are clickable and which ones are not. The fact that this is an issue has also been verified by the observations of the user testing: all participants clicked on the empty line after ‘Hello’ because they thought they could add a name there, but the line was not responsive.

Media types: with regard to question C about what types of media should be included into the life-storybook-application, the outcomes from the interview were as follows: from the provided options, which were photo, video, song and voice, the photo was the most popular choice. It was chosen not only because it commonly is the type of media that is most frequently available, but also because a simple picture can have a lot of power, as was agreed on by three out of the four participants. All of them were positive about including a video with the restriction that it might not be available in every case. Including songs was found to be a good idea by three participants and including a voice by two. However, one specifically stated that someone’s voice is not that interesting since people are more visually oriented, unless the voice is familiar. A general statement that three participants agreed on, was ‘the more the better’, meaning that a combination of different types of media only adds to the effectiveness and experience of using the life-storybook-application.

Adding all these described results as requirements to the previously shown ‘interaction-triangle’, leads to the following visualization:

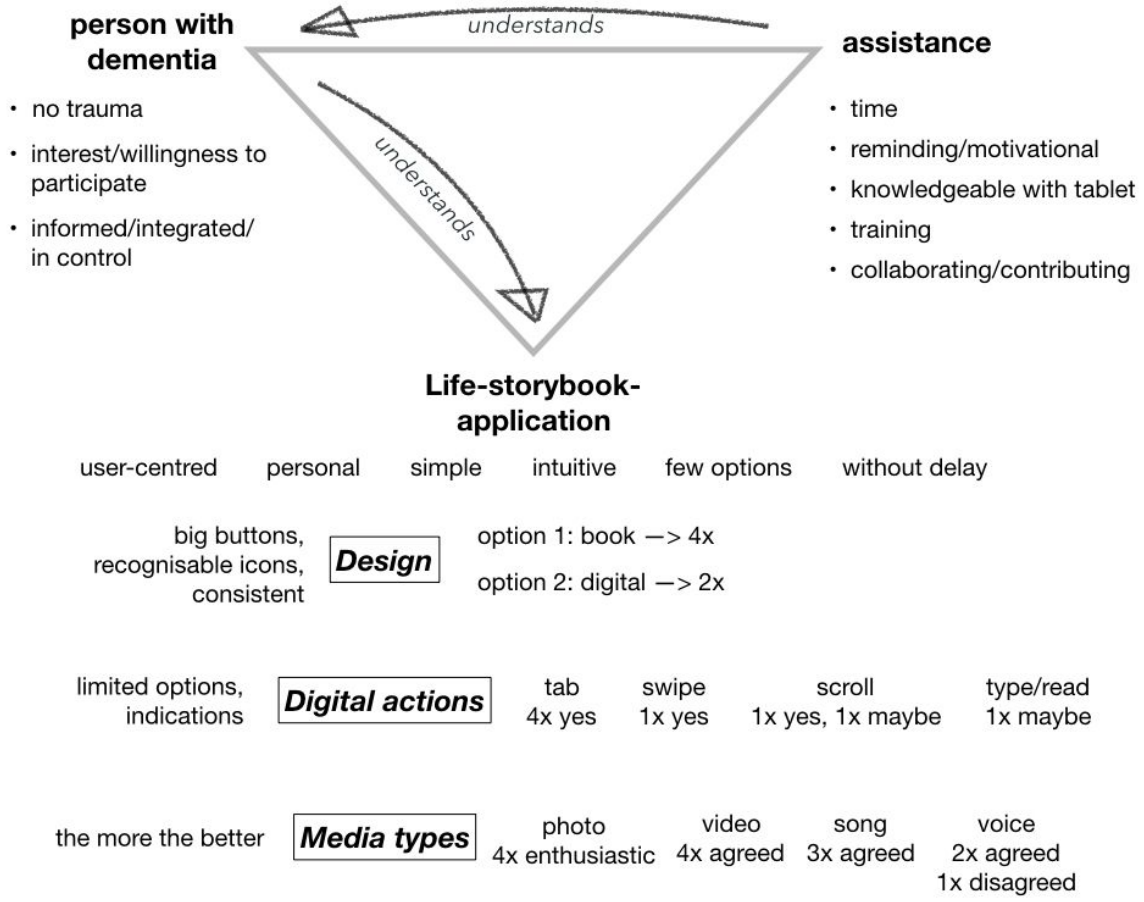


Figure 28: overview over the results formulated as requirements; results for the person with dementia and assistance was obtained from the interview and results for the application were collected in both, the interview and user testing

5.6 Iterated Requirements

In this chapter, all the requirements that have been worked out in the previous two chapters will be put together, summarized and compared to the preliminary functional and non-functional requirements presented in chapter 4.5, which will then be redefined according to the new findings.

Most of the requirements that were derived from the problems mentioned by the participants throughout the interview, refer to the design of the life-storybook-application. By choosing the right design, many of these problems can be tackled. And ‘right’, according to the derived requirements, means most importantly simple and easy to use. This makes the application not only usable for elderly, but also prevents caregivers, relatives or volunteer from spending a lot of time figuring out how the app works or even having to go to a training. Also, due to the issue that elderly naturally prefer a book, the application should be designed as book. All this information corresponds to the non-functional requirement 1 (NFR1) saying that the interface of the application must be usable by elderly. With the new requirements, NFR1 got specified a little more.

One more requirement is going to be emphasized since it points out an important information regarding the basic functionality of the application: when adding content it should be possible to add an unlimited amount to make sure that the content keeps changing. That way, the application is never ‘completed’ which can prevent it from not being used anymore. This requirement influences functional requirement 1 (FR1) stating that the user must be able to add content from the library by specifying it in more detail.

With the requirements obtained from the user testing, the idea of how the life-storybook-application should be designed got even clearer. They agree with the previous requirements that the design needs to be simple and close to a book. However, they specify more, what ‘usable for elderly’ means: easily visible, i.e. big buttons and font size, intuitive and consistent design with only a few options. Whether the application is usable by elderly, is not only influenced by the design but also by the way the user has to interact with the interface. It was found that tabbing works best and that there should not be too many different actions. Furthermore, it is important to make it obvious which action is required. These specifications again refer to NFR1 and give it even more details. Another requirement from the user testing states that the application should be user-centred and personal. This information can be assigned to FR8 and makes it turn into a should-have requirement because it gives it more importance: a profile could not only be included into the application but it should be included since it was found that the application is required to be user-centred and personal. Furthermore, through the user testing it was realized, that it is best to include a combination of different media types into the application. With this information, FR3 can be upgraded.

Summarizing the all the changes that have made at the preliminary functional and non-functional requirements: FR1, FR3 and NFR1 got specified through more details and FR8 became a should-have requirement instead of a could-have. These changes and a general overview are shown in the following graphic:

	previous requirements	⇨	requirements derived from problems	+	requirements derived from user testing	⇨	redefined requirements
1)	add content from library		unlimited amount of content can be added				**add unlimitedly content from the library**
2)	view content						view content
3)	different kinds of media				combination of different media is best		**different kinds of media in combination**
4)	add captions and text						add captions and text
5)	take a photo and add it						take a photo and add it
6)	change content						change content
7)	overview						overview
8)	profile				user-centred, personal		profile
9)	other activities/ services						other activities/ services
10)	no internet connection						no internet connection
					simple, intuitive, consistent, easily visible; designed as book; tabbing is best		**a more detailed definition* of 'usable by elderly'**
1)	usable by elderly		simple & easy-to-use design, close to book				
2)	no lagging				without delay		no lagging
3)	suitable for tablets						suitable for tablets

Figure 29: overview over the transition between the preliminary and iterated requirements; red = must have, purple = should have, turquoise = could have, grey = won't have; requirements 1-10 are functional and the last three are non-functional

6 Realisation

6.1 Technology selection

Before starting to develop the application, a few decisions have to be made on the technology that is going to be used. Firstly, a suitable platform has to be selected that can deploy the life-storybook-application. There are several options: a computer-application, a mobile application or a web-application. The computer-application would be a poor choice since the life-storybook-application is meant to be similar to a real book, as elaborated earlier. This means, that it should be portable and compact which cannot be provided by a computer-application. A web-application is independent of the device it is running on, however, it requires an internet connection.This restriction is not convenient for the the life-storybook-application since it might be used at places where there is no internet connection. Subsequently, a mobile app is most suitable. As already mentioned in the iPact analysis, the device that the application will be running on is a tablet. The reason for that is the size of a tablet, which is small enough so that it is still easily portable and big enough so it suits the user needs of elderly.

Another decision has to be made, which is regarding the language the application will be programmed in. As programming language two options have been taken into consideration: swift and Java. It has been decided to use Java, simply because it enables the application to be more easily scalable. Android Studio is the environment the app has been developed in.

6.2 The HiFi-prototype

6.2.1 The development process

The HiFi-prototype was initially developed in two separate applications: one incorporated the functionality of adding content and the other one all remaining functions. This separation was made to make sure that first the most important requirement, which is FR1, was fulfilled before implementing everything else. The way these two parts of the HiFi-prototype were developed, will be explained in the following.

6.2.1.1 The first part of the HiFi-prototype

The development started by attempting to satisfy the first functional requirement, which is that the user must be able to add content from the library. Since this was achieved pretty quickly, FR5 was approached, since it is related to the first one: allow the user to take a photo within the application that can then be added to the life storybook. The challenge of this step was that in order for the taken photo to be accessible and displayed in the app, it had to be saved first. There are multiple options for where the photo can be saved: to a sd card, to the internal storage of the tablet or in a local server. Since the tablet that is used for this project does not have a sd card and setting up a server would take too much time, the app was programmed so

that after taking a photo, it is saved to the internal storage of the tablet. To be able to access the photo, which is needed to display it, the photo has to be given an unique name. The name is made unique by attaching a timestamp to it. Under this name, the photo is saved at a certain location within the internal storage. The location is specified through its path. In order to display the photo in the application, the path is given as a guide to where the photo is located and once it was found, it can be loaded onto the screen. In code, this process consists of several functions. The order in which these functions are called and what they are doing is visualized in the following:

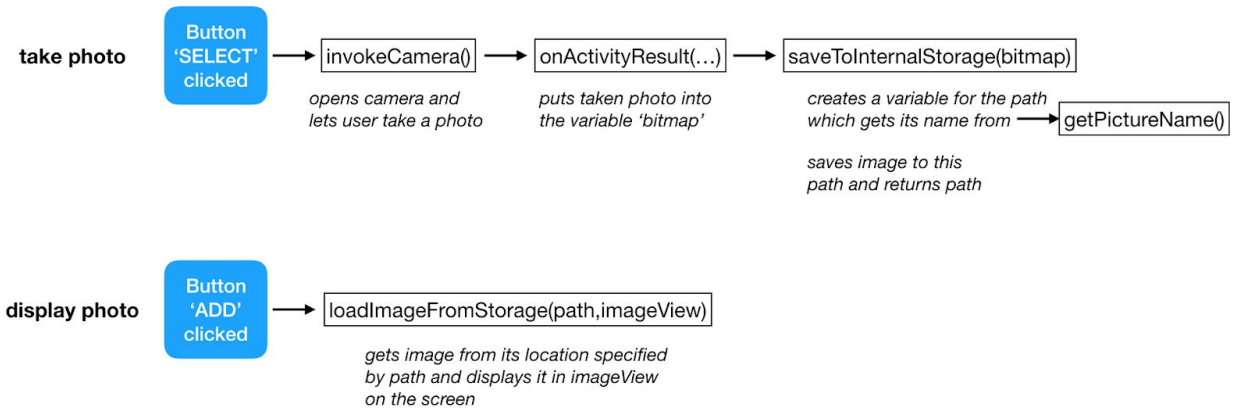
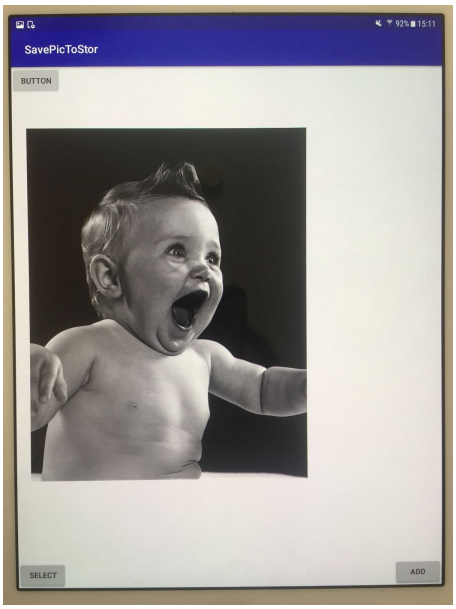


Figure 30: order of functions being called when adding content



Now, that a photo from the library as well as from the camera can be added to the life-storybook-application, a way had to be found to be able to add multiple and different photos. This was achieved by creating a new 'imageView' on the screen, each time the user chooses a photo to be added, which is then displayed within this imageView. With this, the core of the HiFi-prototype was established. A screenshot of the application, after one photo has been added can be seen in figure 31. Additionally, the flow of steps that the user has to follow for adding a photo can be comprehended in figure 32.

Figure 31: screenshot of the state of the application after one photo has been added

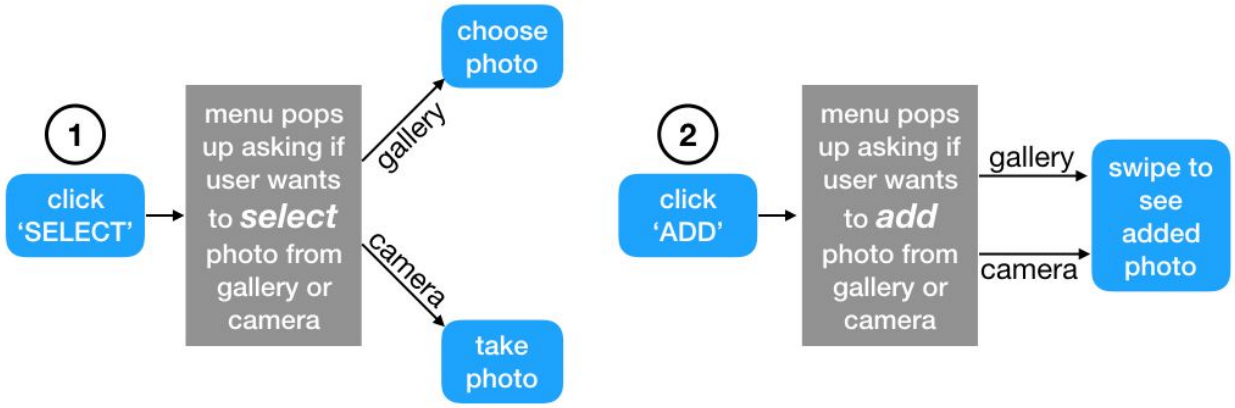


Figure 32: the steps a user has to follow in order to add content

6.2.1.2 The second part of the HiFi-prototype

For this part of the HiFi-prototype, firstly, the launchscreen has been programmed based on the launchscreen of the LoFi-prototype. The following figure shows the transition between the two screens:

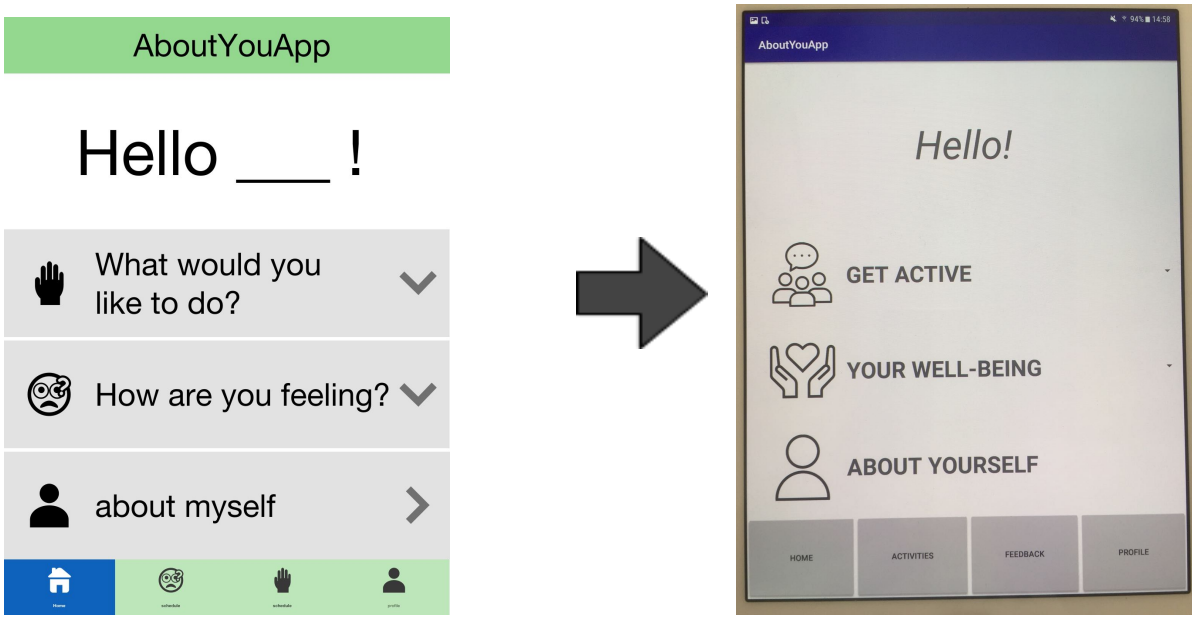


Figure 33: transition from the homescreen of the prototype to the homescreen of the programmed application

A couple of deviations can be noted, e.g. that the empty line after 'Hello' is missing. This can be explained through the requirements that were found by evaluating the user testing in chapter 5.6.3.2. Non-functional requirement 1, that specifies what the app should be like so it is usable by elderly, says that it always has to be clear whether a user action is needed and if so, which

one. Since this is not the case for the line as it created confusion, it got removed. Furthermore the questions got reformulated into compact expressions because they seemed too lengthy. The icons got changed according to a finding that is also part of non-functional requirement 1: the design has to be consistent and icons recognizable. One other difference is that the tab bar does not have icons, but that is only for simplicity reasons.

In the following the launchscreen was expanded by attaching more screens to it. A screen was programmed complying with NFR1, that shows the options for the life-storybook. Another screen got added with the overview over the content of the life storybook according to FR7 and one more screen for the profile as stated in FR8. Next to that, screens were added showing different kinds of media corresponding to FR2 and 3. Since in the user testing it was found that the participants thought a combination of different media types is most effective, three screens with three different combinations have been programmed: One screen showing photos with a voice recording, one screen with a video and one including a photo with a song.

The final step was to incorporate the first part into the second. The first part got upgraded by added a function to also add captions and text to uploaded photos. After that, a complete HiFi-prototype was achieved. In order to get a better overview over all the functionalities of the HiFi-prototype and the navigation between them, an activity-diagram has been created:

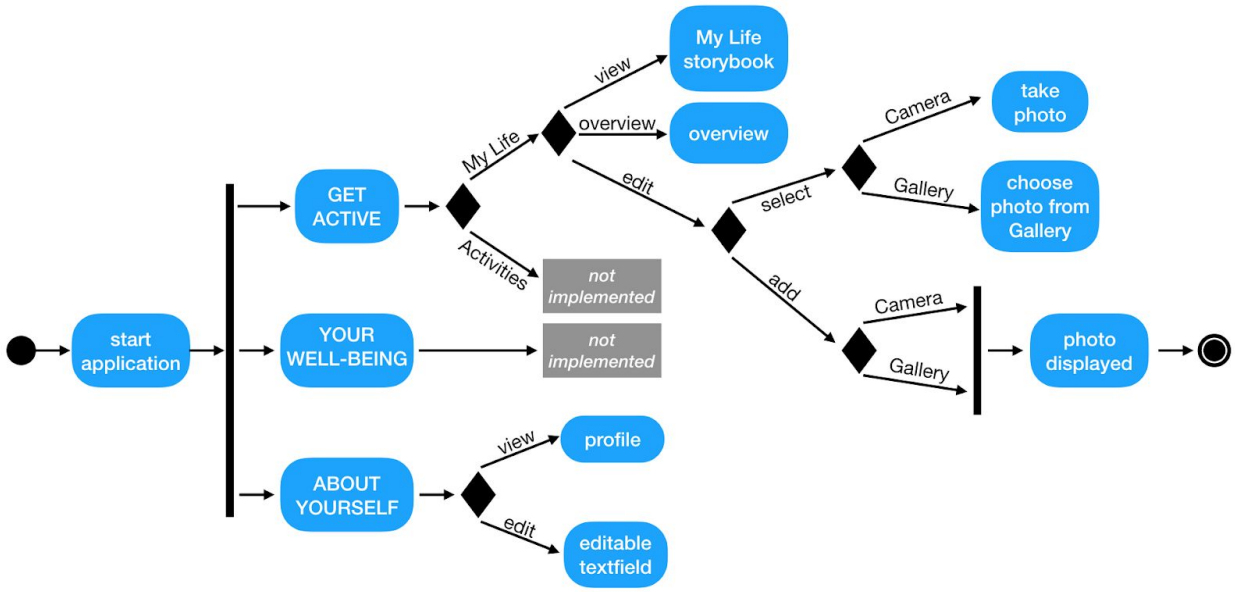


Figure 34: the activity diagram for the complete HiFi-prototype

6.3 Requirements verification

1) Add unlimitedly content from the library	Yes
2) View content	Yes
3) Different kinds of media in combination	Yes
4) Add captions and text	Yes
5) Take photo and add it	Yes
6) Change content	No
7) Overview	Yes
8) Profile	Yes
9) Other activities/ services	No
10) No internet	-
1) Usable by elderly: - Design: simple, intuitive, consistent, easily visible (big buttons/font), close to book, not too many options - User actions: indications for required actions, tabbing works best in general, but swiping for looking through the life storybook, not too many options	Yes
2) No lagging	Yes
3) Suitable for tablets	Yes

Table 7: list of requirements with an indication for whether they are met (yes) or not (no)

7 Evaluation

7.1 User testing

Having developed a working HiFi-prototype, it can now be evaluated through a second user testing. It consists of three parts, the user test, an interview and a questionnaire, and compared to the first user testing, it focussed on a broader range of aspects as will be explained in the following sections.

7.1.1 The purpose

A major difference between the HiFi- and LiFi-prototype is that the HiFi-prototype allows the user to add real content to the application. Next to that, the LoFi-prototype was missing different kinds of media. The results of the interview from the first user testing already indicated that a combination of different media types is best. However, it is still unclear what this combination should include. According to this missing information and the functionality that is new in the HiFi-prototype, the observations from the HiFi-prototype testing are supposed to give answer to the following two questions:

1) Which combination of media is most stimulating?
2) How well does the participant perform in adding a new content?

However, the participants are not only asked to use the HiFi-prototype, but also to answer a few questions in an interview. This process is aimed at testifying and clarifying the findings from the observations of the user test. Additionally, in the interview the participant's general opinion on the life-storybook-application is tried to be obtained. To round off the testing, the questionnaire is meant to reflect the participant's view on the application regarding usability, usefulness and user satisfaction. Its insight can be valuable because unlike the other testings it provides an output that can be determined through numbers.

7.1.2 The method

7.1.2.1 The measures

The ways of measuring the collected data are similar to the previous user testing, however, this time the interview is a lot shorter and mostly information is obtained from the user test itself. Measurement criteria for the observations made while the participants fulfill the tasks for the user test are: their actions, reactions and time spent on a screen which can be retraced through the video recordings. Concrete measurements are achieved through a questionnaire aimed at use of use, use of learning, usefulness and satisfaction. It consists of six statements that can be agreed or disagreed on with a rating scale from 'completely disagree' to 'completely agree'. To be able to interpret the observations even more accurate, a short interview will be conducted to find out more about the participants' preferences and opinions on the application. The interview includes six questions, which are open except for the one on the combinations of types of media, which is multiple choice.

7.1.2.2 The participants

Ideally, the participants would have been the same as in the previous user test, but this was unfortunately not possible. However, one of the experts could be recruited again and the volunteer. Additionally, one other volunteer participated. That way, there were in total three participants, two female and one male with a range of age between 28 and 60 years. The new participant has volunteered in a project called 'HelloMyDear' in which a digital life story was recorded and then converted into a photo album. As already explained for the first user testing, the expert is a researcher in the field psychology and the volunteer has been working with people with dementia on the creation of an online life storybook.

7.1.2.3 The procedure

After creating the questionnaire and formulating new questions for the interview, the participants of the previous user test have been contacted and invited to the second user test. Since only two of them were available, one extra participant was recruited. Two of the sessions took place on the UT campus and one in the library in the city centre of Enschede. They were held in English and took around 45 minutes. The data was collected in the same way as in the previous user testing: to record the audio of the interview the camera was taking a video while being pointed towards the table. During the user test the camera was directed so that it took a video of the screen of the tablet. No faces were included at any time of the recordings.
One session was conducted as follows:

An introduction to the project was not needed anymore, except for the one participant who has not been part of the previous user testing. Next, it was explained to them what is going to happen throughout this user test and that they will be video-recorded without faces. If they agreed with everything, they signed the consent form, that was given to them. Thereafter, the participant was given the tablet and the camera was positioned so that it pointed towards it and turned on. Then the user test started. The participant was asked to do the following tasks:

- Go through the content of the life storybook
- Go to the overview of the life storybook and inspect one event
- Edit your profile
- Add a new photo to the life storybook and give it a caption

Once the participant was done with these tasks, the camera was directed to the table and the participant was asked six questions about their opinion on the application and more specifically, which combination of media types they preferred. Finally, the camera was turned off and the participant was handed the questionnaire, which they were asked to fill out.

7.1.3 Results

The results of the prototype testing and interviews were achieved by analysing the recorded videos and the outcomes of the questionnaire were obtained by calculating the medium value given for each answer. As explained in 7.1.1, the prototype testing and interview are focussed on finding answers to the following two questions:

1) Which combination of media is most stimulating?
2) How well does the participant perform in adding a new content?

Furthermore, the interview and questionnaire are meant to show the participant's opinion on the life-storybook-application in general and its usability and usefulness. The results are split up according to the goal they refer to. First the results answering question 1 and 2 will be presented, then all the remaining results of the prototype testing and the interview and finally the outcome of the questionnaire.

7.1.3.1 Results of the prototype testing and interview on the types of media and adding content (question 1 and 2)

In order to answer question 1 about the best combination of media types, the HiFi-prototype contained three screens showing three different combinations of media: photos with a voice recording, a video and a photo with a song.

During the prototype testing, one of the tasks was to go through the content of the life storybook. In order to make a statement on which of the screens seems to be most stimulating, the participant's first reaction after opening the screen and the time they spent on this screen was noted. In the interview it was easier to get to such a statement since the participants could be asked directly which combination of media would trigger the most response. An overview over all data, consisting of the reactions and times of the prototype testing and the answers from the interview, collected regarding question 1 can be seen in figure 35.

Positive exclamations of the participants while looking through the screen are colored in orange and whenever they did not show any reaction or do any action, the corresponding part is colored in grey. This shows that there was more positive response to the photos with voice recording and the video than to the photo with song. A similar interpretation can be obtained from the time values indicating that with 5 seconds on average, the participants spent the least time on the screen including a photo and a song. Therefore, they might be least delighted by this combination. According to the times, the photo and voice seems most interesting with 24 seconds spent on this screen.

Opposed to that, with the answers from the interview, it becomes clear that the voice recording was perceived with scepsis by the participants. Two of them emphasized that it is important that the voice is familiar and one added that the voice has no effect if it unfamiliar. Regarding the other options, the video and the photo with song, all of the participants were convinced that they could trigger memories.

These results reveal a discrepancy between the participants' actions and reactions during the testing and their answers in the interview. A possible explanation could be the order of combinations in which they were presented to the participants: they are naturally more fascinated by something they encountered for the first time than by something they have already seen before. In addition to that, time spent on the first screen was also used to understand how everything works. This was the case for the second participant who was first busy thinking about what the play and pause button mean. Therefore, more time spent on a screen cannot only be interpreted as more interest, but can also be cause by other factors.

The conclusion is that the video was assessed positively in both cases, the testing and the interview, while for the photo and voice it was emphasized in the interview that the voice should be familiar. Photo and song were evaluated as stimulating in the interview, however, the

reactions in the prototype testing did not reflect that which might be due to the fact that this combination was shown last.

Which combination of media is most stimulating?

P	**prototype testing** task: Go through the content of the life storybook			**interview** question: Which combination of media triggers the most response?
	photo + voice	video	photo + song	answer
1	"What is this?" clicks play "Oh funny, I was asking 'What is this?' and then the voice said 'This is a picture of…'" **13 sec**	"Oh nice!" clicks play and pause **7 sec**	no reaction; does not click play, but immediately wants to go to next page **2 sec**	- all of them are very nice, stimulating and trigger memories - voice nice if user cannot read anymore, familiar voice even better
2	"Nice photos!" "I'm curious" clicks play **47 sec**	"Oh, this is very nice!" clicks play and pause **9 sec**	no reaction; recognises play and pause, but does not click them **10 sec**	- photo and voice does not work so well if voice is unfamiliar - song and video trigger memories but voice does not
3	no reaction; clicks play **13 sec**	no reaction; no action **5 sec**	no reaction; no action **4 sec**	- all three of them - moving photo more interesting - music and sound depends on the person - photos and videos definitely
avg	**24 sec**	**7 sec**	**5 sec**	

Figure 35: results from the prototype testing and interview on question 1

Next to that, the goal was to find out how well the HiFi-prototype works or more specifically, how well the participants perform in adding new content, as specified in question 2. To be able to answer this questions, in the prototype testing the participants were asked to do add a photo to the life storybook and give it a caption.

The table in figure 36 lists all actions of each participant throughout fulfilling this task. Whenever they did something wrong or showed a reaction signifying that something was wrong, the corresponding part in the table is marked in red. Furthermore, if the participant needed a hint to be able to continue with the task, it is highlighted in yellow. The steps each participant went through are similar, with the difference that the second one immediately started with the correct action and therefore has one wrong action and one hint less. The same participant also did not show a negative reaction after clicking the 'add'-button. The other two struggled at two moments, first in the very beginning, they chose the wrong button, and then after clicking 'add', the second button, they were confused that they had to choose 'gallery' again. All participants needed a hint before they swiped to see the added photo.

These struggles were also expressed in the answers the participants gave to the question if something was missing, confusing, unexpected or not working. One stated that the procedure of adding a picture in general is not working. To another participant it was confusing

which of the two buttons ‘select’ and ‘add’ to click first. The last one pointed out that it does not make sense that ‘gallery’ has to be chosen again after clicking ‘add’.

Besides that, two participants also added suggestions to their complaints: the idea was mentioned to make it visually logical which button has to be clicked first and more concretely, the buttons could appear in the order they have to be clicked, so that first only the ‘select’-button is shown and then only the ‘add’-button. With regards to adding a caption, no issues have been observed and the participants stated, that entering a caption is easy and logical.

In conclusion, three struggles occurred: the order in which the ‘select’- and ‘add’-buttons have to be clicked was not clear, the fact that ‘gallery’ has to be chosen twice was not perceived as logical and an indicator is missing that tells the user to swipe after adding a photo.

How well does the participant perform in adding new content?

P	**prototype testing** task: add a new photo to the life storybook and give it a caption	**interview** question: Was there something missing/confusing/ unexpected/not working?
	order of actions	answer
1	**first clicks ‘add’** —> *hint* —> clicks ‘select’ —> gallery —> photo clicks ‘add’ —> **surprised that gallery has to be chosen again** *hint* —> swipes to see added photo clicks on caption to enter text	- not working: procedure of adding a picture - it was very easy to enter data in the text fields
3	first clicks ‘select’ —> gallery —> photo —> clicks ‘add’ —> gallery *hint* —> swipes to see added photo clicks on caption to enter text	- confusing: difference between ‘add’ and ‘select’ is not clear; I was not sure which one to click first - suggestion: first only ‘select’ appears, then only ‘add’
3	**first clicks ‘add’** —> *hint* —> clicks ‘select’ —> gallery —> photo clicks ‘add’ —> **hesitates** —> chooses gallery *hint* —> swipes to see added photo clicks on caption to enter text	- unexpected: it does not make sense that you have to choose gallery again after clicking ‘add’ - suggestion: skip the choosing-part after ‘add’; make it visually logical which button to click first (referring to ‘select’ and ‘add’) - entering a caption is logical

Figure 36: results from the prototype testing and interview on question 2

7.1.3.2 Additional results of the prototype testing and interview

While observing the participants testing the HiFi-prototype, more deficiencies of the application have come to light, which were then also expressed in the interview. These weaknesses will be presented in this section. They refer to either the navigation, design or functionality of the application.

One navigational issue that was observed with all participants was that at some point they would have liked to go back to the homescreen of the application but could not because the application was missing a shortcut that would take them back immediately. Instead the participants had to click ‘back’ multiple times, which was time-consuming and made them feel

uncomfortable. Besides that, back buttons were missing on two screens, which did not only because apparent during the user testing but also was mentioned in the interview.

Another information obtained in the interview that relates more to the design of the application was that the homescreen should be designed so that it could be recognized as such. Further it was mentioned that the design should be more consistent and more pleasant.

Concerning the functionality of the application, the main issue that was observed during the user testing was that participants either clicked on fields which were not responsive or did not click on fields which were. Examples for that are the options on the homescreen, which are not responsive but the participants would have liked to click on them or the events of the overview that were not recognized as clickable by the participants even though they were. The information extracted from this is that there are not enough indications in the app for which action is required. Additionally, the area which could be clicked on, was sometimes too small as it was the case for the arrow of the drop down menu on the homescreen.

All these finding result in a list of things to do to improve the HiFi-prototype:

Navigation:

- more back buttons
- Make homescreen easily and quickly reachable

Design:

- Make homescreen more recognizable as homescreen
- More consistent and pleasant

Functionality:

- Indicate which user action is required
- Make area that can be clicked on bigger

7.1.3.3 Results of the questionnaire

The questionnaire contained six statements about the usefulness, user satisfaction, user friendliness and ease to learn also concerning a person with dementia. The participants could indicate whether they completely disagreed or completely agreed with the statement on a rating scale of five levels. Every level got assigned to a number, where 1 is ‘completely disagree’ and 5 is ‘completely agree’. Accordingly, a 3 means neutral. The average value per statement is shown in figure X. It shows that the participants agree the most that the application is useful and easy to learn. The categories satisfaction and user friendliness also with respect to a person with dementia got a neutral rating. From these results, it can be concluded that at this point the life-storybook-application still needs improvement and it is worth to put more effort into it since it is considered to be useful and easy to learn which increases the chance that it will be used in the future.

The app is easy to user/user friendly	**3**
It is easy to learn how to use the app.	**4**
The app is useful.	**4.7**
I am satisfied with the app.	**3**
The app would be easy to use for a person with dementia.	**3**
A person with dementia could learn how to user the app.	**3.3**

Table 8: the results of the questionnaire

7.2 Summarized results and iterated requirements

Answering question 1 about which media combination is most stimulating, it can be said that the video scored high in both, the prototype testing and the interview, while the photo with a song was supported as stimulating combination only in the interview. The photo with voice recording got a good response in the prototype testing, but in the interview it became apparent that the voice has to be familiar otherwise it does not have an effect.
The answer to question 2, how well the participants performed in adding content, is that the participants struggled adding a photo but found it easy to add a caption. The struggles arose from the fact that the order in which the buttons had to be clicked was not clear and having to choose twice from where the photo should be added seemed illogical. Furthermore, it was not intuitive to swipe in order to see the added photo.

Additional information that was obtained from the prototype testing and interview pointed out issues regarding the navigation, design and functionality of the application. With this information a to-do list could be formulated including things that can be done to fix these issues. The most important points are to add more back-buttons and a way to quickly reach the homescreen, to make the homescreen more recognizable as homescreen and the app more pleasant and consistent in general and to indicate what the user has to do where including big clickable areas.

Finally, the positive message gained through the questionnaire was that the application is considered to be useful and easy to learn, however, its user friendliness and satisfaction scored low. These results match with the previous findings, but also show that it is worth working on fixing the weaknesses of the life-storybook-application due to its usefulness.
An overview over all results and which requirements they influence is given in table 9. In this table, not only are the results assigned to the according requirement but it is also indicated which of the requirements can be marked as fulfilled after the second user test. Accordingly,

'yes' means fulfilled and 'no' means not fulfilled. To be able to see in an instance which requirements could not be met, the corresponding field is colored in red, otherwise it is green.

	Preliminary requirements	**Requirements after 1st user test**	**Requirements after 2nd user test**
1	Add content from library	Add unlimitedly content	Improve the procedure of adding a photo
2	View content		Yes
3	Different kinds of media	Different kinds of media in combination	Video > photo+song > photo+voice
4	Add captions		Adding a caption works well
5	Take photo and add it		Improve the procedure of adding a photo
6	Change content		No
7	overview		Yes
8	profile		Yes
9	Other activities/services		No
10	No internet		-
1	Usable by elderly	simple/intuitive Consistent design Design close to book Easily visible Indications for user actions Limited user actions	More back-buttons Home-button for quick access to the homescreen More consistent/pleasant design obvious homescreen Large clickable fields More indications for user actions
2	No lagging		Yes
3	Suitable for tablet		Yes

Table 9: list of requirements with the newly obtained results attached to them plus indications for whether the requirements after the 2nd user test are met (yes) or not (no)

7.3 Recommendations

Some of the conversations that happened within the user test did not only reveal information that was specifically asked for, but sometimes participants were thinking beyond the questions and proposed valuable suggestions for improving the life-storybook-application. These suggestions will be described in this section.
The life-storybook-application already includes a profile for the person with dementia, but this functionality could be extended by making it possible to create multiple accounts. That way, everyone around the person with dementia gets directly involved in the application and can easily contribute to it. Making additionally an online version out of the life-storybook-application would allow the users to access the app from multiple devices and add content to it. As a consequence collecting material for the life storybook becomes a lot easier since it can simply be shared on the app and is therefore not dependent on locations anymore. Since it does not take a lot of effort to collect data and multiple people can add to it, the quality of the content of the life storybook can be increased. Its content could be enriched by adding material from the internet, e.g. a video from youtube.

Having multiple accounts would also make it possible to provide the user with different versions of the application depending on who logged in. That can be useful because not all options should be accessible by the person with dementia like for example a delete button. Accordingly, in the version of the application that comes up if the person with dementia is logged in some options should be locked.

A suggestion different from the previous ones is to bridge the gap between the digital and an analog life storybook by making the one convertible into the other. Concretely, the idea was to include a ‘print’-button in the app, that transforms the content of the life-storybook-application into a physical book. By combining app and book the issue can be tackled that people with dementia are not used to interacting with a tablet and therefore would prefer holding a book.

7.4 Discussion

As it was already touched upon, at the end of the previous chapter, a major issue of the life-storybook-application is the fact that most commonly people with dementia do not have any experience in using an application. Throughout the process of this project, this issue has always been taken into consideration and was tried to diminish by making the application as usable for elderly with dementia as possible. However, compared to a physical book, some restrictions remain, for example that the person with dementia might not be able to spontaneously grab the application and look through it like they would do it with a book, because they cannot use it by themselves. Additionally, there is the challenge of convincing elderly of something they do not know. On the other side, introducing something new always means that obstacles have to be overcome first. And the life-storybook-application also comes with a lot of advantages like its interactivity, the multimedia aspect, the fact that it is cheap and more dynamic, to recall only some of them. Next to that, the situation in dementia care should not be forgotten: there, new

ways of providing care are trying to be found in order to adapt to recent changes, e.g. elderly living longer at home. The main pillar in this process of restructuring is technology. Innovations like the life-storybook-application perfectly fit into this process and show how technology can provide solutions to these changes.

Looking at the current situation in dementia care and all the benefits that the life-storybook-application offers, the earlier mentioned obstacles do not seem so severe anymore. And it should be kept in mind that they will diminish with time progressing since younger generations will get older and to them these issues do not apply anymore. Therefore, even if the life-storybook-application might not be a solution yet at the moment - it can be in the future.

8 Conclusion and Future Work

8.1 Conclusion

Going back to the beginning, this project started off with the research question, how the digitalisation of a life storybook can enhance its user experience. An answer to his question was found by developing and evaluating a life-storybook-application. Prior to that, in order to be able to realize this application, knowledge had to be gathered. This was done through a literature research, that tried to approach the research question from its fundamentals: starting with researching different kinds of treatment methods for dementia, in the next step the focus was on one of the treatment methods, reminiscence therapy, which then lead to the life storybooks and their digital version. These digital versions already exist in many variations which were presented in a research on related work. At this point, the research was completed and it was moved on towards creating the life-storybook-application.

Firstly, thought was put into how to set up a LoFi-prototype. The input for the LoFi-prototype was provided by the outcome of the research on related work and by the results of a brainstorm. Finally, the prototype was completed and evaluated in a first user test. This user test was aimed at receiving a better understanding of people with dementia in general and their response to technology. Furthermore, the prototype was tested on its usability. With the results of the first user test it was possible to formulate detailed criteria for what it means to make the application usable for elderly.

This information was then used to develop a HiFi-prototype of the life-storybook-application. Also the HiFi-prototype was evaluated in a user test, which this time was more geared towards the functionality and content of the application. Accordingly, the two main goals were to find out if it works to add content and which types of media are considered to be most stimulating. The results were that the procedure of adding content requires improvement and that photos in combination with a video, song or a familiar voice are attributed with the effect that memories are triggered. Since this is the primary goal of a life storybook and it can be achieved through multimedia which is one of the features only a digital life storybook can offer, it can be concluded that the digitalisation does enhance the user experience of a life storybook.

8.2 Future Work

In the further development of the life-storybook-application, the focus should be put on improving its functionality of adding content. This can be achieved by making the procedure required for adding content more understandable and intuitive, e.g. by shorten the amount of steps and by changing the buttons so that it is clear in which order they should be clicked. More weaknesses of the life-storybook-application that are in need of improvement can be found in the to-do list presented at the end of section 7.1.3.2. Additionally, it should be made possible to

change the content of the life storybook, which was a requirement in this project, that could not be fulfilled. In a future version of the application, also some of the recommendations of chapter 7.3 can be included to make use of the possibilities offered by technology even more. In general, there were many more ideas mentioned throughout this project that have been left out for simplicity reasons, but implementing them can increase the quality and uniqueness of the life-storybook-application. One of these ideas was to not only offer a digital life storybook to the user, but also suggest different kinds of activities to them, like playing a game or cooking their favorite recipe. Another idea, that focuses on increasing the interactivity of the application, was to allow the user to give feedback on their well-being and according to this information the app would respond with visualizations or suggestions that are appropriate for the user's current condition. In future, besides improving the deficiencies of the current life-storybook-application and adding more functionality to it, it is also very important to test it directly with people with dementia.

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10 Appendix

10 A. Interview questions

10 A.1 Interview questions of the first user test

Questionnaire about 'life-storybook-app' for elderly with dementia

For my graduation project, I am developing an application on a tablet that is meant to support people suffering from dementia. The application is based on 'Life storybooks', a collection of the most important events in a person's life. The life story book is similar to a photo-album.

In order to create an useful and good 'life story' application, it is important to understand and find out how the application can be simple to use and suitable for users and people of dementia. Due to your valuable experience with creating actual life story books, I would kindly like to ask you to answer the following questions. Your contribution is much appreciated and useful.

Thank you in advance for your time and effort.

People with dementia

In the following section there will be questions about the patients (people with dementia).

1. Are people with dementia aware that they suffer from dementia?

2. What do people with dementia struggle with the most in daily life? What gives them the most joy?

3. What motivates people with dementia and what frustrates them?

4. How problematic are negative memories for people with dementia?

Dementia care

The following section is about your experiences in dementia care.

5. What is the biggest challenge in the work with demented elderly?

6. What kind of memory-assistants for people with dementia do you know?

7. Which method of treating dementia have you found most effective?

8. Have you already used digital life-storybooks before and if yes what was your experience?

- ◯ No
- ◯ Yes:

9. Have you made use of reminiscence therapy and if yes, did you encounter any negative experiences or risks while using it?

- ◯ No
- ◯ Yes:...

10. The goal of this app is to generate positive emotions among the patients. Is there a chance of causing the opposite like creating discouragement among patients using the app since they get constantly reminded of the fact that they cannot remember?

chance of causing discouragement

0 — 100

11. What are the most meaningful indicators when assessing the well-being of the patients?

People with dementia using the application

The following questions refer to people with dementia interacting with technology and, more specifically, with the life-storybook-application. This application is based on real life-storybooks, which means it can be considered as the digitised version of a real book.The life story book is a collection of the most important events in a person's life and is similar to a photo-album.

12. Have the patients been in contact with other technological devices and if yes, how was their response and what was the outcome?

- ○ No
- ○ Yes:

13. Which problems have you experienced with demented elderly using technology?

14. Which of the following design options would you say is more promising?

- ☐ The design of the app is kept is close as possible to an actual book to imitate known experiences patients have using a book.
- ☐ The app includes digital user actions like scrolling or swiping but in such a way that it seems intuitive.
- ☐ None of the above.

Further comments:

15. Which properties of an actual book should be transferred to the app, that you wish to see in the app?

16. How would you estimate the patients' willingness to use the app?

low willingness				high willingness
○	○	○	○	○

17. What could be an important feature that the app should have to make the patients motivated to use the app?

18. Which patients are most suitable for using this app?

19. Who else will be needed for the patients to be able to use the app? What else?

20. Which actions can be executed by the patients themselves (supposing that the patient has early to mild dementia)?

- ○ tabbing
- ○ reading
- ○ scrolling/swiping
- ○ deciding between multiple options offered by the app
- ○ typing
- ○ Other (please specify)

21. How much can or should the patient be included into using the app (supposing that the patient has mild dementia)?

very little: the patient is only passively watching someone else using the app				a lot: the patient should hold the tablet and actively use the app themselves
○	○	○	○	○

22. Which of the following media do you think triggers the most response? (multiple options can be checked)

- ◯ photos
- ◯ videos
- ◯ sound/songs
- ◯ voice recordings of familiar voices
- ◯ Other (please specify)

23. Next to the life-storybook I would also like to include other functionalities in the app. One idea is to create moodboards from certain memories that are part of the life-storybook, that are meant to stimulate the patient in a certain way. An example of a moodboard can be seen below. Do you think that could be a useful/effective functionality?

- ◯ Yes
- ◯ I don't know
- ◯ No, because:

24. The life-storybook does not only include personal memories, but also information about general historic events that happened throughout the patient's life. Could that mix between general and personal content be confusing or could certain general content, e.g. war photos even be disturbing?

- ◯ No
- ◯ I don't know
- ◯ Yes, because:

25. Now, we move to prototype of the application.
Imagine when you start the Life storybook application on the tablet, the following screen shows up. Do you find it clear how to get to where?

- ◯ Yes
- ◯ No, because:

26. By clicking on the 'How are you feeling?-tab' you will get to choose between the options 'physically' or 'mentally' which will lead you to one of the following screens accordingly. Do you think that by answering the questions with the provided options you can give an accurate image about your feelings? Are the questions and answering options clear to you?

27. By clicking on the 'What would you like to do?-tab' you will get to the following screen showing options concerning the life storybook. If you wanted to upload a new image to the life storybook app, which button would you click on?

- ◯ go back to the home screen
- ◯ click on the 'view'-field
- ◯ click on the 'edit'-field
- ◯ click on the 'overview & search'-field
- ◯ none of the above

28. The following screens show the process of uploading a new image to the life storybook. Can you explain what you can do on screen 1 and 2?

1) **2)**

3)

10 A.2 Interview questions of the second user test

- Was there something missing/unexpected/confusing/not working?
- Who would use the application the most?
- What would trigger the most response?
    - → photo + voice
    - → video
    - → photo + song
    - → photo + …
- What is beneficial about the app compared to the real book?
- What could become problematic when trying to implement the app into daily life care?
- Would you prefer using the app over the book?

10 B. Questionnaire

Julia Pühl, j.c.puhl@student.utwente.nl 09/07/18

Questionnaire on the user experience with the 'life-storybook-application'

The application is easy to use/user friendly.

O O O O O

completely disagree *completely agree*

It is easy to learn how to use the application.

O O O O O

completely disagree *completely agree*

The application is useful.

O O O O O

completely disagree *completely agree*

I am satisfied with the application.

O O O O O

completely disagree *completely agree*

The application would be easy to use for a person with dementia (regarding buttons, layout, font-size).

O O O O O

completely disagree *completely agree*

A person with dementia could learn how to use the application.

O O O O O

completely disagree *completely agree*

Thank you! :)

10 C. Informed Consent Form

Information Sheet and Consent

Study Title: Developing a 'life-storybook-application' for elderly with dementia
Investigator: Julia Pühl
j.c.puhl@student.utwente.nl
+49-17620803523
Supervisors: Khiet Truong k.p.truong@utwente.nl, Deniece Nazareth d.s.nazareth@utwente.nl
For independent information about participating in the study contact:
De secretaris van de Ethische Commissie van de faculteit EWI, mw. J.M. Strootman-Baas, mail: ethics-comm-ewi@utwente.nl, tel. 053-489 6719

This project is motivated by the fact that the number of people affected by dementia is increasing and additionally, many of the commonly used treatment methods lack efficacy or only address some of the symptoms of dementia. The focus of this project is on a treatment method called reminiscence therapy, which is about bringing back and keeping memories. Reminiscence therapy often uses 'life storybooks', a collection of the most important events in a person's life, as a tool to capture and illustrate these memories. By reviewing and thinking about their own life events, the feeling of self-esteem and identity is becoming stronger in people with dementia. Life story books allow people with dementia to maintain and share their memories with their family members, caregivers and others. It can also encourage better communication with people with dementia.

You are being asked to participate in this study because of your valuable experience with people with dementia and with creating actual life storybooks. The insights you can provide with your knowledge will help me to create a useful and good 'life-storybook-application', that is suitable for people with dementia.

The purpose of this study is to find out how digital life-storybooks can be designed to enhance user experience and usability. If you choose to participate in this study, you will be asked questions about people with dementia, their interaction with technology, about the app itself and about dementia care in general. Furthermore, you will be asked to interact with a prototype of the application.

If you choose to participate in this study, the following procedure will occur:

- You will be asked to sign this information brochure and consent form
- After signing, you will be given a tablet with a prototype of the 'life-storybook-application' on it.
- You will then be asked to perform some tasks using the application:

- Once you have finished these tasks, you have completed the testing of the prototype and you will then be interviewed about the application, about people with dementia and their interaction with technology and about dementia care in general.
- After the interview, you are done with the research. In total, it will take a maximum of 45 minutes.

First option (in case of video): During the testing of the application, your interaction with the tablet will be video recorded,[KT1] which means that the camera will be focussed on the tablet and your face will be excluded from the video.
Second option (in case of audio): During the testing of the application, audio will be recorded, capturing statements you might give and the conversation between you and the researcher.

If you sign this informed consent, you voluntarily participate in this research. You can decide to stop the research at any time. Notify the researcher right away if you wish to stop being in the study.

Your participation is valuable to scientific research as the info you provide may help among other researchers in the field of dementia care to understand how to optimize treatment techniques combined with technology and what works and what does not.
The personal information gathered for this study will be kept private. We will anonymize all personal information. If information from this study is published or presented at scientific meetings, your name and other personal information will not be used. Furthermore, the personal data collected in this study will be deleted after five months.

You can talk to the researcher about any questions, concerns, or complaints you have about this study. Contact the researcher Julia Pühl at j.c.puhl@student.utwente.nl or her supervisors Khiet Truong k.p.truong@utwente.nl and Deniece Nazareth d.s.nazareth@utwente.nl

By signing this informed consent I hereby declare that:

- in a manner obvious to me, to be informed about the nature, method, target and risks of the investigation.
- I know that my data will be accessible and analyzed by the main investigator Julia Pühl, the supervisors (Khiet Truong, Deniece Nazareth), and other researchers employed by the department of Electrical Engineering, Mathematics and Computer Science.
- I know that the data and results of the study will only be published anonymously.
- My questions have been answered satisfactorily.
- My personal data will remain anonymous and will be destroyed after five months
- I voluntarily agree to take part in this study. While I reserve the right to terminate my participation in this study without giving a reason at any time.
- I understand that the video recordings will not include faces and thus are anonymous
- I understand that the audio in the video will only be used for transcript purposes
-

Name participant:.....
Date:..... Signature: .....
If you want to be updated about the results of the research, write down your email address below:
Email:.....

To complete by the executive researcher
I have given a spoken and written explanation of the study. I will answer remaining questions about the investigation into power. The participant will not suffer any adverse consequences in case of an early termination of participation in this study.
Name researcher:
.....
Date: ..... Signature:.....

[KT1]Not sure if this already necessary – you can also make notes and then videotaping is not necessary in this phase.

10 D. Application code of the main functionality

```
package com.example.juli.homescreen;

import android.Manifest;
import android.app.Activity;
import android.content.Context;
import android.content.ContextWrapper;
import android.content.DialogInterface;
import android.content.Intent;
import android.content.pm.PackageManager;
import android.content.res.Resources;
import android.graphics.Bitmap;
import android.graphics.BitmapFactory;
import android.graphics.drawable.BitmapDrawable;
import android.net.Uri;
import android.provider.MediaStore;
import android.support.v7.app.AlertDialog;
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.util.Log;
import android.view.Gravity;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;
import android.widget.ImageView;
import android.widget.LinearLayout;
import android.widget.TextView;
import android.widget.Toast;

import java.io.ByteArrayOutputStream;
import java.io.File;
import java.io.FileInputStream;
import java.io.FileNotFoundException;
import java.io.FileOutputStream;
import java.io.IOException;
import java.text.SimpleDateFormat;
import java.util.Date;
//import android.class.NinePatchChunk;

public class Gallery extends AppCompatActivity {

    private static final int CAMERA_REQUEST = 1888;
    public static final int CAMERA_PERMISSION_REQUEST_CODE = 234;
    //ImageView imageView;
    ImageView imageView2;
    LinearLayout layout;
    LinearLayout layoutl;
```

```
  LinearLayout layoutT;
  LinearLayout layoutH;
  Bitmap bitmap;
  Uri selectedImageUri;
  Integer SELECT_FILE=0;
  Integer id=1;

  private Button backgallery;

  ImageView imageView;
  Bitmap imageSaved;

  TextView textView;
  //TextView header;
  EditText editText;



  @Override
  protected void onCreate(Bundle savedInstanceState) {
      super.onCreate(savedInstanceState);
      setContentView(R.layout.activity_gallery);

      textView = new TextView(Gallery.this);
      editText = new EditText(Gallery.this);
      textView.setId(id++);
      editText.setId(id++);

      imageView = new ImageView(Gallery.this);
      imageView.setId(id++);
      if(savedInstanceState!=null) {
          String savedText = savedInstanceState.getString("first");
          textView.setText(savedText);
          imageSaved = savedInstanceState.getParcelable("BitmapImage");
          imageView.setImageBitmap(imageSaved);
      }

      backgallery = findViewById(R.id.backgallery);
      backgallery.setOnClickListener(new View.OnClickListener() {
          @Override
          public void onClick(View view) {
              openActivity3();
          }
      });



      layout = findViewById(R.id.layout);
      layoutI = findViewById(R.id.layoutI);
```

```
        layoutT = findViewById(R.id.layoutT);
        layoutH = findViewById(R.id.layoutH);
        //llCaption = findViewById(R.id.llCaption);
        Button photoButton = findViewById(R.id.button);
        Button addC = findViewById(R.id.addC);

        photoButton.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View view) {

                SelectImage();

                /*ImageView imageView = new ImageView(MainActivity.this);

                loadImageFromStorage(saveToInternalStorage(bitmap), imageView);
                imageView.setImageURI(selectedImageUri);
                addView(imageView, 200, 200);*/

            }
        });
        addC.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View view) {

                AddImage();

            }
        });

        /*int selectedNumber = 1;
        if (getIntent().getExtras() != null) {
            selectedNumber = getIntent().getExtras().getInt("Selected number");
        }
        if (selectedNumber == 2) {
            int id = imageView.getId();
            imageView.setImageResource(id);
        }*/

    }



    public void openActivity3() {
        Intent intent = new Intent (this, Activity3.class);
        startActivity(intent);
        overridePendingTransition(R.anim.slide_in_left, R.anim.slide_out_right);
    }
    public void openScrollingActivity() {
        Intent intent = new Intent (this, ScrollingActivity.class);
        startActivity(intent);
```

```
        overridePendingTransition(R.anim.slide_in_left, R.anim.slide_out_right);
    }

    public static int getScreenWidth() {
        return Resources.getSystem().getDisplayMetrics().widthPixels;
    }

    public static int getScreenHeight() {
        return Resources.getSystem().getDisplayMetrics().heightPixels;
    }

    private void AddImage(){



        final CharSequence[] items={"Camera","Gallery", "Cancel"};

        AlertDialog.Builder builder = new AlertDialog.Builder(this);
        builder.setTitle("Add Image from:");

        builder.setItems(items, new DialogInterface.OnClickListener() {

            @Override
            public void onClick(DialogInterface dialogInterface, int i) {
                if (items[i].equals("Camera")) {

                    //imageView = new ImageView(Gallery.this);
                    //textView = new TextView(Gallery.this);
                    final TextView header = new TextView(Gallery.this);
                    //textView.getEditableText();
                    loadImageFromStorage(saveToInternalStorage(bitmap), imageView);


                    addView(imageView, getScreenWidth()-200, getScreenHeight()-1000);
                    Log.i("checkWidth", String.valueOf((getScreenWidth()-200)));
                    Log.i("checkHeight", String.valueOf((getScreenHeight()-1000)));
                    addViewText(textView, getScreenWidth()-200, 150, id);
                    addViewHeader(header, getScreenWidth()-200, 150, id);

                    textView.setGravity(Gravity.CENTER);
                    textView.setTextSize(40);
                    textView.setText("Click to add text");

                    header.setGravity(Gravity.CENTER);
                    header.setTextSize(40);
                    header.setText("Click to add header");

                    imageView.setForegroundGravity(Gravity.CENTER);

                    /*BitmapDrawable drawable = (BitmapDrawable) imageView.getDrawable();
```

```
                Bitmap bitmap = drawable.getBitmap();
                ByteArrayOutputStream stream = new ByteArrayOutputStream();
                bitmap.compress(Bitmap.CompressFormat.PNG, 100, stream);
                Log.i("check", bitmap.toString());
                byte[] arr = stream.toByteArray();
                Intent intent = new Intent(Gallery.this, EmptyActivity.class);
                intent.putExtra("image", arr);
                startActivity(intent);*/



                final AlertDialog dialog = new AlertDialog.Builder(Gallery.this).create();
                final AlertDialog dialogH = new AlertDialog.Builder(Gallery.this).create();
                editText = new EditText(Gallery.this);
                final EditText editTextH = new EditText(Gallery.this);
                dialog.setTitle("Edit the text");
                dialogH.setTitle("Edit the text");
                dialog.setView(editText);
                dialogH.setView(editTextH);
                dialog.setButton(DialogInterface.BUTTON_POSITIVE, "Save text", new
DialogInterface.OnClickListener(){
                    @Override
                    public void onClick(DialogInterface dialogInterface, int i) {
                        textView.setText(editText.getText());
                        header.setText(editTextH.getText());
                    }
                });


                textView.setOnClickListener(new View.OnClickListener() {
                    @Override
                    public void onClick(View view) {
                        editText.setText(textView.getText());
                        dialog.show();

                    }
                });

                dialogH.setButton(DialogInterface.BUTTON_POSITIVE, "Save text", new
DialogInterface.OnClickListener(){
                    @Override
                    public void onClick(DialogInterface dialogInterface, int i) {
                        header.setText(editTextH.getText());
                    }
                });

                header.setOnClickListener(new View.OnClickListener() {
                    @Override
                    public void onClick(View view) {
                        editTextH.setText(header.getText());
```

```
                    dialogH.show();

                }
            });

            //textView.setText("so this is a long ass text just to try it out and see what happens because i have no
clue");

            //addViewImage(imageView, textView, 1000, 1500,1000, 50, id);
            /*LinearLayout.LayoutParams captionViewlayoutParams = new LinearLayout.LayoutParams(
                    width, height);
            captionViewlayoutParams.addRule(BELOW, imageView.getId());
            textView.setLayoutParams(captionViewlayoutParams);
            llCaption.addView(textView);*/
            //addViewText(textView, 100, 100, id);
            //id = id+1;

        } else if (items[i].equals("Gallery")) {

            final TextView header = new TextView(Gallery.this);
            final TextView textView = new TextView(Gallery.this);

            ImageView imageView = new ImageView(Gallery.this);
            imageView.setImageURI(selectedImageUri);
            textView.setText("so this is a long ass text just to try it out and see what happens because i have no
clue");
            textView.setGravity(Gravity.CENTER);
            textView.setTextSize(40);
            addView(imageView, getScreenWidth()-200, getScreenHeight()-1000);
            addViewText(textView, getScreenWidth()-200, 150, id);
            addViewHeader(header, getScreenWidth()-200, 150, id);

            textView.setGravity(Gravity.CENTER);
            textView.setTextSize(40);
            textView.setText("Click to add text");

            header.setGravity(Gravity.CENTER);
            header.setTextSize(40);
            header.setText("Click to add header");

            imageView.setForegroundGravity(Gravity.CENTER);

            final AlertDialog dialog = new AlertDialog.Builder(Gallery.this).create();
            final AlertDialog dialogH = new AlertDialog.Builder(Gallery.this).create();
            editText = new EditText(Gallery.this);
            final EditText editTextH = new EditText(Gallery.this);
            dialog.setTitle("Edit the text");
            dialogH.setTitle("Edit the text");
            dialog.setView(editText);
            dialogH.setView(editTextH);
```

```
                dialog.setButton(DialogInterface.BUTTON_POSITIVE, "Save text", new
DialogInterface.OnClickListener(){
                    @Override
                    public void onClick(DialogInterface dialogInterface, int i) {
                        textView.setText(editText.getText());
                        header.setText(editTextH.getText());
                    }
                });


                textView.setOnClickListener(new View.OnClickListener() {
                    @Override
                    public void onClick(View view) {
                        editText.setText(textView.getText());
                        dialog.show();

                    }
                });

                dialogH.setButton(DialogInterface.BUTTON_POSITIVE, "Save text", new
DialogInterface.OnClickListener(){
                    @Override
                    public void onClick(DialogInterface dialogInterface, int i) {
                        header.setText(editTextH.getText());
                    }
                });

                header.setOnClickListener(new View.OnClickListener() {
                    @Override
                    public void onClick(View view) {
                        editTextH.setText(header.getText());
                        dialogH.show();

                    }
                });

            } else if (items[i].equals("Cancel")) {
                dialogInterface.dismiss();
            }
        }

    });
    builder.show();

}

  public void addView (ImageView imageView, int width, int height) {
    LinearLayout.LayoutParams layoutParams = new LinearLayout.LayoutParams(width, height);
    layoutParams.setMargins(125, 50, 125, 10);
    imageView.setLayoutParams(layoutParams);
```

```
        //imageView.setId(i++);
        layoutI.addView(imageView);
    }
    public void addViewText (TextView textView, int width, int height, int i) {
        LinearLayout.LayoutParams layoutParams = new LinearLayout.LayoutParams(width, height);
        layoutParams.setMargins(125, 50, 125, 5);
        //layoutParams.addRule(BELOW, imageView.getId());
        textView.setLayoutParams(layoutParams);
        textView.setId(i++);
        layoutT.addView(textView);
    }
    public void addViewHeader (TextView textView, int width, int height, int i) {
        LinearLayout.LayoutParams layoutParams = new LinearLayout.LayoutParams(width, height);
        layoutParams.setMargins(125, 10, 125, 5);
        //layoutParams.addRule(BELOW, imageView.getId());
        textView.setLayoutParams(layoutParams);
        textView.setId(i++);
        layoutH.addView(textView);
    }

    public void addViewImage (ImageView imageView, TextView textView, int widthI, int heightI, int widthT, int heightT,
int i) {
        LinearLayout.LayoutParams layoutParamsI = new LinearLayout.LayoutParams(widthI, heightI);
        layoutParamsI.setMargins(175, 50, 175, 10);
        imageView.setLayoutParams(layoutParamsI);
        LinearLayout.LayoutParams layoutParamsT = new LinearLayout.LayoutParams(widthT, heightT);
        //layoutParamsT.setMargins(175, 50, 175, 10);
        textView.setLayoutParams(layoutParamsT);
        imageView.setId(i);
        textView.setId(i);
        layout.addView(imageView, 1, layoutParamsI);
        layout.addView(textView,2, layoutParamsT);
    }



    private void SelectImage(){

        final CharSequence[] items={"Camera","Gallery", "Cancel"};

        AlertDialog.Builder builder = new AlertDialog.Builder(this);
        builder.setTitle("Select image from:");

        builder.setItems(items, new DialogInterface.OnClickListener() {

            @Override
            public void onClick(DialogInterface dialogInterface, int i) {
                if (items[i].equals("Camera")) {

                    invokeCamera();
```

```
            } else if (items[i].equals("Gallery")) {

                Intent intent = new Intent(Intent.ACTION_PICK,
MediaStore.Images.Media.EXTERNAL_CONTENT_URI);
                intent.setType("image/*");
                startActivityForResult(intent, SELECT_FILE);

            } else if (items[i].equals("Cancel")) {
                dialogInterface.dismiss();
            }
        }

    });
    builder.show();

}


private void invokeCamera() {
    if (checkSelfPermission(Manifest.permission.CAMERA) == PackageManager.PERMISSION_GRANTED) {
        Intent cameraIntent = new Intent(MediaStore.ACTION_IMAGE_CAPTURE);
        startActivityForResult(cameraIntent, CAMERA_REQUEST);
    } else {
        String[] permissionRequest = {Manifest.permission.CAMERA};
        requestPermissions(permissionRequest, CAMERA_PERMISSION_REQUEST_CODE);
    }
}

private String saveToInternalStorage(Bitmap bitmapImage){
    ContextWrapper cw = new ContextWrapper(getApplicationContext());
    // path to /data/data/yourapp/app_data/imageDir
    File directory = cw.getDir("imageDir", Context.MODE_PRIVATE);
    // Create imageDir
    File mypath=new File(directory,getPictureName());
    Log.i("pathsaved", mypath.toString());

    FileOutputStream fos = null;
    try {
        fos = new FileOutputStream(mypath);
        // Use the compress method on the BitMap object to write image to the OutputStream
        bitmapImage.compress(Bitmap.CompressFormat.PNG, 100, fos);
    } catch (Exception e) {
        e.printStackTrace();
    } finally {
        try {
            fos.close();
        } catch (IOException e) {
            e.printStackTrace();
        }
```

```
        }
        return directory.getAbsolutePath();
    }


    private String getPictureName() {
        SimpleDateFormat sdf = new SimpleDateFormat("yyyyMMdd_HHmmss");
        String timestamp = sdf.format(new Date());
        String pictureName = "image" + timestamp + ".jpg";
        return pictureName;
    }



    private void loadImageFromStorage(String path, ImageView image)
    {

        try {
            File f=new File(path, getPictureName());
            Log.i("fileloaded", f.toString());
            Bitmap b = BitmapFactory.decodeStream(new FileInputStream(f));

            image.setImageBitmap(b);
        }
        catch (FileNotFoundException e)
        {
            e.printStackTrace();
        }

    }



    @Override
    public void onActivityResult (int requestCode, int resultCode, Intent data){
        super.onActivityResult(requestCode, resultCode, data);
        if(resultCode== Activity.RESULT_OK){

            if(requestCode==CAMERA_REQUEST){

                bitmap = (Bitmap)data.getExtras().get("data");
                Log.i("info", bitmap.toString());
                //imageView.setImageBitmap(bitmap);
                saveToInternalStorage(bitmap);

            }else if(requestCode==SELECT_FILE){

                selectedImageUri = data.getData();
```

```
            /*try {
                bitmap = MediaStore.Images.Media.getBitmap(this.getContentResolver(), selectedImageUri);
            } catch (IOException e) {
                e.printStackTrace();
            }*/
        }

    }



}


    @Override
    public void onSaveInstanceState(Bundle savedInstanceState) {
        savedInstanceState.putString("first", textView.getText().toString());
        super.onSaveInstanceState(savedInstanceState);
        savedInstanceState.putParcelable("BitmapImage", bitmap);
        //savedInstanceState.putString("path_to_pic", saveToInternalStorage(bitmap));
    }

    /*@Override
    protected void onRestoreInstanceState(Bundle savedInstanceState) {
        super.onRestoreInstanceState(savedInstanceState);
        imageSaved = savedInstanceState.getParcelable("BitmapImage");
        imageView.setImageBitmap(imageSaved);

    }*/


    @Override
    public void onRequestPermissionsResult(int requestCode, String[] permissions, int[] grantResults){
        Gallery.super.onRequestPermissionsResult(requestCode, permissions, grantResults);
        if (requestCode == CAMERA_PERMISSION_REQUEST_CODE) {
            if (grantResults[0] == PackageManager.PERMISSION_GRANTED) {
                invokeCamera();
            } else {
                Toast.makeText(this, "Cannot take photo without permission", Toast.LENGTH_LONG).show();
            }
        }
    }
}
```