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Austrian Health Care Application for Refugees

Developing an Austrian Health Care System Mobile Application for Refugees Using Only Visual Language

Diploma Thesis

For attainment of the academic degree of
Dipl.-ing.für technisch-wissenschaftliche Berufe

in the Masters Course Digital Media Technology at St. Pölten
University of Applied Sciences, **specialized area Masters of Interface Design and Engineering**

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St. Pölten, 10.09.2018

Declaration

- The attached research paper is my own, original work undertaken in partial fulfillment of my degree.

- I have made no use of sources, materials or assistance other than those which habe been openly and fully acknowledged in the text. If any part of another person's work has been quoted, this either appears in inverted commas or (if beyond a few lines) is indented.

- Any direct quotation or source of ideas has been identified in the text by author, date, and page number(s) immediately after such an item, and full details are provided in a reference list at the end of the text.

- I understand that any breach of the fair practice regulations may result in a mark of zero for this research paper and that it could also involve other repercussions.

Date: ___09.09.2018___   Signature: ___Perihan Rashed___

Acknowledgements

Abstract

The number of refugees increases on a daily basis in Austria. The language barrier is one of the main obstacles these refugees face when they reach their new home. A solution to this obstacle could be a visual language. This research focuses on exploring how the field of icons and silent instructional animations can help refugees. A healthcare application is developed using visual tools to explain the basic aspects of the health care system like how to schedule an appointment with a doctor in Austria.

The mobile application was developed in three phases using a user-centered approach. The target group was intensively involved in each of those phases. An extensive literature review was conducted to understand the psychology of humans when observing iconic representation and animations. The first phase consisted of interviews with refugees living in Austria to understand their user needs. Secondly, there was a mid evaluation questionnaire with foreigners in Austria before the final prototype was implemented. Lastly, the final user test involved refugees from five different countries.

The first workshops for the concept development involved the Lower Austrian Health Care System as well as the Media and Computing Research Group of the University of Applied Science in Sankt Pölten. The Lower Austrian refugees organization LARES, contact the refugees to participate in this research.

The expected outcome of this study is proven to be valid; developing an Austrian healthcare application with only icons and silent instructional animation would help refugees understand the health care system and overcome the language barrier. The data collected from this study could be a start for many developments in the future.

Kurzfassung

Die Zahl der Flüchtlinge steigt täglich in Österreich. Allein in einem fremden Land zu sein, könnte das Leben sehr schwierig sein, besonders wenn man die Sprache nicht kennt. Die visuelle Sprache könnte eine einheitliche Lösung sein, die jeder verstehen kann. Diese Forschung konzentriert sich auf die Erforschung von Icons und stillen Lernanimationen mit Flüchtlingen. Mithilfe von visuellen Tools wird eine Anwendung für das Gesundheitswesen entwickelt, um die grundlegenden Aspekte des Gesundheitssystems zu erläutern (beispielsweise wie man einen Termin beim Arzt in Österreich vereinbaren kann).

Die mobile Anwendung wurde in drei Phasen mit einem User-Centered Design Ansatz entwickelt. Die Zielgruppe wurde in jeder dieser Phasen intensiv einbezogen. Eine umfangreiche Literaturrecherche wurde durchgeführt, um die Psychologie von Menschen zu verstehen, wenn ikonische Repräsentationen und Animationen beobachtet werden. Die erste Phase bestand aus Interviews mit Flüchtlingen in Österreich, um deren Bedürfnisse zu verstehen. Danach gab es vor der endgültigen Umsetzung des Prototyps in Österreich einen Mid-Evaluation-Fragebogen mit Ausländern. Phase drei beinhaltete den letzten User test. Er umfasste Flüchtlinge aus fünf verschiedenen Ländern.

Die ersten Workshops für die Konzeptentwicklung betrafen das NÖ Gesundheitssystem sowie die Forschungsgruppe Medien und Computing der Fachhochschule St. Pölten. Die niederösterreichische Flüchtlingsorganisation LARES kontaktierte die Flüchtlinge, um an dieser Forschung teilzunehmen.

Das erwartete Ergebnis dieser Studie wurde verifiziert. Die Entwicklung einer österreichischen Gesundheitsapplikation mit nur Icons und stiller Lernanimation würde den Flüchtlingen helfen, das Gesundheitssystem zu verstehen und die Sprachbarriere zu überwinden. Die aus dieser Studie gesammelten Daten könnten für viele zukünftige Entwicklungen in Angriff genommen werden.

Contents

1 Introduction

1.1 Problem and Motivation

The number of refugees has been increasing in Austria year by year, in 2016 only, 42,703 refugees were welcomed (AIDA, 2018). This figure does not include migrants who entered the country for other motives, such as professional or educational. The majority of these refugees do not speak German and even the ones who do are unfamiliar with the Austrian health care system. In this study, a health care application is developed using icons and silent instructional animations. Having a tool which improves the understanding of the health care system in Austria is important for those who do not know the language or are new to the system.

Several similar applications have been developed in Germany to help its refugees get easily integrated into the system. One of the applications is called "Anokommen". It aims to explain to new migrants things related to the documents processing during the first weeks in Germany. Moreover, the application not only focuses on the health system but on broader topics, it also uses plenty of text, complicating the user interaction.

The goal of this thesis is to develop a concept and a prototype using only icons and silent instructional animations to explain key topics in the Austrian health care system. This concept will then be tested with refugees living in Austria. The target group for this research are young refugees, since they are more familiar with new technologies. Moreover, whether they are in camps or not they have access to the elderly and they can be their source of knowledge transfer in case they needed help.

Finding a solution for this issue, may not just be applied to the Austrian health system, but to other different use cases. For instance, it can be used in different countries that have high numbers of migrants, or even be used in governmental systems, like applying for a driving license in a new country and more. The ones that could benefit from this research are not just the governmental systems but also everyone new to the country and does not understand the country's local language.

1.2 Research Questions and Goals

The research questions that should be solved throughout the development of the healthy system application are as follows:

Main Research Question:

How can we explain such a complex topic like the health care system only with icons and silent instructional animations in a mobile application?

Sub-research Questions:

1. Which user research methods can be used to develop mobile applications?

2. What methods can be used to develop a concept for mobile applications?

3. What is the role of User Experience design in mobile application design?

4. What are the different methods that can be used to evaluate mobile application design?

5. What are pictorials and how do human perceive/understand them ?

6. What needs to be taken into consideration when designing pictorials?

7. What are instructional animations, where are they used and how do humans understand them?

The research aims to confirm/reject the following hypotheses:

1. Explaining areas in the Austrian health care system via silent instructional animations would make it understandable for refugees in Austria.

2. Refugees in Austria can comprehend and navigate in a health mobile application with no text and only icons.

3. Developing an Austrian health care system mobile application with only icons and silent instructional animation would help refugees in Austria understand the health care system correctly.

1.3 Methodology

In the following section the fields of icons design, silent instructional animations, usability in application design, user experience design and its testing methods will be explored. Chapter 4 discusses the following phases in detail.

User Interviews:

It is important to understand from both sides, the health government's side as well as the user's side, which factors are needed to be present for such an application. Therefore, it is planned to conduct design workshops with a team from the Lower Austrian Health Care government to understand their requirements and to define the problem more clearly. Moreover, an interview will be conducted with seven refugees to understand their needs as well and evaluate their point of view. These interviews will help in addition to the literature research, answer several research questions.

Lo-fi Phase:

After collecting the needed information from the interviews and literature, the next step would be developing a lo-fi prototype. As a start, a storyboard and an action flowchart will be created. Then a draft of the icons will be designed and tested on six to eight foreigners living in Austria and do not speak German. During this development phase, it is important to get feedback and to use this feedback to improve the visuals. The concept is based on a user-centered design approach. The target group's needs are the main component of the design that are integrated directly into the design process. This transforms multiple ideas into one main concept.

Hi-fi Phase:

As mentioned in the previous paragraph, the study uses a user-centered design approach, which means both the lo-fi and hi-fi prototypes will go through four phases. The first one specifies the context of use, the second one specifies the requirements, the third one involves creating a design solution (this has many stages going from a rough idea to a final concept) and the last step involves evaluating the design through collecting feedback and conducting interviews. This process is a repeated lifecycle. When the HTML hi-fi demonstrator is ready, a final user test will take place with 10 refugees in their organization. Expected from this test is a final feedback on the prototype and knowing if there should be any improvements that should be taken into consideration to improve the usability of the application.

1.4 Structure

The research consists of six chapters. Chapter 1 gives an introduction on the research. It mainly focuses on the goal, presenting the research questions and the methodology.

Chapter 2 of the thesis focuses on defining the main terminologies and concepts used in the research. Terms like *user experience design, usability* and *user-centered design* are elaborated since they play a big role in this study. From section 2.1.3 to section 2.1.5 the focus is more on the visual aids used later on and the psychology of humans perceiving them.

While chapter 2 gives an overview on the terminologies, chapter 3 goes more into detail in terms of definitions. It focuses on the literature review and answers the seven research questions mentioned in section 1.2.

Chapter 4 contains the development of the application using a user-centered design approach. The design workshops, user interviews, questionnaires and final user test are discussed in this chapter. According to this, the eighth research question is answered.

Last but not least, chapter 5, discusses the outcomes of the user test. All three hypothesis that are mentioned in chapter 1 are either confirmed or rejected in this chapter. Furthermore, the interpretation of the results are supported by the literature review. Following this is chapter 6, where everything discussed in the thesis is summarized and the final outcome is stated.

Figure 1.1, gives an overview of the thesis' structure.

Chapter 1: Introduction

Chapter 2: Terminologies

Chapter 3: User-Centered Design Approach

Q1: Which user research methods can be used to develop mobile applications?

Q2: What methods can be used to develop a concept for mobile applications?

Q3: What is the role of user experience design in mobile application design?

Q4: What are the different methods that can be used to evaluate mobile application design?

Q5: What are pictorials and how do human perceive/understand them?

Q6: What needs to be taken into consideration when designing pictorials?

Q7: What are instructional animations, where are they used and how do humans understand them?

Literature Review & Analysis

Chapter 4: User-Centered Design Process of the Austrian Health System Refugees Application Project Development

Q8: How can we explain such a complex topic like the health care system only with icons and silent instructional animations in a mobile application?

H1: Explaining areas in the Austrian health care system, via silent instructional animations, would make it understandable for refugees in Austria.

H2: Refugees in Austria could comprehend and navigate in a health mobile application with no text and only icons.

H3: Developing an Austrian health care system mobile application with only icons and silent instructional animation would help refugees in Austria understand the health care system correctly.

Design Workshops & Interviews & Questionnaire & User Tests

Chapter 5: Discussion
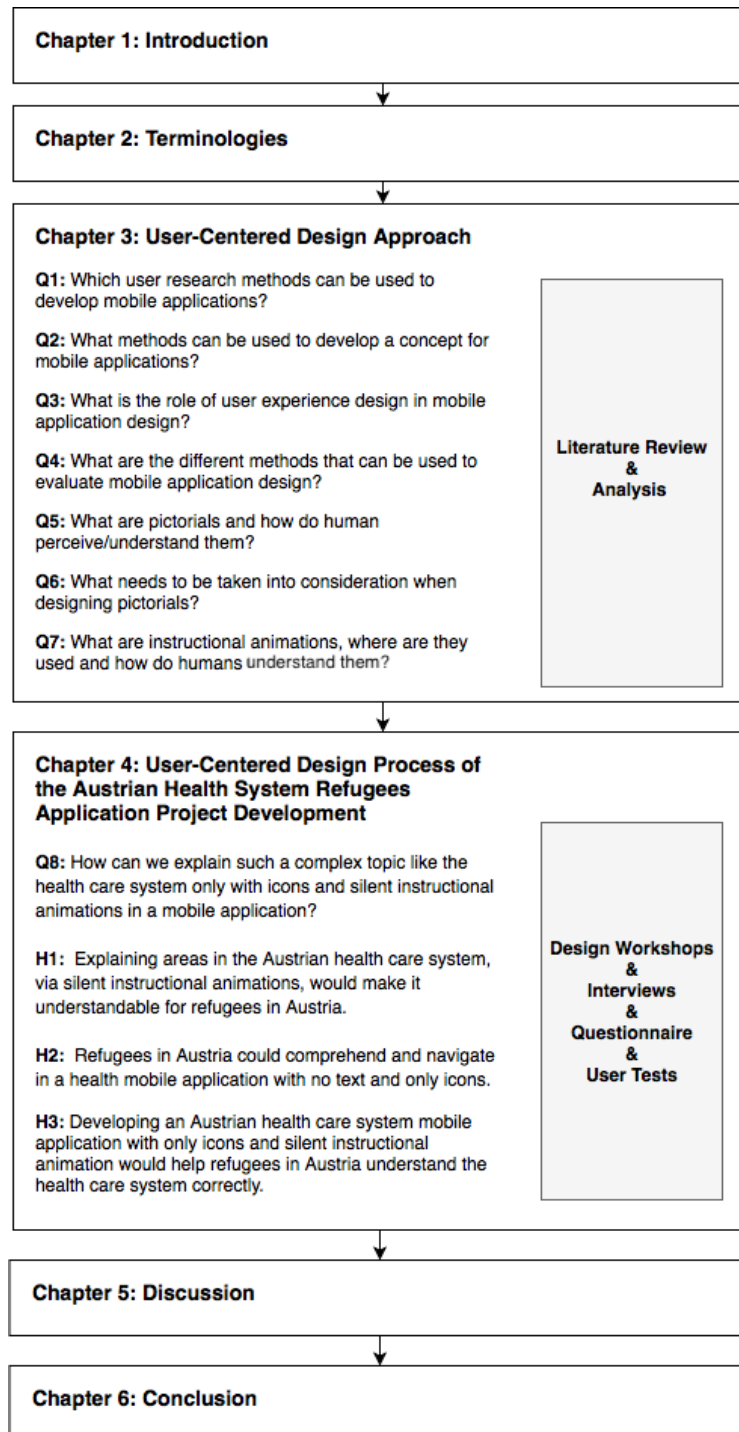
Chapter 6: Conclusion

Figure 1.1. Structure of the research

2 Terminology

This chapter discusses the theoretical part of the thesis. This includes the terms definition of the *Usability* and *User Experience Design*. Then, the process of the *User Centered-Design* will be interpreted. It is important to understand the basics of User Centered-Design, since it is used in the methodology and is the core scientific approach in this thesis. Afterwards, the medical terms used in the Austrian Health System will be defined. Lastly, the methods used for transmitting information through human senses will be explained.

2.1 Definitions

This section includes the definitions of the most important terms used for the development of this thesis.

2.1.1 User Experience Design and Usability

According to the article *UX Curve: A method for evaluating long-term user experience*, User Experience Design is about the users' satisfaction with the usability, accessibility and pleasure during their journey when using the product (Kujala et al., 2011, p. 477). It is about the interaction between humans and machines in different contexts and is considered a conceptual design discipline.(Soegaard and Dam, 2012).

In 2009, a survey about the definition of User Experience Design was conducted with 275 researchers from the academia and industry of design. The scientific as well as the practical views that were formed describe User Experience Design as a dynamic concept. It is "context-dependent and subjective, which stems from a broad range of potential benefits users may derive from a product"(Law et al., 2009, p. 727).

User Experience Design is a huge field that includes different elements from usability in interaction design, visual and information design and a lot more. Usability is the extent to which a user or the specified target group(Nielsen and Molic, 1998, p. 2). It exists in different fields; it can be related to the usability of a car, a machine or a software. It is about

the ease of use of the product (Nielsen, 2016).

According to ISO 9241, the 5 main standards of usability are:

1. **Learnability:** the ease of use when using the product.

2. **Efficiency:** how fast can the user accomplish the task.

3. **Memorability:** when returning to the product after a while, is it easy to remember the steps?

4. **Errors:** the amount of errors which occurred.

5. **Satisfaction:** how satisfied is the user with the product? (Abran et al., 2003, p. 326)

There are four key components that need to be solved with usability. These are the user, the task given, the environment the user is in and lastly the tool that is being used (Shackel and Richardson, 1991, p. 23).
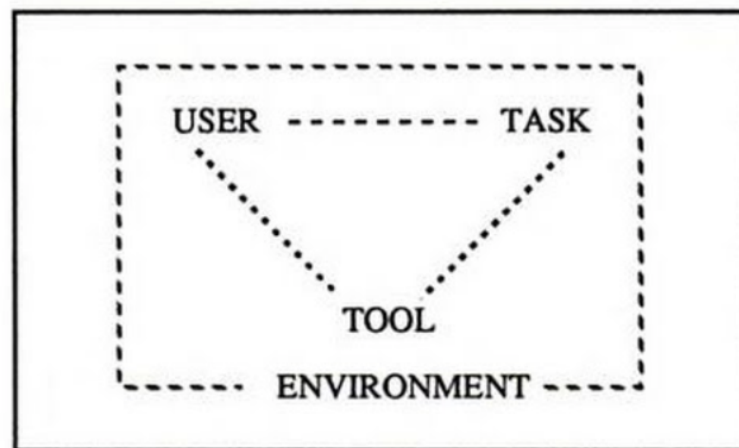
Figure 2.1. The four principle components in a human machine system (Shackel and Richardson, 1991, p. 23).

As shown in 2.1, the tool is connected to the task and the user. This triangle takes place in the environment created by the designer and the usability depends on the relationship in this figure and the connectivity between principles. A good usability would make the tool easy and effective to use(Shackel and Richardson, 1991, p. 23).

"[E]asy = to a specified level of subjective assessment. [E]ffectively = to a specified level (human) performance)" (Shackel and Richardson, 1991, p. 24).

2.1.2 User Centered Design

User Centered Design, also called UCD, is the process which "outlines the phases throughout a design and development life-cycle all while focusing on gaining a deep understanding of who will be using the product"(Zaphiris and Ioannou, 2017, p. 72). According to the International Usability Standard, ISO 13407, there are a few methods and factors that need to be taken into consideration in the process of User Centered Design . Applying these 9 points during the UCD process ensures that we have a good usability and user experience in our software or product (Timo Jokela et al., 2003, p. 55).

1. "Active involvement of customers (or those who speak for them)
2. Appropriate allocation of function (making sure human skill is used properly)
3. Iteration of design solutions (therefore allow time in project planning)
4. Multi-disciplinary design (but beware overly large design teams)
...And four key human-centered design activities

1. Understand and specify the context of use (make it explicit – avoid assuming it is obvious)
2. Specify user and socio-cultural requirements (note there will be a variety of different viewpoints and individuality)
3. Produce design solutions (note plural, multiple designs encourage creativity)
4. Evaluate designs against requirements (involves real customer testing not just convincing demonstrations) (Travis, 2003, p. 3)."
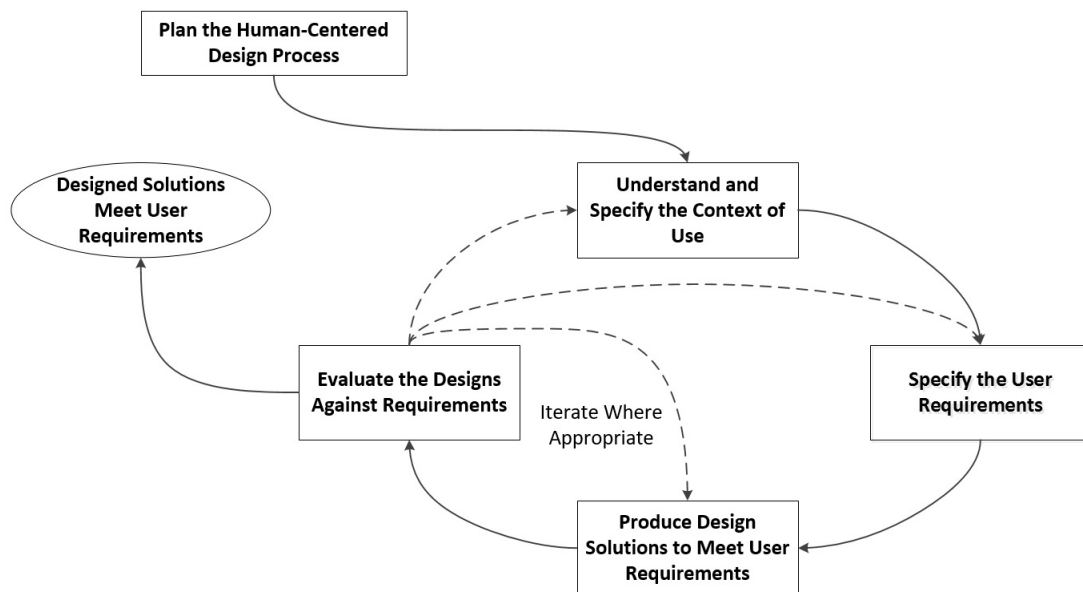
Figure 2.2. Human Centered Design Process (International, 2011).

Figure 2.2 explains the exact steps that are usually taken throughout the User Experience Design process. We first need to understand the users' needs, understand the environment and the context of use. This is achieved using different user research methods like interviews. Section 3 will go more into detail about the different user centered research methods. After understanding the user needs we specify the requirements needed to produce the appropriate design solutions for our target group, which is the next step. Last but not least, we evaluate our designs through user tests. This process is a life-cycle, which means after getting feedback from the users and results from the user tests we improve our design and create another iteration till we design a solution which meets the user requirements.

2.1.3 Information Transmission

This section explains the role of the human senses in transmitting information. There are several ways to transmit information to a human being. Humans have five senses in their body and they are all connected to their sensory cortex in their brain (Brandt, 2003, p. 220) (see figure 2.3). Perception does not have to be collected through the eyes, it can be also collected through the ears, nose, skin and tongue.
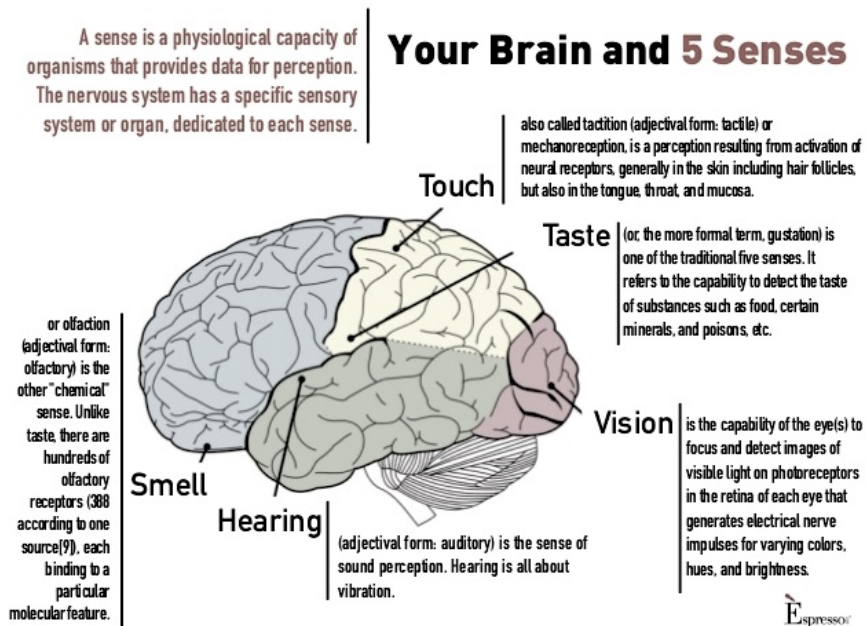
Figure 2.3. Human senses connected to the brain (Èspresso1882 Australia, 2018).

Vision

In design we mostly use our vision, also called sight., which "dominates over the other four and it is the most seductive sense of all" (Rv et al., 2015, p. 3). It helps us understand where we are and what we are looking at through many factors. For example, the color, the look of the texture, size of a place, depth and much more (Rv et al., 2015, p. 3). It can also be very manipulative as often we have the wrong first impression because of our vision boundaries, or if we are color blind. Light plays a huge role when it comes to our vision. A theory by the Greek called the emission theory states "that the 'fire' from the eye sends out invisible probes in order to see objects" (Wong and Kwen, 2005, p. 5).

Hearing

Hearing , also called auditory, is responsible for us receiving sounds. Sounds can create an emotional connection and help us create memories but they also play a huge part when it comes to communication (Rv et al., 2015, p. 3). "Communication of language means transmission of thoughts from brain to brain. Each thought may be broken down into images. Each image corresponds to one word and to one individual visual picture" (Fisch, 1957, p. 230).

Smelling, Tasting and Touching

In terms of mobile application design there are sensors that play less of a role in comparison to others. For instance, the sense of smelling, tasting and touching.

Smelling is also referred to as the olfactory. Each place has a scent, which makes every scent related to a memory. This is called the *Poust Effect*, which "refers to the vivid reliving of events from the past through sensory stimuli. Many of us are familiar with those special moments when we are taken by surprise by a tiny sensory stimulus (e.g. the scent of your mother's soap) that evokes an intense and emotional memory of an episode from your childhood"(Campen, 2014).

The sense of tasting, also called gustatory along with smelling play a huge role when it comes to food. Also the taste of food is connected to our brain, memory and is a way of transmitting a sort of emotion to our brain. We can determine texture, pain, temperature of something through our tongue (Chiras, 2005, p. 93).

Lastly, the sense of tasting, which is also referred to as tactile; humans develop a sense of emotional connection to an object after touching it and feeling its texture. The definition of this sense has changed over the years. According to the ancient Greece, "Aristotle defined touch as the sensation through the flesh. It included everything but vision, audition, olfaction, and gustation. Thus, it included even visceral sensation in the current knowledge"(Iwamura, 2009, p. 4005).

2.1.4 Instructional Animation

"An animation can be defined as a series of rapidly changing computer screen displays suggesting movement to the viewer"(Höffler and Leutner, 2007, p. 723). Gavriel Salomon is an educational psychologist who mainly worked on cognition and the effect of media on cognition. In 1979, he came up with a framework called the supplementation framework which "proposes that an animation, by dynamically displaying a process or a procedure, should be able to compensate for a student's insufficient aptitude or skill to imagine motions"(Höffler and Leutner, 2007, p. 723). "Dynamic visualizations might help learners to build mental models by supporting inference drawing" (Zumbach et al., 2008, p. 2).

Cognitive Theory

According to Mayer's cognitive theory of multimedia learning 2.4, there are three sub-theories related to learning with multimedia: "the human information processing system in-

cludes dual channels for visual/pictorial and auditory/verbal processing (i.e., dual-channels assumption); each channel has limited capacity for processing (i.e., limited capacity assumption); and active learning entails carrying out a coordinated set of cognitive processes during learning (i.e., active processing assumption)" (Mayer, 2009, p. 31).

According to the paper *Learning and Understanding Science Instructional Material*, written in 2003 at the University of New South Wales, "the theory assumes that all learning occurs through a very limited working memory and an unlimited long-term memory, which is structured into hierarchically ordered automated schemas" (Carlson et al., 2003, p. 629). Schemas represent the organization and the relationship of information which are created in our minds (DiMaggio, 1997, p. 627). For example we have schemas for letters; each letter has a representation in our minds, which allows us to relate to the letter as soon as we see it (Carlson et al., 2003, p. 629).
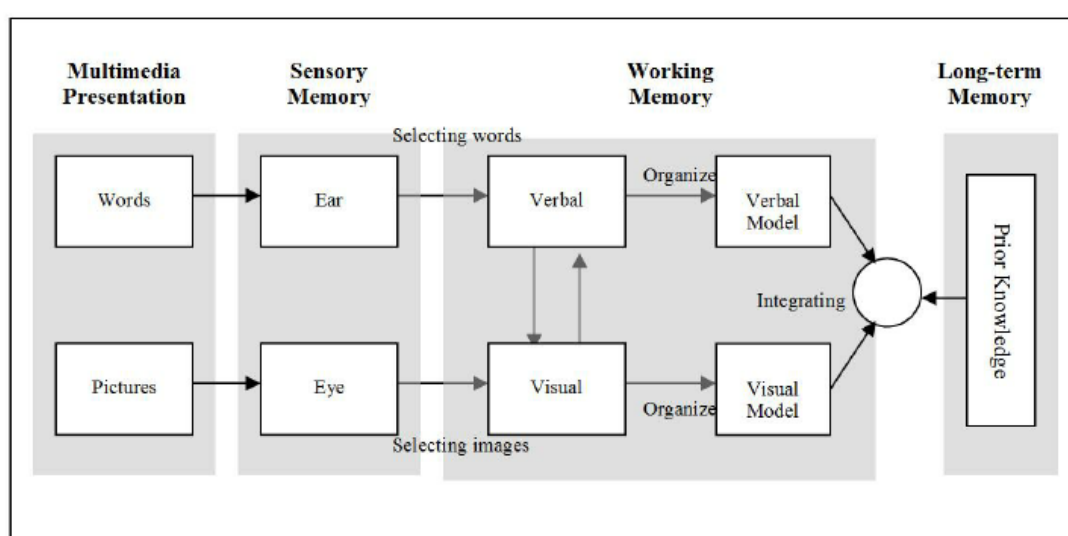

Figure 2.4. A framework for cognitive theory of multimedia learning drawn from Mayer (Mohamad Ali and Segaran, 2013, p. 70).

2.1.5 Pictorials and Icons

According to the Cambridge dictionary, a pictorial is when something is "shown in the form of a picture or photograph". In the *Use of pictorial aids in medication instructions: A review of the literature* paper it has been proven that "the use of pictorial aids enhances patients' understanding of how they should take their medications" (Katz et al., 2006, p. 2391). In biology books for instance, many topics are explained in forms of pictorials, especially complex information(Brandstetter et al., 2017, p. 2). This strategy does not only apply to adults, children books are also full of pictorials since they cannot read yet at a certain age. In Singapore, it is believed that using pictorials in maths "encourages children to

make a mental connection between the physical object they just handled and the abstract pictures, diagrams or models that represent the objects from the problem" (Maths, 2018) as displayed in figure 2.5.
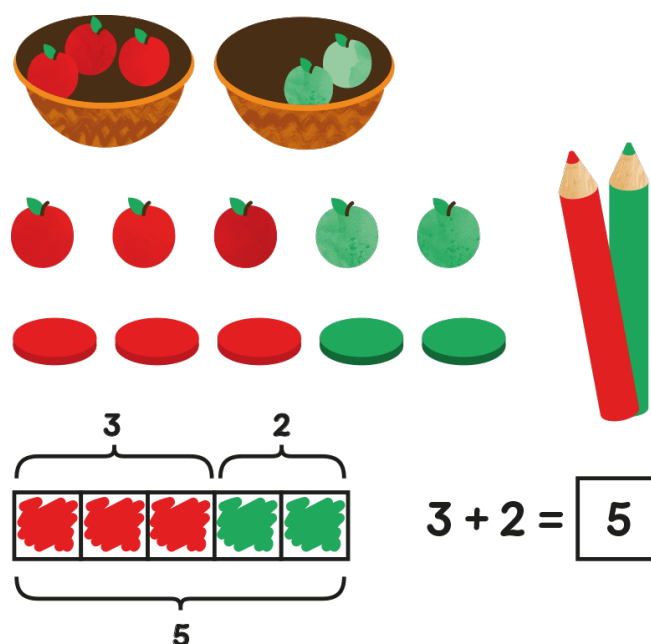

Figure 2.5. Using pictorials to help children understand a maths problem(Maths, 2018).

2.1.6 Austrian Health Care System Terminologies

This section defines medical terms for refugees and asylum seekers used in the Austrian health care system. The terms are defined according to a document which was handed out to the Media Computing Research Group of the University of Applied Sciences Sankt Pölten.

Health Insurance

Almost all people in Austria are covered by social insurance. The good health system in Austria only works because working people finance it with their taxes and duties. Medical care in Austria is free, so you do not have to pay the doctor with a health insurance contract. The health insurance pays for all medically necessary services in case of illness, the decision is made by the attending physician. The e-card is a proof that you have health insurance. Luxury treatments (such as cosmetic surgery, dental implants) are not covered.

E-Card

As soon as you are registered as an asylum seeker in Lower Austria, your information with be communicated to the Lower Austrian Regional Health Insurance Fund (NÖ GKK). This means you will be covered by the state health insurance. Health insurance is linked to the provision of basic services. You get a health insurance card, the so-called e-card. With this card you can go to a doctor of your choice.

The e-card is an electronic card on which the citizen's name, date of birth and insurance number are stored. On the front of the e-card are the name and the social security number. The social security number consists of 10 digits, the first 4 digits and the date of birth with 6 digits. The e-card is only valid for the owner on whose name it is issued and not for family members or friends. Abuse of the card is prohibited and punishable. An ID may be required in addition to the E-Card for identity verification.

General practitioner / Family Doctor

If you need medical help, first go to the family doctor (general practitioner) in your area who will take care of your treatment and, if necessary, refer you to a specialist or hospital. In case of illness, the family doctor is the first and most important point of contact. It is ideal if you always go to the same family doctor who knows you personally and can treat you in the best possible way.

Changing you general practitioner: If you are under treatment with a general practitioner you should stay with the same doctor or inquire about a change of health insurance during the current quarter. With the beginning of a new quarter, the doctor can be changed without consultation with the health insurance.

Checkups: Many diseases can be better treated if you recognize them early. Checkups help to find diseases before they cause them. Many health check-ups are paid by the health insurance. Your doctor will be happy to advise you on recommended check-ups.

Assistance in Emergencies and Accidents

In the case of emergencies and accidents, outside the opening hours of your family doctor, you should contact the health advisory service, the emergency medical service or in urgent cases directly the rescue.

Emergency numbers are available in Austria by phone free of charge. Emergencies are

illnesses or injuries which have to be treated immediately, e.g. acute respiratory distress, acute pain, accidents and serious injuries, complications during pregnancy.

3 User Centered Design Approach

This chapter explains the methods which are used as a basis of the development of this project. As explained in chapter 2, having a user centered design approach aims for understanding the users needs first in order to develop an application which matches their desires. "Human-centered design (HCD) is the process of ensuring that people's needs are met, that the resulting product is understandable and usable, that it accomplishes the desired tasks, and that the experience of use is positive and enjoyable" (Norman, 2013, p. 347). In order to understand the user needs, we had to do some user research, which will be explained into detail in the next section. This process includes identifying a target group and understanding their needs. Following this process comes the conception phase which focuses on how to generate ideas, the process and methods used to develop a prototype. This process includes design thinking methods and user experience design methods. Lastly, the evaluation methods which were used throughout this process are explained.

3.1 User Research Methods

This section includes the definition of identifying a target group and its users' needs. Moreover, it explains how these methods could be used for the development of this project. In this section the first research question "Which user research methods can be used to develop mobile applications?" is answered.

3.1.1 Target-group

To understand the users needs we need to identify the target group first, also called the target audience. It is important to identify the target group at an early stage so that you can shape your product according to their feedback and experience. We can not expect every one from the population to understand our product. Therefore, it is important to have a guideline for limiting the features being developed to match the needs of our target group. Target groups are not only used in design but also in business especially in marketing. In the marketing field, it is identified as a specific group in the targeted market who are the recipients of a product, a service or a message (Armstrong and Kotler, 2015, p. 196).

The target audience identified should have the same or similar factors to the population of the target group. The more specified the characteristics for the target group, the more similar their needs are going to be (Saltos, 1999, p. 4).

In order to determine the correct target audience, there are three factors which need to be taken into consideration: 1. demographics, 2.psycho-graphics and 3.consumer lifestyle as in their behavioral information (Hoek et al., 2018, p. 1). Demographic information include general aspects of the person like gender, ethnicity, income, qualification and marital status (Sharma, 2015, p. 326). While psycho-graphic information according to Weinstein in his article *Segmenting B2B technology markets via psycho-graphics: an exploratory study*, is "the use of psychological, sociological, and anthropological factors, self-concept and lifestyle to determine how the market is segmented by the propensity of groups within their market – and their reasons – to make a particular decision about a product, person or ideology" (Weinstein, 2014, p. 258). Lastly, the behavioral information, also called behavior based segmentation, is a "segmentation based on purchase behavior aims at discovering groups of customers that exhibit a similar purchase behavior" (Brijs et al., 2015, p. 4).

All of these segmentations help us determine which target group we have, which helps us have a more accurate user research since we set ourselves factors that are focused on their needs and need to be fulfilled.

3.1.2 User Needs

After identifying the target group, we need to understand their needs. A book called *The Design of Everyday Things* originally called *The Psychology of Everyday Things* by Donald Norman, a former director of the institute for Cognitive Science at the University of California, talks about the psychology of users when it comes to usability. "The focus of this book, and of the discipline called **human-centered design**, is to ensure that the result fits human desires, **needs**, and capabilities" (Norman, 2013, p. 346).

There are different methods to understand the user needs. These methods are called evaluation methods see section 3.4. You can conduct interviews before designing your product and get continues feedback from your targeted users. To help you determine if you are on the right track you may follow *The Seven Stages of Action* 3.1. Any user of your product should be able to relate to these questions and respond to them. "The information that helps answer questions of execution (doing) is *feedforward*. The information that aids in understanding what has happened is *feedback*" (Norman, 2013, p. 133).

Figure 3.1. The Seven Stages of Action as Design Aids (Norman, 2013, p. 132).

When evaluating the outcomes from the seven stages of actions we can focus on the seven fundamental principles of design which are (Norman, 2013, p. 133-134):

1. **Discoverability:** Simplifying the design as much as possible to make the actions visible for the user.

2. **Feedback:** The user gets a continues feedback from the product to reassure that his/her actions were received.

3. **Conceptual model:** "The design projects all the information needed to create a good conceptual model of the system, leading to understanding and a feeling of control. The conceptual model enhances both discoverability and evaluation of results" (Norman, 2013, p. 134).

4. **Affordances:** A term by James J. Gibson, one of the greatest psychologist in history (Gibson, 1983, p. 285), which in the design environment means that the design has what it takes to make the user actions possible to be committed.

5. **Signifiers:** Signs are visible enough for the users and are well communicated.

6. **Mappings:** The product/design has what it takes to map the actions of the user with the outcome of it.

7. **Constraints:**" Providing physical, logical, semantic, and cultural constraints guides actions and eases interpretation" (Norman, 2013, p. 134).

3.1.3 Personas

Creating personas is "a technique that employs fictitious users to guide decision making regarding features, interactions, and aesthetics" (Lidwell et al., 2010, p. 182). Alan Cooper, an American software designer and programmer introduced in his book *About Face 3: The Essentials of Interaction Design* the use of personas (Cooper et al., 2007, p. vi) ."A persona is a model of a user that focuses on the individual's goals when using an artefact"(Blomkvist, 2002, p. 1) Personas are usually used in user-centered design and marketing. It is a fictional character made by the designers to help them understand the user needs better and put the user in a realistic scenario. According to the characteristics and personality of this character and its scenario, the designer starts setting goals and limitations to the product or service. The information of the persona can be collected from the interviews of the stakeholders or real users. "The use of personas in the design process is increasing in popularity, though empirical evidence for the technique as compared to more traditional approaches is lacking" (Lidwell et al., 2010, p. 182). They are created at an early stage of the design process, typically during the first phase.

Alan Cooper also mentioned five points of strengths the tool of personas provides (Cooper et al., 2007, p. 79):

1. **Determination** of the product behavior.

2. **Communication** with internal and external stakeholders. It works as a common language.

3. Creating a **committed** design as in having a common understanding. Since personas resemble real people.

4. Design can be tested on personas this way the **effectiveness** of it is measured.

5. Is a common tool in marketing and other departments, therefore it **contributes** to their effort planes.

3.2 Concept Methods

This section discusses the different methods which can be used during the design process phase. This includes how to generate ideas 3.2.1, developing wireframes and mockups 3.2.2 and lastly developing a prototype 3.2.3. Moreover, it focuses on the design thinking process which is explained in detail in sub-section 3.2.4. In this section the second research question "Which methods can be used to develop a concept for mobile applica-

tions?" is answered.
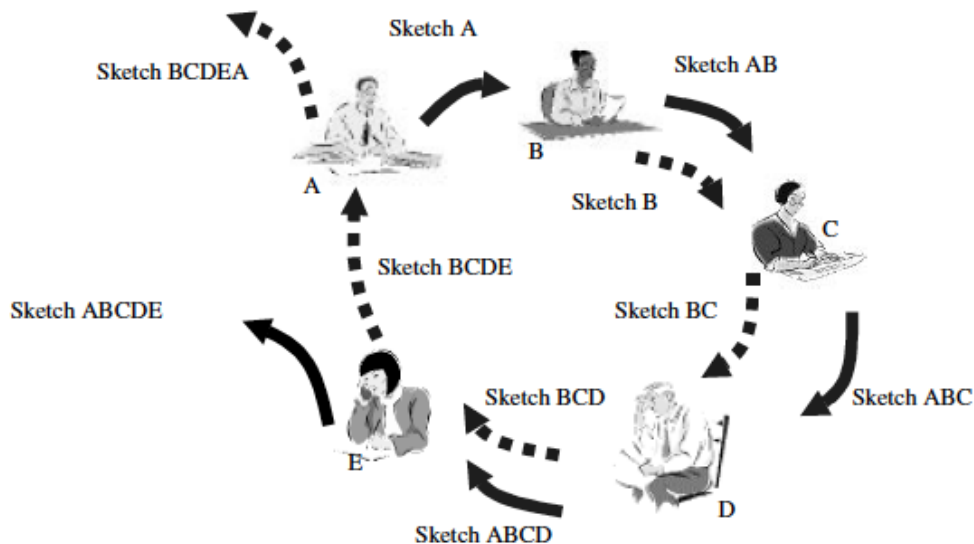
3.2.1 Idea Generation

"Creativity can be understood in terms of the cognitive processes by which people work with knowledge in the generation of ideas" (Scott et al., 2004, p. 362)." The idea generation phase is usually done in teams as it is useful to get feedback from other teammates and share your ideas out loud. Nevertheless, doing it in a team is not conditional. Also this process may involve sketching on paper, flip-charts or boards. This is the phase of creativity and experimentation, where it is accepted and expected to think outside the box without being judgmental.

There are many techniques when it comes to idea generation. "Each technique reflects beliefs about the creative process. Such beliefs can be derived from personal experience, popular assumptions, or scientific research" (Smith, 1998, p. 108). In this section we will focus on the mostly used techniques nowadays:

1. **Brainstorming:** "involves generating a large number of solutions to a problem (idea) with a focus on the quantity of ideas. During this process, no ideas are evaluated; in fact unusual ideas are welcomed" (Scarlett et al., 2009, p. 1). It is a technique which does not have to be used in a group setting. Brainstorming is also called *the mother of all idea generation techniques* and is also the most used technique (Scarlett et al., 2009, p. 1).

2. **Critique:** is mostly used to receive feedback from others. Therefore, it is one of the techniques which needs to be conducted in groups. "This technique often spurs new thought by finding solutions to design flaws within current concepts" (Scarlett et al., 2009). Since, everyone who is part of this process receives feedback, every participant needs to accept the feedback and be honest when they express their opinions.

3. **Role Playing:** This process is also done in groups. It involves creating scenarios. These scenarios should be similar to a real life situation of the targeted users. Participants should act them out and asses them. "This technique is a tool for both team-based ideation and communication to users and/or clients"(Scarlett et al., 2009, p. 1).

4. **Collaborative Sketching:** also called C-Sketch, "is an idea generation method that was proposed originally in 1993 in the Design Automation Lab (DAL) at Arizona State University" (Shah et al., 2001, p. 169). As the name of the method indicated, collaborative sketching requires a group work. Before each designer starts sketching, there

needs to be a clear problem definition and cycle time set. During the cycle as you can see in 3.2, "designers work independently, developing a sketch of their proposed solution to the problem for a predetermined length of time (cycle-time). At the end of each cycle, the sketch is passed to the next designer" (Shah et al., 2001, p. 169). Each designer may edit the sketch as much as they want from their point of view.

Figure 3.2. Collaborative Sketching (Shah et al., 2001, p. 169).

3.2.2 Wireframes and Mockups

After evaluating the ideas that came out of the idea generation sessions and deciding on which way the designer would go, it is time to start developing wireframes and mockups. In figure 3.3, you can see that a mockup is a more advanced version of a wireframe. A wireframe focuses on developing the structure, function and a rough version of the content. In a mockup, the style, colors and the final content is added.
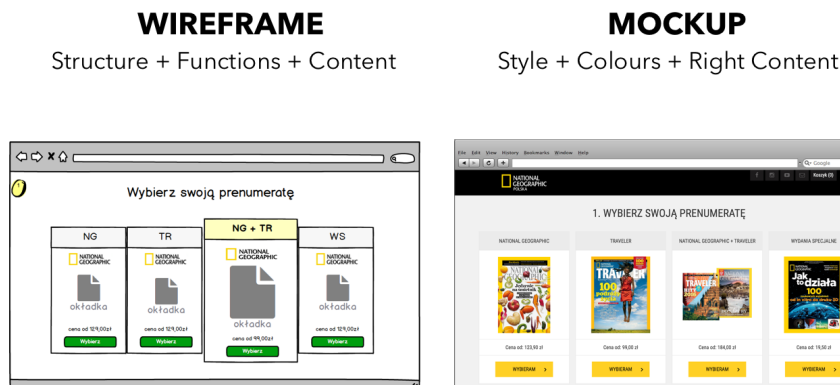
WIREFRAME
Structure + Functions + Content

MOCKUP
Style + Colours + Right Content

Figure 3.3. Difference between wireframes and mockups (Warcholinski, 2018).

Each of these stages is expected to be tested, and the results of the test should be taken into consideration for the next iteration. The more advanced the version is, the tougher it is to edit it. Therefore, it is recommended that the testing takes place as early as possible in the process. "In the early stages of this process, the mock-ups can be pencil sketches, foam and cardboard models, or simple images made with simple drawing tools" (Norman, 2013, p. 359).

LOW-FIDELITY
REPRESENTATION

MEDIUM-FIDELITY
REPRESENTATION

HI-FIDELITY
REPRESENTATION

Sketch   Wireframe   Mockup   Prototype
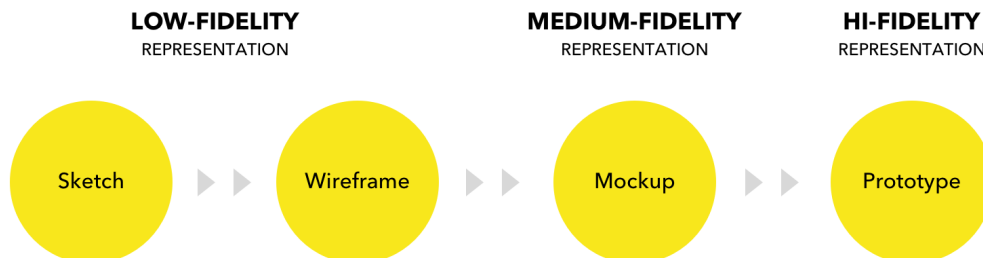
Figure 3.4. Process of designing an application (Warcholinski, 2018).

There are multiple levels in this phase as you may see in 3.4. The **low-fidelity** level includes simple sketches and wireframes. In this phase, notepads, labellings, drawing simple shapes are involved (Wodtke and Govella, 2009, p. 185). It is the stage where most changes happen fast, since all ideas are still rough. The second level is called **medium-fidelity**, this level involves advanced mockup designs. This is the closest version to the final product, therefore it usually takes longer to develop (Wodtke and Govella, 2009, p. 257). Lastly, the **hi-fidelity** level, which is the final prototype, is explained in detail in the following sub-section 3.2.3.

3.2.3 Prototyping

In the previous section, low-fidelity and medium-fidelity stages of wireframing have been discussed. In this section the last fidelity phase which is the hi-fidelity stage is discussed. In this phase, the final prototype is developed. "A prototype is an initial model of an object built to test a design" (Hackney Blackwell and Manar, 2015, p. 1). Usually a prototype represents a stimulation of the end product, service or software. "Prototypes provide a concrete basis for discussions between developers, users and management. They help in discussing difficulties, clarifying problems and preparing decisions. Where necessary, prototypes are supplemented by written system specifications" (Budde et al., 1992, p. 35).

There are two main concepts of prototyping, **horizontal** and **vertical** prototyping. In both concepts the prototype is perceived as layers of implantation. "In horizontal prototyping, only specific layers of the system are built, e.g., the user interface layer along with its forms and menus, or functional core layers such as database transactions" (Budde et al., 1992, p. 39). Meaning, it allows for a simple view of the whole product. While vertical prototyping is "a selected part of the target system is implemented completely ("down through all layers")" (Budde et al., 1992, p. 39). According to Nielson in his book Usability Engineering, vertical prototyping is benefiting when it comes to database design, to gain knowledge on network sizing and performance engineering and to simplify complex systems by reducing their features (Nielsen, 1993, p. 95).

3.2.4 Design Thinking

Under the term design thinking lay many methods, which help find creative solutions for design problems (Liu, 2009, p. 99). "The first Design Thinking Research Symposium was an exploration of research into design and design methodology, viewed from a design thinking perspective" (Dorst, 2011, p. 521). This symposium help develop many design thinking methods, based on not only design generally but also the hum psychology and much more. Which allowed this phenomena to be used not only in the design field but also in the Information Technology and Business fields (Dorst, 2011, p. 521).

The process of design thinking may go into iterations, which can end up redefining the initial problem. It is therefore a solution-based process(Dorst and Cross, 2001, p. 427). According to Bryan Lawson in his book *How Designers Think*, designers usually use solution focused strategy rather than problem focused strategies. This means "their emphasis is more on reaching a solution rather than on understanding the problem" (Lawson, 2006, p. 182). There is on the other hand problem focused thinking, which "investigates who or what sustains the problem, when and where it occurs, why it has continued to be a problem, and how [users] can try harder to overcome the problem" (Priest and Gass, 1997,
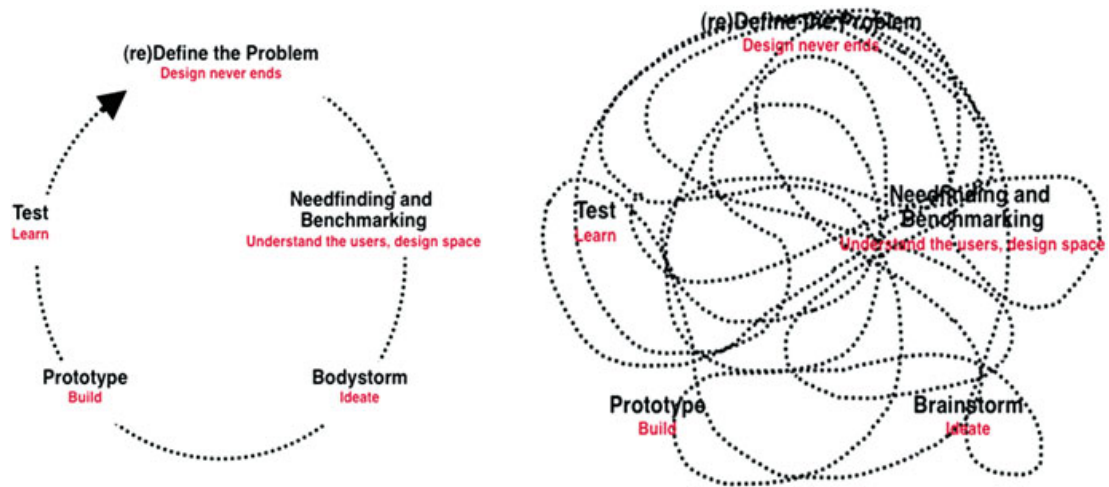
p. 34).

Figure 3.5. Design thinking process reality versus how it should actually be (Plattner et al., 2011, p. xiv).

As displayed in figure 3.5, on the left side this is how the design thinking process should work in an iterative cycle. However, in reality as shown on the right side, this is how it ends up being. Therefore, Christoph Meinel and Larry Leifer in their book *Design Thinking Research* in 2001, set four rules to avoid such situations.

Design Thinking Rules:

1. **The Human Rule:** *All Design Activity is Ultimately Social in Nature*
   using design thinking will lead to *human-centric point of view*, which enables solving technical problems in a way that satisfies the user.

2. **The Ambiguity Rule:** *Design Thinkers Must Preserve Ambiguity*
   pushing the designers' limit to experiment and be different and creative with their thoughts using their knowledge.

3. **The Re-design Rule:** *All Design is Re-design*
   the human needs may not change and therefore, the design may become a new version, also an advanced version of the previous designs which already exist.

4. **The Tangibility Rule:** *Making Ideas Tangible Always Facilitates Communication*
   creating prototypes, a way to know if the design idea would work or not by testing it. In order to test it, the designer needs to prototype it. Making it tangible allows for both the designer and the user to understand what the service or product is about.

3.3 User Experience Design Methods

As mentioned in section 2.1.1, user experience design is about the users' satisfaction with the usability, accessibility and pleasure during their journey when using the product (Kujala et al., 2011, p. 473). In this section more in detail regarding user experience design, starting from the information design sub-section 3.3.1 to the visual design sub-section 3.3.2. The last sub-section 3.3.3, discusses how mobile applications can be effectively designed. In this section the third research "What is the role of User Experience design in mobile application design?" question is answered.

3.3.1 Information Design

"Information Design is defined as the art and science of preparing information so that it can be used by human beings with efficiency and effectiveness" (Jacobson and Jacobson, 2000, p. 15).

In 2002, Robert Jacob set in his book *Information Design*, a few main objectives regarding information design:

1. Creating documents which are understandable and easily retrievable.

2. To design interactions with instruments that are simple. This involves finding several issues within the style of the human-computer interface.

3. To allow users be comfortable in their three-dimensional space.

Information design is part of interface design as depicted in figure 3.6. However, it is the combination of information design, interaction and sensorial design that make interface design possible. The discipline of **information design** "addresses the organization and presentation of data its transformation into valuable, meaningful information" (Jacobson and Jacobson, 2000, p. 268). **Interaction design** on the other hand, focuses on the development of interactive products; it's the combination of old art and new media at the same time. It focuses on the development of a story and telling it in an interactive way. Lastly, **sensorial design** , which focuses on combining all communication instruments through our senses, for example, through sound design, vocal communicational and much more.
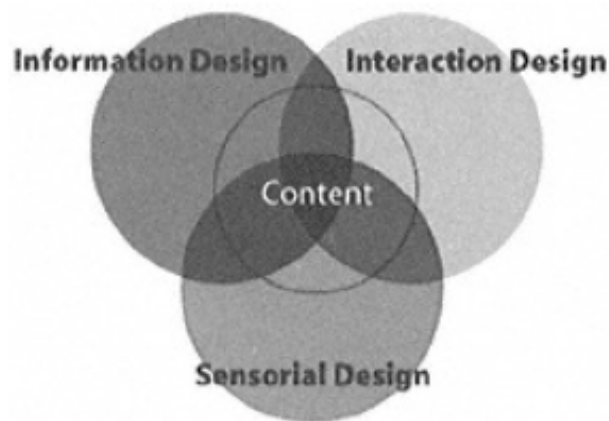
Figure 3.6. "Interface Design is a combination of three categories of disciplines: information Design, Interaction Design, and Sensorial Design (which includes all kinds of visual, auditory, written, and other sensorially-related disciplines)" (Jacobson and Jacobson, 2000, p. 268).

Information design is used a lot in data visualization and information graphics. In 1861, Charels Joseph Minards, a French civil engineer who is well known in the information design field, designed the Napoeln's March diagram 3.7. This is an early example of Information design. The "Napoleon's March on Moscow" graphic of 1869 was followed only by two tableaux graphics, one showing the decline in the study of Latin from 1818 to 1864 and the other showing an increase in the mean age of students at each level of promotion at the École Polytechnique. (Friendly, 2002, p. 32-33).
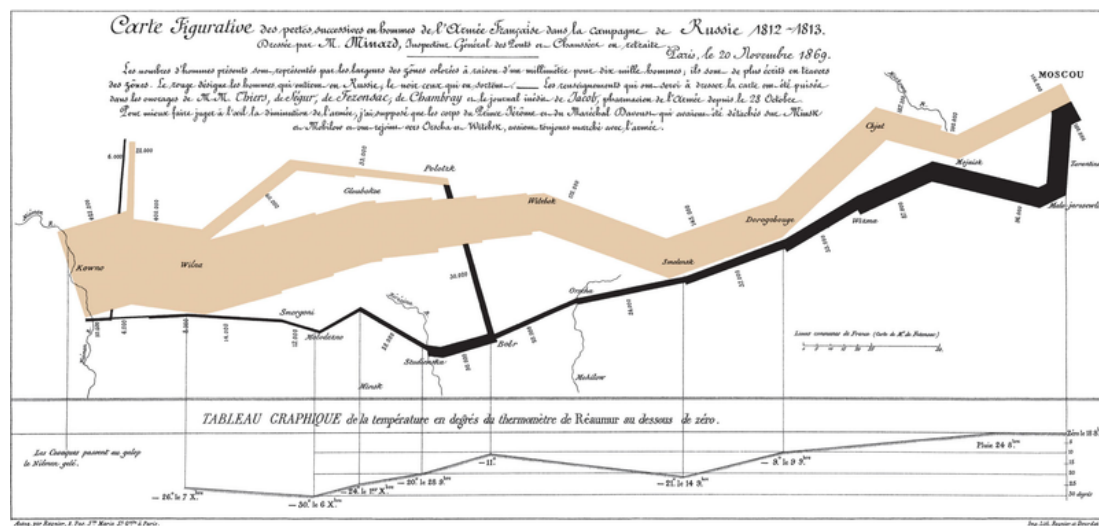
Figure 3.7. Charles Minard's 1869 chart of Napoleon's 1812 campaign(Friendly, 2002, p. 37).

3.3.2 Visual Design

Visual design focuses on the final appearance. There are visual design elements and principles that can be followed to make the design process less complicated. William Strunk, an American professor of English at Cornell University and author of The Elements of Style, once said:

> *The best designers sometimes disregard the principles of design. When they do so, however, there is usually some compensating merit attained at the cost of the violation. Unless you are certain of doing as well, it is best to abide by the principles* (Lidwell et al., 2010, p. 13).

In the book *Universal Principles of Design*, there are 125 ways discussed "to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design" (Lidwell et al., 2010, p. 4). The book mentions many elements and principles of visual design are discussed, therefore we will go through the most known and used ones nowadays.

Design Elements:

1. **Color:** "Color is used in design to attract attention, group elements, indicate meaning, and enhance aesthetics" (Lidwell et al., 2010, p. 48). To have a balanced combination of colors, it is best to limit the colors which are being used. To have the best color combination, a designer can use the color wheel. This allows the designer to have "adjacent colors on the color wheel (analogous), opposing colors on the color wheel (complementary), colors at the corners of a symmetrical polygon circumscribed in the color wheel (triadic and quadratic), or color combinations found in nature" (Lidwell et al., 2010, p. 48) see figure 3.8. Light colors are used for the foreground while darker ones are used for the background.
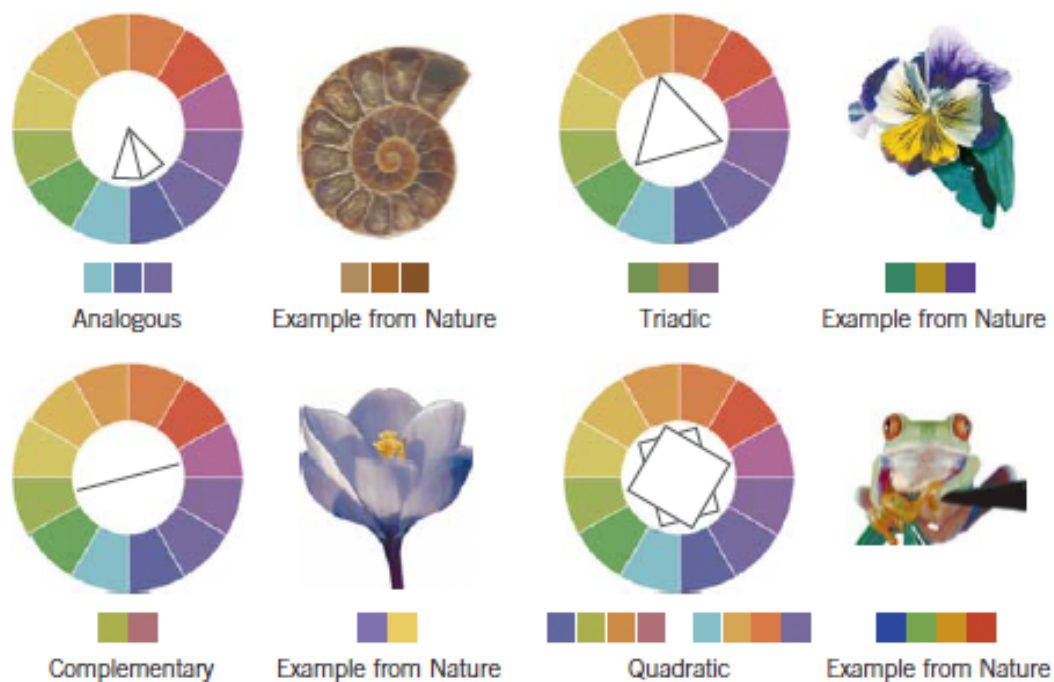
Figure 3.8. Color combination on the color wheel(Lidwell et al., 2010, p. 48).

2. **Line:** "Lines can be horizontal, vertical, dotted, zig- zag, curved, straight, diagonal, bold, or fine. Lines can show direction, lead the eye, outline an object, divide a space, and communicate a feeling or emotion"(Stout, 2000, p. 1).

3. **Space:** Here we have active white space and passive white space. "White space that is used deliberately is called active white space and is an integral part of your design that structures and separates content" (Technology, 2005, p. 39). While passive space is empty space which act like a border.

Design Principles:

1. **Proportion:** The relationship between the layers in terms of size, shape and quantity. Also whether they are positioned vertically or horizontally (Stout, 2000, p. 3).

2. **Emphasis:** There are many ways to emphasis the importance of an element. For example through contrasting colors, different line shapes, changes in size and using a plain background color.

3. **Balance:** This can be achieved through having symmetrical or asymmetrical shapes. Symmetry, also called formal balance, is the simplest way for boosting balance. It can be identical in size and shape, this will make it look symmetrical, balanced and static. While "asymmetrical designs also are called informal designs because they suggest movement and spontaneity"(Stout, 2000, p. 3) (see fig. 3.9). It is more difficult to

make it look balanced compare to symmetrical shapes.
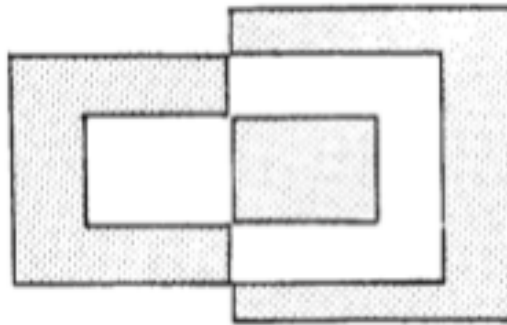
Figure 3.9. Asymmetrical shape (Stout, 2000, p. 3).

3.3.3 Mobile Application Design

Nowadays million of mobile application can be found on the mobile stores. What differs one from the other is its usability and design. "A mobile application (or mobile app) is a software application designed to run on Smartphone, tablet computers and other mobile devices and/or taking in input contextual information" (Kirubakaran and Karthikeyani, 2013, p. 80). There are native apps and mobile apps, each can be designed to work on a mobile operating system (e.g.,ios, andriod, etc.). Web apps can be accessed from any browser and any desired operating system. Nevertheless, it always requires Internet connection to the device for the web app to be accessed.

"When building mobile experiences, it is impossible to create a great experience without three ingredients: context, information architecture, and visual design"(Fling, 2009, p. 109). With information architecture, it is meant the flow of the information presented to the user. The architecture of the application can be developed using storyboard flowcharts and action flowcharts. Storyboard flowchart is a map which presents the pages of the mobile application in a hierarchy, while action flowcharts focus on the flow of the user actions.

There are also limitations to the designer's creativity. How creative you can be depends also on how much the device you are targeting can process. It is very challenging to develop an application that can work on both big and small screens, advanced and less advanced devices (Fling, 2009, p. 109). When the user uses the application for the first time, it is important that the design leads to user's high expectations.

The International Organization for Standardization (ISO), managed to standardize in their ISO 9214 seven presentation attributes that define requirements for a good mobile appli-

cation UI (Standard, 2010, p. 11).

1. **Clarity:** the content displayed can be understood efficiently.

2. **Discriminability:** the content is displayed clearly.

3. **Conciseness:** no overload of unnecessary information.

4. **Consistency:** the user interface is designed uniquely and in a constant way.

5. **Detectability:** there is a clear hierarchy, which the user can distinguish easily.

6. **Legibility:** the content is easily readable.

7. **Comprehensibility:** the content is direct and can be easily understood.

Mobile applications can be "in web, native and hybrid meaning that they use web technologies, programming languages used by mobile platforms and specific cross platforms tools that are able to mediate on these two methods" (Pastore, 2013, p. 521) . Mobile web applications can be developed using languages like HTML, CSS in combination with JavaScript. They have the advantage that they do not need to be downloaded and can be accessed via any smart-phone. On the other hand, the challenge is to make it responsive to any size screen.

3.4 Evaluation Methods

If we cannot test it then we cannot prove it. This section discusses the usability testing methods that are used before and after the design process starts on paper. Sub-section 3.4.1 discusses the conduction of interviews and using surveys as an evaluation method. The sub-section 3.4.2 discusses the different usability and user experience tests which a designer can use. These can be very useful when the prototype is in process or is ready to be tested. In this section the forth research question "What are the different methods that can be used to evaluate mobile application design?" is answered.

3.4.1 Survey and Interviews

Designers do not have to be always right about their assumptions. Not because they believe their product works well or is needed means that it would be perceived as expected from the users. This is why it is very important to conduct surveys or interviews with the target users to verify their assumptions. "While questionnaires can provide evidence of

patterns amongst large populations, qualitative interview data often gather more in-depth insights on participant attitudes, thoughts, and actions" (Harris and Brown, 2010, p. 1).

In a book called *Research Methods in the Social Sciences* by Barbour and Schostak, they set certain concepts for conducting interviews. One of these key concepts is **power** relation, which is the power between the interview and the interviewee. It is very important to balance this power. Secondly **value**, which represents the value of the interview and the interviewee's responses. Then comes **meaning** , which "refers to the meaning the interviewer intends to convey. This process might sometimes be incorrectly done, and therefore an alternative truth or reality might be declared" (Alshenqeeti, 2014, p. 41). Last but not least **wording**, which is about the way the interview questions are worded. For example, long questions tend to have short answers and vice versa. Therefore, "the shorter the interviewer's questions and the longer the subject's answers, the better an interview is" (Somekh and Lewin, 2004, p. 43).

"A survey is a data-gathering and analysis approach in which respondents answer questions or respond to statements that were developed in advance" (Kasunic, 2005, p. 3). We often confuse a survey with a questionnaire. According to Kasunic a survey is a process while a questionnaire is the tool of this process. A survey research process can be divided into seven steps (see fig. 3.10).
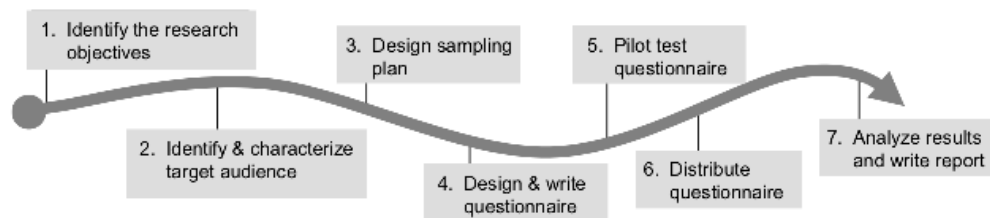
Figure 3.10. The survey research process, seven steps (Kasunic, 2005, p. 7).

1. **Identify research objectives:** Setting an objective on what the survey wants to accomplish and identifying the problem that needs to be solved.

2. **Identify and characterize target audience:** Identifying the target audience and understand their background to set the correct terminology.

3. **Design sampling plan:** It is important to ensure that those who respond to the survey are representative of the target audience.

4. **Design and write questionnaire:** "The survey objectives and internal questions must be translated into carefully-worded questionnaire items crafted to facilitate analysis and interpretation" (Kasunic, 2005, p. 7).

5. **Pilot test questionnaire:** The questionnaire must be responded to by members from the target audience to avoid any errors.

6. **Distribute the questionnaire:** The questionnaire should be distrusted according to the sampling plan.

7. **Analyze results and write report:** "The results should be collected and translated into appropriate graphical displays that facilitate understanding" (Kasunic, 2005, p. 7)

3.4.2 Usability Testing

In user-centered design, usability testing is key to have a successful design. "The testing stage is where the product is tested to ensure that it meets design requirements and specifications, and will be accepted by the target audience" (Lidwell et al., 2010, p. 78). Nowadays, usability testing has been emerging more and more in the field of human-computer interaction (Bernhaupt et al., 2008, p. 746)."The term usability testing to refer to a process that employs people as testing participants who are representative of the target audience to evaluate the degree to which a product meets specific usability criteria (Rubin and Chisnell, 2008, p. 21).

Goals of usability testing according to Rubin in his book published in 2008, *How to Plan, Design, and Conduct Effective Tests*:

1. **Informing Design:** The goal of conducting the test is to send a message through the design. Therefore, it is important to collect data on its usability to refine it. The goal of conducting a usability test is to ensure that the product is **useful**, has **value**, is **easy to use**, allows for **efficient and effective** actions and is **satisfying to use**.

2. **Eliminating Design Problems and Frustration:** When assuring the least amount of frustration of using the product, we push for a **positive relationship** between the user and the organization, we **establish high expectations** and reach them and we make sure that the **user feels important**.

3. **Improving Profitability:** Having the results of the user tests document will only ensure that the next version of the product is an improvement. This will help the profits of the organization.

The steps which need to be taken into consideration when using this methodology are the following: Firstly, formulating a hypothesis which describes the expected test results. Secondly, it is important to have a target group and to understand their needs and characteristics. "Experimental controls are crucial or else the validity of the results can be called

into question, regardless of whether statistical significance is the goal"(Rubin and Chisnell, 2008, p. 23). The third thing that needs to be taken into consideration is having a control group for validating the results. The size of the sample group needs to be big enough since it is representing a way bigger population.

3.5 Instructional Animation and Learning

As mentioned in section 2.1.4, instructional animation, are used to explain instructions for a specific task, or to support understanding a complex subject. They can also be referred to as educational animations. This sections tries to answer question number seven "What are instructional animations, where are they used and how do humans understand them?".

3.5.1 Six Levels of Explanations in Animation

According to Shaaron Ainsworth in his article *How do animations influence learning?*, published in 2008, there are six levels of explanations with animations:

1. **Expressive Explanations:** This characteristic takes place when a task that needs to be presented in a sequence.

2. **Cognitive, Perceptual and Motor Explanations:** "An analysis of cognitive, motor and perceptual consequences of learning with animations showed that while they may make dynamic information explicit, which should reduce the amount of cognitive effort required to learn about dynamic systems, they also introduce significant problems for perceptual processing and memory because of their transient nature" (Ainsworth, 2008, p. 16)

3. **Affective and Motivational Explanations:** Even if the animation learner expresses that they are now more motivated to learn because of the animation, it does not have to be true.

4. **Strategic Explanations:** It is important to set the correct strategy for learners when studying via animations. However, it was proved that new learners tend to choose the wrong strategy.

5. **Metacognitive Explanations:** Achieving effective metacognition by animations can be tough. Subsequently, research shows that learning via animation could give the illusion of understanding.

6. **Rhetorical Explanations:** "Animations can serve in supporting social learning is mixed with some researchers reporting increasing effective communication and some decreased" (Ainsworth, 2008, p. 16).

3.5.2 Animation Types

All of these characteristics are dependent on each other. If one looses control of one of them it would affect another characteristic. Therefore, to ensure that the animation for learners is affective, one has to have control on all of the characteristics.

It is also necessary to choose the type of animation used. According to Lirong Xiao for learning there are three types of animations (Xiao, 2013, p. 286), **expositive**, **interactive** and **quizzes** animations. Expositive animation refers to the usual animation, and there are many softwares for creating expositive animations, for example, Adobe Aftereffects `https://www.adobe.com/at/products/aftereffects.html` for 2D digitalized animations. However, there are also stop motion animations which rely more on the manual creativity rather than the software. This refers to "a technique that involves creating the illusion of 'motion' through the physical manipulation of objects, both inanimate and living" (Nässi, 2014, p. 10). The second type of educational animation is 3D interactive animations which is a combination of 3D animation, sound design, effective music and visual mayhem. "Based on the 3D interactive animation techniques and effective sound design, one can devise narratives that work within the limits of teaching needs" (Nässi, 2014, p. 287). Lastly quizzes, where learners are tested on the content displayed.

3.5.3 Animation Development Process

Like many development process, animation has its own development cycle. According to professor Mark Windschitl in his article *Instructional Animations: The In-house Production of Biology Software*, when developing an instructional animation with his students, this is how the development cycle goes (see fig. 3.11) as displayed in the following chart as an iterative process:
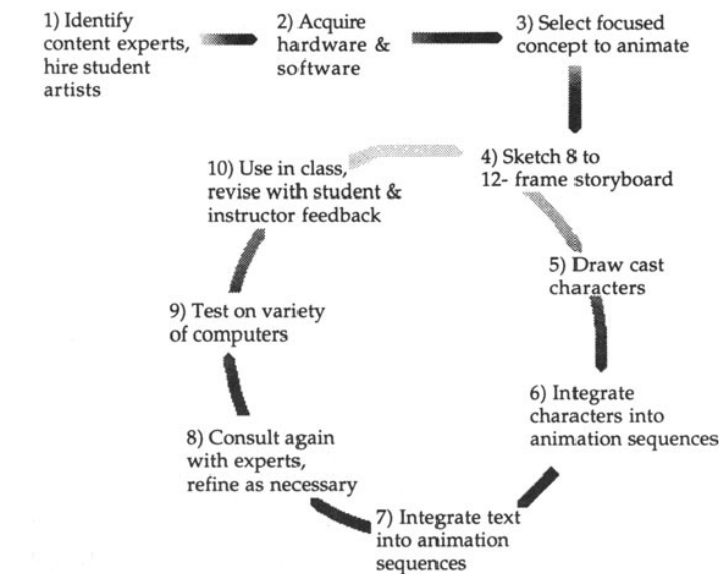
Figure 3.11. Animation development cycle(Windschitl, 1996, p. 82).

It is important to keep the animation simple, only relevant information needs to be perceived. Also, the users need to be in control of the animation. Therefore, having a control panel where they can move forward, backward, pause etc. is necessary. "Highly abstract characters should be used in the animation only if your learners are of at least average intellectual ability" (Windschitl, 1996, p. 91).

3.5.4 Animation in Health

Health animation have been proven to be effective especially for people with low health literacy. Health literacy means "the degree to which individuals can obtain, process, understand, and communicate about health-related information needed to make informed health decisions"(Berkman et al., 2010, p. 14).

An online experiment with 231 participant aged 55 and older with low health literacy took place in Amsterdam. The participants were randomly exposed to one of four experimental messages which were either presented through written text, installations or animations. The results were significant, "when exposed to spoken animations, people with low health literacy recalled the same amount of information as their high health literate counterparts (P=.12), whereas in all other conditions people with high health literacy recalled more information compared to low health literate individuals" (Meppelink et al., 2015).

If all of these elements and characteristics mentioned above are take into consideration

when developing instructional animation, the probability of it being affective to the viewer is very high. The use of this kind of animation is very popular nowadays in the educational field. This is because after conducting many tests on children and adults, it has been proven to be an effective learning tool compared to traditional tools if used properly.

3.6 Iconic Representation

"Iconic representation is the use of pictorial images to make actions, objects, and concepts in a display easier to find, recognize, learn, and remember" (Lidwell et al., 2010, p. 132). Creating pictorials can be challenging since it represents words that communicate important information. For example, if traffic signs are not understood properly because of their complex shapes and design, the driver could get into serious trouble. In Dhaka city, they conducted a study on traffic signs to make sure they are understood properly. Twenty regulatory sings, seventeen warning signs and five informatory signs 3.12 were evaluated. The results of the survey indicated that even if the signs were effective "it was found that driver education and use of a driver's handbook can be the primary ways to teach the meaning of traffic signs" (Razzak and Hasan, 2018, p. 28). In this section research questions five "What are pictorials and how do human perceive/understand them?"and six "What needs to be taken into consideration when designing pictorials?" are discussed.

Figure 3.12. Informatory signs evaluated in Dhaka City in 2009 (Razzak and Hasan, 2018, p. 21).

3.6.1 Types of Iconic Representation

There are four types of iconic representation according to the book *Universal Principles of Design*:

1. **Similar icons:** refer to representing simple actions, objects or a concept. For instance, a curved road can be represented with a curved line.

2. **Example icons:** usually represent a more complex action, object or a concept. It uses images. For example, an airplane sign is usually represented by a figure of an airplane.

3. **Symbolic icons:** use mainly abstract images that usually do not represent an object, concept or an action accurately but are still understandable. "For example, a door lock control on a car door uses an image of a padlock to indicate its function, even though the padlock looks nothing like the actual control" (Lidwell et al., 2010, p. 132).

4. **Arbitrary icons:** the relationship between the icon and the action needs to be learned. This is because it is usually represented in a very abstract way. For instance, the radiation sign is recognizable because we learned the meaning of it.
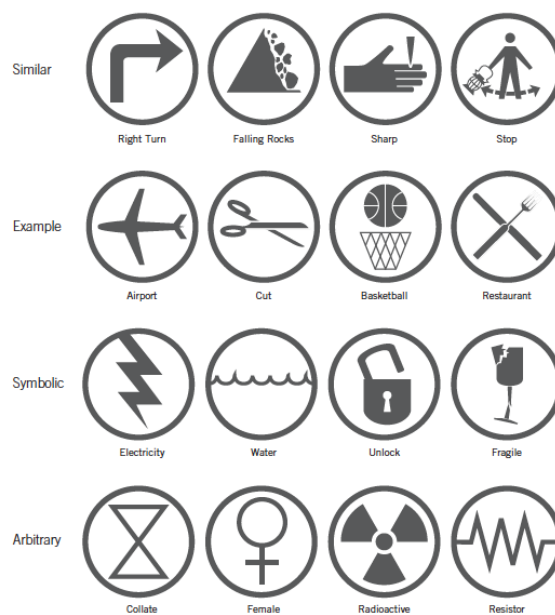
Figure 3.13. The different types of iconic representations (Lidwell et al., 2010, p. 133).

3.6.2 Understanding Iconic Representational

The reason why icons are recognizable is because since we are born to develop a relationship between a figure and what it is. This is referred to as inherited archetypes. "This gives rise to a fundamental question which goes far beyond the scope of our inquiry, namely, whether a pictorial notion can be inborn or whether it must first be experienced in order to enter the subconscious as a memory"(Frutiger, 1989, p. 115). Icons can been the one lan-

guage that all cultures can understand. It does not matter where one is from, one will most probably understand the WC or airport sign. Human beings are always able to learn and new language and pictorials and signs are languages. With one pictorial a whole concept or action can be explained. The Ancient Egyptians language is purely pictorial script.

In the requirement Engineering field, users from different cultures may use your software. Therefore, they have decided to create an icon based language. Not only because of the multi-culture also in case of an emergency people from different backgrounds may collaborate to solve the issue. Therefore, "the need of a standard representation to reduce the ambiguity and multitude of semantic interpretation becomes more apparent, and - thirdly, direct manipulation on the icons allows us to have a fast interaction and improves human-communication among those who do not speak the same natural spoken language, thereby helping to reduce misunderstanding and promoting collaboration" (Heimbürger et al., 2014, p. 8). With only simple icons, which can be learned easily, they were able to represent requirement engineering notations (see 3.14).
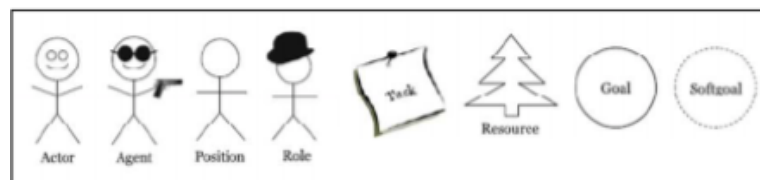
Figure 3.14. Requirement Engineering Icons Notations (Heimbürger et al., 2014, p. 9).

A paper called *An iconic language for the graphical representation of medical concepts* published in 2007 discusses how the development of a graphical language helped many medication errors to decrease (Lamy et al., 2008, p. 1).The language was called VCM (Visualisation des Connaissances Médicales; Visualization of medical knowledge) (Lamy et al., 2008, p. 2). VCM used a limited number of graphical shapes in combination of a rules-set. The icons were tested with more than 11 general practitioners. "Evaluators were asked to register their VCM training time, to indicate the meaning of VCM icons and sentences, and to answer clinical questions related to randomly generated drug monograph-like documents, supplied in text or VCM format"(Lamy et al., 2008, p. 1). The results of the tests indicated that the language was easy to learn and understand. An example of how the questionnaire looked like can be seen in figure 3.15. They were able to form sentences, explain diseases and much more with the combination of these icons.
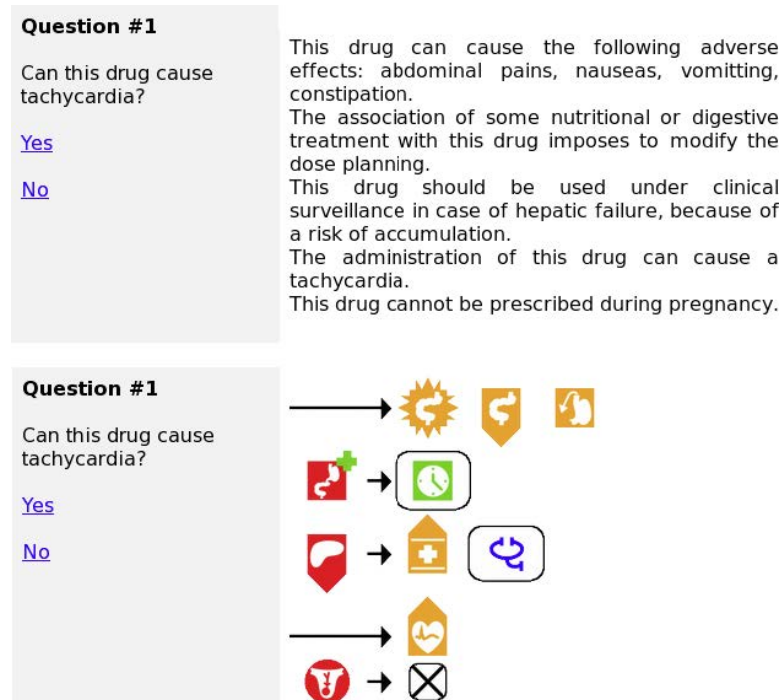
Figure 3.15. "Screen-shots of the evaluation software (extracts). The two screen-shots show the same document, expressed in text at the top, and VCM at the bottom" (Lamy et al., 2008, p. 6).

What is very interesting is not just the results of the test but rather how those icons were developed. They were developed in three steps:

1. Choosing graphically representable medical terms.

2. Creating a list with the terms and which attributes be could presented through them: such as organs, system related, etiology and physiopathological process.

3. Setting rules for these attributes and designing icons out of them: choosing the appropriate color, shape, size and pictogram. Also, they combined icons to express the relationship between them. For instance, "if a concept A belongs to the concept class B, then the icon for B should be visible in the icon for A" (Lamy et al., 2008, p. 3).
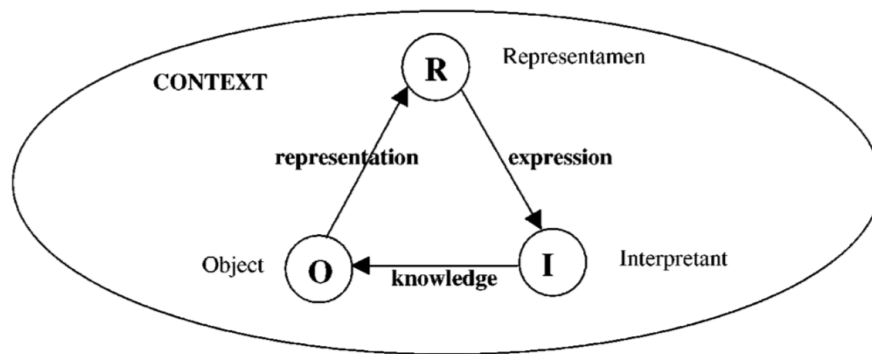
Figure 3.16. The process of understanding an icon(Goonetilleke et al., 2001, p. 743).

Figure 3.16 explain the the process of a user understanding icons. An icon is made by the following factors: a representamen "R" (a representer), an object "O" (what's represented) and an interpretant "I" (the process of interpretation). The effectiveness of understanding an icon or a representation depends on what and how something is represented. The relationship in the figure between R and I is displays the process of understanding an icon (expression). Lastly without a particular context an icon is meaningless (Goonetilleke et al., 2001, p. 743).

As mentioned before, human beings can learn a new language (spoken or visual). It all depends however on how logical and easy the language is. " Icon design is still predominantly artistic in nature and as a result icon selection is generally based on usability evaluations after a set of alternative icons are developed" (Goonetilleke et al., 2001, p. 741). For a mobile application, it is not preferred that users spend hours understanding and learning what each icon means. Since this is supposed to ease the understanding of the health care system, it should be also easy to comprehend. Therefore, using the right elements and logic behind designing the icons and testing them on users, is the key aspect of developing a good user experience journey.

3.7 Refugees Mobile Application State of The Art

This section discusses current mobile applications for refugees in the market. There is a very limited amount of applications for refugees available. In this section two applications are considered

In 1, an application called "Ankommen" was mentioned. This application is developed for refugees in Germany, to help them settle in. It uses icons only on the first page (see figure 3.17) and is available in only limited languages. It also aims to teach its users the

German basics. The three icons presented on the first page represent, 1.learning German, 2. getting help on finding a job, 3. basic life activities in Germany.
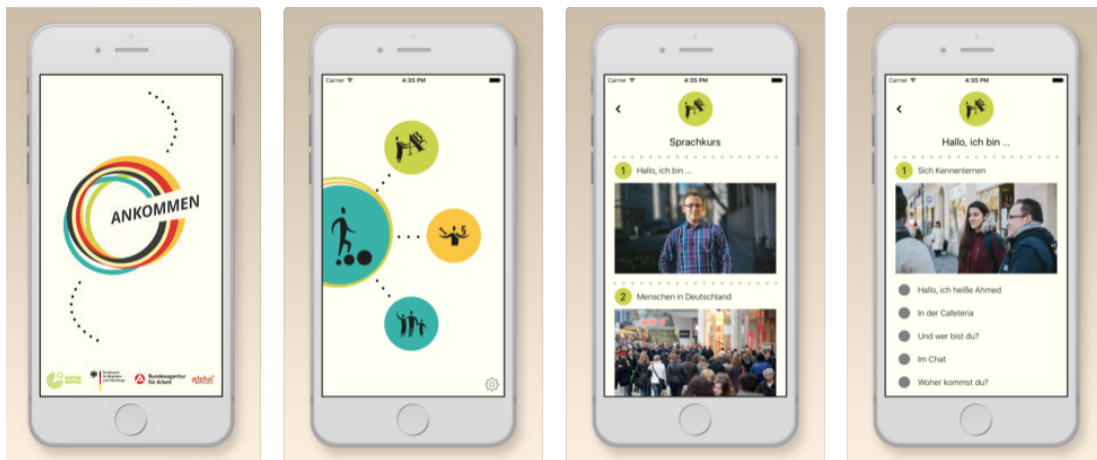
Figure 3.17. Ankommen application screenshots.

The second application is called UKAPO which aims to solve "the problem of persons with disease who can not speak to explain their medical issues"(Appadvice, 2018). Figure 3.18 shows screenshots of the mobile application. The most common symptoms are visualized and only little text is used. When interacting with the icons the disease is pronounced. It a way to learn the name of the symptom as well as communicate with the doctor or a pharmacist. This application is not free is available for free.

Figure 3.18. UKAPO application screenshots (Appadvice, 2018).

4 User Centered Design Process of the Austrian Health System Refugees Application

This chapter focuses on the development and evaluation of the Austrian Health Care System prototype for refugees living in Austria. As mentioned in the previous chapter, a user centered design approach is used to develop this prototype. During the winter of semester 2018, the Media Computing Research Group started working on this project with the co-operation of the Lower Austrian Health System Government. After understanding the requirements from the government, the team started with a brainstorming workshop and presented the outcomes of those ideas them. The outcome of this workshop helped develop a low-fidelity prototype which is presented in section 4.5. Furthermore, to understand the refugees needs, user interviews were conducted with them. While working on the low-fidelity prototype a short survey was conducted to get feedback from users on the current stage. Lastly, in section 4.5 the hi-fidelity prototype is presented in addition to the final user test. The icons used in this project are designed by Christoph Taucher the graphic designer who was part of the Media Computing Research Group St. Pölten.

4.1 Target-group

The primary target-group is refugees and migrants, who their mother tongue is not German. The focus is on the young refugee arriving to Austria and know little about the Austrian Health System. Refugees who speak German well are not part of the target group.

4.2 Understanding the Users' Needs

Part of the user centered design approach is understanding the users needs first. Therefore, this section goes through this first phase, where user interviews are conducted. The section explains the method used, the goal of the interviews, the procedure of the inter-

views and lastly the conclusion and results. This part of the study is independent from the Media Computing Research Group of the University of Applied Sciences Sankt Pölten, and the results are only used for this research.

4.2.1 Methodology

To understand the users' needs a one to one interview was conducted with 5 subjects of the target group. This interview took place on the 25th of April 2018 from 2 pm to 4 pm, at the LARES organization office in Sankt Pölten, Austria. LARES is a refugees organization, which offers care and support to many refugees and asylum seekers in Austria. Part of their responsibilites include consulting, care and support, housing and accommodation, education and training, integration, medical and psychotherapeutic treatment ("LARES Niederösterreich - Mitte," 2018). When contacting them as a student, they offered me support directly and connect me to 5 refugees and offered their office to conduct the interviews.

4.2.2 Goal

The goal of this interview was to understand the refugees' perception and understanding of the Austrian health system. Moreover, it was important to learn about their experiences since they arrived to Austria and if they faced any difficulties with the Health System. Therefore, the interview consisted in open questions to allow the interviewees express themselves as much as possible. The interviewees were also given the opportunity to express their option freely about the idea and to suggest solutions for their different cases.

4.2.3 Procedure

As mentioned before, five refugees were interviewed separately. The interviews were recoded via smart phone. One refugee was from Iraq and the 4 others were from Afghanistan. The group included one female and 4 males. The following tables display the most relevant data about the interviewees. Each subject has an ID as they requested to stay anonymous. The German language proficiency level ranges from A1 (which is the lowest level) untill C2. Each levels is always divided into two parts (e.g. A1, A2; B1, B2; etc..).

Table 4.1. General data on the subjects.

Participant ID	Gender	Age	Nationality
P1	male	35	Iraq
P2	male	18	Afghanistan
P3	male	19	Afghanistan
P4	male	19	Afghanistan
P5	female	18	Afghanistan

Table 4.2. Language proficiency and duration of stay in Austria.

Participant ID	Duration of stay in Austria	German Language Proficiency	Mother-tongue language
P1	2,5 yrs	A2	Arabic
P2	7 yrs	B2	Dari
P3	2 yrs	B1	Dari
P4	3 yrs	A1	Dari
P5	2 yrs	A2	Dari

Each subject was given a 15 minutes slot starting from 2:15 pm. At 2 pm, I was welcomed at their office and was given a conference room to prepare for the interviews. At 2:15, the first interview took place with the Iraqi refugee who arrived 2.5 years ago with his wife and 4 years daughter. Each subject was introduced to the interview process, the master thesis topic and was given a consent paper to sign. They were also given the opportunity to choose the language of communication, either German, English or Arabic. All interviews were conducted in German except for the first interview with the Iraqi refugee, was conducted in Arabic. The whole process took approximately 2 hours.

The interview questions were decided into three sections. Section one included general questions about the age, gender, nationality and year of arrival to Austria. Section two was specific to the Austrian Health System and the experience of the interviewee with it. In the last section of the interview, the subjects were asked about their literacy, pictures related

to health, and their ideas on the topic.

4.2.4 Interview Results

In this chapter the results of the interview questions will be analyzed. The results are divided into quantitative and qualitative data.

Knowledge Rating

Question one allowed the subjects to rate their knowledge about the Austrian Health System, from 1 to 5 (see Figure 4.1).

It was interesting how subject number 4, was very confident when answering this question and overestimated his knowledge. During the interview, he himself admitted that he overestimated his knowledge of many rules and rights like when to change the generalist or that a patient is even allowed to do that. The average of the 5 subject's knowledge on a scale of 5 is 2.6.
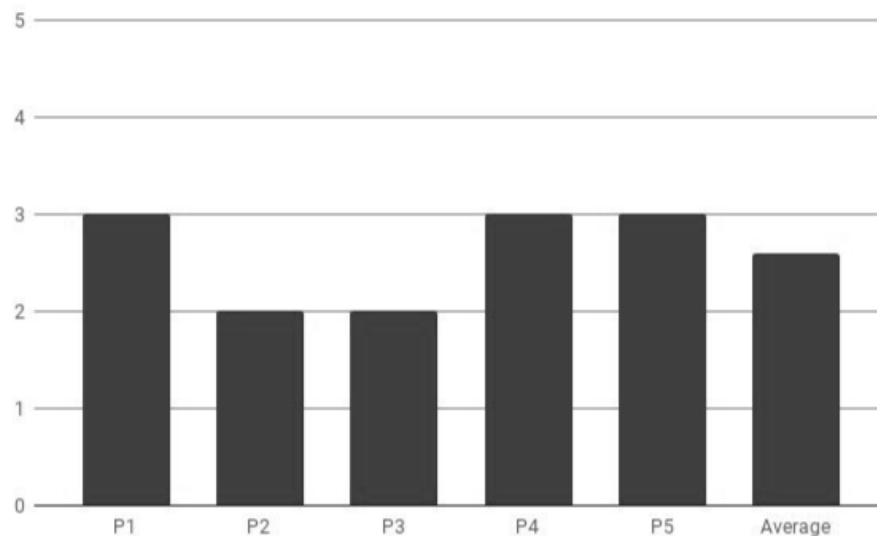
Figure 4.1. Subjects rating their knowledge about the Austrian Health System.

Looking for Information

When being asked about how they inform themselves about the Austrian Health System, the answers were as followed:

Table 4.3. Participants' response to their source of information

Participant ID	Source of Information
P1	I seek help from the LARES organization, this is only possible during the week. Otherwise I ask a pharmacist.
P2	I have no one to ask, sometimes I ask the organization.
P3	I do not use Google, I try to ask the organization.
P4	I ask other citizens.
P5	I used to ask my supervisor, but they are responsible for us for only a short period of time.

As we can see in table 4.3, before the refugees got connected to LARES organization, they barely knew anything about the system. According to subject number one, LARES can be only connected to during their working hours on the weekdays, therefore if anything happens during the weekend, the subject seeks help at a pharmacy. Some of the subject do not even seek help and the ones that were relaying to their supervisors when they first arrived are alone now.

Difficulties

When asked about the difficulties they faced with the health system, the first subject explained that he did not face any major difficulties with the health system. However, he is always scared and insecure when he goes to the doctor because of the language barrier he faces. It is very difficult for him to explain himself and understand the doctor. From his point of view all the medical terms are very hard to understand.

Subject number two, admitted that he faced difficulties before with the health system. He was not informed about his rights or how to go to the doctor when he first arrived to Austria. No one from the LARES organization informed him about the health system when he was new to it. Moreover, problems he faces now do not even have anything to do with the language but rather because of the health system's rules and process. According to him, even when he knows how to express himself or ask a question, he does not know who to communicate his questions to.

Subject number three said that he only goes to the generalist and to the hospital, since he does not have information about any doctor. Moreover, he does not know the rules or his rights, he said: "I do not know what to do in case I need a surgery, or what steps a female should take in case of pregnancy." He also faces many language barriers.

Subject number four faced may problems when he arrived to Austria. He did not know how to speak German nor English. He came alone to Austria and did not know anyone. Therefore, he had no knowledge about the health system.

Lastly, subject number five talked about his experience when she had fever, and did not know what to do. Therefore, she did not go to the doctor and ended up googling how to treat it by herself. Luckily, she ended up finding a doctor who speaks her mother tongue language.

The five examples mentioned have many things in common and all faced difficulties with the Austrian Health System. It's clearly not related to the quality of the health system, but rather to their misinformation of it due to the language barrier.

Past Experiences

Question number four allowed them to talk about their experience when they went to the doctor. According to subject number one, the worst moment he had is when his baby daughter fell off the bed. He instantly called the ambulance but was not able to tell the doctor what happened. Lastly he used signs to explain how the accident occurred.

Subject number two tries to avoid going to the doctor as much as possible. Even when he is in pain, he thinks of all the effort that needs to be done and ends up avoiding the whole situation.

Subject number three believes that because of the language barrier, he is not getting the right treatment. He started to understand that after he injured his leg in a cricket game and went to the hospital. Although he was going through a severe pain, doctors could not really understand him and ended up not prescribing anything to him. Subject number five explained that he suffers from the same problem as subject three.

Lastly, subject number five always goes to the same doctor since she is the only one who speaks her mother tongue. Although she feels that she is not getting the appropriate help she needs, she knows that she can't go to another doctor due the language barrier.

Ideas

It was also interesting to hear from the subjects suggestions to help their needs (see table4.4).

Table 4.4. Subjects' ideas regarding the Austrian Health System.

Participant ID	Ideas suggestions
P1	An application that teaches you the medical terms in German
P2	Animations which show you what to do in certain situations
P3	-No ideas-
P4	An application which connects me to a community like mine or a community of citizens that would support me in situations when I need a medical advice
P5	It would be good ti have medical pictorials

4.2.5 Conclusion

In conclusion, we see that the main issues are related to the language barrier. Even though all subjects got help from the LARES organization when they first arrived, they still faced many issues related to understanding the doctor or the steps which need to be taken when they are sick. We can imagine how tough the situation could be for other citizens who do not have access to such an organization.

At the end of the interview each subject was shown a pictorial which is related to health (see Figure 4.2). The icons were designed by Christoph Taucher as he was part of the project at the Media Computing Research Group of the University of Applied Sciences Sankt Pölten. All subjects were asked, if they could understand and interpret the meaning of the following icons. Surprisingly, all 5 subjects were able to interpret all the icons correctly. From their point of view, the simpler the icons the easier it is for them to understand their meaning. The fact that the subjects were able to understand the pictorials, confirmed that it could be possible to communicate through non-verbal visuals. This led to the path of understanding how humans interpret visuals and which visual conventions exist.

Pictorial Meaning:

- Pictorial 1: doctor

- Pictorial 2: opening time

- Pictorial 3: e-card

- Pictorial 4: changing your doctor

- Pictorial 5: selecting a doctor

- Pictorial 6: taking a medicine

- Pictorial 7: ask for a medical advice

- Pictorial 8: doctor's appointment

- Pictorial 9: injection

- Pictorial 10: medicine instructions

Figure 4.2. Pictorial related to health and the Austrian Health System (Taucher, 2018).

4.3 Concept Development Phase

The concept development phase depended heavily on the research done on refugees in Austria as well as the requirements of the Lower Austrian health care government. This phase took place before the user interviews where conducted with the refugees. The results are an outcome of intensive brainstorming with the Media Computing Research Group of the University of Applied Sciences Sankt Pölten and the team health care government of Lower Austria. This section focuses on the idea generation by developing flowcharts and sketches in groups. There were three workshops that were held; the first two ones included only the Media Computing Research Group and the third one included both the Media Computing Research Group and a team from the health system of Lower Austria department. The first two focused more on brainstorming, and collecting ideas. While the second workshop was more about minimizing the outcomes of the first workshop and the

third one was held to present the ideas, get feedback and decide on one finale idea. The first workshop took place on the 9th of November 2018, the second one was on the 20th of November 2018 while the workshop with the health system of Lower Austria took place on the 24th of January 2018.

4.3.1 Medical Terminology System/Ontology

In order to have a consistent structure in the implementation, a generic applicability of the concepts as well as a basis for collecting the ideas, a system was created. This helped us arrange and link the medical terms and concepts used for the platform. The developed system divides the terms into categories. These can be represented in graphical representation classes/pictorials. The category-specific patterns of mediation, help facilitate the interpretation of the visual information presented to the users. The framework can serve as a concrete basis and therefore easy-to-understand entry into the information. The medical areas are also an entry point and connect the terms to each other. As mentioned in the previous section, this part of the project took place before the user interviews and is adopted from the outcome of the Media Computing Research Group of the University of Applied Sciences Sankt Pölten.

Categories within Medical Terms

- **Objects:** Are physical artifacts with certain properties which are needed in certain situations, e.g. the e-card which is similar to the insurance card.

- **Persons:** Are people with certain tasks or skill, such as a doctor.

- **Actions:** Are goal related activities in certain situations, e.g. Visiting a gynecologist during pregnancy.

- **Functions:** Are properties or effects of abstract or non-physical things, e.g. Medications (whose effect is independent of form) or psychiatry (which is a medical concept).

- **Behavior:** Culturally expected or required behavior due to medical or organizational requirements, e.g. the visit of a relative in the hospital or keeping a distance while sneezing.

Terms and Categories in the Framework

- **Event:** Occurs in the short term, e.g. have a positive pregnancy test.

- **Situation:** Prolonged, e.g. stand before birth.

- **Desire:** To reach a destination, e.g. do not want to get pregnant.

Medical Branches

- **Acute treatment:** Based on an event, e.g. I have a lot of pain in my stomach

- **Precaution:** Based on a situation or desire, e.g. vaccination

- **Information:** General, non-event related information, e.g. Deductible for medicines

Layers of Transmitting Information

- **Navigation (entry level):** The top level must ensure a simple switch to information. In the simplest case, it covers the 17 terms linearly, or it can offer pre-selection according to the use case.

- **Information:** It is directly linked to the navigation and consists of an easy-to-understand or interpretable entry (primarily visually held). If required, it can be extended with detailed information. From both the overview and the details, there should be links to appropriate information according to the medical terms.

- **Tips:** Additional references to other sources of information or in-depth topic, such as links or telephone numbers.

- **Training:** Optionally, interactive activities can be incorporated into the platform for learning or deepening knowledge. This offers itself with a playful character, especially for the youngest of the target group.

4.3.2 First and Second Workshop

In this section, workshop one and two are discussed.

Workshop one consisted in each team member sketching their own idea according to the persona and scenario presented. It was mainly a kickoff workshop that helped understand

the concept of the project.

The second workshop was mainly for minimizing the ideas to draft mockups. The persona which was presented has the following characteristics: Her name is Faria. She is a 15 year old Syrian girl who has a high media affinity and knows how to speak English and Arabic. The goal was for her to understand how to go to the generalist, know what each doctor is for, and understand what the e-card is for.

Moreover, the team was given the following scenario:

Faria is not used to the cold winter conditions in Austria. She played outdoors with the younger children and was not dressed warm enough. Now she has a sore throat, ear pain and feels limp. She wants to see a doctor for a check-up. She has received information material from the Lower Austrian Provincial Government on health information and is now checking them out.

Kickoff questions:

- In which form is the information material available? (Silent book, animation, ...)

- Which information is included?

- Is there a print version for the digital version?

- If text occurs, in which languages?

The schedule of the first workshop is presented in table 4.5

Table 4.5. Schedule of the idea generation workshop with the Media Computing Research Group Sankt Pölten.

Time	Task
14:30 - 14:35	Meeting
14:35 - 15:10	Information on the project (problem, goal, target-group, platform)
15:10 - 16:10	Terminology structure / ontology overview
16:10 - 16:25	Idea generation (sketching)
16:25 - 16:30	Conclusion

Outcome

Even though not many ideas were taken over to the second workshop, it helped us think outside the box and come up with a logical solution. The methods used here are brainstorming, sketching and creating mockups. For mobile devices, we came up with six main ideas which were divided into two levels (see fig 4.3). The first level is the entry point and consists of frequently occurring events and situations that are easily understandable with known visualizations. The second level has visual aids to help tackle events, situations, or desires selected from the first level.

The team came up with four entry point ideas and three second level ideas.

First Level (Entry Level Ideas):

- **Chatbot:** In a chatbot, the most important pictograms or symbols of the health guide are explained via a dialogue. Color coding of the topics supports the recognition of meanings. This list of pictograms takes on the role of a graphic term index.

- **Stories:** Important emergency numbers (emergency number 144, or emergency number poisoning center) are displayed at the top of the application's homepage. Underneath is the menu item "Stories". These are stories that can be played through. One possible story may be: "I need a family doctor, what to do?" And then, step by step, explaining what is necessary (as a kind of checklist) with text / image combination. Further below, there is glossary containing a list of the most important terms in the health sector by means of icon and label.

- **Carousel:** On the entry screen, terms are displayed one after the other. By swiping left and right you can navigate through the available categories / objects etc. Clicking on one of these categories (e.g. e-card in the figure below) leads to a detailed view.

- **Events and Wishes:** The list of terms is broken down into ontology and are connected. After defining all wishes, events and situations, they are split into two levels. At the first level is the entry, which consists of frequently occurring events and situations or wishes. These should be understandably communicable with known visualizations. The levels below contain related objects, persons, functions and behavior or references to subsequent or supplementary situations, events and desires. This is a restructuring of the information that is closer to the target audience and their context of use than the order of terms or areas.

Second Level (Information-transmission Ideas):

- **Video:** An example could be an animation video explaining the E-Card along with

German text as audio track (volunteers subtitles could be inserted). The video contains explanations: What is the E-Card? Where do I need the e-card? What's on the e-card? Videos may need to be split in case of large amounts of information. Between the videos there would be a small "game", where the information from the videos is once again visually supported (e.g. quiz: show a question, but shortly thereafter also the answers fade in. So the users do not have the feeling of being tested)

- **Interactive Graphics:**

  Based on the scenario of the E-Card there are 3 main points:

  1. The information on the map

  2. Misuse of the card

  3. The need to present an ID card in addition to the E-Card

  A good solution is a map with arrows / hotspots refering to the most important information units on the map. If you scroll down, the information should slowly fade out and a horizontal navigation bar containing two interactive animation videos should pop up.

  The first animation should show information about how the card should not be used, or that no one other than the owner may use it. The second video should clarify that in addition to the card, you have to present an ID.

  In order to reach further possibilities / steps, a mind map showing the dependencies between different things, should be displayed. For example, two arrows that go away from the video - either to a doctor or a hospital. Clicking on one of these options shows you what to do next.

- **Deck:** The individual terms are divided along the ontology into their respective categories and the respective frame and then divided into the individual maps. Each map has a visualization (icon, picture, animation) and a symbol for the category (e.g house by object, call sign for actions, star for functions, a person icon for behavior, ...) or the frame, the term in German Text, an icon for details and an arrow for "Next". If you click on a text of the term, it should be read to you. The icon for details comes with additional information consisting of visualizations and text, as well as references to related topics. A good way to involve the help of volunteers in interpreting the information, would be having a phone number to forward. The helpers will then receive an SMS with the link at the same time as the call. When clicking on the arrow, the next terms are displayed. The terms are arranged in a temporal or logical order. For

example, when visiting a doctor, the search for the practice before taking the e-card with you in succession, the explanations for the different areas of the e-card would be arranged one above the other. The result is a mental map that connects all terms and explanations horizontally or vertically. Parts of this map can be printed and provided with QR codes as labels, so that they can be hung, for example, refugee homes or hospitals.
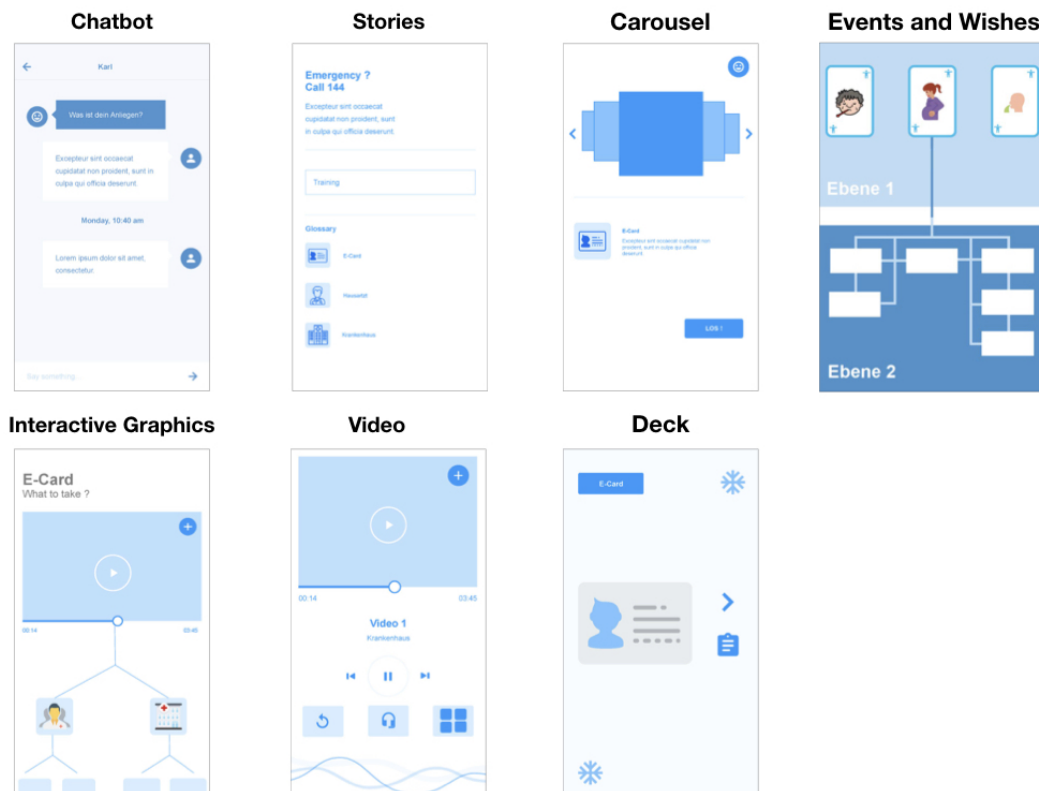
Figure 4.3. Mockups of the 6 main ideas from the second workshop, "Events and Wishes" screen design as well as "Deck" were designed by Christoph Taucher

4.3.3 Third Workshop

The third workshop took place at the office of the health care system of Lower Austria. We presented the six ideas mentioned before and asked them to rate them in order to have one last concept. The workshop took place on the 19th of January 2018. The schedule of the workshop is presented in table 4.6

Detailed Plan:

- Introduction, explaining the requirements / task, the terminology system (15 min)

Table 4.6. Schedule of the third workshop.

Time	Task
10:30 - 10:40	Meeting
10:40 - 11:20	Presentation of the concepts
11:20 - 12:30	Rating ideas(Heat Map - Straw Poll)

- Powerpoint presentation (30 min)

- Explaining the rating method (30 min)

- Speed critique session (30 min)

- Straw poll (10 min)

Methodology:

Concept Presentation: The concept was presented via powerpoint and the mockups were printed on an A3 and presented on the table and pinned to wall.

Heat Map:

- Distribute 10 stickers per person (5 for entry-level options and 5 for level two) and use only one color.

- People are not allowed to talk to each other.

- Stick stickers on those concepts or parts of them. The better the concept the more stickers you can assign to it.

Speed Critique:

- Go to a sketch and set the timer to 3 minutes.

- The moderator briefly describes the sketch again and names the parts that have received most points.

- The moderator also mentions the questions and concerns.

- From there, the creator (University team) can respond and briefly argue and answer questions / concerns.

Straw Poll:

- Everyone gets two stickers (different color than the one above).

- Within 10 minutes, the participants can decide what they like best about the topic of entry and information.

- When the time is up, the stickers should be placed.

- A minute is then taken by everyone to briefly share the decision on the final idea.

Outcome:

The **entry-level** "**Events and Wishes**" received **12** points, "Glossary with Stories" and "Carousel" each received 4 points, while the "Chatbot" remained without points.

The distribution of points for the **second level of information** was as follows: "**Videos/Animation**" received **12** points, "Playing Cards" 8 points and the variants "Mindmap" and "Interactive Animations" received 5 points each. The information transfer via "Stories" remained without points (see fig: 4.4).
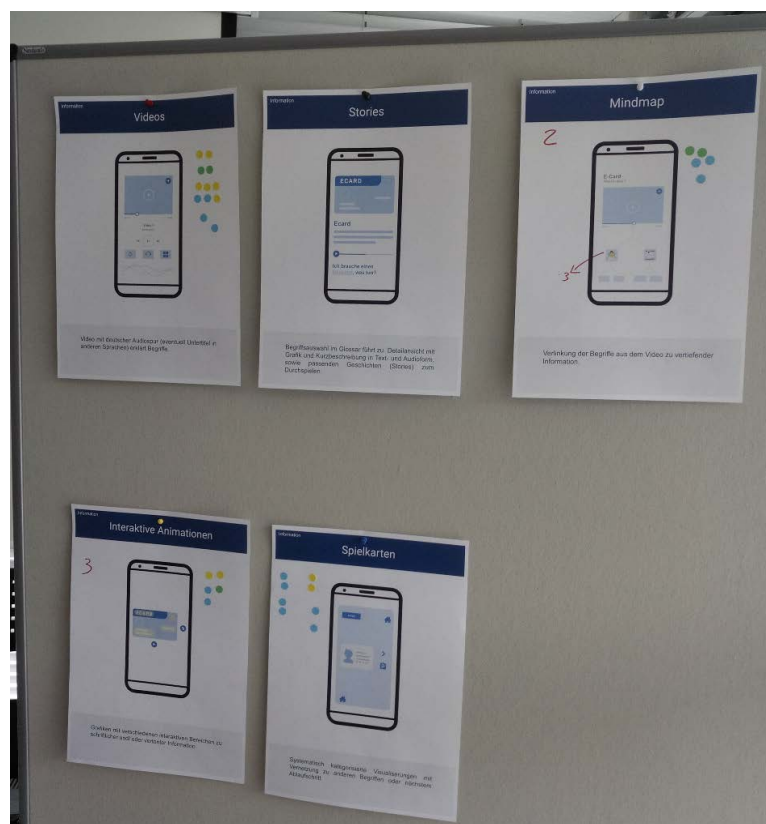
Figure 4.4. Second level rating distribution

While discussing the outcomes at the workshop, it turned out that the understanding of "Videos" and "Interactive Animations" by the team of the University of Applied Sciences St. Pölten is different from the one of the working group of the state government of Lower Austria. In fact, while the working group also included "interactive animations" or animations of all kinds under "Videos", the University of Applied Sciences St. Pölten team understood real videos as a source of information for "videos", whereas "interactive animations" should really cover animations. This meant that the weighting was changed because the working group of the state government of Lower Austria would prefer animated films.

The process, which is now to be further developed in the next step, looks like this:

Concept Definition

The entry into the web application is via "Events and Wishes". A visual depiction shows situations, events or desires such as "I am sick", "I am about to give birth" or "I want to maintain my health". Users choose the right presentation for them (because they are currently faced with the relevant questions, or because they want to inform themselves) and reach a detailed page. The information transfer point (from level 2) chosen for this discussion is "Mindmap" in combination with "animations". For the chosen situation, an animated video that provides explanations and information is shown. Depending on the video content, visual situations are again shown below the video (e.g. via pictograms or icons). For instance, in the video for the E-Card, the family doctor is mentioned, therefore under the video appears the icon for "family doctor". If this is selected, a change to the corresponding information video takes place.

4.4 Concept Mid-Evaluation Phase

This phase is mainly to get an early feedback about the project to see if it's on the right track before going to the implementation phase. This is part of the user centered design process. Here, the icons and storyboard of the animation are being tested. During this step, the evaluation method, the process, the goal and the participants are discussed in this section.

4.4.1 Methodology

The evaluation method in this phase is a questionnaire. There were in total seven participants. The survey collected qualitative and quantitative data. The concept of the applica-

tion was explained to each one of them before they started answering the questions. The tool used to conduct this questionnaire is Google Forms. This tool was chosen because it was simple and helpful for the mid-evaluation phase.

4.4.2 Process

The participants were invited to my house to do the survey. This took place on 19.08.2018 from 16:00 to 17:30 in Linz. There were four female participants and three male participants, all of them foreigners living in Austria. Every participant was presented an introduction of the project and an electronic consent form.

The questionnaire was divided into four sections. Section one focused on general information related to the participant (age, nationality, etc.). The second section was focused on the entry point of the application. The participants were given a scenario and were asked to choose an icon according to that scenario. The third section focused on the secondary level of the application. In this section, the users were asked to explain in a short answer what they understand from each icon presented. The icons were related to the doctor, being at the doctor's office and getting documents from the reception. The forth section was mainly about the animation. The participants were presented with number storyboard images and were asked to tell a story in a paragraph of what this animation could be about. Lastly, they were asked to rate the importance with certain situations that should take place in the application.

The results of this questionnaire were taken into consideration for the development phase. It was important to test the icons with foreigners who are highly educated however do not speak German very well and come from different backgrounds. If they were not able to understand certain things then the probability of refugees understanding them would be very low.

4.4.3 Goal

The goal to this questionnaire was to test how comprehensive the icons and the animation are to foreigners living in Austria. The participants were chosen because they had similar characteristics to refugees in terms of having language barriers and having a different health care system to what they are used to in their home countries.

4.4.4 Participants

In this section the collected data on the participants who voluntary took part in the questionnaire are presented in table 4.24. All of the participants are smart phone users.

Table 4.7. Participants' Characteristics

Participant ID	Gender	Age	Nationality	Duration of Stay in Austria	German Language Proficiency
P1	Female	18–29 years	Egyptian	1 year	B1
P2	Female	18–29 years	Egyptian	3 years	B1
P3	Male	18–29 years	Egyptian	5 years	A2
P4	Male	18–29 years	Egyptian	3 years	B1
P5	Male	18–29 years	Egyptian	2 years	A2
P6	Female	18–29 years	Egyptian	2 years	C2
P7	Female	18–29 years	Romanian	5 years	B2

4.4.5 Results

As mentioned before, there were four sections in the questionnaire. In section one, all participants were presented with the entry level icons 4.5. There we have an event (e.g. you are sick), a situation (e.g. you injured yourself) or a desire (e.g. you want to prevent getting sick). The task was to connect each icon with the corresponding situation. The participants were given three scenarios:

1. You are feeling sick so you open the Austrian Health System app. You can only see clickable pictorials which should navigate you. Which one of these icons explains that you are feeling sick.

2. You want to go for a check up. Which one of these icons describes that you want to have a check up or prevent getting sick?

3. You accidentally hurt yourself and need to go to the hospital. Which one of these icons describes that you hurt yourself?

All seven participants solved this task correctly.
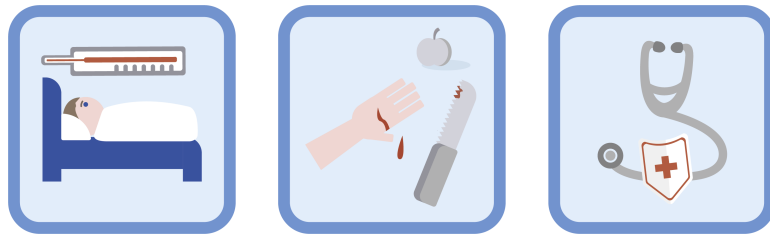
Figure 4.5. Event, situation and desire (Taucher, 2018)

In section two, the meaning of the icons/pictorials presented in the mobile application were tested. In this section qualitative data is presented. In part one of this section they were given a scenario which said the following:

You land on the doctors page, the doctor icon is connected to everything related to having/going to a doctor. What does each icon mean?
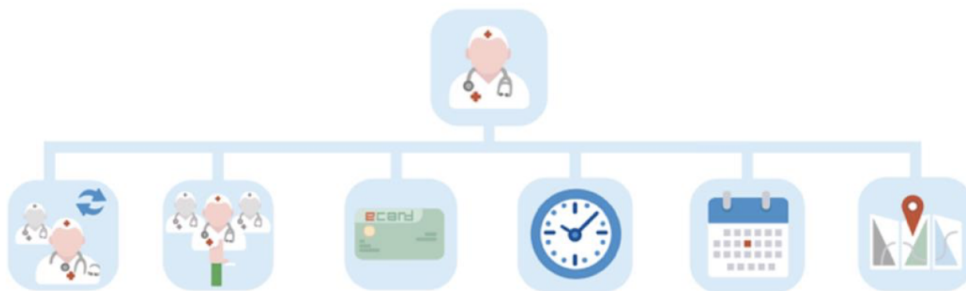
Figure 4.6. Things related to going to the doctor. Icons presented to the participants to interpret (Taucher, 2018)

As presented in table 4.8, participants understood that this icon means doctor is related to the doctor. On the other hand, in table 4.9, only three out of seven participants understood that the icon means switching or changing your current doctor.

Table 4.8. Participants' responses to icon number one: doctor

Participant ID	Interpretation
P1	Getting information about a doctor
P2	Doctor related actions
P3	Doctor
P4	The doctor's info
P5	Doctor Checkup
P6	Doctor
P7	Going to the doctor

Table 4.9. Participants' responses to icon number two: changing your current doctor

Participant ID	Interpretation
P1	Refresh the search for different doctors
P2	Change my doctor
P3	Switching doctors
P4	Change doctor
P5	Not sure
P6	Connect with a doctor
P7	Synchronizing medical data from previous doctor

All participants were able to understand icon number three, which is choosing a doctor and icon number four which is the e-card (the insurance card in Austria) correctly. (see tables 4.10 and 4.11).

Table 4.10. Participants' responses to icon number three: choose a doctor

Participant ID	Interpretation
P1	Choose between different doctors
P2	Choose a doctor
P3	Choose a doctors
P4	Choose a doctor
P5	Which doctor to choose
P6	Choose a doctor
P7	Choosing a doctor given a list of options

Table 4.11. Participants' responses to icon number four: e-card / information on the e-card

Participant ID	Interpretation
P1	Getting information about the E-card
P2	E-card info
P3	Insurance card
P4	Insurance (e-card)
P5	Insurance card
P6	Insurance card
P7	Showing the electronic health card

In tables 4.12 and 4.13, we see the interpretations of icon number five, which is doctor's opening hours to take an appointment and icon number six, which means doctor's workdays are presented. The answers are expressed in different ways but they are all going into the same direction. In other words, they are all related to opening hours or taking an appointment. Since both of those icons are extremely related to each other and can be reached through the same source (either by phone or online), they could be combined in one icon. The same goes to icon number seven, which is the location of the doctor. The results for this icon are presented in table 4.14.

Table 4.12. Participants' responses to icon number five: doctor's opening hours

Participant ID	Interpretation
P1	Time availability of the doctor
P2	Doctor's opening hours
P3	Appointment time/Waiting time/opening hours
P4	Choose an appointment time
P5	Timetable
P6	Schedule an appointment (time)
P7	Choosing a time for the appointment

Table 4.13. Participants' responses to icon number six: doctor's workdays

Participant ID	Interpretation
P1	Book an appointment
P2	How to make a doctor's appointments
P3	Appointment date/Days available
P4	Choose an appointment date
P5	Calendar
P6	Schedule a date of the appointment
P7	Choosing the date for the appointment

Table 4.14. Participants' responses to icon number seven: doctor's office address

Participant ID	Interpretation
P1	Address of the doctor clinic
P2	How to find a doctor's clinic location
P3	Location
P4	Choose location
P5	Maps
P6	Location of the doctor
P7	Choosing the place for the appointment

The second part of section two focused on things the doctor can offer once the patient is at the doctor's office. The icons related to this topic are presented in figure 4.7. The participants were asked to interpret each of these four icons.
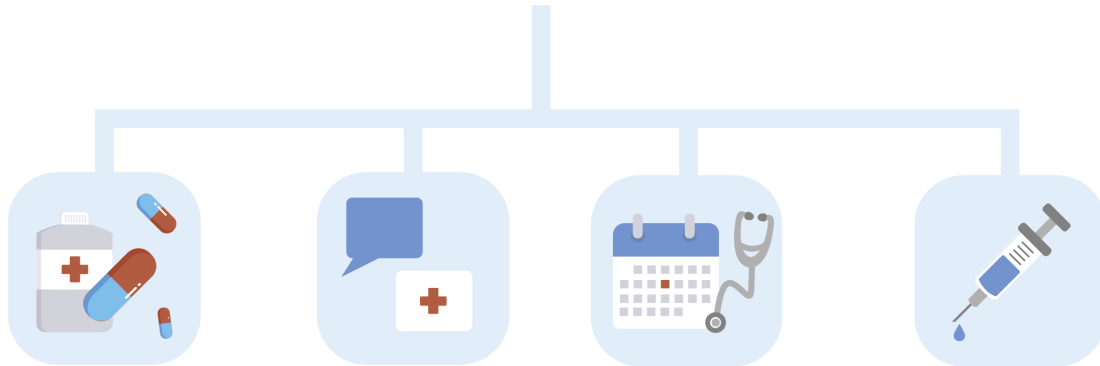
Figure 4.7. Things the patient may do or get from the doctor (Taucher, 2018)

All participants were able to understand that icon number one had something to do with medicine and prescription (see table 4.15). Similarly are the responses to the other three icons. Most of the participants understood them correctly. Five out of seven participants understood icon number two and three correctly (see tables 4.16 and 4.17). However regarding icon number four, which was vaccination/injection, six out of seven interpreted it correctly (see table 4.18)

Table 4.15. Participants' response to icon number one part two: medication / treatment of a disease

Participant ID	Interpretation
P1	Medicine
P2	Drug prescription
P3	Medication
P4	Prescriptions
P5	Pills
P6	Prescription
P7	Medicines (pills)

Table 4.16. Participants' response to icon number two of part two: medical advice/question/consultation

Participant ID	Interpretation
P1	Ask questions
P2	Medical advice
P3	Medical questions
P4	Health advice
P5	Not sure
P6	Consultation
P7	Diagnosis / Psychotherapy

Table 4.17. Participants' response to icon number two of part two: preventive medical checkup appointment

Participant ID	Interpretation
P1	Book an appointment
P2	Check up dates
P3	Follow up appointment
P4	That you can make an appointment
P5	Check up in a certain date
P6	Appointment for check up
P7	A follow up appointment

Table 4.18. Participants' response to icon number two of part two: vaccination

Participant ID	Interpretation
P1	Vaccination
P2	Vaccination
P3	Injection/vaccine
P4	Vaccination
P5	Helping to take a certain medicine
P6	Vaccination
P7	Injection

The deeper and more specific the icons were, the harder it was to understand them. This was proved in the last part of section number two. The participants were presented with icons that refer to documents they can get at the reception from the nurse (see figure 4.8). For the first icon which stood for "specialist referral", only one out of the seven participants understood it correctly (see table 4.19). Same thing goes to the next icon, the majority of participants, did not understand that the icon means a hospital transferal / referral document (see table 4.20).

Figure 4.8. Documents patients can receive at the reception from the nurse (Taucher, 2018)

Table 4.19. Participants' response to icon number one part three: referral to a specialist

Participant ID	Interpretation
P1	Check-up report
P2	Sick leave document
P3	Diagnosis/specialist referral
P4	Check-up report
P5	Not sure
P6	Description of the health status
P7	Diagnosis / description of the health state

Table 4.20. Participants' response to icon number two part three: referral to a hospital

Participant ID	Interpretation
P1	Check-up report but it's not clear if I should submit it to my doctor
P2	Specialist transfer document
P3	Hospital referral
P4	Something to take to the hospital
P5	Not sure
P6	Transfer to a hospital for another examination
P7	A recommendation for the hospital

What's interesting about icon number three (license certificate) is that only the participants who have a license understood this icon (see table 4.21). This brings us to the the following question: if humans do not experience a specific event would they recognize a visual of it? In this case maybe the issue was not in the design of the icon but rather in the fact that the participants could not relate to it.

Table 4.21. Participants' response to icon number three part three: license certificate

Participant ID	Interpretation	Has an Austrian driving license
P1	The results of the report are fine and I can go home	No
P2	Hospital transfer document	No
P3	You are free to go	No
P4	Patient is good to make a driver's license	Yes
P5	Not sure	No
P6	Confirmation of visiting the doctor for work	No
P7	A confirmation that you are able to drive	Yes

When it comes to icon four and five, none of the participants were able to understand any of the two (tables 4.22 and 4.23). This shows that, as opposed to the car icon license, the problem in understanding icon four (medical certificate) and five (sick-leave) can definitely be linked to the visuals.

Table 4.22. Participants' response to icon number four part three: medical certificate

Participant ID	Interpretation
P1	Test results
P2	Hospital transfer document
P3	Bill of health
P4	Heart condition ok
P5	Need to do heart checkup
P6	Proof of health check up
P7	A confirmation that your health state is fine

Table 4.23. Participants' response to icon number five part three: sick-leave

Participant ID	Interpretation
P1	Not clear for me
P2	Time spent at doctor document
P3	No idea
P4	No idea (receipt maybe?)
P5	Not sure
P6	Unclear what it means
P7	Not very sure, maybe a confirmation for work

Section number four of the questionnaire focused on understanding the animations. The participants were shown the storyboard of the animation like in figure 4.9, and were asked to explain each shot of the storyboard. Participants were able to identify the shots but not completely. This allowed to highlight few issues in the storyboard. For example, the arrow in the first picture have been the other way around. Moreover, images three and four would make more sense if they were switched. In addition to that, there should be more contrast in the colors if there is something that needs to be emphasized. The detailed answers of the animation storyboard can be seen in table B in the appendix.
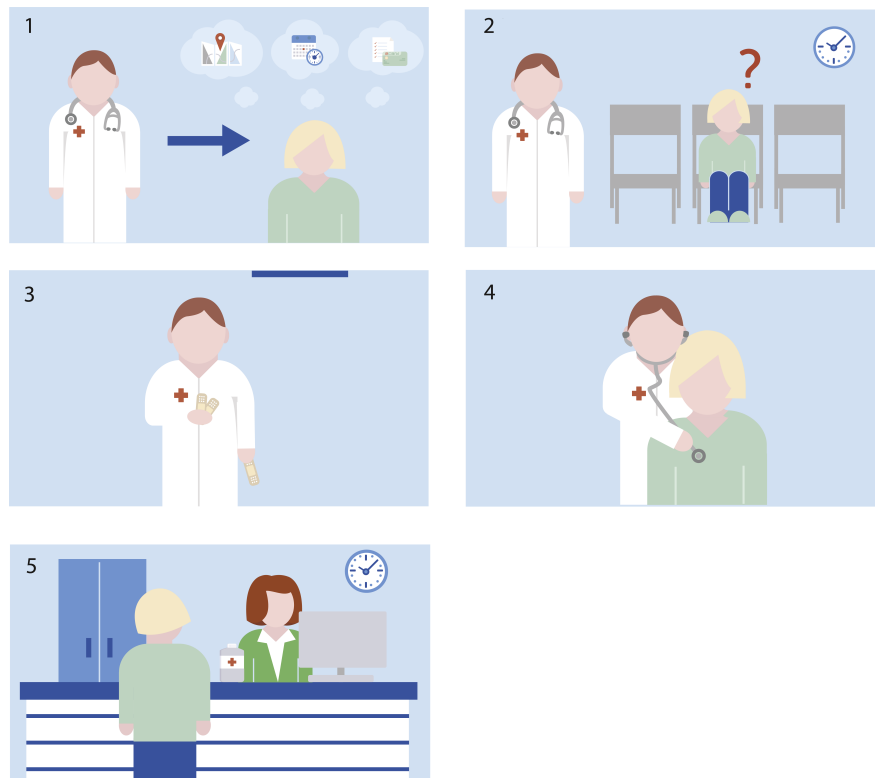
Figure 4.9. Animation storyboard: steps of going to the doctor (Taucher, 2018)

At the end of the questionnaire, the participants were asked to rate the importance of having specific information/features in the app. The rating scale was from one to five and there were ten features presented to them:

1. How to choose a Hausarzt (generalist)?

2. How to change you Hausarzt (generalist)?

3. Learning about the e-card?

4. How to take an appointment?

5. How to get vaccinated?

6. How to get a sick-leave?

7. How to get transferred to the hospital?

8. How to get transferred to a specialist?

9. How to find the doctor's location?

10. How to get a medicine?

Figure 4.10 shows a chart of the rating average. As we can see the features with the highest rating are: how to choose a generalist, how to get transfered to a hospital and how to get transferred to a specialist. Since final user-test only has a prototype of the application, only a few scenarios are going to be developed. Thus, it was important to know the most important scenarios to the user and start with them in the development phase. According to the data, the features that have documents in them were the least rated. This is because once you are at the doctor's office, you can ask directly the staff about them and do not need further help after that.
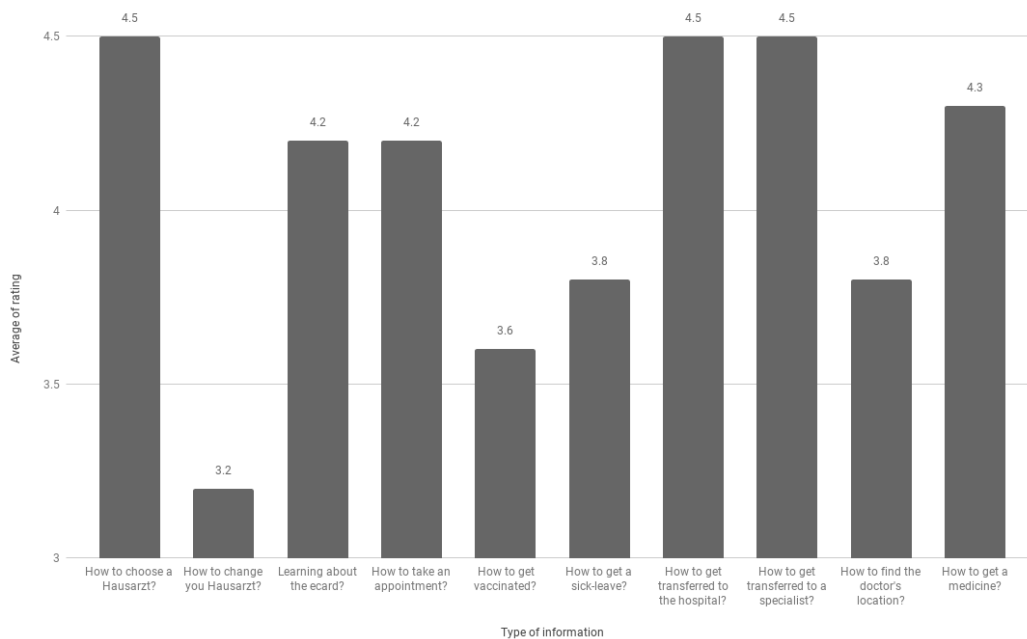
Figure 4.10. Participants rating the most important information which need to be available in the application

4.4.6 Concept Revision

According to the data presented above and the feedbacks, the following revisions will be taken into consideration for the next iteration. The location, appointments and opening times will be combined in on icon, since they can be reached from one source. Secondly, it appears that the more the icons went into details the harder it was for the participants to interpret them. Moreover, once the patients are in the doctor's office they can ask about those detailed issues. It also seemed like if the user did not experience a specific event, like getting a driving license, it would be hard for them to recognize the icon related to it. Moreover, for the last user prototype, the only chosen scenarios include how to choose a generalist doctor and how to get transferred to a hospital in case of an emergency. This is because these two scenarios were rated as the most important ones. The reason why

the scenario of getting transfered to a specialist doctor will not be developed in the first iteration (even though it had the same rating of the two other scenarios), is because once you have a generalist, he/she can refer you to a specialist. Lastly, the animations will be more specific in terms of actions and the colors will have more contrast.

4.5 Platform Design and Development

After the concept revision, it was time to focus on the visual aspect of the application. This section focuses on the development of the user experience design discussed in the theoretical chapter 3. The development phase includes also the creation of the instructional animations. The process of development started with flowcharts, sketches and storyboarding untill it reached actual mockups and programming.

4.5.1 Flowcharts, Sketches and Storyboard

Flowcharting is the language between the designer and the developer. Figure 4.11 shows the flowchart which was handed to the developer. The flowchart explains the flow of the three scenarios, displaying the flow of the pages and the user actions. The user's journey can end at the hospital page at the e-card page.
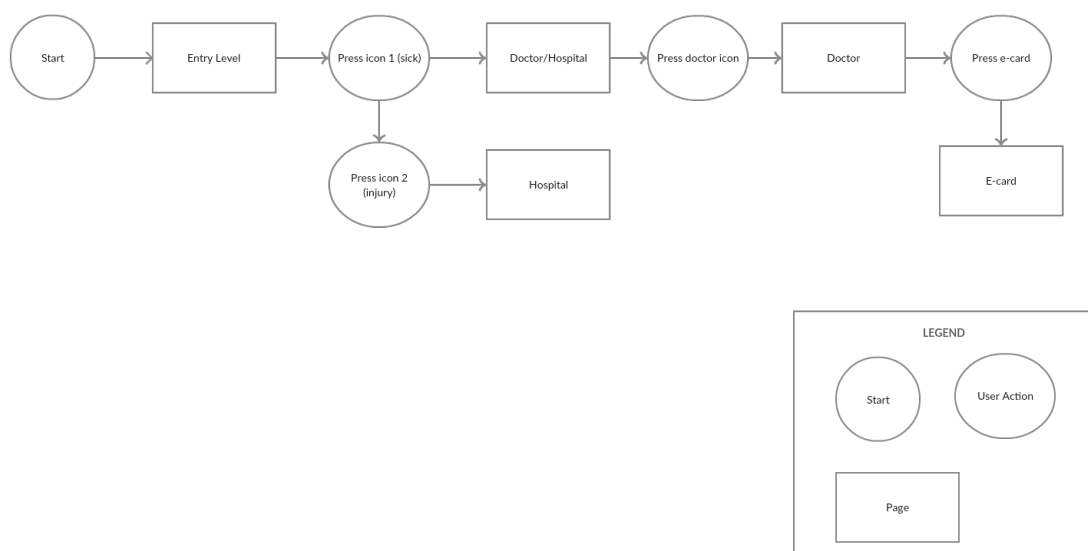
Figure 4.11. Flow of pages and actions for the application developments

After that, the structure of the pages was designed. Figure 4.12, is an example of how one scenario would go. It all starts with the entry level page, where the users chooses either an event or a desire. The chosen icon leads the user to the second level of the application where the user may have a choice between for instance a doctor, a hospital or something else depends on the scenario chosen. Lastly, the instructional animations are shown as an additional source of information.

1 Entry level

2 Second level

3 Animation to the chosen icon
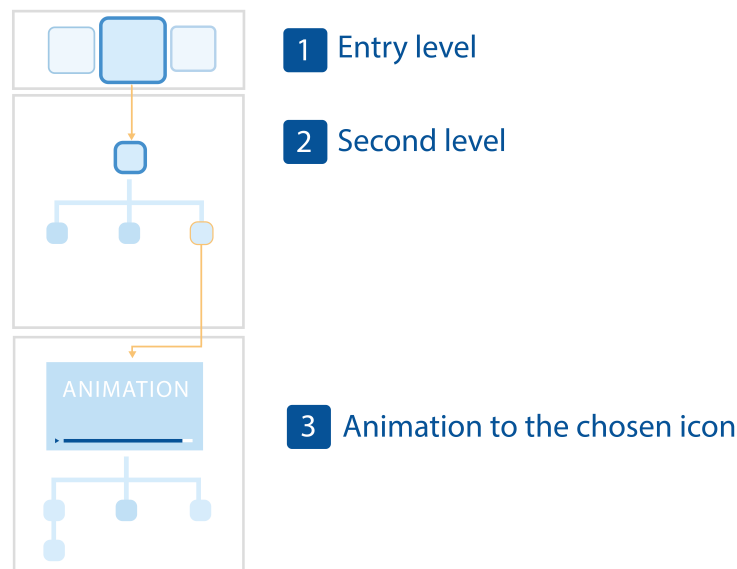
Figure 4.12. Structure of the application

The development of animations, started with storyboard sketching (see figure C). Each frame was sketched which allowed for a more efficient way of development. Changing frames on paper can be a lot faster than changing it on the software. The animations were developed using Adobe Aftereffects `https://www.adobe.com/at/products/aftereffects.html` and Adobe Illustrator `https://www.adobe.com/at/products/illustrator.html`.

The were in total two animations. The first animation was explaining the steps which should be taken when someone is sick and wants to go to the doctor. The second animation focused on how to call the ambulance in case of an emergency or an injury. In the first animation, a short tutorial of using a website for finding doctors in Austria called docfinder.at was previewed. The reason for using silent animations and not narrated animations, is because the goal of the research is to focus on the visual language. Spoken language is a variable which could affect the results of the user tests. Images of the animation frames can be found in appendix C.

4.5.2 Mockups and Development

The last phase of development focused on implementing the application. The designs were creating using Adobe XD `https://www.adobe.com/at/products/xd.html?promoid=PYPVQ3HN&mv=other` and Adobe Illustrator. The icons were designed using Adobe Illus-

trator, while the screens were designed using Adobe XD. According to the results of the last questionnaire with the foreignness living in Austria, the scenarios were decided on. These were choosing a generalist doctor and getting transferred to a hospital. The application prototype was implemented on the iPad Air 2 using HTML, CSS and JavaScript. Figure 6.6 shows the doctor's page in the application, however all screens can be seen in appendix D.
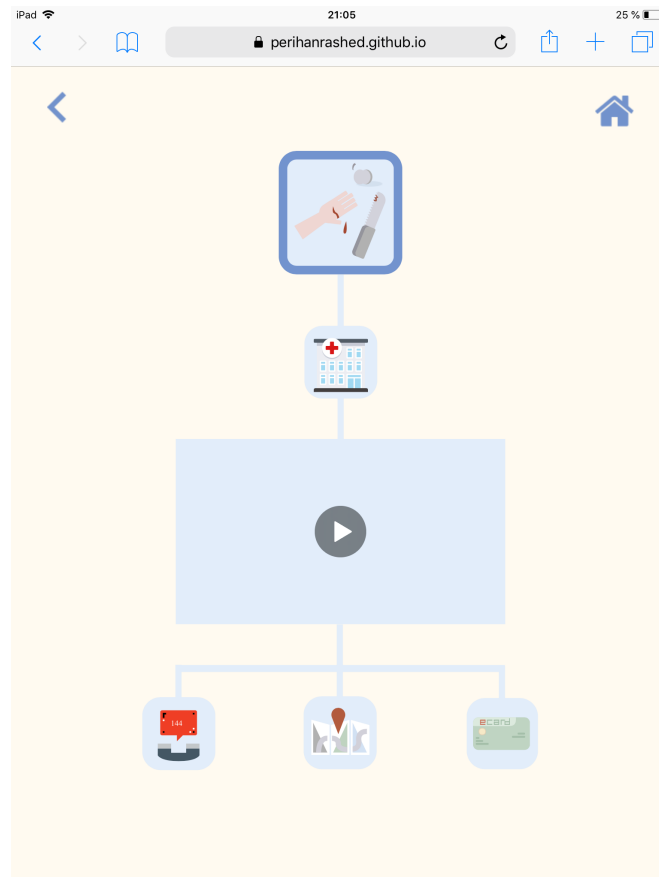
Figure 4.13. Hospital page. Icons by Christoph Taucher (Taucher, 2018).

4.6 Final User Test

The final test focused on evaluating whether or not the developed platform meets the needs of the target group. In this section, the methodology 4.6.1 is explained as well as the procedure 4.6.2 which took place. Moreover, the goal is specified as well as the research questions which should be answered by this test 4.6.3. Lastly, the results are presented in the last part of this section. 4.6.5.

4.6.1 Methodology

User tests interviews as well as user experience test were conducted. The participants were presented with the application on the ipad air 2 and were given three tasks, these are presented in subsection 4.6.5. The prototype could be found on this website: `https://perihanrashed.github.io/`, however it is only responsive on an iPad.

The subjects had the questionnaire at the end once they finished performing the tasks. The following factors were measured: 1. **learn-ability**, 2. **errors**, 3. **efficiency** and 4. **satisfaction**. The definitions of these four factors are explained in section 2.1.1 chapter 2 These methods were used to test whether the flow of the application is understood or not as well as the icons and the animations. All the users' actions were screen-recorded as well as documented on Google forms.

4.6.2 Process

The final user test took place on the 27.08.2018 at the LARES office, in Sankt Pölten. There were in total ten refugees who participated in this test. Sandra Schweiger, the facility manager, was the one who arranged with the refugees to take part in this test. The user test took place in their meeting room and each user was individually tested. It took time from 11:00 in the morning untill 14:00 in the afternoon. Each user test took approximately 10 minutes and we had a 5 minutes break between each test to prepare the next one.

At the beginning of each session, the user would get a brief explanation of what the project is about. Then, they would sign a consent form. Afterwards, a few demographic information on the subjects are collected to understand their characteristics. The collected characteristics can be found in table 4.24. Once they are given their first task, the screen-recording on the iPad starts. This allows for further evaluation (e.g. the duration it took them to finish each task). After there were done with the three tasks, there was a short questionnaire regarding their experience using the application.

At the end of the questionnaire, they were given the opportunity to ask anything regarding the project and the following factors were evaluated.

4.6.3 Goal and Hypothesis

As mentioned above, the goal of this user test is to evaluate the application from the user experience point of view as well as the usability point of view. Moreover the results should answer the three main hypothesis of the thesis which are:

1. Explaining areas in the Austrian health care system, via silent instructional animations, would make it understandable for refugees in Austria.

2. Refugees in Austria could comprehend and navigate in a health mobile application with no text and only icons.

3. Developing an Austrian health care system mobile application, with only icons and silent instructional animation, would help refugees in Austria understand the health care system correctly.

4.6.4 Participants

As mentioned previously, all participants who too part of this user test were refugees living in Austria. The age range was from 13 to 44 years old. They all had different German language proficiencies and came from four different countries. This range in every aspect of their demographic characteristics, allows for more input. There were in total ten participants who voluntary took part of the experience. Some of them were very new to Austria and some have been living there for six years(see table 4.24).

Table 4.24. Participants' Characteristics

Participant ID	Gender	Age	Nationality	Duration of Stay in Austria	German Language Proficiency
P1	Female	17 years	Afghani	3 year	B1
P2	Female	15 years	Afghani	3 years	A2
P3	Male	16 years	Afghani	3 years	A2
P4	Male	44 years	Bengali	3 years	A1
P5	Male	17 years	Afghani	3 years	B1
P6	Male	46 years	Syrian	0.5 year	A1
P7	Female	13 years	Syrian	3 years	A2
P8	Female	26 years	Algeria	6 years	A2
P9	male	16 years	Afghani	3 years	A2
P10	Female	39 years	Syrian	1 years	A1

4.6.5 Results

Participants were given three scenarios and tasks:

1. If you are sick and want to go to the doctor, which of the following icons would you choose?

2. If you want to get information on the e-card, which of the following icons would you choose?

3. If you injured yourself and want to call the ambulance, which of the following icons would you choose?

Errors and Rate of Success:

Below, the three tasks' results are evaluated. The first task had the lowest rate of success. Many participants confused between icon number one (sick icon) and three (check up icon) 4.5. Table 4.25, indicates whether the task was not solved, partially solved or solved. The results show that only three participants where able to do the first task completely successfully. Moreover, five participants managed to complete half of the task successfully, while two participants failed to solve the task.

The task was divided into two parts. Part one was choosing an icon in a scenario where the user is sick. The second part was to choose the doctor's icon. The majority of participants assumed that the first icon does not indicate that someone is sick and is up to going to the

doctor, since the patient is in bed and can barely move. Therefore, the first task had the most errors.

Could not solve it: 0

Partially solved: 1

Solved: 2

Table 4.25. Results of task 1: If you are sick and want to go to the doctor, which of the following icons would you choose?

Participant ID	Success rate	Observations
P1	0	She clicked on the 3rd icon (check up icon) instead of the 1st icon (sick icon). A recommendation would be to have the thermometer without a bed. The bed indicated that she could not move
P2	1	User clicked on the 3rd icon (check up icon) at first, then clicked on the 1st one before finally chosing the doctor's icon
P3	1	He chose the 1st icon (sick icon), and then could not identify the doctor's icon.
P4	1	Partially solved. He chose the 1st icon to indicate that he is sick but then chose the hospital icon to go to the doctor.
P5	0	He chose the 3rd icon (check up icon) instead of the 1st icon (sick icon) because the first icon indicated to him that he cannot move out of bed and can't even go to the doctor.
P6	2	He chose the 1st icon (sick icon) to indicate that he is sick. However, he chose the correct icon for the doctor.
P7	2	She chose the right icon to indicate that she is sick and then the correct icon to get to the doctor.
P8	1	She chose the 3rd icon (check up icon) to indicate that she wants to go to the doctor and not the 1st icon (sick icon). She explained that she did so because in the first one, she would not be able to move. However, she chose the correct icon for the doctor.
P9	1	He chose the third icon and not the 1st one because the first one mainly indicates that he has fever instead of generally sick/feeling unwell. He later chose the correct icon for the doctor.
P10	2	She chose the right answer and it was clear to her which option to choose.

Regarding task number two, only one participant was unable to solve it. This is due to the fact that all refugees do not hold an e-card, instead they have a an insurance paper. This brings us to the question whether or not this task is even valid or appropriate. However, all other nine refugees who know what the card looks like were able to identify the icon successfully (see chart 4.14).
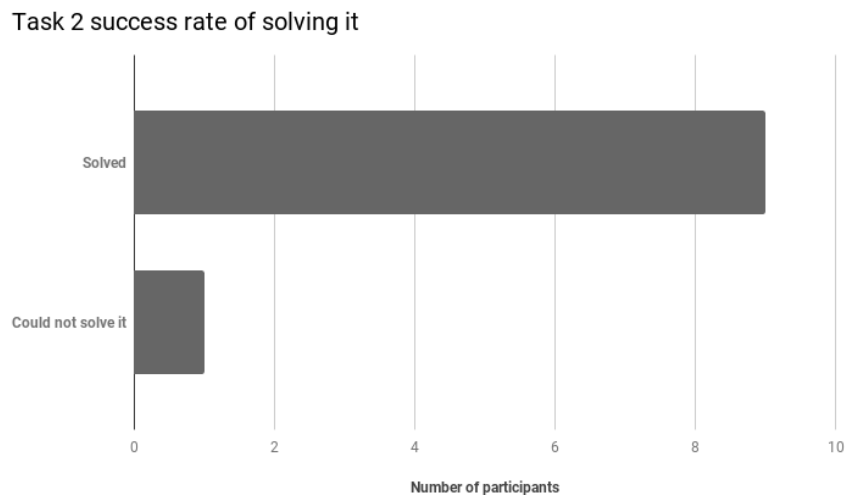
Figure 4.14. Results of task 2: If you want to get information on the e-card which of the following icons would you choose?

In the final task, participants were asked asked to choose the icon that indicated that they were injured. In this case, all nine participants were able to solve this task except for one participant (see chart 4.15). According to her, she clicked on the first icon (sick icon) because she can usually put a plaster and fix the injury herself if it's minor. However, she still managed to understand that the second icon indicates that she hurt herself. A recommendation would be car accident or something more extreme.

Task 3 success rate of solving it
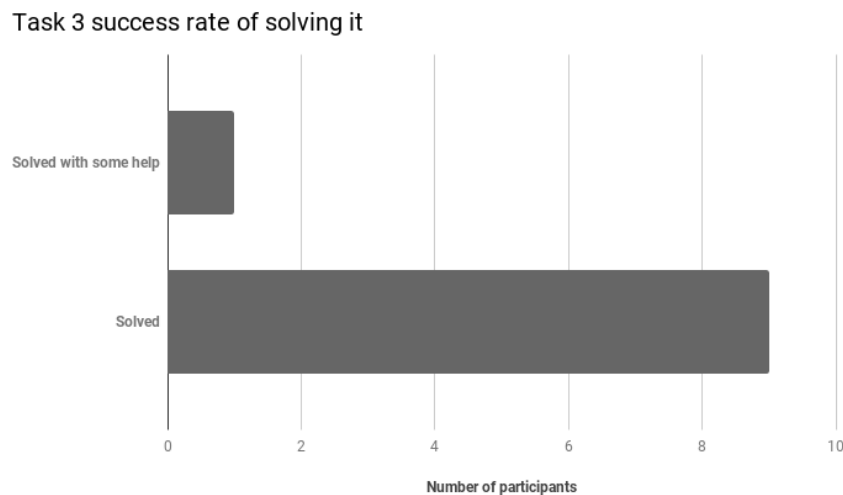
Figure 4.15. Results to task 3: If you injured yourself and want to call the ambulance, which of the following icons would you choose?

Learnability:

To evaluate the ease of use, all participants were asked if the icons and the two animation videos were easy to understand. Chart 4.16, shows the data collected on understanding the icons. The icons where most misinterpretations occurred were the hospital icon and the sick icon. However, most misinterpretations actually happened with the sick icon. This was due to the fact that it seemed like the figure in the icon was unable to move. These points need to be taken into consideration for the next iteration. The first animation, out of the two presented to the participants, gave instructions on how to choose a generalist doctor and how to go to him/her. The second one explained in case of an emergency or injury, how to call the ambulance and get transferred to the hospital. All nine participants understood the animations very well even though they were not narrated. The data did not rely only on their yes or no answer. After they watched each animation, they were asked to explain what they learned from it in their own words. Although some refugees did not know about the website docfinder.at, they were able to understand how to use it and that it was a page for finding doctors. However, they suggested that the tutorial of docfinder could go slower since they had no background information about it.

Resposes of the question: Were the icons easy to understand?
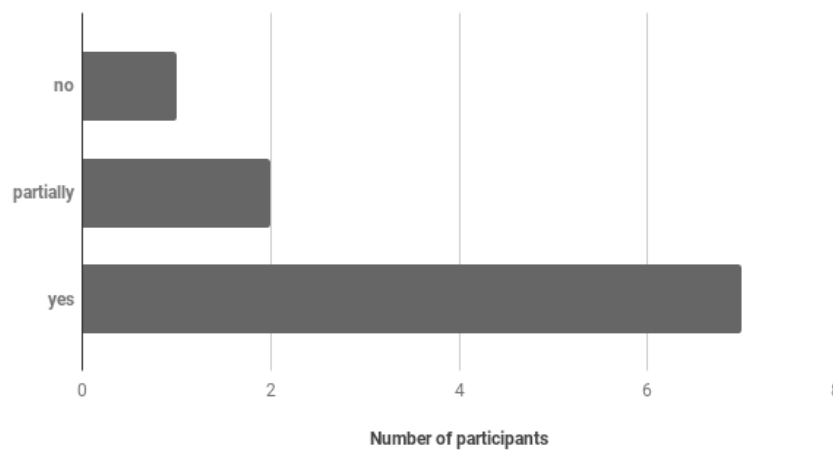
Figure 4.16. Data on whether the icons were easy to understand.

Efficiency and Satisfaction

Since all the users' actions were recorded, the time that took them to finish a task was evaluated. The optimal time which was put for each task excluded the time of the animation. As we can see in table 4.26, all participants were able to finish the tasks within the optimal time given.

The optimal time for each task:

- **Task 1:** 20 seconds

- **Task 2:** 10 seconds

- **Task 3:** 15 seconds

Table 4.26. Duration of completing each task in seconds

Participant ID	Task 1	Task 2	Task 3
P1	00:15	00:07	00:14
P2	00:18	00:08	00:15
P3	00:16	00:10	00:11
P4	00:18	00:09	00:14
P5	00:18	00:07	00:15
P6	00:15	00:06	00:09
P7	00:16	00:06	00:10
P8	00:14	00:10	00:11
P9	00:12	00:09	00:10
P10	00:14	00:08	00:09

In terms of satisfaction, all participants were asked if they would download such an application and if they believed it would be useful. All participants agreed that they would download such a application on their smart-phones and that it could definitely be useful especially because of its **ease of use** and **simplicity**. They were all able to memorize the ambulance number and the documents that they would need to take with them to the ambulance and to the doctor, as well as how to choose a doctor.

In conclusion, during this user test, we were able to have a complete user experience test. The following factors were successfully measured: the ease of use, how fast and efficient the users were able to complete each task, their satisfaction rate as well as the errors that occurred and the value they have gained from such a service.

Reviewing the Hypothesis

According to the data collected in the previous section 4.6.5, the hypothesis are reviewed. This section confirms whether each hypothesis was confirmed or rejected.

H1: Explaining areas in the Austrian health care system, via silent instructional animations, would make it understandable for refugees in Austria:

This hypothesis was confirmed. Instructional animations could be a good source of information and learning. 100 percent (10 out of 10) of the refugees understood the animation correctly. They were able to explain in their own words what they understood and learn even small details like the documents they would need and the ambulance phone number in such a short time. Even though the animation was not narrated, they were able to comprehend it very well. They also confirmed in the end questionnaire that the animation was clear to them.

H2: Refugees in Austria could comprehend and navigate in a health mobile application with no text and with icons only:

This hypothesis was confirmed. This is because, they were able to understand all the icons in the tasks except for one icon (sick icon). However, they gave a reasonable explanation why it was not appropriate for the task. The navigation itself seemed clear to them since they navigated smoothly from one icon to another. On the other hand though, as proved in the previous survey in section 4.4.5, the more complex the icon were (e.g. representing several documents), the more complex it was to understand them. However, in the last test, seven out of ten believed the icons were easy to understand, two out of ten believed that they were partially understandable and only one out of ten believed they were difficult to understand (see chart 4.16).

H3: Developing an Austrian health care system mobile application, with only icons and silent instructional animation, would help refugees in Austria understand the health care system correctly:

This hypothesis was confirmed since the three tasks given in the user test had a high rate of success (see charts 4.14 and 4.15 and table 4.25). However, the more complex the information that needs to be transmitted, the harder it gets to represent them. Therefore, as long the application is about the basics, it should work successfully. The scenarios for the prototype application were selected according to how important they are for foreigners living in Austria (see figure 4.10). According to the user experience parameters, the prototype was successful in its learnability, efficiency and satisfaction.

5 Discussion

This chapter discusses the the interpretation of the results section 5.1 along with the limitations and need of additional research section 5.2. Moreover, it focuses on the implications for practitioners section 5.3 and for the research section 5.4.

5.1 Interpretation of the Results

There were in total seven main research questions, these have been clarified through this literature review research. The main goal of this paper was to explore the field of the visual language with people who come from different backgrounds and do not speak the same language. This concept was tested in areas of the Austrian health care system via a mobile application that uses only icons and silent instructional animations. Moreover, there were three hypothesis which were confirmed in this paper.

The first hypothesis is that explaining areas in the Austrian health care system via silent instructional animations would make it understandable for refugees in Austria. The hypothesis was supported by the data in the last user test. This could be because instructional animations are a good source of learning. As mentioned in (see section 3.5.4), it has been proven that instructional animations are very effective with people having a low health literacy (Berkman et al., 2010, p. 9). Moreover, the animations were effective because they followed Windschitl's strategy in his book *Instructional Animations: The In-house Production of Biology Software* (see section 3.5.3). The animations focused on being simple and presented only relevant information (Windschitl, 1996, p. 80). However, according to the feedback provided a flaw of the animations as well. In fact, not everyone knows the platform docfinder.at and therefore the tutorial presented in the animation could be more emphasized.

The data also supported the second hypothesis: refugees in Austria could comprehend and navigate in a textless health mobile application with icons only. An interpretation for this could be that only the so called *similar* icons were created. According to Lidwell in his book *Universal Principles of Design*, similar icons "use images that are visually analogous to an action, object, or concept"(Lidwell et al., 2010, p. 132). However, the more complex

concept gets, the harder it is to represent it in a *similar* icon (see section 3.6.1). Similar icons are very simple to understand if they reflect real-life visuals. An example of this is a doctor represented as a human wearing doctor's clothes. However in cases where more complex concepts need to be explained, users need to learn the icons first. For example, Lamy in 2009 tried to create a visual language for doctors representing diseases and much more. To do so, he gave them time to learn this visual language first (Lamy et al., 2008, p. 2).

Lastly, the third hypothesis was that: developing a textless Austrian health care system mobile application, with only icons and silent instructional animations, would help refugees in Austria understand the health care system correctly. The data collected confirm this hypothesis. An interpretation for this could be that both the icons and the animations were successful and are individually a good source of learning. Combining them strengthened this source and created a unique visual language. Another point is that the scenarios presented to the refugees were considered as simple but also are the common thing that one needs to know about the health care system. These scenarios were rated in the mid-evaluation phase as the most important knowledge which needs to be presented to a foreigner living in Austria (see figure 4.10). Any further details can be reachable once the patient is at the doctor's office. As long as the concept presented has already a relationship in our minds with real life situation, humans would understand it (Frutiger, 1989, p.115). This is also what we call inherited archetypes, which is a concept explained in more detail in section (3.6.2). Last but not least, the structure of developing the icons followed Lamy's strategy: 1. Choosing graphically representable medical terms. 2. Creating a list with the terms and which attributes could presented in them (e.g. organs or etiology and physiopathological process). 3. Setting rules for these attributes and designing icons out of them: choosing the appropriate color, shape, size and pictogram (Lamy et al., 2008, p. 3).

5.2 Limitations and Need for Additional Research

One challenging aspect was communicating with the refugees. As presented in table 4.24, most of the refugees know only the basics in German. They also did not speak English. It was possible to perform the user test with Arabs in Arabic which could be why they were able to perform it well. However, for the ones who could not speak neither English nor Arabic and only little German, it was challenging explaining the tasks for them as well as understanding them well.

Furthermore, additional research could be done in the field of cultures and exposure. In fact, it's possible that different cultures understand icons in different ways. As mentioned previously, one of the reasons why humans understand icons is because they are learned

in their childhood. Different educational systems in different countries could cause mis-understanding the the icons. It could actually be one of the reasons why everyone from Afghanistan misunderstood the sick icon.

Additionally, it would be interesting to explore the same methodology in different fields. For example, what steps need to be considered for obtaining a driving license or a residency card. This can be developed not only for refugees, but also for foreigners in Austria.

It was also noticeable the more the participants were educated the faster they understood the icons and animations and were able to complete the tasks in a more efficient way. Therefore, it could be that the level of education affects the way we understand visuals. It would be also interesting to explore this field more and maybe define according to the results a more accurate target group.

Furthermore, exploring to what limit complex visuals could be presented can make an interesting aspect to test. Untill now, only *similar* icons were used. However, exploring the other types of icons as mentioned in the Universal Design book could be a solution for representing more complex concepts (Lidwell et al., 2010, p. 132).

The last limitation is related to the implementation of the icons and the animations. The level of implementation was still in the prototype phase. It's possible that the more professional they look the better impression they leave. Moreover, this could give the opportunity of comparing a version of the application with text and a version with no text. Afterwards, a user-test can be made to compare the results. Doing so could help have obvious data on whether or not the level of understanding the information is the same.

5.3 Implication for Practitioners

This study confirms that developing a textless Austrian health care system mobile application, with only icons and silent instructional animations, would help refugees in Austria understand the health care system correctly. This was however tested with simple scenarios, using similar icons which are easy for humans to understand.

Another finding is that a key to making effective silent animations (without narration), is making them simple and focus on the relevant information only. The combination of animations and icons create a strong source of information to the learners.

5.4 Implications for Research

This study contributes to research in several ways. First of all, the study examines how developing a visual language could be a good source of information for people from different backgrounds. Secondly, the study aims to explore the field of silent instructional animation and how it could be a good source for learners. Third of all, it examines developing mobile applications to explain complex topics like the health care system with no text at all. Lastly, the study also proposes additional research areas which could be takes into consideration in the future.

6 Conclusion

The conclusion of the final user test is discussed in chapter 5. It is possible to develop an application to help refugees in Austria understand the health care system only with icons and silent instructional animations. This has been proven via different factors in the last user test. The process started with researching the animation and icon development areas as well as the user center design fields (see chapter User Centered Design Methods 3). The seven research questions stated in chapter 1 were answered via the literature review research in chapter 3. Afterwards, the three workshops took place to develop a concept and the first user interviews with refugees were conducted to understand the user's needs. (see chapter User Centered Design Process of the Austrian Health System Refugees Platform 4). During the design phase, a mid evaluation questionnaire was completed by foreigners living in Austria, and according to the results and feedback, the final prototype was developed. Lastly, the final user test was conducted with ten refugees from different countries living in Austria. According to the results of the final user test, the the main hypothesis of the study were confirmed.

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Appendix

A First User Interview Questions

General Information:

- Name:

- Gender:

- Age:

- Nationality and Mother-tongue Language:

- When did you arrive to Austria?

- What is you German language level?

Health System:

- From 1 to 5, where 5 is perfect and 1 is not at all, how would you rate you knowledge about the Austrian Health System?

- How do you inform yourself about the Austrian Health System?

- Do you have difficulties understanding the Austrian Health System ? If yes, what kind of difficulties (eg. Language barrier , process etc.)

- Have you been to the doctor before in Austria? If yes how was your experience? Did you know what to do?

- Do or did you face any problems with the Austrian Health System? If yes, which problems?

- What positive thoughts do you have about the Austrian Health System?

Literacy and Pictures:

- What kind of pictures/icons are you familiar with when it comes to health?

- What do you think about a Health System which explains itself using only pictures and icons?

Pictorial Information System:

- What kind of ideas do you have regarding the usage of pictorial info system?

B Responses to the Storyboard

Table 6.1. Participants' response to icon number five related to documents they can get from the reception

Participant ID	Interpretation
P1	1. First, the patient has to take an appointment to visit the doctor and get the address of this doctor. 2. Second, the patient goes to the clinic. 3. Third, the doctor prepares his tool set. 4. Forth, the doctor examines the patient. 5. Finally, the patient gets a report at the reception and the medicine prescribed to him.
P2	1. First a person needs to look for a doctor and his location, book an appointment and fill check that he accepts public insurance patients. 2. Make sure to go to the doctor at the booked time, wait in the waiting area until your name is called. 3. Doctor will do the blood tests needed. 4. Proceed with his examination . 5. Take the prescribed medication document from the doctor and make sure to go to the pharmacy to get the needed drugs.
P3	1. Patient goes to doctor after finding his location, setting up an appointment and bringing the correct documents (arrow should be pointing towards the doctor not the patient). 2. Patient waits for his turn. 3. Doctor applies first aid to the patient. 4. Doctor performs a more detailed checkup. 5. Patient is given medications or referrals.

Participant ID	Interpretation
P4	1. First picture looks like the doctor is going to the patient (should be the other way around). 2. Then the patient is at the doctor's clinic waiting for his appointment. 3. The doctor is holding what looks like band aids but it's not clear what the picture represents. 4. Then the doctor does the checkup. 5. The patient is at the pharmacy buying his medications.
P5	1. Took an appointment and e-card and filled up and application. 2. Patient at the waiting room. 3. Doctor giving the patient a medicine (color not clear). 4. doctor checking up the patient. 5. asking for a follow up appointment.
P6	1. The app can provide different things to the patient: looking for a nearby doctor, scheduling an appointment, checking up the insurance card information. 2. The patient is in pain and doesn't know what how to see a doctor. 3. The doctor prescribed medicines to the patient. 4. The patient goes for another check up at the doctor. 5. The patient afterwards goes to the reception to get the prescription.

Participant ID	Interpretation
P7	1. The patient is on time and everything was validated with the electronic health card. 2. Patient is calling the patient at the time of the appointment 3. The doctor is healing a wound 4. The doctor is also checking the lungs of the patient 5. The patient receives medicines from the nurse at checkout

C Animation storyboard
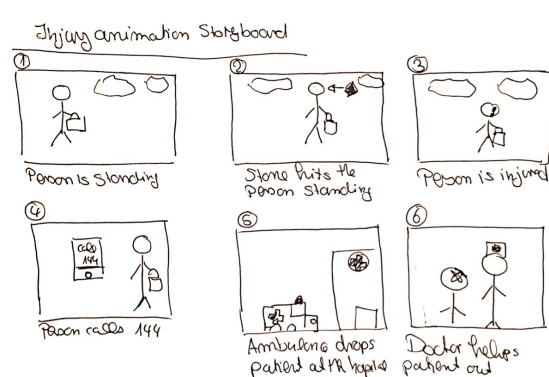
Figure 6.1. Animation storyboard sketch for the injury scenario
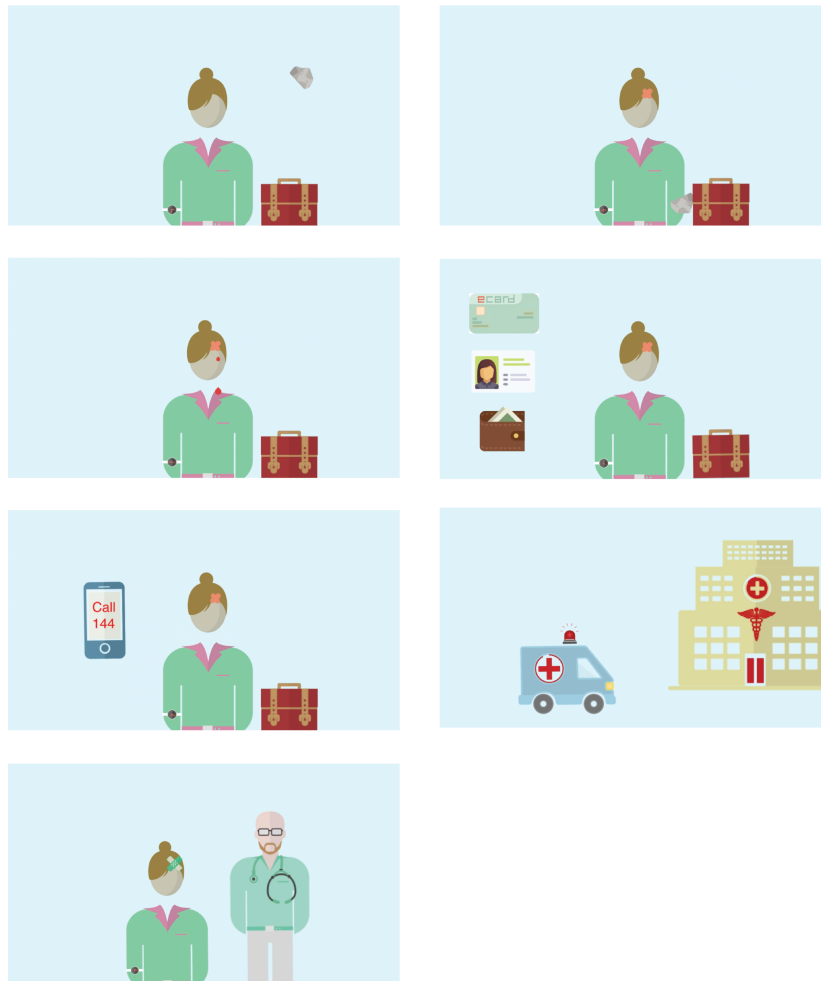
Figure 6.2. Animation frames: Steps to get transferred to the hospital in Austria
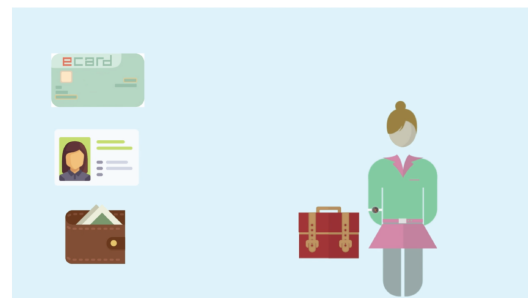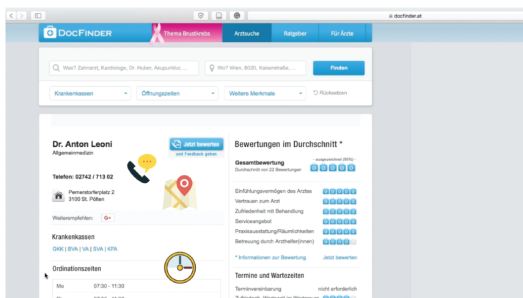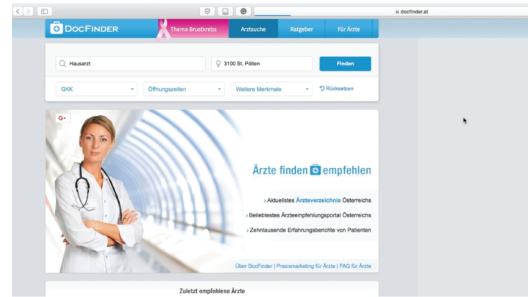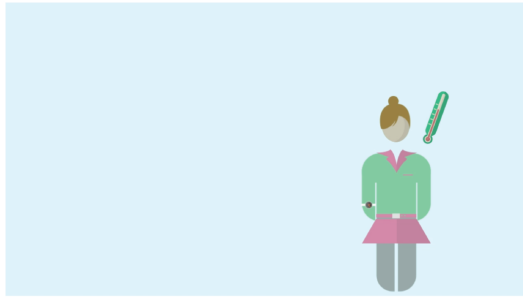
Figure 6.3. Animation frames: Steps to take to choose a generalist doctor in Austria

D Application Screens
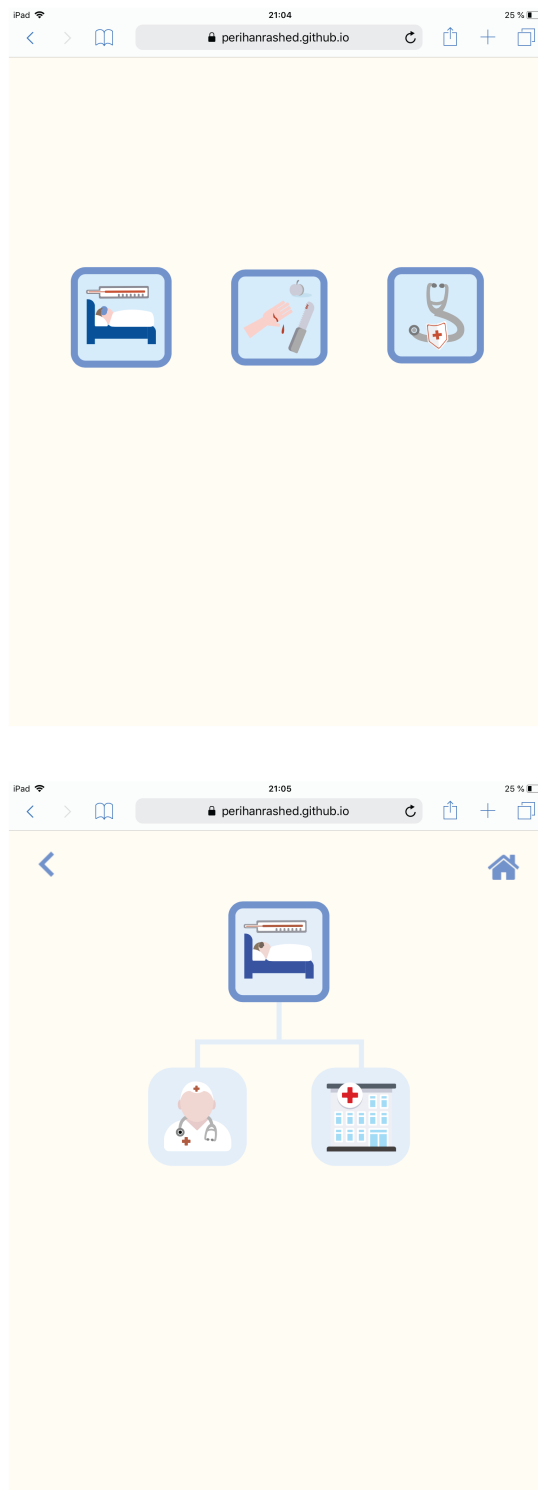
Figure 6.4. Entry level page and feeling sick page. Icons by Christoph Taucher (Taucher, 2018)

Figure 6.5. Doctor's page and e-card page. Icons by Christoph Taucher (Taucher, 2018).
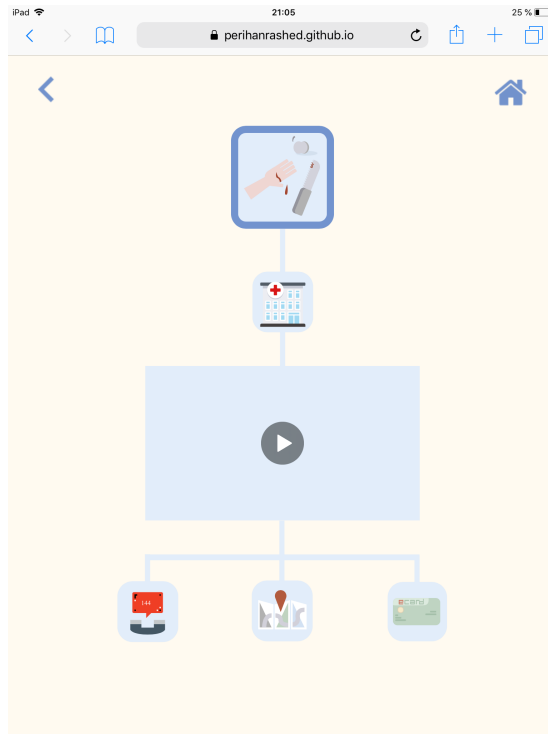
Figure 6.6. Hospital page. Icons by Christoph Taucher (Taucher, 2018).

E User Test Questions

General info:

- What is your name?

- How old are you?

- Where are you from?

- Since when do you live in Austria?

- What is your German level?

- Are you a smartphone user?

Scenario 1:

- You are sick and want to know about the application, how to go to the doctor.

- You need information about the E-card

- You hurt yourself and have to call the ambulance / go to the hospital?

- Was it easy to navigate and understand the application?

- What did you like?

- Do you have suggestions for improvement?

- Was it easy to understand the icons?

- Was it easy to understand the animation?

- Would you install the application on your smartphone?

- Do you still have questions about the test or the project?

F Mid-Evaluation Questionnaire

Figure 6.7. General information page

Figure 6.8. First level icons. Icons by Christoph Taucher (Taucher, 2018).

Figure 6.9. Second level icons, related to going to the doctor. Icons by Christoph Taucher (Taucher, 2018).

Figure 6.10. Second level icons, related to going to the doctor. Icons by Christoph Taucher (Taucher, 2018).

Figure 6.11. Second level icons, related to going to the doctor. Icons by Christoph Taucher (Taucher, 2018).

Figure 6.12. Second level icons, related to being at the reception. Icons by Christoph Taucher (Taucher, 2018.)

Figure 6.13. Second level icons, related to being at the reception. Icons by Christoph Taucher (Taucher, 2018).

Figure 6.14. Animation storyboard and rating features. Animation images by Christoph Taucher (Taucher, 2018).
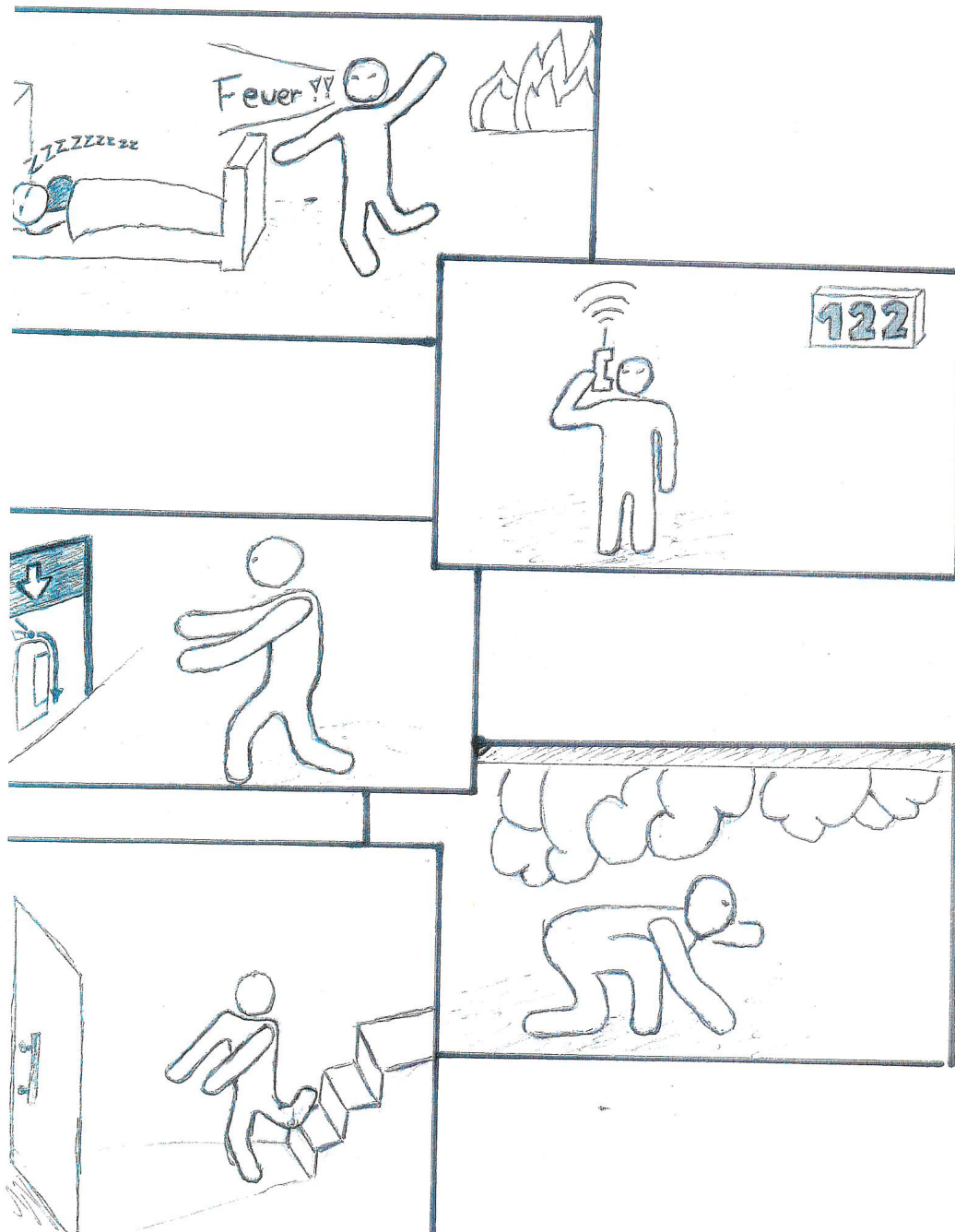
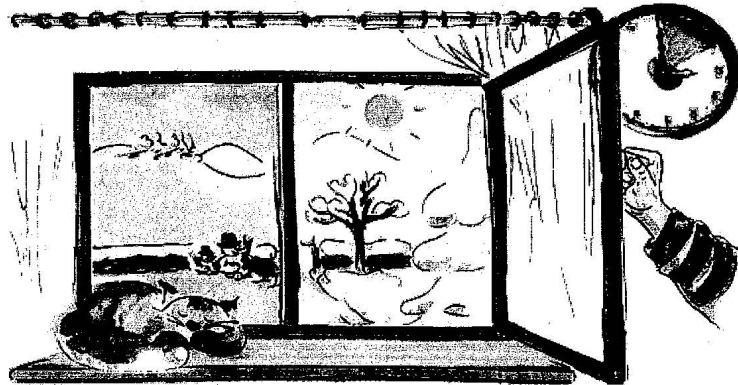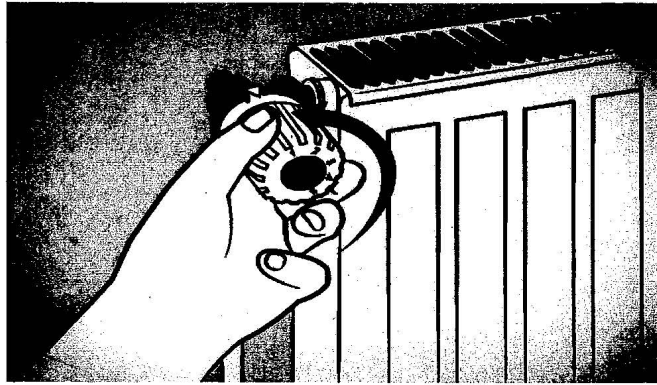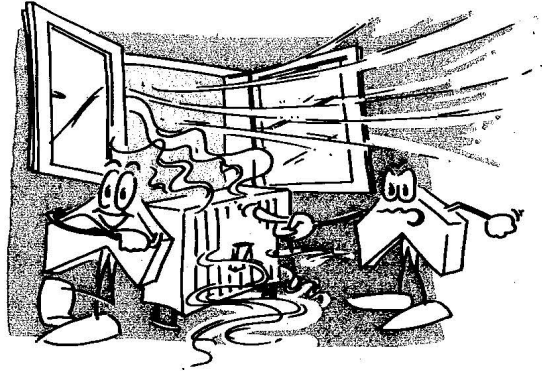*Figure 6.15.* Instructional pictorials in case of a fire. (LARES, 2018).

Figure 6.16. Daily house instructions (LARES,2018).