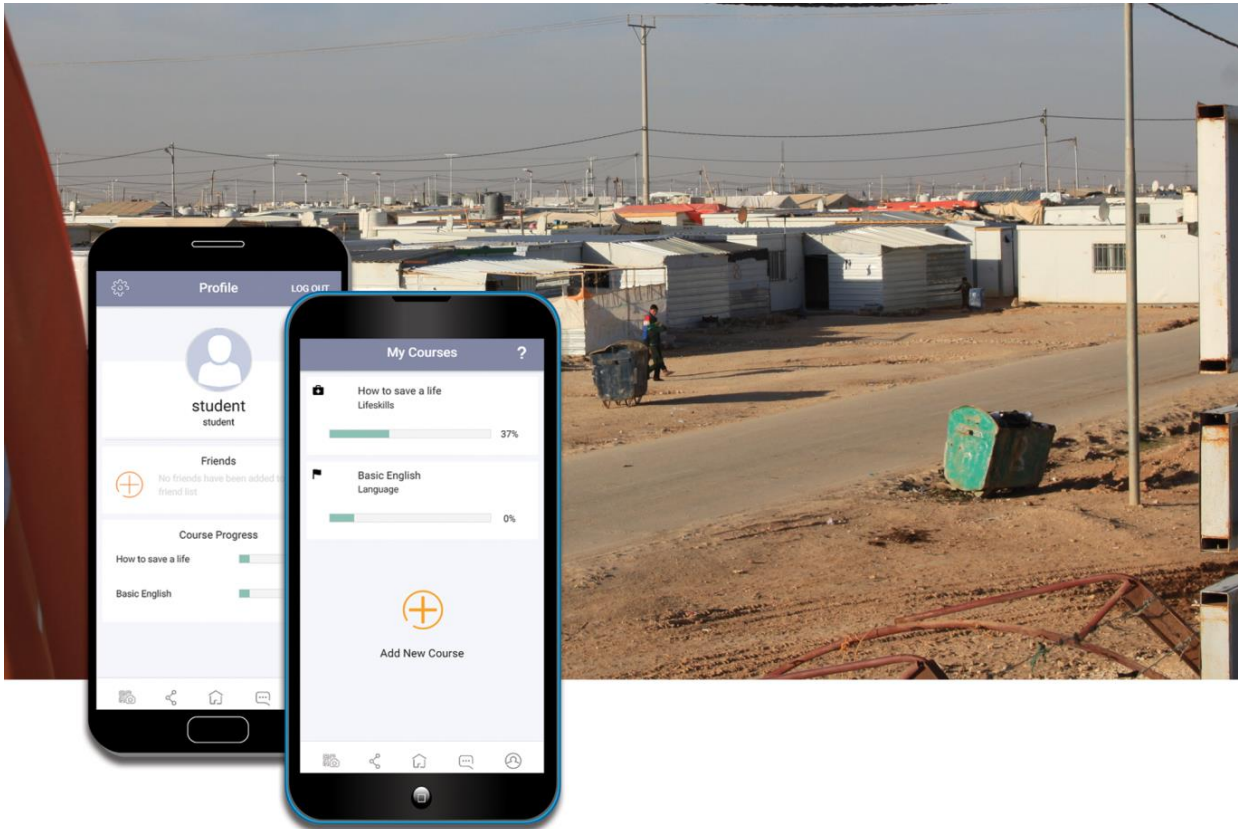# CHALMERS

REMOTE CLASSROOM
A Mobile Learning Platform for Education in Emergencies
Bachelor of Science Thesis in Computer Science and Engineering

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Cover:
Two smartphones, from different operative systems, with the application Remote Classroom running on them. In the background a picture of the Zaatari refugee camp is shown. The picture is used with permission of the photographer Jonas Landgren.

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ABSTRACT

The aim of this thesis is to investigate and identify the essential design characteristics of an education platform meant to be used for education in emergencies. A sense of safety and normality, better preparation for rebuilding the society, and belief in the future are all aspects that can be derived from education during emergencies. In present day, 3.5 million children are denied education even though it is a human right. This thesis primarily focuses on the area in and around Zaatari refugee camp, located in Jordan close to the Syrian border.

The work was conducted as a case study to investigate and get an understanding of the situation where several interviews were held. The case study led to a series of design iterations where concepts where created and evaluated. The iterations concluded into a prototype implemented as a hybrid mobile application. The prototype was evaluated using remote expert sessions and a field study at Studium, a Swedish for Immigrants center.

From the study, it was clear that the situation for refugees differed both on an individual and geographical level. Although, some general similarities were found that could be applied to most refugees. In the report, these similarities are presented as four core factors; smartphone ownership, economical limitations, weak infrastructure and cultural differences. From these factors, several design characteristics, such as cross-platforming, backward compatibility, short lessons, assessment of understanding, offline usage and sharing, universal design, etc., were identified. Some of these were implemented in the application while some were held on a conceptual level, resulting in an educational platform adapted for refugee needs.

Keywords: Mobile Learning, Micro Learning, Hybrid Application, Education in Emergencies, Offline Sharing

SAMMANFATTNING

Målet med denna rapport är att undersöka och identifiera grundläggande designkriterier av en utbildningsplattform menad att användas vid utbildning i nöd- och krissituationer. En känsla av trygghet och normalitet i vardagen, bättre förberedelse för återuppbyggnad av samhället samt framtidstro är alla aspekter som kan härledas utifrån utbildning i nödsituationer. Idag finns det 3,5 miljoner barn som nekas utbildning, även fast det är en mänsklig rättighet. Denna rapport fokuserar främst på området i och kring flyktingslägret Zaatari, beläget i Jordanien ett stenkast ifrån den Syriska gränsen.

Arbetet utfördes genom en fallstudie för att undersöka och få en uppfattning om situationen där flera intevjuer hölls. Fallstudien ledde till en serie designiterationer där koncept skapades och utvärderades. Iterationerna utmynnade i en prototyp som implementerades som en hybrid mobilapplikation. Prototypen utvärderades genom expertsessioner på distans och en fältstudie på Studium, ett Svenska för Invandrare center.

Utifrån fall studien så var det klart att ingen flyktingsituation är den andra lik, men det finns generella likheter som kan appliceras på många flyktingar. I rapporten presenteras dessa likheter som fyra huvudsakliga faktorer; innehav av smarta telefoner, ekonomiska begränsningar, svag infrastruktur och kulturella skillnader. Ifrån dessa faktorer har flera designkriterier, t.ex cross-platforming, bakåtkompabilitet, korta lektioner, offline användning och delning, universiell design, etc., identifierats. En del implementerades i applikationen medans en del hölls på en konceptuell nivå, vilket sedan resulterade i en utbildningsplattform anpassad för flyktingar.

Nyckelord: Mobilt Lärande, Mikrolärande, Hybrid Mobilapplikation, Utbildning i Nöd- och Krissituationer, Offlinedelning

Preface

This research project would not be possible without the help of a lot of people. We, the authors of this report, want to thank Jonas Landgren for the guidance through the project, thoughtful insight and providing us connections with relevant people for the study.

We would also like to thank Firas, Oula and Ben from the Jamiya project, Jumana and Karam at Jesuit Refugee Service, and Adel and Andrea at Lighthouse Relief for giving us insights in their areas of expertise.

Last but not least, a big thank you to all the participant during the field test at the Swedish For Immigrants center for giving us valuable feedback about the application and the concept in general.

Glossary and Acronyms

BSON - Binary JSON, a binary form of representing data in MongoDB.

CSS - Cascading Style Sheets used for presentation of a markup language.

Education in Emergencies - Education provided in areas of crisis.

HCD - Human Centered Design

HTML - HyperText Markup Language for creating web pages and web applications.

Hybrid Application - Cross-platform web application wrapped into a native mobile environment.

ICT - Information and Communication Technologies

JSON - JavaScript Object Notation, human-readable file format used to transit data.

JWT - JSON Web Tokens, method for representing claims securely between two parties.

LMS - Learning Management System

MEAN - A web technology stack, consisting of MongoDB, Express, Angular and Node.

Mobile Learning Platform - A portable education platform.

MOOC - Massive Open Online Courses

MVP - Minimum Viable Product

NGO - Non-Governmental Organization

SCSS - Style sheet language which translates into CSS.

TS - TypeScript, a strict superset of JavaScript adding optional static typing and class-based object-oriented programming.

UNHCR - United Nations High Commissioner for Refugees

UNICEF - United Nations Children's Fund

Contents

1   Introduction

Disasters happen all over the world. There are natural disasters such as hurricanes and earthquakes, occurrences the humans have no control of, and there are disasters that are consequences of armed conflicts such as the wars in the Middle East. These disasters and conflicts force people to flee their homes in a desperate attempt to survive and find a safer place for themselves and their families. This brings lots of challenges to the exposed and vulnerable people. These challenges can be everything from having to survive, find a safer place, integrate into new societies, find a way to continue with education etc.

Education is one of the first things that people ask for during a crisis and it can affect the mental health of the refugees in many ways (Nicolai, 2003). There are a lot of important and positive effects that apply on children and young adults and some of them are: a) *A sense of safety and normality.* Children get something to look forward to and a place where they do not have to worry about their situation. (Nicolai, 2003). b) *Better prepared for helping restore their communities.* Through education, young people can gain the knowledge and confidence to take initiative in creating valuable links and efforts in restoring their community (Nicolai, 2003). c) *Belief in the future.* Education is a great tool for processing the experienced crisis (Nicolai, 2003) and is key for a successful integration in society (Bodewig, 2015).

Education is a Human Right (United Nations, 2015) but at the moment there are more than 3.5 million children living under United Nation's (UNHCR's) mandate that are not going to school. This means that millions of people get their rights denied every day because of reasons they have no impact on. Obstacles reducing the possibility to education can be that educational services that are too far from the refugee camps or too expensive to attend. Other obstacles can be of cultural, linguistic, or administrative origins.

Education can be provided with technology and countries world wide are focusing more and more on integrating Information and Communication Technologies (ICT) into their educational systems (Hepp, Hinostroza, Laval, & Rehbein, 2004). As the authors of *Technology in Schools: Education, ICT and the Knowledge Society* explains that ICT can be everything form computers, software, scanners but also internet etc. They also mention what kind of role ICT has in the Educational System: "ICT can and should play a variety of roles inside a school. Some of the more important ones are pedagogical, cultural, social, professional and administrative. ICT, if sensibly deployed and with carefully selected software, can positively affect many aspects of school life, from a healthy questioning of present teaching practices to a gradual improvement of the quality, scope and depth of the learning environment, as well as to provide a remarkable opportunity for teachers' development." (Hepp et al., 2004, p.2).

The purpose of the *Remote Classroom* project is to help people in emergencies on their difficult way through a crisis by facilitating the opportunity for education during that period. The vision of this project is to develop an IT-artifact, a study platform, that will act as a bridge between instructors and learners. The study platform will offer education in remote places and situations where the demand for education is larger than the possibility to provide it. In this research the following research question has been fundamental in order to find a suitable solution: *What characteristics should a mobile learning platform have in order to meet the needs for education in emergencies?*

1

2 Education in Times of Disruption

Educational systems in areas that are exposed to tragedies such as natural disasters or armed conflicts, are being disrupted and extremely damaged. In times comparable to these situations, the affected communities have to move and with that, a part of the community get displaced. During this time, families suffer with their living situation where young adults and children are forced to work so they can afford basic living needs such as food and a place to sleep. That in turn leads to damage on the mental and physical health as well as social and intellectual aspects of the children and young adults, making them neglect education in the long run (UNICEF et al., 2006). Susan Nicolai mentions that another hindrance for education is that the educational systems that existed before are affected and broken down by destructed buildings which lead to an unstable infrastructure (Nicolai, 2003). She highlights other problems such as security issues but also the fact that all school supplies are being either damaged or looted from schools. These details are small but were once a part of a functional educational system (Nicolai, 2003).

The importance of education after a disaster can be seen from two aspects; the meeting of fundamental human right but also assistance to normalizing the surroundings and improving the mental health of the affected people (UNICEF et al., 2006). Education in emergencies is defined by Susan Nicolai as "A set of linked project activities that enable structured learning to continue in times of acute crisis or long-term instability" (Nicolai, 2003) . In her article, Nicolai explains that a good education response during a crisis should aim for different goals such as maintaining the continuity of the affected communities' education, be adjustable to the time constrains or location of the people, have enough support for mental and physical health, enhance integration etc.

A crisis can impact a person's life in different ways; personal impact, impact on systems and impact on society. These different ways can be seen as different levels where it starts with personal impact being the every day life of a person. The next thing to be damaged are the systems around the person such as schools, work and institutions relevant for well being. The last level would be the impact on society such as cultural norms being challenged, social networks damaged, and economic resources affected (Nicolai, 2003).

One country that currently is extremely relevant when talking about education in emergencies is Syria, a country that has suffered from armed conflicts since spring of 2011 (Crisp et al., 2013). The authors from UNHCR's "From slow boil to breaking point: A real-time evaluation of UNHCR's response to the Syrian refugee emergency" summarized the situation in Syria and highlighted the fact that a lot of Syrian refugees that manages to start an education in another country, for example Lebanon, eventually drop out of school because of language barriers (Crisp et al., 2013). The authors further mention that for the individuals that do find a way to educate themselves in another country, other barriers can be work (which leads to not having time), expensive transport or school materials (that they cannot afford) and limited teacher resources (which leads to finite teaching in classes). This is a complex situation, they explain, that has not a simple solution but organizations such as UNICEF and UNHCR should review their plans and budgets in order to try and help as many people in need of education as possible since the current programs are not good enough.

3   Technical Infrastructure in Refugee Camps

When leaving their homes in order to find security in a new county, smartphones have become one of the refugees most valuable properties ("Migrants with mobiles; Refugees and technology", 2017). It is mentioned in the article that the phones can provide information on travel routes, be used to contact smugglers and, most important of all, the makes it easy to keep in contact with friends and family. Several studies on refugees use of technology have been made and they all found that mobile phones is the most widely used devices, in Zaatari Camp in Jordan 88 % of youth owns a mobile hand device ("Migrants with mobiles; Refugees and technology", 2017; Mason & Buchmann, 2016; Maitland et al., 2015). Among these, Maitland et al. (2015) found that the most popular brands in Zaatari are Samsung, Nokia and iPhone.

Arriving to a new country, it is in general easy for refugees to access Internet through SIM-cards that can be bought close to the camps (Mason & Buchmann, 2016). Even though the SIM-cards are fairly cheap, the refugees often have to compromise on food and other necessities to be able to afford staying connected ("Migrants with mobiles; Refugees and technology", 2017). Wi-Fi on the other hand, is much less common and rarely works and according to the author of *Migrant With Mobiles*, camps in France do not have any access to Wi-Fi to make the stay in the camps seem less permanent. Instead, the refugees walks long distances to access the Internet for free.

Upon accessing Internet, the refugees mostly use it for social media and instant messaging as Facebook and WhatsApp. Informational search though, are not that commonly used and some are not familiar with the concept of a website. (Mason & Buchmann, 2016). Mason and Buchmann (2016) also found that voice messages are commonly following illiteracy och difficulty in typing Arabic or Latin letters on the devices. Even though the use of social media is widely spread, many refugees lack a lot of the expected technical skills and knowledge. (Mason & Buchmann, 2016). Among refugees, almost none have an email address which usually is required for confirming passwords, accessing online education and downloading applications (Maitland et al., 2015).

In conjunction with their study on mobile and internet use, Maitland et al. (2015) evaluated the quality of mobile Internet in different locations in Zaatari Camp. They did the assessments of the accessible networks within the camp and found both a 3G network called High-Speed Downlink Packet Access (HSDPA) and the 2.5G network Enhanced Data rates for GSM Evolution (EDGE). The study showed that EDGE was accessible more often than HSDPA through the operators Zain and Orange and the operator Umniah provided HSDPA more than half of the times.

The possibility to use mobile phones or other technology is dependant on the electrical infrastructure in and around camps. In Jordan, water and electricity were already under great strain before the refugee crisis and is now a true scarce (Mason & Buchmann, 2016). Mason and Buchmann (2016) also describes and present pictures of mobile charging stations on Lesvos powered by generators, a strong evidence that electricity is a limited resource.

4   Learning and Technology

The development of new technology can be said to be in a constant growth. Society has reached to a stage where new technologies can be tools in all kinds of areas; health-care, government, transportation etc. Education is no exception here. This chapter will bring up how technology has contributed in reforming learning.

4.1   Mobile Learning

Mobile learning focus on the use of personal digital devices that enable teaching and learning to take place in contexts beyond traditional classrooms. Mobile learning could be perceived as a development from E-learning (Nawaz, 2013). Since the beginning of E-learning as a paradigm in the 1970's, the educational system has been remodeled a few times (Nawaz, 2013). Nawaz tells that during the 1970s and 1980s, E-learning was knows as *Computer Assisted Learning* or *Technology Based Training.* He further explains that later in the 1990s, concepts like e-mail and group discussion were introduced to the paradigm in addition to the new digital course management system. Today, the concept of E-learning is massive and is backed up by the World Wide Web which has access to immeasurable information.

Mobile learning, as a new phase of E-learning (Georgiev, Georgieva, & Smrikarov, 2004), is a form of distance education that is performed on a mobile device such as smartphones, tablets, laptops etc. It provides more flexibility in education for classroom learning, distance learning but also field studies (Park, 2011). Mobile learning as a new learning paradigm, brings new requirements to the mobile technology when it comes to education (Kukulska-Hulme, 2007). Kukulska-Humle pinpointed three different fundamental motives of using mobile technology in education: The first one is improving access, the second one is examine the potential for changes in teaching and learning, and the third one is adjustment with wider institutional or business aims.

To explain the concept of mobile learning better, Yeonjeong Park tried to divide and define the learning paradigm into four types (Park, 2011). She mentions that transactional theory (TD), which she refers as "the extent of psychological separation between the learner and the instructor" (Park, 2011, p.84) and "the critical concept of distance learning" (Park, 2011, p.84), as a relevant attribute to the framework she presents. Another relevant attribute is learning activity, which she divides into individual and social.
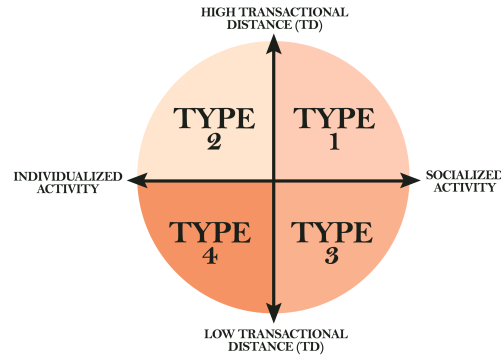
Figure 1: Visualization of the four types of mobile learning. High transactional distance relates to little contact with the instructor and high socialized activity means that the learners often are engaged in group activities. Graph based on the framework in article by Park (2011).

Park produced the framework based on transactional distance (high versus low) and activity (individualized versus socialized). The different types are illustrated in Figure 1.

Type 1 - High Transactional Distance and Socialized Mobile Learning Activity: This type describes a mobile learning activity where the communication and psychological gap between the students and the lecturer is high and the learners are involved in group activities and projects. All the predetermined learning material is distributed through mobile devices where the knowledge is exchanged between students and the instructors have minimal involvement.

Type 2 - High Transactional Distance and Individualized Mobile Learning Activity: This type describes a mobile learning activity where every student separately has a high communication and psychological gap from the lecturer while receiving very structured predetermined course material through a mobile device. Every individual controls their own learning process in order to succeed with it and all the interaction is between the learner and the course material.

Type 3 - Low Transactional Distance and Socialized Mobile Learning Activity: This type describes a mobile learning activity where the learners communicate with mentors and other learners through mobile devices or in person. The communication and psychological gap is very small and the instructions are less organized. There is a large number of group activities where the students engage in social interaction.

Type 4 - Low Transactional Distance and Individualized Mobile Learning Activity: This type describes a mobile learning activity where the there is less communication and psychological gap between the involved students and teachers. The course material is loosely structured and the learning outcome is not defined. Resembling the traditional way of learning, this type of mobile learning allows the students to interact directly to their teachers on a daily basis, where the teacher has control over the learning while giving the students the chance to work individually.

4.2   Learning Management Systems

As technology continuously plays a more significant role in learning, the tools for managing formal as well as non-formal learning increases. According to Watson and Watson (2007), Learning Management Systems (LMS) will have an important role but is sometimes be hard to distinguish from other computer education terms.

Watson and Watson (2007) have found that a common thought is that LMS are platforms that solely provide information and exercises through tutorials and drill-and-practise programs. They, on the other hand, argue that LMS should be seen as a framework that manages every part of the learning process; from learning material and progress analysis to registration and administration. This type of system is gaining popularity within higher education institutions and it is now rather the rule than the exception that LMS is used as a compliment to classic classroom teaching (Coates, James, & Baldwin, 2005). Cotes, James and Baldwin (2005) further argues that LMS reduces the need of physical space and makes courses more flexible and easy to manage which raise the opportunity for education in places where physical infrastructure is more limited.

In order to individualize learning as much as possible with an LMS, the system has to be automatized in correcting tasks, which puts many limitations on what kind of tasks that can be used as it only allows for multiple choice questions or short answers (Coates et al., 2005). Coates, James and Baldwin (2015) argues that integrating LMS too much in classic education would result that this type of assessment became dominant, which could be of great concern in higher education where a deeper knowledge is requested.

4.3   Micro Learning

The rapid growth of mobile learning and its accessibility from the web during the past decades has made it an important source for self learning. As the demand for learning increases and time available decreases, the long term learning periods and large amount of content that mobile learning is based upon leads to making mobile learning in its classical definition less attractive (Bruck, Motiwalla, & Foerster, 2012). As a solution for this problem, a new concept called micro learning have been developed. Bruck (2016) have defined micro learning based upon three characteristics: 1) Information is reduces and compressed into small units. These are linked to each other in a structured way. 2) Re-design of the way learning content is presented according to the small units. 3) Giving the learner an opportunity to decide when, where and at what pace to learn.

Dividing the course material into many small pieces is sometimes criticized because one might think that important information will be lost. However, this do not have to be the case when a large amount of material only would mean more pieces. The idea is that the linked parts together will make up what is called lessons or courses in classic learning and as with most learning methods, micro learning is not suitable for all kinds of education (Bruck et al., 2012). Micro learning is classified as informal learning (Kovachev, Cao, Klamma, & Jarke, 2011) and is therefore not appropriate for learning complex practical skills (Jomah, Masoud, Kishore, & Aurelia, 2016). Because of that, it is important to look at micro learning as a compliment rather than a replacement of classic learning (Bruck et al., 2012).

The concept of micro learning, and its new way of approaching learning, contributes with many opportunities for efficient learning as the units are based upon one single idea (Pajarito & Feria, 2015). This allows the learners to focus on one specific topic at a time which lets the brain process less information and decrease stress (Jomah et al., 2016; Pajarito & Feria, 2015). The micro format of the content makes is perfect for pocket-size devices (Jomah et al., 2016) and it is easy to incorporate in daily life (Kovachev et al., 2011).

4.4 Existing Platforms

A popular concept of online education is MOOCs (Massive Online Open Course) that universities often use to offer courses to the public. Concepts like gamification are also gaining popularity where learners acquire knowledge through game-like activities. Below is a description of some well known platforms and how they operate.

- *Khan Academy* is a video based education platform offering courses in everything from math and science to history and economics. Learners can study at their own pace and track their progress. Khan Academy offers courses in several languages (Kahn Academy, n.d.).

- *edX* offers courses from universities all around the world. The course content consists of videos, interactive features and instant automated feedback. Feedback is given by green check marks and edX also offers discussion forums where learners can help each other (edX, n.d.).

- *Duolingo* uses gamification for language learning. Lessons consists of speaking, listening and translation exercises of which instant feedback is given. Duolingo uses streak count to keep learners motivated (Duolingo, n.d.).

- *Codecademy* is an online learning platform focusing on interactive learning of programming. The platform uses short text based instructions and the possibility to compile and run code for instant feedback. If the learner are having trouble with exercises, help is offered through alerts.

- *Edraak* is a MOOC platform that offers a variety of courses in Arabic. In collaboration with edX, Edraak can offer high level university courses in Arabic (Edraak, n.d.).

- *Kolibri* is a soon to be released, web-based platform with the goal to make education accessible for everyone. The hope to offer self paced learning with "byte-sized" videos. All content will be shareable through syncing with other devices (Learning Equality, n.d.).

5   Research Approach

In addition to the technology influences on learning, designing for a specific target group requires thoughtfulness when choosing the approach of the project. This project was conducted with a design-oriented approach that was mainly based in the methodology of Human Centred Design. Human Centered Design is considered a well motivated approach for this project because it requires the designer to step back from his own preferences and requirements in favor of the target group's wishes and experiences (Giacomin, 2014).

The Human Centered Design methodology has the approach to generate as many ideas as possible which are evaluated as early as possible in order find useful design characteristics and from that move forward (IDEO.org, 2015). IDEO (2015) describes the process as an iterative cycle consisting of three stages; *Inspiration* is where a fundamental connection to and understanding of the target group is created, *Ideation* is the stage where gained information is used to think of new solutions and finally, *Implementation* is where ideas are converted into a product.

5.1   Research Setting

The field of Education in Emergencies is very wide and includes countless situations where humans are experiencing crisis, no matter if it is armed conflicts, natural disasters or infectious outbreaks. To limit the project, a focus on armed conflicts and refugees was chosen, more specific towards refugee situations in Amman and Zaatari Camp in Jordan, as well as Lesvos in Greece. Jordan was chosen because it is a place where many refugees end up when they flee the wars in Syria and Iraq, and Lesvos because it serves as the main portal into Europe and a place where many get stranded. In Jordan, a close collaboration with the Jesuit Center and their associated contacts was conducted. Jesuit Center in Amman provide post secondary education for refugees such as English classes and diploma courses. On Lesvos, contact was held with representatives from the non-profit organization *Lighthouse Relief* which is providing assistance to refugees arriving by boat on the north coast of Lesvos.

Since the project has a design-oriented approach, the focus was mainly on the IT and design aspects of the project. Though educational material would be needed to test and evaluate the platform, the focus of the tests was the practicality and ease-of-use in accessing course material as a learner. This meant that the quality and academic value of the specific material used in the tests was of less importance.

Developing a mobile learning platform implies that the product includes computer- or mobile-based material, which means that being able to use this kind of technology is crucial. Therefore, the project aims primarily to people with proper reading and writing skills in their native tongue and previous experience with technical devices such as smartphones and laptops. It is also expected that the users have a need for education and therefore, the target group is assumed to have motivation and a will to use the material in the courses presented by the solution of this project.

5.2   Data Gathering and Evaluation

Since this was a project with undefined guidelines, a case study was formed where a lot of research and data gathering was required in order to narrow down specifications related to the research settings. The case study eventually lead to a list of requirements, forming the basis for further development.

5.2.1   Interviews

Performing interviews is a reoccurring task within human or user centered design and a useful technique when gathering information about users (Wilson, 2013). The interviews, together with the literature review, served as a crucial tool in order to get a solid understanding of the situation and goals of refugees. These two components, that made up the case study, where also the foundation on which the requirements later would be formed.

In order to get the most out of the interviews, they needed to be constructed wisely. Generally speaking, there are three methods when performing interviews. These include structured, semi-structured and unstructured interviews and they all have their appropriate areas of use. The type of method chosen for the interviews conducted in the case study could be considered semi-structured. The semi-structured interview has similarities with the structured interview in that both have a predefined set of questions. The difference in the structure is that the interview allows for follow up questions, so called probing (Preece, Rogers, & Sharp, 2015) and more spontaneous elements in the interview. This makes it possible to explore for new content, clarify if needed and get a deeper understanding(Wilson, 2013).

Based on this approach, the interviews were slightly varied depending on the interviewee and the point in the study that the interview was conducted. They ranged from a more unstructured approach in the first stages of the study to having more structured elements later on when more knowledge was obtained and more specified questions could be asked. The interview guides were also constructed based on these factors.

5.2.2   Concept Evaluation

Evaluation on a concept level was needed in order to investigate if the progress was in conformance with the user requirements constructed based on the case study. Primarily, the progress was on a regular basis measured towards the list of requirements itself, to make sure that decisions in the development could be supported by the requirements and that the development by extension followed a human centered design. However, a more thorough investigation was done on a few occasions, involving experts in the field and potential end users.

The evaluation sessions were different from the usability evaluation, section 5.2.4, in that the interaction between the participants and the interface was not of highest importance, but instead the discussion of the concept. In order to focus on the concept and not on the design details, the participants did not interact with the interface themselves and instead the prototype was shown

help of an emulator. However, a discussion about the interface was conducted where things such as layout for Arabic text was discussed as well as color scheme and icons in the application. During these sessions mediating objects, such as an instructional video of the concept, was used before a discussion was held around the concept in general; its pros, cons, limitations, opportunities and areas of improvement.

5.2.3 Heuristic Evaluation

Heuristic evaluation was used for usability inspection on a theoretical level and targets the more obvious usability problems (Preece et al., 2015). The interface was evaluated using Jacob Nielsen's heuristics for user interface design. In Preece et. al., (2015) they include the following subjects:

1. Visibility of system status

2. Match between system and the real world

3. User control and feedback

4. Consistency and standards

5. Error Prevention

6. Recognition rather than recall

7. Flexibility and efficiency of use

8. Aesthetic and minimalist design

9. Help users recognize, diagnose and recover from errors

10. Help and documentation

The test was conducted by investigating parts of the system and comparing its characteristics with the different heuristics. An assessment can then be made as to what extent the interface corresponds to desirable standard (Nielsen, 1992). Theoretical evaluation methods, such as heuristic evaluation, has the benefit of often being time efficient, compared to empirical testing methods and quick usability assessments can be made by novice evaluators as well as experts in the field (Nielsen, 1992). The developers of the interface may also perform heuristic evaluations. It is however, in that case, difficult to get around the obvious bias that follows when someone familiar with the system evaluates it, and a more precise evaluation may call for expert evaluators (Preece et al., 2015). To get an even more objective view of the usability status and problems that may occur during use, and not simply try to predict user reactions, some empirical usability testing might also be recommended (Preece et al., 2015).

5.2.4 Usability Testing

Usability testing was used as a complement to the heuristic evaluation in order to cover more unexpected reactions from the users and give a more thorough depiction of the user interaction (Preece et al., 2015). By using observation during evaluation, it was also possible to measure how well the prototype supported the tasks and goals of the user (Preece et al., 2015). Tests such as these can provided both qualitative data, such as difficulties in understanding a symbol, as well as quantitative data, like number of mouse clicks or time needed to finish a task (Nielsen, 1993b).

The tests were performed by letting the participants execute well defined tasks that were constructed so that they represent the uses of the system in future field situations, as instructed by Nielsen (1993b). Nielsen also suggests that the test leader should, if possible, stay out of interaction with the participant during the execution of the tasks. Some situations may call for interaction however, such as the user getting completely stuck in the interface. A problem when doing these observations is however that the test leader does not know what is going on in the mind of the participant. In an attempt to get around this issue when evaluating an interface, so called 'Think Aloud Protocols' were used. This is a technique based on that the observed person expresses her or his thoughts and actions in words when performing a task and is something that should be explained to the participant before executing the test (Preece et al., 2015).

Once the tasks were completed, the tests were complemented by letting the participants fill out subjective questionnaires about the examined system. This was done before any further discussion about the tasks or the system in order to avoid bias when filling out the questionnaires (Nielsen, 1993b). The questionnaires were intended to provide insight on how the participants perceived the interaction with the interface, the questionnaire can be seen in Appendix A.

5.3 Analysis of Data

Analyzing the data was a vital step in transforming the gathered information from interviews and evaluation activities into concrete actions in the design. In short, the analysis of data can have a qualitative approach, a quantitative approach, or a combination or both (Preece et al., 2015). The choice of method for analysis heavily depends on the data acquired and the goals of the study. Here follows the methods used to analyze the data acquired.

5.3.1 Analysis of Interviews

To handle the data acquired from the interviews correctly, the audio files from the recorded interviews were transcribed. Transcription might be an inconvenient and time consuming task, since most people do not write as fast as people speak. However, it is a crucial aspect of handling quantitative inquiries and may also facilitate further analysis (Oliver, Serovich, & Mason, 2005). Typing down what was said in the interviews also reduce the bias from the investigator because the result will not reveal what the investigator interpreted or remembered, but what was actually said.

Categorizing or coding statements in interviews is one of the most used approaches when analyzing data (Kvale & Brinkmann, 2014) and was also the approach chosen for this study. The relevant data obtained from the interviews was visualized through the use of affinity diagrams, which is used to identify themes in qualitative data (Preece et al., 2015) by grouping pieces of data, e.g. quotes from interviews, based on their natural relationship. The groups themselves are not predefined, but emerge during the process. Individual contributions should eventually form themes or trends in the data which relate to the goal of the study.(Preece et al., 2015)

5.3.2 Analysis of Usability Tests and Questionnaires

In order to draw conclusion and suggest improvements based on the data of the conducted usability tests, the data needed to be analyzed. Which approach to use primarily depends on what kind of data was acquired, e.g. if the sessions were recorded or if just notes were taken. Recording the usability tests allowed the investigator to subsequently go through the recording and look for problems or other interesting aspects that occurred during the session, like comments by the participant. A way of visualizing the issues is to put these in a matrix containing the observed problems, number of participants having the same problem, its possible causes and its possible solutions (Rexfelt, 2016). In this phase, it is important to not make personal interpretations to early but to stick to what was really observed (Rexfelt, 2016). Based on these results, the designer can then choose to adopt these solutions considering factors such as severity of the problem.

The questionnaires supplied qualitative and quantitative feedback regarding the interface. The purpose of the questionnaires was to investigate the participants' general impression of the interface and how they perceived the interaction with the interface, which partly presented qualitative data through open-end questions. Quantitative data was also obtained through the use of gradations where the participant selected the degree to which the experience aligned with the, in the design process, stipulated words of value, such as *calm*, *inspiring* and *professional*. Both the qualitative and quantitative data acted as validation of the participants' experience when interacting with the interface, as well as feedback for improvement.

5.4 Development Tools

Several methods and theories were used as tools in the project work. These include methods for generating ideas, theories of emotional responses to color, work methods and principles of code design.

5.4.1 Brainstorming

Brainstorming was used in the design process as a tool for generating ideas and solving problems that had been identified. The method is used in a creative process to generate, refine and develop a large amount of ideas with the potential for great variety (Preece et al., 2015) and the method can also have great variation in execution to fill its purpose (Wikberg Nilsson, Ericsson, & Törlind, 2015). A few basic rules should, according to Wikberg Nilssson, Ericson and Törelind (2015) be applied in a brainstorming session. The first rule is to never criticize anyone and to not worry about the ability to realize the idea in this phase, this can be done after the session when evaluating the ideas. Secondly, aim for the wild and crazy and ensure that everyone in the team is comfortable in expressing their ideas. A creative climate should be promoted on order to reach the not so conventional solutions. Another rule is to try to combine and improve the ideas of others in order to make use of each others creativity. This should be distinguished from criticizing, as pointed out in the first rule. The idea is instead to spark ones creativity by being stimulated by others. A final rule is also to aim for quantity instead of quality. The idea is that the more ideas to choose

from, the higher chance of getting quality in a few of them. Other recommendations for the session could be to involve participants of different backgrounds or disciplines in order to cover a broad range of experience (Preece et al., 2015), as well as assigning a facilitator that is responsible for the formalities and sticking to the rules previously defined (Wikberg Nilsson et al., 2015).

The brainstorming approach used in the design process was to first clearly state what the purpose of the session was, i.e. what is to be investigated. This could be done with questions like "how can..." or "in what ways...". During the sessions, the ideas that the participants generated were written down, sketched or mind-mapped so everyone could see them. This should be done in order to spark the creativity to develop the ideas of others or merge them with your own (Preece et al., 2015).

5.4.2 Agile Way of Working and Iterative Design

Since the case study was continuous throughout a larger part of the project, resulting in new data appearing over time, an iterative approach to the progression of the project seemed natural. The investigating group was divided into two teams, one responsible for the design and evaluation and the other on implementation.

In the design team, in order to ensure that a functioning interface was designed, it was helpful to develop it in an iterative manner. By using feedback, either from within or outside the group, the design could be improved step-wise. This idea is based on the fact that designs often require some trial and error before obtaining desirable standard and rarely acquire the best solution right away (Preece et al., 2015). Theoretical and empirical testing can give valuable feedback when evaluating the usability in a design and should therefore be conducted several times in the design process if needed. The test results from each opportunity are then analyzed and adjustments are made in the design to fix the problems that emerged during the test(Nielsen, 1993a).

In the implementation team, the management framework that has been used is a loose variant of the broadly used agile work method Scrum (Fox, 2014). Application requirements was specified from the case study. Those Requirements were then translated into use cases which were prioritized in a backlog. By utilizing the backlog, short iterations in sprints were planned. The ambition was to after each sprint have a more refined product. At first, sprints were planned to last for two to three weeks but as the project developed, the sprints were shortened to one week. Discussions with the purpose to ascertain the advancement of each team members tasks were held weekly. Mainly, the discussions circled around what was finished and which tasks needed to be transferred to the next sprint.

During the iterative process, the workflow between the teams can be described as both parallel and vertical. Parallel in the matter that a design suggestion was presented to the developers working as a blueprint for the developers. The implementation of the design was then evaluated, pointing out improvements for the next design. Vertical as in exchanging ideas and discussing improvements.

5.4.3 Code Design Principles

For the sake of simplifying the development and enhancing maintainability, code design principles can be of use. Separation of concerns is a method which effectively lowers complexion of larger software applications. The concept can be simplified as splitting features and content, that on an abstract level has no association, into separate modules (Hürsch & Lopes, 1995). High values of separation leads to an increased extent of code re-usability and makes it easy to replace and re-factor code. Usage of separation of concern, and the advantages that comes with it, was applicable in the development process. Mainly to prevent the possibility of disorganized code due to the application being built by several developers, whom worked on different parts simultaneously.

Model view controller (MVC) is a design principle which utilizes the concept of separation of concern. It divides the project code into three main categorize, a model, a view and a controller. In short, the model is responsible for the application state and handling application functionality. The view basically renders the model and the controller is responsible for the application behaviour (Krasner, Pope, et al., 1988). Due to the separation, MVC offers an advantageous way of designing software architecture.

5.4.4 Color and Emotions

The relationship between color and emotions was investigated as a foundation for picking the color palette to be used in the interface. Based on this, colors could be picked that aligned to the desirable expressions. The investigation of emotional responses to color was also done to overcome insecurities about cultural barriers regarding color that may exist.

This investigation indicated that, although emotional response of color is a subjective matter, some hues generally evoke more positive emotions than others. For example, a study of American collage students (NAz & Epps, 2004) found different hues had different emotional responses based on what the hues were associated with. In the study, the color green evoked the highest rate of positive responses and was according to the participants associated with relaxation and comfort, partly because of the connection to nature. The color red was associated with both positive and negative emotions, reminding the participants of love and romance, as well as Satan and evil. The fact that colors are being loaded with associations also implicates that there might be, to some extent, cultural differences. This difference was exemplified when 160 university students of four different nationalities expressed their emotions towards different hues (Choungourian, 1968). The study concluded that "definite cultural and some sex differences were found" (p.1203). Factors such as these might therefore be taken into account when designing products that will be used in cultures different from that of the designer's.

6   Design Process

Since new information was constantly acquired throughout the project, adjustment of the product requirements was a consistent procedure. Therefore, an iterative approach, as described in section 5.4.2, was appropriate in the design process .

Below is the design process described in the form of multiple iterations. The strive was to let each iteration consist of five steps; *Establishing Requirements*, *Idea Generation* (Concept), *Prototyping*, *Implementation*, and *Evaluation*. The steps are visualized in Figure 2. Seen from the perspective of the Human Centered Design model, as described in section 5, Establishing requirements and Evaluation are connected to *Inspiration*, Idea generation to *Ideation*, and Prototyping and Implementation belongs to the *Implementation* stage. Depending on the iteration, some steps were stressed more than others.
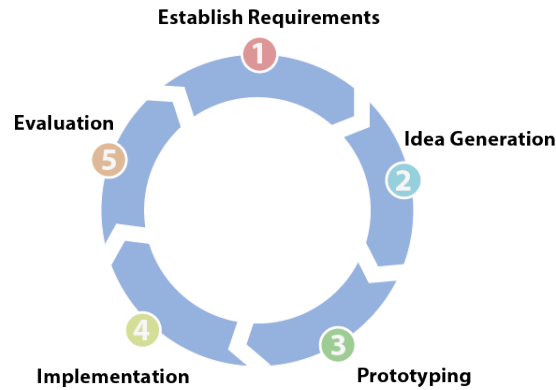

Figure 2: Illustration of the design process according to the guidelines in *Interaction design - beyond human-computer interaction* by Preece, Rogers and Sharp (2015). Every iteration consists of five phases; establishing requirements, idea generation, prototyping, implementation, and evaluation.

6.1   First Iteration - Understanding the Problem

To define the specific problems of the target areas the initial main focus was to collect as much information as possible about education for refugees and the refugee camps. The information gathering consisted of an extensive case study, including both a literature study of related work and interviews, see section 2 and section 5.2.1. The literature study was used to get a general perception of the situation while the interviews reported personal observations and experiences deriving into a more profound perspective.

In this phase, a total of six people were interviewed. The interviews followed a semi structured approach, described in section 5.2.1. The interviewees were chosen because of their different experiences related to education in refugee areas as well as their general knowledge of living situations and technical infrastructure in refugee areas. The purpose of combining these groups were to cover a large spectrum of experiences in order to gain as much knowledge as possible. The interviews were conducted over Skype[1] and recorded, using a software for screen recording to facilitate the analysis of the interviews. The following people were interviewed:

- Andrea - Working as volunteer for the Swedish NGO Lighthouse Relief on the island of Lesvos, Greece

- Jumana - Academic officer at Jesuit Refugee Services, Amman, Jordan

- Adel - Refugee and volunteer worker in Moria refugee camp on Lesvos, Greece

- Firas - Teacher assistant in Zaatari refugee camp. Involved in the Jamiya Project, whose mission is to pursue improved education opportunities for asylum seekers, refugees and conflict-affected communities. (*About the Jamiya Project*, n.d.)

- Karam - Iraqi student and refugee living in Amman

- Brian Tomaszewski - Assistant Professor at Rochester Institute of Technology and Research Assistant at The Pennsylvania State University. Experience includes past work with internationally-focused organizations with interests in GIS (Geographic Information Systems) and disaster management. Experience of teaching in Zaatari refugee camp and has investigated mobile usage in Zaatari (Maitland et al., 2015)

One of the initial decisions that had to be made was what type of solution that should be developed, a pure software application or a combination of both software and hardware. Information gathered from both related work, section 3, and interviews stated that most refugees own a smartphone. A hardware solution was therefor settled as being redundant and it was decided to move forward with a mobile application.

A few key points could be determined from what was expressed in the interviews. The situation for refugees vary greatly between different areas and can also vary between individuals within said area. Particularly, factors that affect the situation for a refugee is the regional refugee policy, the specific geographic location as well as their background, education and personal finances. With all this said, there are also similarities. There is a great need and a strongly expressed desire among many refugees to get education and they are all affected by lack of resources, non sufficient material and underdeveloped infrastructure. Motivational problems with the existing education was also found. Most of the existing education for refugees provided by NGO's can be described as non-formal and therefore cannot provide proof of merits, e.g. attending higher education.

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[1]Skype - a software for instant messaging, calls and videoconferencing over Internet Protocol

6.2 Second Iteration - Analyzing the Gathered Data

Next step of the project was to acquire deeper analysis of the collected data and establish which requirements that had to be taken into consideration when designing the product. The affinity diagram, which is shown in figure 3 and described in section 5.3, was used for this and resulted in a categorization where the collected data from the interviews was broken down and gathered into various focus areas and challenges.

The result from the categorized data was then transformed to a series of product specifications, supposed to provide a well structured checklist used to keep track on what functions the application needed. The specifications were divided into two sub-sections, one focusing on technical requirements and the other on user needs. Some of the highly prioritized specifications are presented below.

- The product needs to be usable in areas with restricted internet access.
- The product needs to be distributed in areas with restricted internet access.
- The product needs to function on smartphones and mobile units regardless of brand and operating system.
- The product should be able to present a variety of courses.
- The product should be efficient to use in small windows of time.
- The product should be able to provide help for users that are stuck, either with functionality or course related questions.
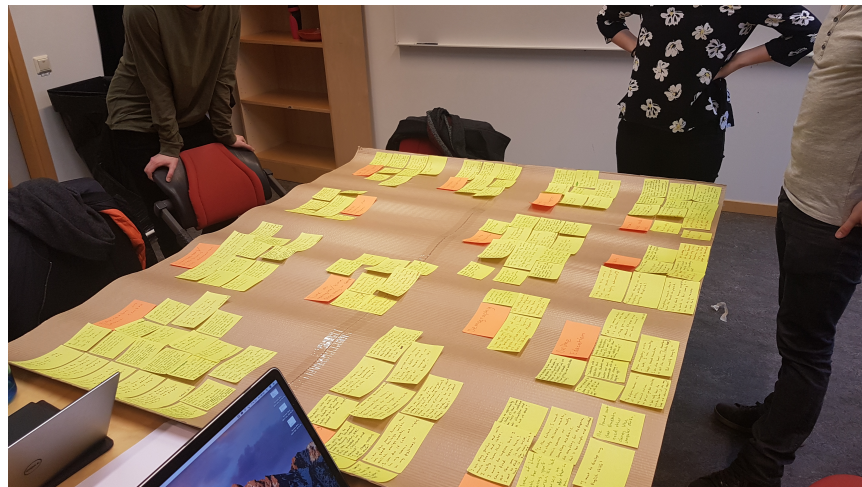- The product needs to be usable for people of different nationalities.

Figure 3: The Affinity Diagram that was used to categorize interview quotes according to different themes. The headlines are presented on orange post-its and quotes on yellow.

The concept could at this point be stated to be a mobile education platform where students can open and attend a variety of courses. However, more specific functionality about how the product should tackle the issues discovered in the case study was not defined. Based on the product specifications, brainstorming sessions, see section 5.4.1, where conducted to transform the requirements into ideas and solutions. A series of prototyping sessions then followed where the overall structure of the application was stipulated. The consideration of the concept of micro learning, see section 4.3, led to a division of the material into courses, lessons and quizzes. Each course should consist of several lessons, each including a series of slides, containing the course material. The material should be presented in chunks, to be usable in short time intervals. At the end of each lesson, the user should be tested with a small quiz. It was also decided that a user should be given a way to follow their progress and that there should be ways of getting help about the course when needed, e.g hints or a Frequently Asked Questions (FAQ) section.

During this iteration, several sketches were made on paper and whiteboard, to build pages in the application and to illustrate an application structure as seen in Figure 4. The sketches and the whiteboard schemes were then summed up into a first digital design prototype using the software Adobe XD[2], see figure 5. At this point, focus was solely on getting the proper functionality and issues regarding user experience such as usability, colors and icons was deliberately held on a minimum level.
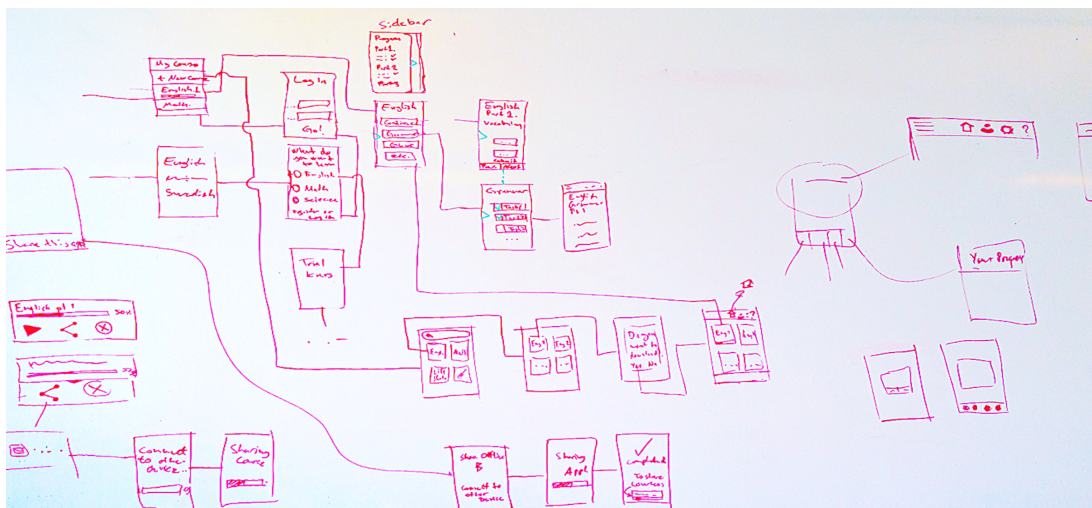

Figure 4: Picture of one of the whiteboard schemes used to provide an overall view of all pages needed to be designed in order to form a working prototype.

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[2]Adobe Experience Design CC - a cross-platform tool for designing and prototyping websites and mobile apps
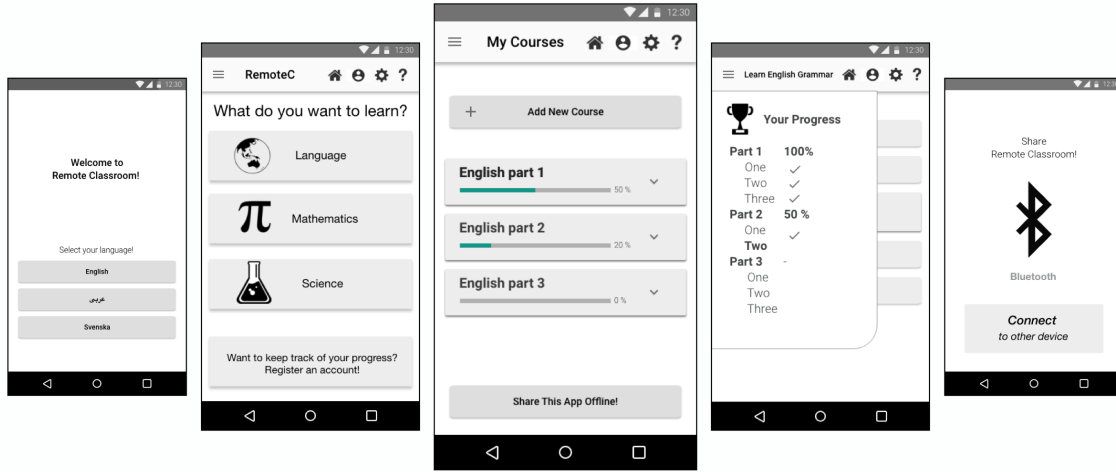
Figure 5: Presentation of pages from the first digital design prototype. Shown here are the welcome page, the trial page, a list of downloaded courses, a sidebar for trackin progress, and the page for offline sharing using bluetooth.

Simultaneously, the implementation team started to establish what kind of mobile application that should be implemented. The decision stood between whether to go for a Native, Web or Hybrid application. After assessing the differences (Budiu, 2013) together with the product requirements, a Hybrid application was chosen. This choice was mainly due to the need for availability throughout different mobile operating systems and the need for some native functionality, concerning offline sharing. Having selected the application type, frameworks for the application was surveyed. In the decision process, due to the relatively short time schedule, prior experience of the developers needed to be taken in consideration. Therefore any framework not built with JavaScript, HTML and CSS were excluded which lead down to the selection between two frameworks; Ionic (*The Ionic Framework*, n.d.) and React Native (*React Native*, n.d.). Based on a study conducted by Majchrzak, Biørn-Hansen and Tor-Morten Grønli (2017) regarding an analysis of above mentioned frameworks, together with expert recommendations from practised developers, Ionic was considered to suit the needs of the implementation team and was therefore chosen as framework.

After the decision of the frontend framework, the backend structure still remained. Through community knowledge, mostly blogs and forums, it was found that the use of MongoDB, Express, Angular and Node.js, also known as a MEAN stack, were commonly used in the environment of mobile- and web development and thus chosen for the application.

In order to evaluate the concept, an evaluation workshop, section 5.2.2, was initiated together with the Syrian academic Oula Abu.Amsha and the founder of the Jamiya Project[3], Ben Webster.

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[3]Jamiya Project - Aiming to provide higher education to Syrian refugees (*About the Jamiya Project*, n.d.)

Abu.Amsha was titled academic adviser on the Jamiya Project, where she was communicating with students at Zaatari camp through WhatsApp[4]. During the workshop, the early digital prototype was presented and the concept of the platform was discussed. The discussion resulted in confirmation of our ideas around offline sharing and the usage of micro learning. It also gave new insights regarding the difference of text-alignment in English and Arabic, communication between students in the form of study groups, and the importance of being able to share only parts of a course, due to restrictions in data storage on phones.

Figure 6: Group picture from the concept evaluation workshop. On the left, the presented prototype can be seen.

6.3 Third Iteration - Minimum viable product and application structure

The evaluation workshop provided some new information and perspectives to the project. Based on this information, together with previous work, the concept was starting to take form.

Following the prototyping sessions, there was a long backlog that was difficult to prioritize. Therefore the decision was made to define a *Minimum Viable Product* (MVP). To define the MVP, another brainstorming session, was conducted with focus on the following questions: *"What will be presented?"*, *"How should it be presented?"* and *"How should the knowledge be tested?"*. As seen in figure 7, ideas were categorized into three groups depending on their importance. A red border indicates high priority and thus the fundamental parts of the implementation. The outcome of the session was that the MVP should consist of the following units:

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[4]WhatsApp - An instant messaging application for smartphones

- Course material should be presented in short texts or glossaries, possibly together with explanatory images.

- Examination should consist of short quizzes in the form of multiple choice questions placed directly after every lesson.

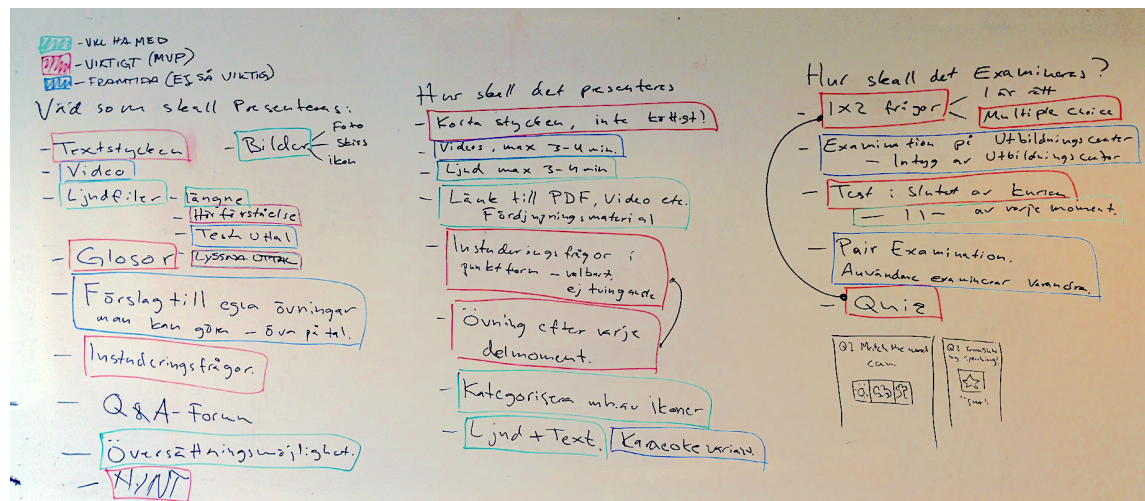- Simple hints, provided to help students understand the course material.

Figure 7: Notes from the workshop where the Minimum Viable Product was constructed. Functionality was prioritized using borders of different colors; red equals very important, green stands for a what to be implemented if time allows and blue is not to be implemented (figure is in Swedish).

While the implementation of the MVP was started and with the most important functionality more or less set, the prototyping switched over to a new phase, now considering issues regarding user experience. All the important functionality needed to be placed in a clear and logical way to provide a good interaction for the users and the early digital prototype needed improvements in this area. A workshop session about this was held where the structural ideas was discussed and decided upon with help from usability and design principles, mainly Nielsen's heuristics for user interface design (Preece et al., 2015).

The following structure was established during this session:

- The application should have a header and a footer that remains mostly solid during all user interactions.

- The header should mainly contain information, like the users present position in the application. When needed, icons for help, hamburger buttons and previous page can be placed in the header as well.

- The footer should contain icons for navigating to different sections of the application and should not change during user interaction.

- A course is visually presented as a rectangular box containing the name of the course, a progress indicator and possibly a course-unique icon.
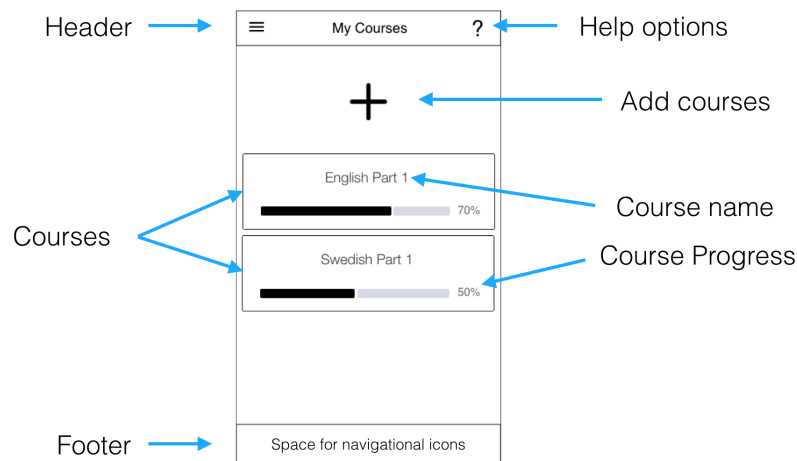

Figure 8: An illustration presenting the main application structure of the course page. The page consisted a header with a help option, page content consisting of downloaded courses and an add button, and a footer with icons for navigation.

Using the MVP-structure, it became very clear that even if course material was outside the project scope, the design prototypes still needed some example courses to present the ways of handling different types of media and different languages. The example courses were also considered to be useful in subsequent tests of the application. It was decided that at least two simple example courses would be created, one course considering important life skills, like performing CPR and taking care of cuts and wounds, and one course teaching basic English for Arabic speaking learners. The reason for choosing these subjects was partially to be able to cover all parts of the MVP and partially because language courses and life skills were two of the most frequently requested educational subjects by our interviewees.

Based on the MVP, the implementation of the core structure started. The work was structured in an agile way, as described in section 5.4.2. The implementation team was divided into two units, one responsible for recreating the design suggestions into an interface and the other for the underlying logic. The following areas were implemented:

- Landing page

- Sign up- and log in page

- Customized header and footer components for navigation

- Pages holding the content for showing course material and examination quiz

To summarize, during this iteration of a lot of decisions and prioritization were made leading to the foundation of the product being set.

6.4   Fourth Iteration - Visual styles, courses and developing the MVP

In order to define the expressions that was desirable for the application, a number of expressions was selected and visually ranked. The result is presented in Figure 9. The expressions was selected based on the results from the interviews together with some general opinions of relevant expressions. For example, *Professional* and *Serious* came from how the interviewed students expressed positive and negative aspects of the education available today while *Calm* and *Inspiring* were considered generally desirable for a learning application. A collection of pictures, relating to these expressions was also put together in order to provide visual support to the design team. Using these two documents together with the predefined application structure shown in Figure 8, the design prototyping continued with producing a variety of color schemes using two different visual styles for icons. These can be seen in figure 10. The prototyping then resulted in the two alternatives shown in figure 11, which was compared and evaluated relative each other.

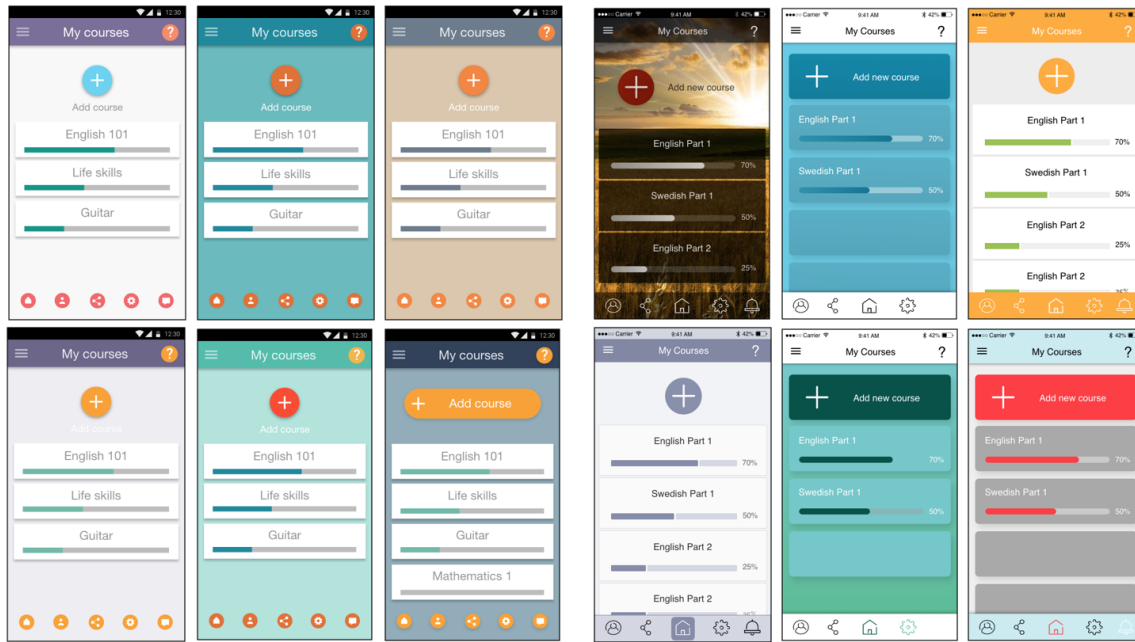Figure 9: A presentation of the visually ranked expressions selected for the application

Figure 10: A selection of the created design suggestions with different color schemes and visual styles.
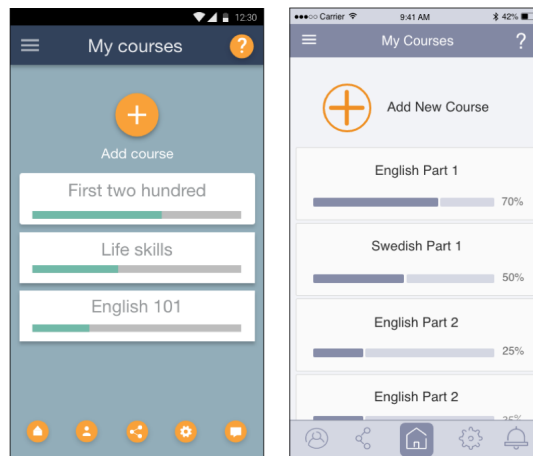

Figure 11: The two design suggestions that were chosen for a more thorough evaluation.

The evaluation of the different design prototypes took place during a workshop where they were evaluated with the research on emotional reactions to colors as in section 5.4.4, Jacob Nielsen's heuristics in section 5.2.3, and the preferences of the developers in mind. This resulted in the creation of the final visual style and color scheme, which are summarized in the following list:

- Overall, the colors and their composition are quite muted, the reason for this can be traced from the selected expressions, Figure 9, giving a calm expression.

- The combination of the two nuances of blue (#8287A4 and #F5F6FA) was chosen with the research on emotional reactions to colors taken into consideration. The color blue was argued by previous studies to be associated with words such as calm and trustworthy (Amsteus, Al-Shaaban, Wallin, & Sjöqvist, 2015) making it a suitable main color for this application.

- The orange #FBA228 is chosen as an action color and is repeatedly used for highlighting prioritized buttons and icons.

- The green #89C49F is a functional color, used to present progress and success.

- The footer was decided to be white in order to not be distracting for the user while reading text on the application.

- The font used is Helvetica Neue. Helvetica is a clear and common font used in many websites and printed material (Shinn, n.d.) and since this is a multi-platform application, Helvetica was considered to be a neutral alternative to the more brand specified fonts Roboto (google/android) or San Francisco (apple/ios).

The decided color scheme and visual style, presented in figure 12, can be described as a combination of the two color schemes in figure 11 that was selected for further evaluation. Adjustments were also made to the size of the icons. To circumvent the problems with text and icon alignment when switching between Western and Arabic interfaces, discussed in the evaluation workshop during the second iteration, section 6.2, it was decided to center icons and text when possible.
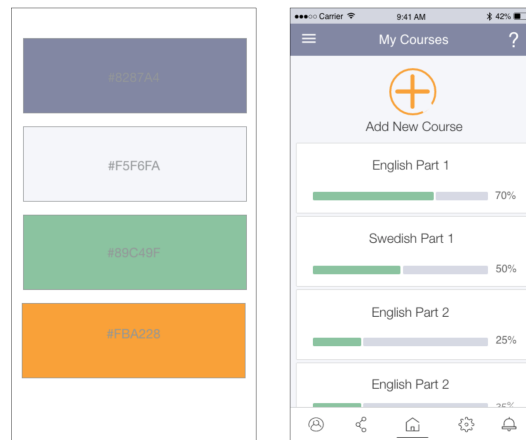

Figure 12: Visualization of the final color scheme and application style.

When the visual style was set, focus turned to developing the example courses. The life skills course, presented in figure 13, was put together with free-to-use images and text from The American Red Cross (Cross, 2016). The course starts with a description page, informing the user on both content and learning outcomes. Then a list containing the lessons was presented. Here the user had a choice to either start the course from the beginning, i.e. first lesson, or continue from where the previous session ended. The lessons consisted of slides, each expected to take less than a minute to go through, following the idea of micro-learning described in section 4.3. A progress bar informs the user on the number of slides, as well as on where the current slide is in the order. At the end of each lesson, there is a short quiz based on the foregoing content.
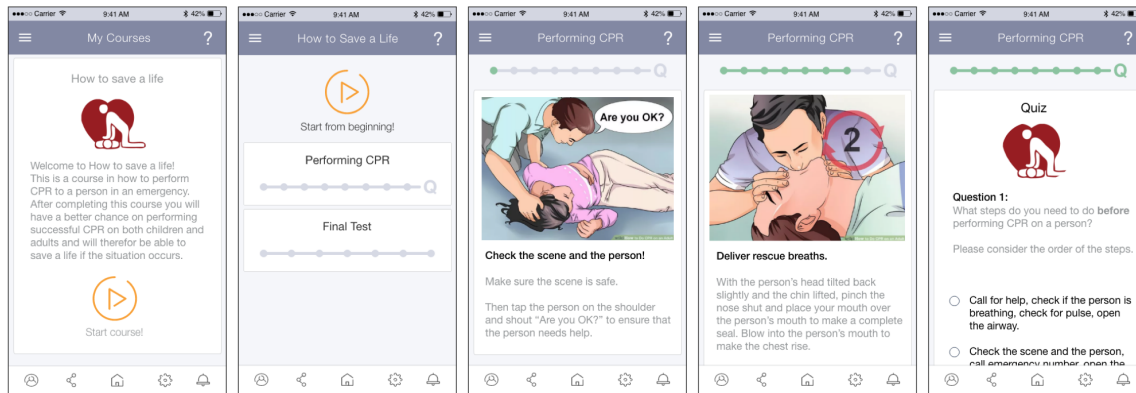
Figure 13: Slides from the life skills course "How to save a life". The course consisted of a description page, lessons divided into slides with short text-based content, and was ended with a quiz after each lesson.

The language course shown in figure 14 followed the same format as the life skill course, but instead of using images, icons and spacing where used when presenting the content. The course also included functionality for converting text to computer generated speech, known as *Text To Speech system*, making it possible for the user to hear how the English words and sentences are pronounced.

Figure 14: The language course "Basic English" presented material introducing the Latin alphabet, basic grammar, and some words and phrases. The course used Text To Speech in order to let the learner listen to pronunciation of letter and words.

When the courses were constructed, evaluation of the usability was to be carried out on the design prototype. Using Adobe XD, a restricted but r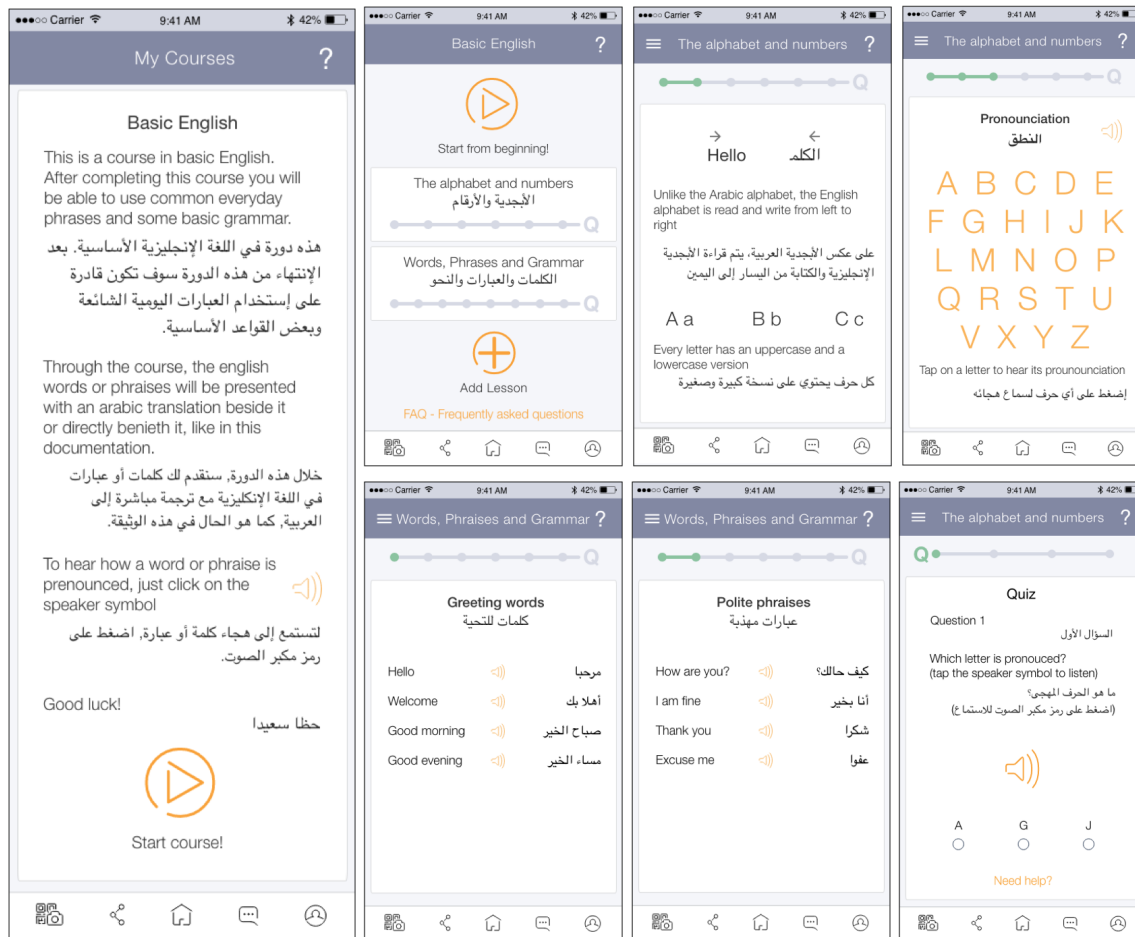ealistic simulation of the implemented application was created. This simulation was further used in subsequent tests. First, a Heuristic evaluation, described in section 5.2.3, was performed. The Heuristic evaluation mainly showed that the application had very low status concerning error prevention and an almost non-existent feedback when performing some tasks, seen in Appendix B. Based on these results, the design prototype was changed prior to further testing. Secondly, evaluation through usability test were performed using the strategy described in section 5.2.4. This process was inspired by the iterative design process, see section 5.4.2, by repeatedly performing tests, analyzing the results, making corrections to the design prototype and performing tests once again to evaluate the new status.

On the first two tests, the focus was purely on usability in order to make a usable application. Issues regarding the concept or the possible cultural differences was decided to be evaluated on a later occasion. With this in mind, the design prototype tested at this time was all in English and the selected participants were Swedish with good English reading and writing comprehension as well as being experienced in interacting with smartphones. During the tests, the participants were asked to perform three tasks, Appendix C, testing the application's performance on the following areas:

- Navigation through all, as yet designed, parts of the application

- Finding, downloading and going through a new course while having internet connection

- Sharing courses and lessons through Bluetooth with a friend while lacking internet connection
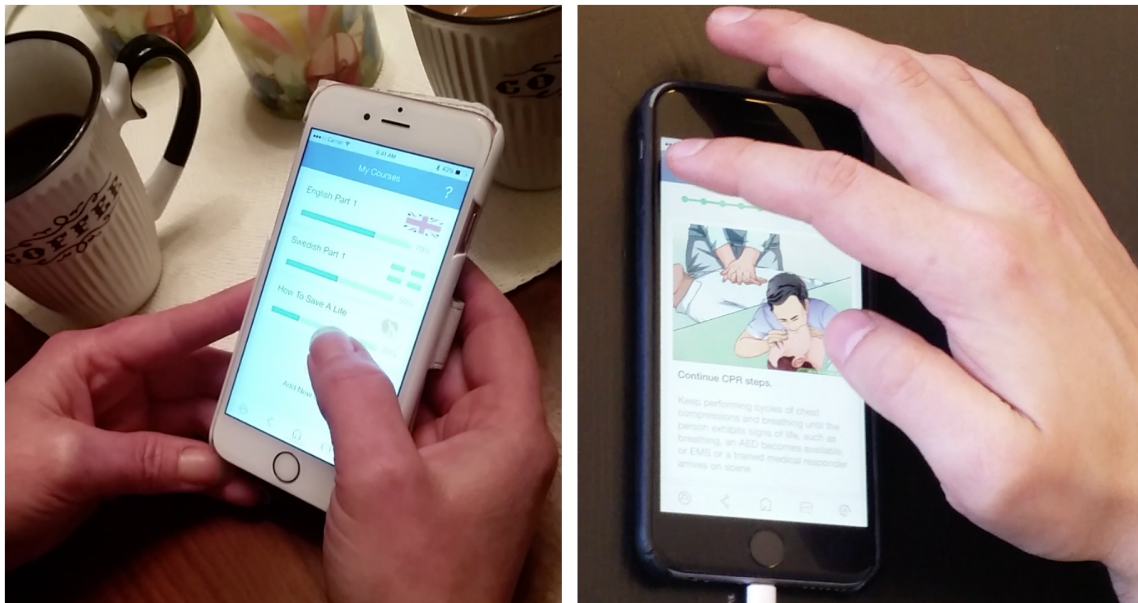
Figure 15: Frame shots from one of the early usability testing. Here, the test people were instructed to start and take the course How to Save a Life.

The first iteration of usability tests was performed on two women, 22 and 45 years old. The design prototype tested was using Bluetooth to share the courses. The analysis of the test showed only minor problems and the general impression of the test was that the design prototype and its functionality performed quite well.

During the fourth iteration, the development team continued to work with the core functionality of the MVP. Also, solutions to meet the product requirements, found in section 6.2, were discussed and tested. One of the more important requirements concerned the distribution and sharing of material in areas with low Internet connectivity. To meet the requirements of offline sharing, three different methods were explored:

- Bluetooth peer-to-peer connection

- Near-field communication (NFC) file transferring

- Barcode scanning of QR-codes

Due to restraints with the Ionic framework, peer-to-peer connection via Bluetooth was discarded. Transferring files via NFC was only available for Android phones, which would counter out the benefits of cross platforming, and was therefore also discarded. Thus resulting in bar-code scanning of QR-codes being the method selected. Simultaneously the possibility to distribute the whole application offline was explored, but was at this stage found unsolvable. The issues around offline distribution are further discussed in section 10.7.

6.5 Fifth Iteration - Finishing the Prototype

Since the sharing technique was changed from Bluetooth to QR-codes, the design prototype had to be corrected in order to include this feature for the following usability tests. To perform the sharing, the providing user have to generate the QR-codes and the receiving user have to scan them.

Using the updated design prototype, a new iteration of usability tests were performed. The participants were this time two women and one man between 21-23 years of age. The test showed significant problems in sharing the courses with QR-codes. When analyzing this, using the methodology of section 5.3.2, several reasons were found:

- The users had no previous experience of using QR-codes for the purpose of transferring data, making the task difficult to perform.

- The users did not understand that they had to scan more than one code in order to get the whole course

- The task is partly demanding on how well the co-operation between the users work since there is no real communication between the phones.

The conclusions made from the tests were that the sharing function had to be made much clearer in order to be understood and that the interface must, when using the QR-scanner, tell what part of the course is scanned and provide the user with proper warnings if things are scanned in the wrong order. These corrections were made and a third iteration of usability testing was initiated, this time with two men, aged 65 and 24. In this test, the QR-sharing performed well and since no additional problems were found, the decision of ending the design prototyping phase was made. All further evaluation was performed on the implemented application.

At this stage, the underlying functionality of the MVP was done and the product requirements determined in more detail. The final step was then to make the application match the interface of the design suggestion. This mostly concerned fixing the layout. The fifth iteration also consisted of an overall clean up of the code, fixing bugs and re-factoring.

At the end of this iteration, the implemented application was up and running with an interface that resembled the design prototype. Additional work and bug-fixes were made continuously even after this iteration, but as a whole, the application was ready for field testing, thus marking the end of the design process.

7   Final Concept and Application Evaluation

In order to evaluate the final concept, a series of tests and discussions were held. Three remote evaluation sessions were performed over Skype, where both the concept and the final prototype were discussed. A field study containing usability tests and a group discussion was held at Studium, a school teaching Swedish for immigrants in Gothenburg.

7.1   Remote Evaluation Sessions
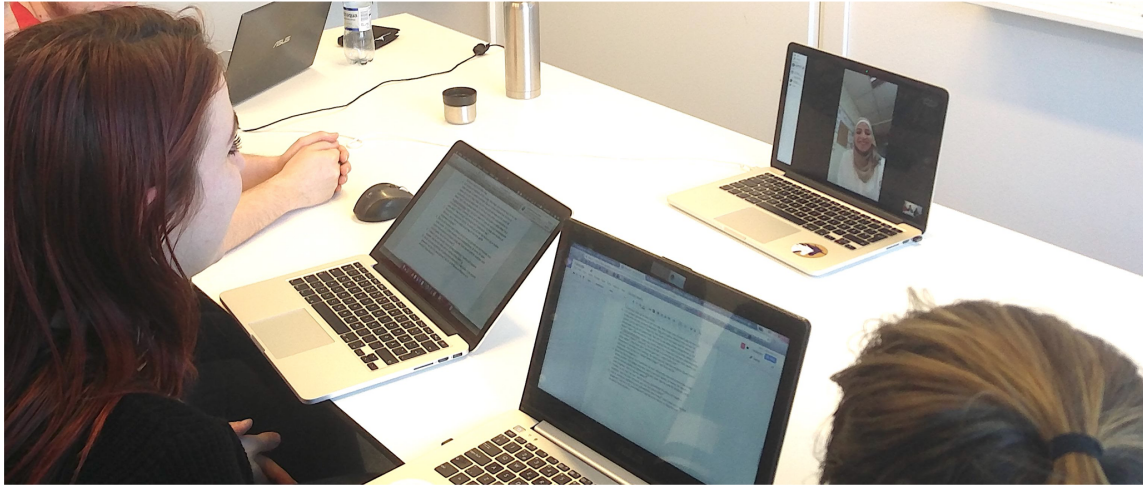
Figure 16: Picture from one of the remote concept evaluation sessions. The evaluation was conducted using Skype and both the concept and the final prototype were evaluated.

All of the remote evaluation sessions were performed using the same structure. The interviewee was first given a link to a short video on YouTube where the basic concept was presented through texts, graphics and simple animations. When the video was finished, a discussion was held about the concept after which the application was presented to the interviewee while the he or she was spectating. This was due to technical limitations, since letting the observer control remotely resulted in performance issues and delays.

The interviewees for these sessions were a refugee studying at the Jesuit Refugee Service, an academic officer at Jesuit Refugee Service, and a Syrian academic that was previously involved in the evaluation workshop 6.2. The most important inputs from these sessions are summarized below:

1. *The Concept* - The concept was received as potentially very helpful for refugees. It was considered useful for both educational purposes and as a way for NGO's to spread information such as how to avoid infections or how to search for asylum at the current location.

2. *The Navigation* - Previous research argued that Arabic speaking users prefer navigating through applications in a mirrored way compared to English speaking users (Hemayssi, Sanchez, Moll, & Field, 2005). This was arguably disproved since all of the interviewees were familiar with the Western navigation. The one stated exception would be when reading long texts in Arabic, presented on several slides, since it would feel natural to switch pages in the same direction as in a book.

3. *The Usability* - The interviewees expressed the shared impression that the application looked clean and seemed easy to interact with. The Syrian Academic suggested improvements in forms of informational videos on the more complicated parts, like how to perform the sharing procedure. Details such as icons and symbols were stated as easily understandable and the different colors used in the application were considered as culturally acceptable.

4. *Translation* - The Arabic translations, and how they were aligned in the interface, were approved by all interviewees with the comment that it felt natural.
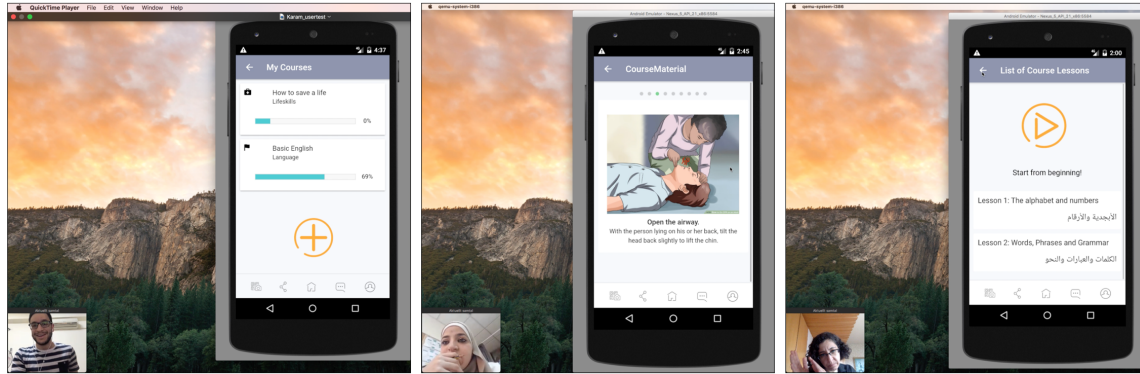
Figure 17: Frame shots from the remote interview sessions where the application was presented on an emulator through screen sharing.

7.2 Field Test

The tests at Studium were performed with four people, all Arabic speaking with experiences of living as refugees. After a short introduction, the attending group was split into two smaller groups. The two groups were then shown the same concept video as used in the remote evaluation sessions. After that, usability tests were conducted on both groups separately, now using the implemented prototype. After the usability tests, a group discussion was held with all the participants concerning the concept. During these tests, some previously unnoticed problems occurred:

The Course Progress bar was interpreted as a download bar, leading to some confusion. The reason to why this was not discovered earlier could be since the previous tests were performed on an emulator where the test persons did not expect anything to actually be downloaded.

The Course Progress Section on the profile page was interpreted as courses and not progress, leading to some confusion. This section was probably not enough separated from the course view and could be interpreted as clickable.

The QR-sharing still proved to be problematical. After some initial complications, one group managed to share a course while the other had problems scanning the codes in the right order, eventually failing to perform the task. A reason to this could be that it depends on cooperation between the users. Another could be that not enough guidance was provided. There were also some style differences between the implemented application and the design prototype, deriving from the lack of customization options for the built in barcode scanner, which might have affected the result.

Figure 18: Group picture from the field test at Studium.

During the group discussion, the input gained from the remote evaluation interviews was confirmed. The concept was endorsed and the offline sharing was stated necessary although its execution was considered to be too complicated. Informational videos inside the application was once again suggested to solve this issue. Also, the importance of hearing the pronunciation of words in the language course was highlighted, as stated by one of the interviewees.

8   Final Prototype

The final prototype is the implementation of the final design suggestion. The main purpose of the prototype was to be used in field testing. Therefore, some requirements of the product has been prioritized more than others. These requirements concerned the ability to share material offline, and short time usage. Below follows a description of the final design suggestions and the implemented prototype.

8.1   Final Design Suggestion

The design process resulted in a final suggestion presented by the design team, with a few changes being made after the final evaluation. The remaining parts of the design were then handed over to the implementation team. The most fundamental parts of the interface are presented below together with a description.
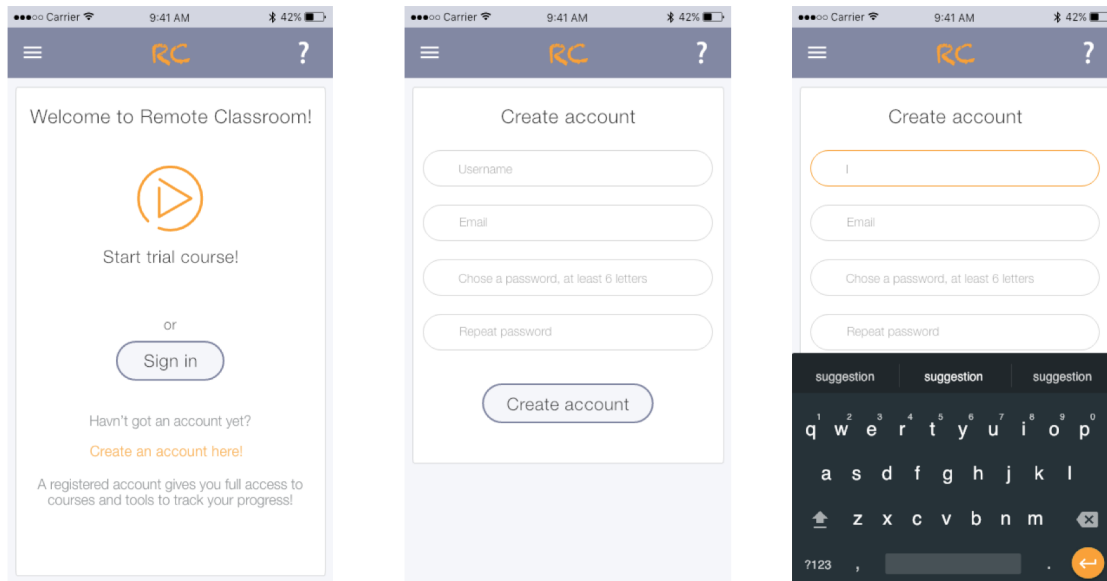
Figure 19: Design suggestion of landing page and registration. This is the first screen that the user will encounter. On the first frame, starting from left, the user can either choose to start a trial course, log in to an account or create a new account. The second and third frame display the creation of a new account.

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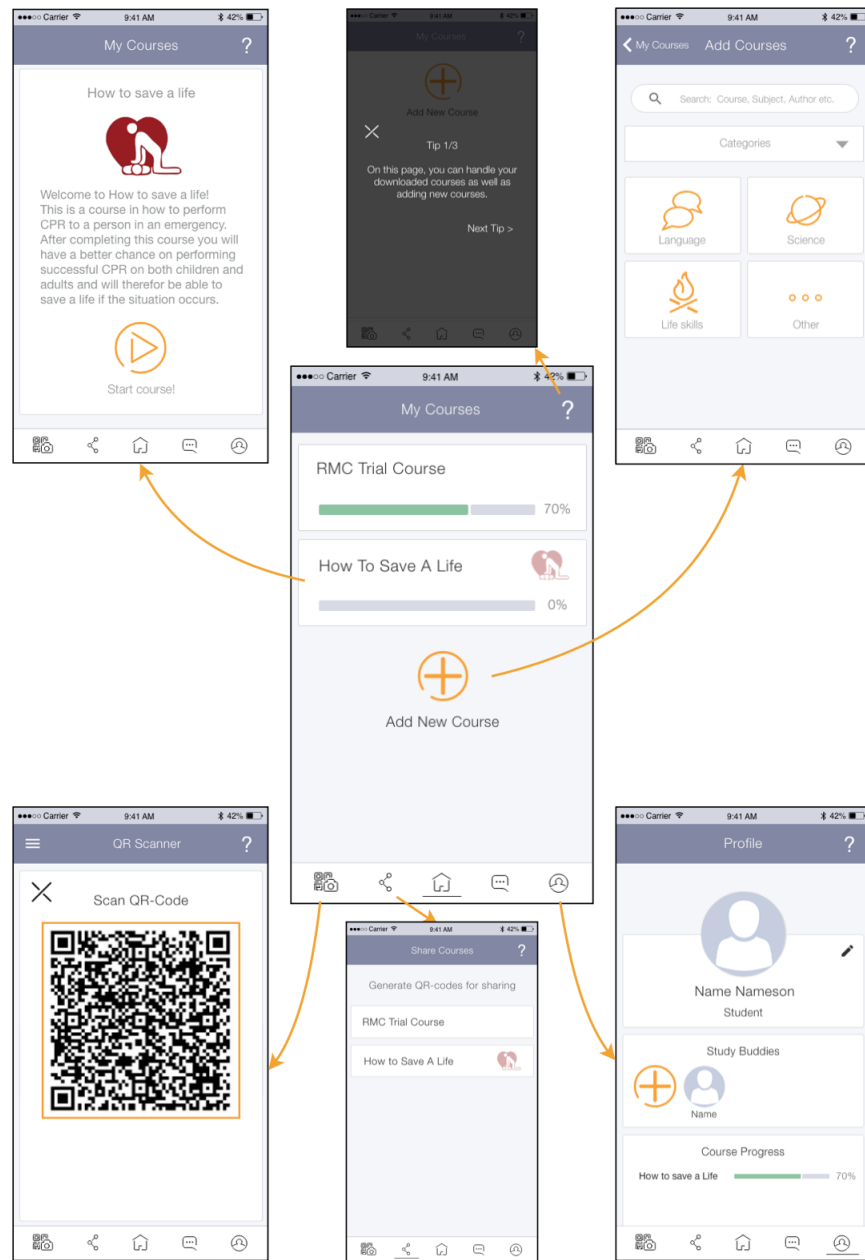
Figure 20: This diagram describes the main navigation flow off the final design suggestion. The centered page is the first to be shown after signing in. The navigation bar at the bottom of the page is used to navigate to the core parts of the application. The icons represent, from left to right, scanner for QR barcodes, sharing courses by generating QR codes, the user's courses, messaging(not yet implemented) and user profile.

The design of the course structure which was introduced in section 6.4 and can be seen in figure 13 as well as in figure 14, were not changed in later iterations and is therefore a part of the final design suggestion.

8.2 Application Architecture

The application was built using the web technology stack called MEAN. The front end is built using Ionic, which is powered by Angular.js. The back end with MongoDB as database together with Node and Express as server. Information is sent between Client and Server using JSON. Between server and database information is sent as BSON.
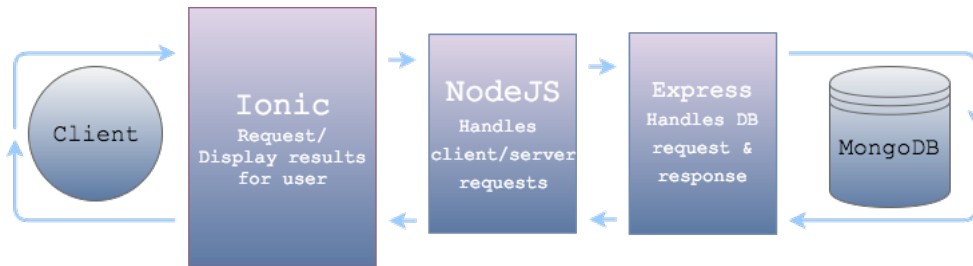

Figure 21: Illustration of the application flow. Ionic is used on the front end. Node and Express together with MongoDB is used on the back end. Data is transmitted between front and back end as JSON objects.

Because of the lack of consistent internet connection, functionality on the server was decided to be as minimal as possible [5]. Hence, most of the implementation is done in Ionic.

An Ionic application is built by using high-level building blocks called components. Each component package contains three files, one HTM-file responsible for layout, one SCSS-file responsible for styling and one TS-file responsible for logic. Ionic comes with a large library of predefined components allowing quick construction of an interface, but also provides the option to implement custom components. Navigation through pages in Ionic works similarly to a memory stack where the options are to either push a page, i.e go forward, or pop a page, i.e go backwards. Furthermore, there is the option of setting a new root page. This option eliminates the previous stack and is useful when navigating to a page with no resemblance to the previous page.

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[5]Keeping the application size small, due to the constraints concerning limited phone memory on the target phones, somewhat disagrees with this statement. However internet connection was considered a more pressing matter and thus prioritized.

Adding new pages and functionality to the application was done with separation of concerns, high-lighted in section 5.4.3, in mind. Examples of separation can be found in the pages and components packages where the HTML file handles what is presented to the user, the view, while the ts file contains the data and data modification methods. In this example it is visible that the separation is not complete, the TS-file works partially as both a controller and a model. Further separation of the model, however, would create a more clear MVC-pattern, section 5.4.3.

The courses are stored in the database as JSON objects, an extract of a course object can be seen in figure 22. They were divided into multiple lessons where each lesson consisted of multiple slides and a quiz. A course contains a title, an image, a category, a description, a list of lessons and a list of questions. The list of lessons contains the slides for each lesson and the list of questions contains the questions and answers for each quiz. In the current implementation, all courses follow this specific structure, making each course follow the same pattern and thus limiting the variation of how course material is presented in the application. That said, the course material, e.g the text on a slide or the content of a quiz, can vary in any way the provider wants.

Figure 22: Extract of a Course object, as implemented in the database.

The interface of the application was created by replicating the design suggestions provided by the design team. The layout of the pages were written in HTML and styled with SCSS to get an as exact interpretation of the suggestions as possible. An outline of the result of the design implementation can be viewed in figure 23.
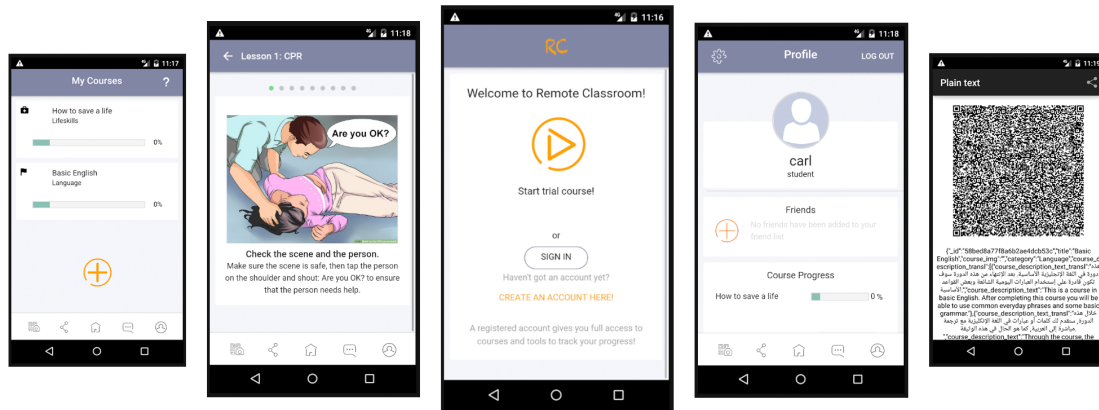
Figure 23: Screen shots from the final implemented prototype showing the list of downloaded courses, presentation of course content, the landing page, the profile page, and a QR-code used for sharing courses offline.

8.3   Application Functionality

The functionality of the application is based on the design suggestions given by the design team. The application can be divided into three core parts, one regarding registering and signing in a user, the second managing courses and the third retrieving courses. Several pages were constructed for each part. For instance a profile page, a course content page, etc.

- **Register and Login**
  This part consists of three pages; a landing page, a sign in page and a registration page. Registering and signing in is managed by using JWT's which is locally stored until the session is ended.

- **Managing Courses**
  This part concerns everything that has to do with the interaction of courses. Here, a home page displaying the users active courses, pages for representing courses and a profile page displaying course progression etc., was implemented. It provides functionality such as carrying out courses and locally storing progress when a user has read a slide or has finished a quiz.

- **Retrieving Courses**
  In this part, a page for adding courses from the database and removing locally stored courses as well as a page for generating QR-codes were created. Downloading directly from the database was implemented using Angular's HTTP get functions to communicate with the server. It is by far the easiest way for the user to receive a course but is restricted to internet connection, thus limiting its use. Offline sharing of courses is done by generating and scanning QR-codes. The following list describes the steps needed to share one course:

1. The user that has the course generates a course shell.

2. The receiver of the course scans the generated course using the integrated scanner.

3. The course holder then proceeds by generating codes, one at a time, for the lessons that should be shared.

4. The receiver scans the codes in the order they are generated.

After the user has retrieved a course, it is locally stored in the application using Ionics built in Storage.

The amount of characters a QR-code can handle depends on the characters that are being sent (*QR Code Standardization*, n.d.). Since there are binary characters in the JSON objects, such as parenthesizes, binary QR-codes must be used thus limiting the capacity to 2900 characters. After parsing the JSON objects to strings, they consists of approximately 14000 characters. Therefore, a full course do not fit into a single QR-code. This is solved by splitting the string every 2900:ed character, then generating a QR-code for each section of the string. Then, after each consecutive scan of the codes, the string is puzzled back together and parsed back to a JSON object.

9   Findings

When the project started, the knowledge about refugees' living situation and need for education was very limited. By conducting a case study, better understanding of the challenges in accessing education for refugees was achieved. Based on this information, a prototype, with the aim of helping refugees to access education, was developed. The design of the prototype had its foundation in the following four aspects and limitations that was found to be correlated to most refugee situations in the researched areas.

1. *Smartphone ownership* - Smartphones, most popular are iPhones and Android phones, have become a life line for refugees by providing navigation and contact with friends and family on other locations. Even though smartphones are beeing used daily, they are rarely used for accessing education.

2. *Economical limitations* - Being a refugee is expensive and because of that, many has to work or spend a lot of time standing in line to access items necessary for survival such as food, clothes and hygiene products. These people do not have the opportunity to visit the learning centers that are available in the area. Also the learning centers have a limited amount of people they can serve at one time, resulting in many people being without education even though they tried to be admitted several times. A solution for this could have been the large amount of MOOC platforms that are available through universities and other organizations, which brings up the third limitation.

3. *Weak technical infrastructure* - Accessing the internet living in a camp is far from easy. Wi-fi is almost never available and the mobile networks are too weak and unreliable for participation in MOOCs. In addition, governments of the host countries sometimes put a restriction on the network in order to prevent the distribution of propaganda.

4. *Cultural differences* - Refugees all have different cultural backgrounds which had to be considered in the design work to increase usability for people of different backgrounds.

To address the above aspects, the prototype was given the characteristics below, some were implemented while others where kept on a conceptual level:

A *Cross-platforming* - A hybrid application was chosen since many different brands of smartphones are being used and the application needs to be easy accessed to increase the motivation to use it.

B *Backward compatibility* - The smartphones owned by refugees are of varying age which means the application had to be built on a platform that supports older versions of operating systems.

C *Short lessons* - Since time to study is limited, the application should be designed for courses that have the content divided into small units. That way, studying can be performed, for example, in evenings, in a queue or on the bus.

D *Assessment of understanding* - Evaluation of the achieved knowledge from a courses is essential in a learning application. Because the offline usage is an essential part the application, it needs examination methods that supports auto correction. Examples of this kind is multiple choice questions, fill in the blanks etc.

E *Help functions* - By providing help, as FAQs or Q&As, for understanding the course material, the probability of the users to stay motivated could be increased. First time user information of the functionality would also lower the barriers to start using the application.

F *Collaboration* - In order to increase motivation, a possibility to connect with friends is wanted. From this part of the application, the user is supposed to be able to write direct messages about courses to their friends.

G *Offline usage* - To make the courses accessible without network connection the course progress as well as the course material had to be stored locally on the device.

H *Offline sharing* - Sharing course content as well as sharing the entire application between two devices without internet connection opens up a new dimension of mobile learning. With offline sharing of the application, a larger population could be reached and more would get access to education. The possibility to only share parts of courses is useful when the user is short on phone memory.

I *Multiple languages* - The application had to handle different languages and the challenges that comes with different language families such as text alignment (left-to-right/right-to-left), different alphabets etc. By centering as much text as possible, the alignment problem could be solved.

J *Universal interface design* - Designing the interface as universal as possible decreased the chances of the users not understanding how to navigate or the interface being culturally inappropriate.

Evaluations of concept and usability with experts within learning and people that have first hand experience of being a refugee, generated the following results:

a *Backward compatibility* was verified as the implemented prototype has been runned without any problem on a Samsung Galaxy 3 with the operating system Android 4.4. This operation system was as released about 4 years ago.

b *Sharing course content with QR-codes* is conceptually very good but having to scan more than one QR-code per lesson proved to be problematic. Culturally, QR-codes were not a problem and learning centers can have use of the possibility to share courses by printing QR-codes on paper.

c *Tip pages for help with the applications functionality* was shown to be needed even though the application in general was easy to use. Help was specifically needed about how to share material with QR-codes and the help that was implemented needs to be shown more clearly.

d *Collaboration* with friends was not implemented meaning that the functionality was not tested. On a conceptual level however, the idea of being able to have course related conversations with friends is good. It is important that the chat function is as simple as WhatsApp, one of the most common communication tools in and around the camps.

e *Presenting course material in small pieces with multiple choice questions* works well for courses that present important but relatively simple material, for example life skills courses. When it comes to more complicated academic material the limitation to a smartphone screen is problematic. The possibility to present videos would enhance the implemented prototype.

f *The interface design and language challenges* were solved in a good way. The style of the application was clean and easy to understand. The centering of text was easy to follow both in English and Arabic and the Arabic speaking people had no problem in understanding the icons that were used. Using Western navigation (when swiping) was in general not a problem among the test participants.

10   Discussion

This chapter highlights the problems that the project faced and the thoughts and discussions that were brought up throughout the process.

10.1   Project Goals

One of the bigger challenges that we faced during the project was the defining of our scope. Since there was a risk of the project scaling into a massive size, the need for reasonable limitations was crucial. Not knowing exactly what was needed and what tools we wanted to use made this difficult. The initial thoughts were oriented towards a hardware solution since we assumed that there were a large deficit of technical components. Understanding that the refugees are fleeing war, not poverty and thus have access to smartphones, changed the orientation towards a software application.

An alternative approach to the project could have been to limit the scope to solutions on a proto-typing level, i.e. not doing any implementation into an actual application. Even though this would not result in runnable software, the project would in this case provide valuable content to future work as a highly developed concept. This would indeed bring a few benefits to the outcome, such as elaborating the case study, refining the design and being able to further evaluate the concept, as a result of the time saved from the often arduous and time consuming software development. Implementing the prototype had, however, some important benefits. Firstly, an implementation of functionality proves the feasibility of the technical aspects of the concept, making it more legiti-mate. Secondly, it also highlights possible difficulties or obstacles in the use of technologies, as in the case of the offline sharing by Bluetooth. Reviewing the technical feasibility can thereby act as feedback to the design work, forcing the design team to revise these aspects and in the end produce a more viable concept. Thirdly, implementing the functionality also provided the opportunity to investigate more accurately how a user handles these functions, as some functions may be hard to illustrate and test using a prototype. These aspects, together with the fact that the skill set within the project team benefited this approach, contributed in determining that the concept should not be held on a prototype level, but instead be implemented into software.

10.2   Remote Classroom as a Mobile Learning Platform

Looking back at the four types of mobile learning in section 4.1, we classify our final prototype as belonging to *Type 2*. Our initial ambition was to implement the platform to have the features that are presented in *Type 1*. The main difference between those types is that Type 2 is focused on individuals while Type 1 is group-based. The reason to why this was not achieved is due to limitations appointed in the MVP, where collaboration between students was not prioritized as essential functionality. That said, future expansion of the product to include solutions for collaboration would get the product moving towards *Type 1*.

The concept of micro learning was initially implemented in order to get a reasonable structure when presenting a large amount of data on a small smartphone screen. In our findings though, it can be

seen that the idea of using micro learning was of even more importance than we initially expected. Since living as a refugee is expensive and a lot of time is spent working or standing in line waiting for basic material, it is difficult to attend education that demands their full attention during large time spans. Therefore, adapting micro learning was more of a necessity than just a feature.

The idea of the application was to make it stand on its own as a learning management system. The design prototype contains most of the requirements of an LMS with features for signing up for courses, tracking progress and the possibility for an instructor to manage courses marked as closed. The implemented version however, does not have all these requirements fulfilled. The MVP required us to choose a focus towards the learner interaction and therefore, the part of the application towards instructor functionality was left relatively unexplored. In future implementation though, this should be examined and developed with the instructors needs in mind since their part is essential in making the application a stand alone learning management system.

10.3   Challenges of Providing Education for Everyone

Open courses would simplify the access to courses independently of instructors and location. An issue with this is that the instructors often use copyrighted material that is not possible to distribute to everyone, which could potentially result in a lower quality of the course material. An additional issue with making the platform open in the sense of letting anyone add a course is the aspect of propaganda distribution. During the case study we have found that governments often deny access to some websites to prevent the spreading of propaganda and getting the application denied to be used in the intended areas is not wanted.

Realizing these problems gave rise to a number of thoughts; How do we prevent propaganda to find its way into the application? How do we make courses accessible to as many as possible, without breaking the rules of copyrighted material? What if a course is of significance for human survival? The Remote Classroom application has so far not been able to implement final solutions to these challenges. On a conceptual level, the thought is to offer both closed and open courses. The open courses can be accessed by anyone with the application and is supposed to be used for more general courses that are not led by an instructor. The closed course option can be used when a specific organization want to offer content to a more specific group of people, for example learners taking courses at a study center. Preventing illegal material in the application is a bit harder to solve and no real attempt to solve this has been made. An idea is to somehow be able to perform background checks of people and organizations that want to upload courses and by that make sure only reliable material is distributed.

10.4   Social Impact on the Targeted Audience

Why would our final prototype make an improvement for refugees and their situation? What makes our prototype better suited for refugees in refugee camps than the existing platforms mentioned in section 4.4, is the adoption to usage in areas with unstable internet connection. One of the problems with general MOOC's in refugee camps is the requirement of internet in order to access

the website. The functionality with distribution and use without internet access is considered to be the most important adoption, making it a prime criteria to consider when developing an application with these areas in mind.

In order to provide a better accessibility to education, the impact on other problematic areas might also improve, such as economy, social factors and the environment. For example, as mentioned in section 1, education is proven to help families. Benefits from school activities affects parents since they can work to make money, decreasing the levels of stress and exposure in their situation.

Another problem is that the educations that are offered from the different NGO's are mostly on a non-formal level; providing children and young adults with knowledge and mental support but nothing of the progress is being acknowledged. Education forms like these are very good in the early stages of a crisis but is not ideal in the long run. The young adults that want education, often want some kind of proof, such as diplomas, on that they have fulfilled an education and with that have the possibility to continue where they left of once they arrive to a new country. If there is no such possibility, motivation may be lost which might lead to them neglect schooling.

10.5   Cultural Differences in Mobile Applications Design

The cultural differences concerning navigation, mirroring and the positioning and aligning of the Arabic language in mobile applications was stated as a potential problem in our case study. Interviewed experts and the previous research mentioned in section 7 both stated this as necessary but was arguably disproved since the people in our tests and concept evaluations all stated that they were used to the Western style navigation. There can be several reasons for this. Since most of our interviewees had proper English skills and high experience of smartphone use, they can be assumed to use English applications to a greater extent than most. Previous research puts a lot of focus on designing websites and not specifically mobile applications, leaving out possible differences.

To conclude, our study suggests that the importance of changing the navigational directions and mirroring the interface when designing a multicultural mobile application is overstated but more research is needed to support this.

10.6   Interviews and Field Study

As mentioned, one of the biggest concerns in the beginning of the project was the limited knowledge and understanding of the situation and how that could lead to a solution that was not used by the target audience. The use of a human centered design approach prevented the final prototype to be based on our own assumptions, to instead focus on the targeted audience needs.

Considering the interviews, the use of semi-structured interview method proved to be a wise choice. This made it possible to adapt every interview in order to find as much information as possible within the interviewees area of expertise. Conducting the interviews via Skype worked very well and made it easy to record interviews for further analysis. For the concept evaluation the screen sharing sometimes was a bit slow but overall it seemed easier to focus on the concept instead of the course material when they did not have the opportunity to click wherever they wanted.

Due to the geographical distance between the study group and the focused areas, the amount of interviewed people living in this areas were too limited to state that our results are generalized. A solution to this could have been to hand out a form to the students at, for example the Jesuit Centre, but in the beginning of the project we were cautious not to put pressure on our contacts. Afterward, we have realized that they enjoyed helping out and probably would not have minded handing out a form.

Regarding finding a relevant group of people that could test our application was far from easy. The initial thought was to conduct a field study in Jordan but when we could not find funding for this, we had to start looking for solutions in Sweden. Then we got in contact with a "Swedish for Immigrants"-school who could provide test persons with Syrian background which was perfect for the project. However, there was some concern regarding how well we would be able to communicate with them, if they would be biased because of nervousness and afraid to ask if they did not understand. The team was quite confident that the technology would work without and major issues but very nervous about issues like the testers would not understand the concept or focus too much on the content of the course. When reflecting back at the tests the conclusion is that on one hand our expectations were pretty accurate but on the other not at all. Two of the test people were not shy at all as well as being very god English speakers. These were the ones taking the lead in their respective group. The understanding of the concept was quite well, even if they, as expected, had a hard time taking focus away from the course content. The other two were more shy, probably due to the language barrier, and did not say that much to us. However they talked in Arabic to the their respective group member who translated.

Regarding the final evaluations, our implemented application was tested on experts, teachers, refugees and people living in Sweden with prior experience of living as refugees. This group had valid experiences with a strong connection to our targeted audience and was able to provide very relevant feedback. Even so, there is still issues regarding the fact that we never got the opportunity to test our application on people living in refugee camps today. If we have had this opportunity, we could have achieved a much more direct and up-to-date feedback towards our concept. We would also have gotten a more profound image on how relevant our application would be from their point of view. There is certainly a difference between discussing however an application would have been useful for a person with prior experience of refugee camps but living in Sweden today compared to having the same discussion with a person currently living in a refugee camp. How motivating our application would be, how issues like stress and an unstable environment with uncertain future plans could affect the perception of our concept are all issues that could have been added to our prior input.

10.7   Implementation - Framework and Functionality

The considerable amount of documentation provided about both Ionic and Angular made it really easy to kick-start the project. The detailed documentation proved particularly valuable for the less experienced developers on the team since it vastly lowered the threshold knowledge of the framework. There is also a well established community surrounding the framework, delivering tutorials and answers to problem related questions. However, since the framework is still young and is yet to reach its full potential, some functionality that we wanted to have in our application was not supported. Especially in the case of peer to peer Bluetooth functionality, which lead to difficulties when trying to solve the problem with offline sharing. The initial thought about offline sharing was to do it via Bluetooth and if Ionic would have supported peer-to-peer connection this would probably have been the solution we would have gone for. The restrictions in our current solution, i.e the need for several scans needed for one lesson, would not have been a problem with Bluetooth. Bluetooth is also commonly used in data sharing while QR-codes almost exclusively is restricted to spreading web-URLs. With this in mind, some of the confusion we experienced when testing our sharing solution could probably have been avoided.

On the other hand, the unconventional aspects of our offline sharing is what makes it interesting and special. Should a solution to the problems addressed in section 8 be found, such as an effective compressing algorithm, sharing large data via QR-codes would be much more effective.

While talking about the sharing of courses, it is also suitable to mention our attempts on sharing the whole application between phones. We constructed a test for sharing the whole application, i.e the apk-file, through Bluetooth in a separate native Android environment. What could be found from the test was that devices developed from high end brands such as Google Nexus and Samsung did not allow transferring of apk-files through peer-to-peer connectivity. The restriction is probably the result of trying to prevent the spread of malicious software as well as to prevent illegal file sharing of mobile applications.

When we found out that Bluetooth peer-to-peer connection was not supported by Ionic, we could have changed to a framework that did. The problem was that when this was realized, we had already spent a lot of time both learning Ionic and implementing functionality. A change of framework would have raised the need for a new learning process as well as additional time spent on reimplementation and could have limited the functionality of the end product. Instead we choose to stick to Ionic and focused on finding an alternative solution for sharing. The solution with QR turned out to work well and had some interesting aspects to it. However, in the future we will probably do a more thorough research before choosing frameworks.

10.8   Suggested Future Improvements

In order to improve the platform for future work the following objectives are recommended:

- Multiple language support for the application.

- Integrate WhatsApp, or similar functionality, into the platform for communication and knowledge sharing.

- Support for video in the course content.

- Separate platform allowing instructors to create custom courses.

- Optimizing the offline sharing by either compressing the course to fit into a single QR-code or re-investigate the possibilities of sharing via Bluetooth.

11 Conclusions

Complex problems, as education in emergencies, are difficult to solve and often have many possible solutions. This project aimed to develop a mobile learning platform adapted to the living situation of refugees living in Zaatari and Amman in Jordan and Lesvos in Greece. During the project, the following research question was a central part of the purpose: *What characteristics should a mobile learning platform have in order to meet the needs for education in emergencies?*

By using a Human Centered Design approach, the user was set in focus. From interviews and literature studies, four core factors were found being highly important to have in mind regarding the researched area. These factors were smartphone ownership, economical limitations, cultural differences and weak technical infrastructure.

These core factors acted as guidelines when brainstorming was used to find requirements for the application. Several design suggestions were created and some of the brainstormed solutions were implemented while some were held at a conceptual level. Throughout the project, usability and concept evaluations were conducted and contributed to the identification of important characteristics. A selection of these are cross-platforming, offline usage and sharing, course material presented according to the principle of micro learning, auto corrected assessment of understanding and universal design where western navigation in general is accepted.

Since the concept was tested and evaluated mostly on people with good English skills and a higher level of education, the above mentioned characteristics can be somewhat biased. Therefore, the subject might be in need for more research on the actual targeted audience in order to verify the characteristics further.

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A   User Interface Experience - Questionnaire

User Interface Experience

1. **What is your age?**

   _____

2. **What is your native language?**

   _____

3. **If you can, describe the experience with the application with a few words.**

   _____

   _____

   _____

   _____

   _____

4. **Using the application was...**
   Mark only one oval.

	1	2	3	4	5	6	
Complicated	◯	◯	◯	◯	◯	◯	Smooth

5. **The application was...**
   Mark only one oval.

	1	2	3	4	5	6	
Clear	◯	◯	◯	◯	◯	◯	Confusing

6. *Mark only one oval.*

	1	2	3	4	5	6	
Inspiring	◯	◯	◯	◯	◯	◯	boring

7. *Mark only one oval.*

	1	2	3	4	5	6	
professional	◯	◯	◯	◯	◯	◯	playful

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8. **The use of the app was...**
   Mark only one oval.

	1	2	3	4	5	6	
stressful	◯	◯	◯	◯	◯	◯	calm

9. **How was your experience with the app in general?**
   Mark only one oval.

	1	2	3	4	5	6	
Very bad!	◯	◯	◯	◯	◯	◯	Very good!

10. **Was there anything in the app that could be improved?**

_____

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B   Heuristic Evaluation Tasks

Use Case: Öppna profilsidan för att se aktiva kurser	
Visibility of system status	
Match between system and the real world	
User control and freedom	
Consistency and standards	
Error prevention	
Recognition rather than recall	
Flexibility and efficiency of use	
Aesthetic and minimalist design	
Help users recognize, diagnose, and recover from errors	
Help and documentation	

Use case: Öppna en kurs för att se lista på alla lessons	
Visibility of system status	
Match between system and the real world	
User control and freedom	
Consistency and standards	
Error prevention	
Recognition rather than recall	
Flexibility and efficiency of use	
Aesthetic and minimalist design	
Help users recognize, diagnose, and recover from errors	
Help and documentation	

C   Usability Test Scenarios

Scenario 1

Du har fått ett tips om en ny utbildningsapp av en kompis och har laddat ner den till din telefon. Du ska nu öppna den för första gången och testa hur den fungerar.

Du hade tänkt att testa kursen 'How To Save A Life' som du också blev rekommenderad av en vän, samt genomföra denna. Försök att göra detta.

Försökspersonen genomför uppgiften

Du har hört att det går att det går att dela kurser och hade tänkt att testa detta eftersom att din kompis skulle vilja ha kursen 'How To Save A Life' och inte har tillgång till internet. Försök att utföra detta.

Du skulle också vilja lägga till Nils som studiekamrat för att kunna kommunicera med varandra och hjälpa varandra när det behövs. Genomför detta.

Scenario 2

Sätt dig nu in i situationen att du har haft appen ett litet tag. Du skulle vilja fortsätta kursen 'How To Save A Life' där du senast slutade. Navigera i appen till den punkten i kursen där du avslutade.

Om du skulle vilja ta dig till ett annat kapitel i kursen eller se hur långt du har kvar. Hur skulle du då gå tillväga?

Gå till quiz-sidan

Om du skulle behöva hjälp med kursinnehållet för att du kände dig osäker, hur skulle du då gå tillväga?

Scenario 3

Nu är vi i situationen att din kompis ska dela kursen 'How to Save a Life' till dig samt dess innehåll. Visa hur du då skulle gå tillväga.

För att ta del av de olika kapitlena i kursen krävs det att jag delar dessa till dig också. Hur skulle du göra här?