# Fighting child marriage in developing countries: design and development of a mobile application

Tesi di laurea in
MULTI-AGENT SYSTEMS

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# Abstract

Child marriage is still a great issue in developing countries and even if the interventions to prevent it are having results, they are not enough to eliminate the problem. Among the strategies that seem to work most to fight child marriage, there is the empowerment of girls with information combined with education of parents and community.

As smartphones are more accessible year after year in developing countries, this thesis wants to investigate if a mobile app could be effective in fighting child marriage and which characteristics such an app should have.

The research was organized in four phases and used design and creation and case study methodologies. Firstly, the literature was analyzed and an initial design was proposed. Secondly, expert interviews were performed to gain feedback on the proposed design, and afterwards prototype was built. Thirdly, a case study in the Democratic Republic of Congo (DRC) was performed to test the prototype, gaining insights and improvements through group interviews with 26 girls aged 15-19. Finally, a first version of the app was developed and a second phase of the case study was run in the DRC to understand if the girls were able to use the app. This phase included 14 girls of which 6 had participated in the prototype testing and used questionnaires as a data generation method.

The app was built following the Principles for Digital Development. Even if this app is built based on the case study in DRC is modular and easily adaptable to other contexts as it is not content-specific. It was shown that is worth continuing to study this topic and it was defined a conceptual framework for designing learning apps for developing countries, in particular, to fight child, early, and forced marriage.

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# Acknowledgements

# Preface

This thesis project was carried out at the Norwegian University of Science and Technology in Trondheim (Norway) and with the collaboration of AidProfen, a non-profit organization based in eastern Democratic Republic of the Congo.

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# Acronyms

**CEFM** Child, early and forced marriage

**DRC** Democratic Republic of Congo

**HCI4D** Human-Computer Interaction For Development

**ICRW** International Center for Research on Women

**ICT4D** Information and Communication Technologies for Development

**ITU** International Telecommunication Union

**IVR** Interactive Voice Response

**NGO** Non-governmental Organization

**NSD** Norwegian Centre for Research Data

**SMS** Short Message Service

**SUS** System Usability Scale

**UN** United Nations

**UNFPA** United Nations Population Fund

# Chapter 1

# Introduction

Among UN's sustainable development goals, number 5.3 aims to "Eliminate all harmful practices, such as child, early, and forced marriage and female genital mutilation" by 2030 [59]. There are only 8 years left until the deadline, and despite data showing a decrease in the number of children married each year, 100 million girls are predicted to marry before the age of 18 by 2030 and the COVID-19 pandemic has put 10 million additional girls at risk [66].

Child marriage is a marriage that involves people under 18 years of age and it is considered a human rights violation that affects mostly girls. Child marriage is diffused worldwide, but the higher percentages are found in the less developed countries, where the 36% of women aged 20-24 were married before the age of 18 and 10% before the age of 15 [67].

Several factors lead to child marriage and they also vary from place to place [42]. The main causes lay in insecurity and conflicts, legal issues, family values, religion, individual beliefs and knowledge, and social norms [42].

Many interventions have been actuated to fight child marriage, both from private and public organizations in the last two decades. The strategies of the different programs have been classified by the International Center for Research on Women (ICRW) [43] into five main categories based on their approach. The analysis made by ICRW [43] and Psaki et al. [54] evidenced that among the interventions that seem to work more there is the empowerment of girls with information combined with the education of parents and communities.

Technology and mobile phones are accessible by an increasing number of people in developing countries [32] and some research in the field of ICT4D, such as [21, 47, 40, 33], starts to study the usage of mobile applications with various purposes in developing countries. Numerous obstacles arise as a result of variables such as poor internet connection quality and excessive costs, as well as potential users' low level of education and digital illiteracy.

Plan International's report on digital technologies used to combat child mar-

riage [35] describes various mobile apps used to fight child marriage at a local level with a positive outcome. Inspired by one of these apps, Brevik [12] started to design a mobile app to combat child marriage at a global level, proposing and testing six different designs.

This thesis wants to study how a mobile app to empower girls and families with information could be effective, how it should be designed by developing guidelines valid at a global level, and realizing and testing the first version of it in developing countries.

The project applied the design and creation method. It started from Brevik's proposed designs and added more functionalities and features based on the literature from Information and Communication Technologies for Development (ICT4D). Successively, expert interviews with people from different countries of the world were conducted and analyzed with thematic analysis, obtaining a refined list of guidelines that brought to the design of a prototype. Then, a case study in the Democratic Republic of Congo was run to understand how girls in developing countries perceive child marriage and an app to fight it, and to gain feedback on the prototype through group interviews. Afterwards, the first version of the app was implemented and tested in the same setting with a session where the girls had to try the app and fill in a questionnaire.

The contributions of this thesis are the development of an app usable by girls in the DRC but adaptable to many different realities as it is built in a modular way, and the design of a conceptual framework with guidelines for developing mobile apps to fight child marriage in developing countries. Many of these guidelines are also usable for designing apps with other learning purposes that target the same population.

## 1.1   Research Questions

The research project will address the following research questions based on what has been previously stated:

**RQ1**: How can a mobile application be effective in fighting child marriage in developing countries?

**RQ2**: How should a mobile application that targets girls in developing countries to fight child marriage be designed?

## 1.2   Thesis outline

The outline of the thesis is as follows. Chapter 2 covers the research methods used in the research and the research process with a brief introduction to all the

phases. Chapter 3 analyzes the literature related to the research topic and proposes some guidelines to build an app to fight child marriage based on the literature. Chapter 4 exposes the data collected through the expert interviews that wanted to get feedback on the guidelines and proposes a prototype based on the results. Chapter 5 covers the first part of the case study in DRC that focused on testing the prototype and getting to know the target audience. Chapter 6 explains the app development and Chapter 7 displays the results of the second part of the case study that had the goal of testing the app. Chapter 8 shows the contributions that are the app and the general conceptual framework. In conclusion, Chapter 9 closes the thesis with a summary of the project, the limitations of the research, and the future works.

# Chapter 2

# Research methods and process

This chapter mainly explains the research methods used in the research and the research process with all the phases followed. Afterward, are also analyzed the beneficiaries of the study, the followed research paradigm, and the ethical issues derived from the research process.

## 2.1 Research methods

This research used two research methods: design and creation and case study. The main method used is design and creation, which has been applied iteratively multiple times. A case study has been used to run a real-world evaluation of the artifacts produced by the previous method. The application of the methods to the research is further explained in section 2.2.

### 2.1.1 Design and creation

The research method chosen for this research is design and creation as its main goal is to build and evaluate new IT artifacts. This method is widely described by Oates et al. [52] and it consists of 5 iterative steps:

1. **Awareness**: articulation of a problem;

2. **Suggestion**: finding an idea that might help in solving the problem;

3. **Development**: implementation of the idea previously found;

4. **Evaluation**: analysis of the developed artifact in a critical way;

5. **Conclusion**: definition of the results and discussion of the new knowledge earned as long as unexpected results.

### 2.1.2  Case Study

Case study is defined as an "An empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" [72]. This method allows to analyze a real-world situation in depth without the simplifications that other methods such as experiment and survey have, and part of the specific-case knowledge generated might be relevant in different contexts [52].

### 2.1.3  Excluding other methods

Other strategies that were considered but then excluded are:

- **Ethnography**: this method "focuses on understanding the culture and ways of seeing of a particular group of people" [52]. An ethnography made in different parts of the world could have given the possibility to have a deep knowledge of the target audience and of the differences between the different communities and study what is their perception of technology. Nevertheless, it requires that the researcher spends time on the field to observe the behavior of the people and it was not possible to physically go in developing countries to run this kind of study.

- **Action Research**: this method "concentrates on research that is relevant to people, bringing actual improvements in action" and "can bridge the gap between the academic world and the everyday world" [52]. In fact, having some groups that were exposed to the application usage, and control groups that did not, could have shown if it was something that people would use, how to design it to favor the usage and if it was effective in preventing CEFM. The problem is that to evaluate if a project could be effective in preventing CEFM, years are necessary, because the girls should grow up after the age of 18 to be counted as girls that escaped CEFM.

- **Experiment**: an experiment is generally used when some hypothesis needs to be verified and it is carried out on simplified systems. This research did not want to verify any hypothesis so this method was excluded.

- **Survey**: this method "focuses on obtaining the same data from a large group of people in a standardized and systematic way" [52] and to be generalized it requires a large sample. People in developing countries are hard to reach so it was not possible to find a representative sample to allow the generalization of the findings.

## 2.1.4 Data generation methods

The data generation methods used were documents, interviews and questionnaires. In each stage of the research the most appropriate method was chosen.

**Documents** were mostly used in the initial part of the research to study the background. Between the documents, were considered academic publications, books, NGO reports, databases and relevant websites. When more documents were found on the same topic, they were compared and only the most relevant kept into consideration.

**Interviews** were used in the central part of the research. All the interviews were designed as semi-structured, which means a list of questions was prepared but deviation from it were allowed. A dialogue with the interviewees was encouraged to obtain more insights on the different questions an discuss about unplanned topics. Moreover, this design gave the possibility to modify, add an remove questions between the different interviews and also during a single interview, for example keeping only the most important questions if the interviewee gave long answers and so there was less time left for less important topics.

Finally, a **questionnaire** was used to evaluate the produced artifact in the last user testing session. The questionnaire was built with both close and open questions. The close questions used mainly Likert scale (rate from "Strongly disagree" to "Strongly agree") and semantic differential scale (for example rate from "too difficult" to "too easy").

## 2.1.5 Data analysis methods

Both qualitative and quantitative data analysis methods have been used to analyze the collected data.

**Qualitative analysis** Textual data collected through interviews has mainly been analyzed with qualitative methods because of the nature of the data itself. It would have not made any sense to apply quantitative methods such as word counting.

The qualitative method used to analyze textual data is **thematic analysis**. Thematic analysis is a process for finding patterns (themes) in the generated data and the coding of these themes allows to organize the information in a systematic way that permits a facilitated understanding and interpretation [10].

**Quantitative analysis** To carry out the quantitative analysis simple methods and statistics, such as tables and charts have been used.

Moreover, for the app testing the **System Usability Scale** [16] was performed. The SUS is a 10 items questionnaire with sentences to be rated with a Likert scale.

This is a reliable tool to measure the usability of a system [8]. To calculate the score of the SUS, it is necessary to: subtract 1 from all the odd items, subtract the responses from 5 for even items, sum up all the obtained scores and multiply by 2.5 to convert the possible range of the values in [0,100]. Bangor et al. [7] have conducted a study to map SUS scores to adjective ratings scale, and the finsings are the following:

- Worst imaginable = 12.5

- Awful = 20.3

- Poor = 35.7

- OK = 50.9

- Good = 71.4

- Excellent = 85.5

- Best imaginable = 90.9

Finally, also **Spearman Correlation** was used to calculate the correlation between some of the numerical data collected. Spearman rank correlation represent the monotone relation between two variables through a number between -1 and +1 and it is used instead of Pearson's correlation when the variables are ordinal [56]. If a variable increase when the other increase, then the Spearman correlation coefficient is positive, if one icrease when the other decreases, then the correlation is negative. If they do not show one of these behavior than they are not correlated and the Spearman correlation rank is 0 [56].

## 2.2 Research process

The research process has been structured in 4 phases, as shown in figure 2.1:

1. **Background**: In this phase, the literature was searched to understand the background. Four main areas were analyzed: the phenomena of CEFM and the state of the art in fighting it, currently available apps to fight CEFM, the state of the art in creating software for developing countries, and the guidelines to follow when developing for women. The analysis of the literature brought to the finding of six interfaces for the app taken from a previous research and the definition of some improvements for them based on the literature. All the findings from this phase are further explained in Chapter 3.
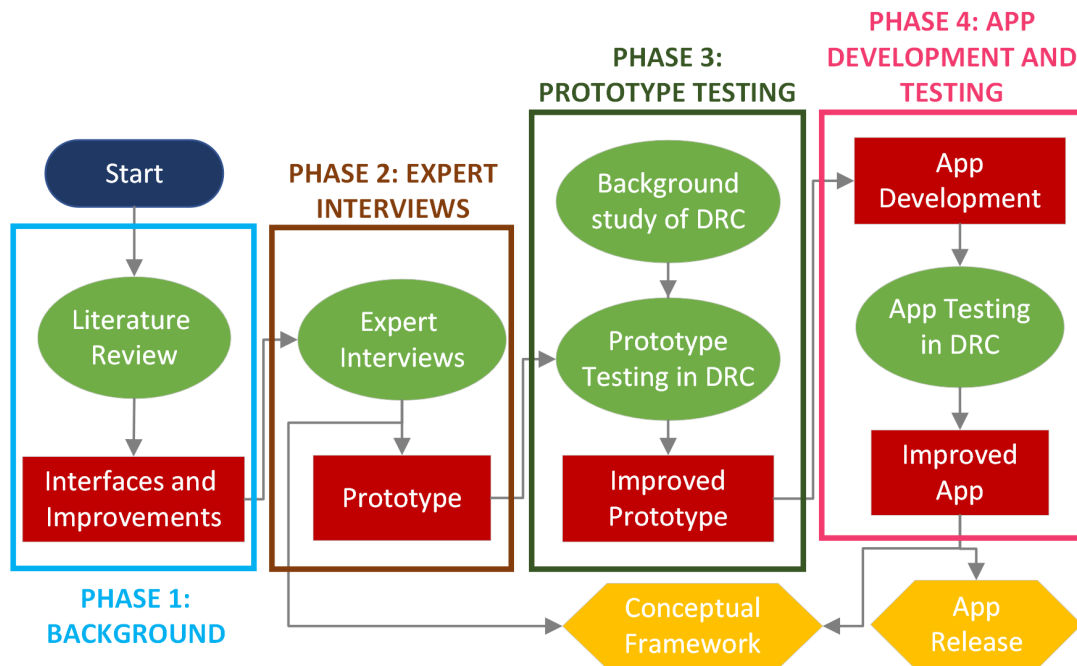
Figure 2.1: Research Process

2. **Expert Interviews**: In this phase experts were interviewed to understand if an app could be a good solution to help in fighting CEFM and what they thought about the interfaces and improvements of phase 1. The analysis of the collected data brought to the design of a prototype for the app and to the definition of a conceptual framework with the best practices when developing an app to fight CEFM. The collected data and analysis from this phase are further exposed in Chapter 4.

3. **Prototype Testing**: In this phase, the Democratic Republic of Congo, a country where CEFM is diffused, was chosen to run a pilot study for the app. The situation in the country was studied and a meeting with young girls was held to understand the needs of the target audience and have feedback on the developed prototype. The collected data brought to the design of a final prototype. The collected data and analysis from this phase are further exposed in Chapter 5.

4. **App Development**: In the last phase, a first version of the app was built and another meeting was held to see if the girls were able to use the app and if it was useful. This time the girls had to fill in a questionnaire and the result brought to the development and release of an improved app and to

the design of the final conceptual framework for developing apps to combat
CEFM. The development process of the app is explained in Chapter6 while
the collected data and the analysis are further exposed in Chapter 7.

Figure 2.2 shows the mapping of the various phases and activities performed
in the design and creation method. This research cyclically applies three times the
method to improve the produced artifacts throughout the iterations.

The case study has been used internally in the design and creation method. It
was suited to this context as the app generated needs to be location-specific, while
the conceptual framework that consists of general guidelines is partly generated
from the generalization of the location-specific findings. This methodology was
carried out during the whole iterations 2 and 3 of the design and creation method.

## 2.2.1   Phase 1: Background

The main focus was to understand the state of the art in fighting CEFM and in
designing software for developing countries as well as the usage of technology in
those countries. The documents analyzed comprehended academic publications,
reports from NGOs, public databases, and Master and Ph.D. thesis regarding Infor-
mation and Communication Technologies for Development (ICT4D) and Human-
Computer Interaction For Development (HCI4D) and usage of technology in devel-
oping countries. Academic publications have been searched over Google Scholar,
ACM and Science Direct with keywords and queries such as "child marriage", "child
marriage AND (software OR mobile)", "low-literate (software OR mobile)", "child
marriage AND (covid-19 OR challenges OR prevention)", "ICT4D", "HCI4D", "mo-
bile AND ICT4D" "software development AND women". Some publications have
been found by snowballing on the most relevant publications. Reports form NGOs
have been found manually on the different NGOs' website resource pages. Public
databases have also been searched manually.

All the documents considered were in English. All articles published before
2010 were excluded and when more documents were found on the same topics, the
more recent ones were the first to be considered. Of the academic publications,
only the peer-reviewed were considered. Non-academic publications were included
when there was not any academic publication on that topic.

### Data analysis

The documents were analyzed in with qualitative methods. For every document
read, a summary with the most important findings was written and after all the
documents on a certain topic were read a comprehensive summary on that topic
was written.
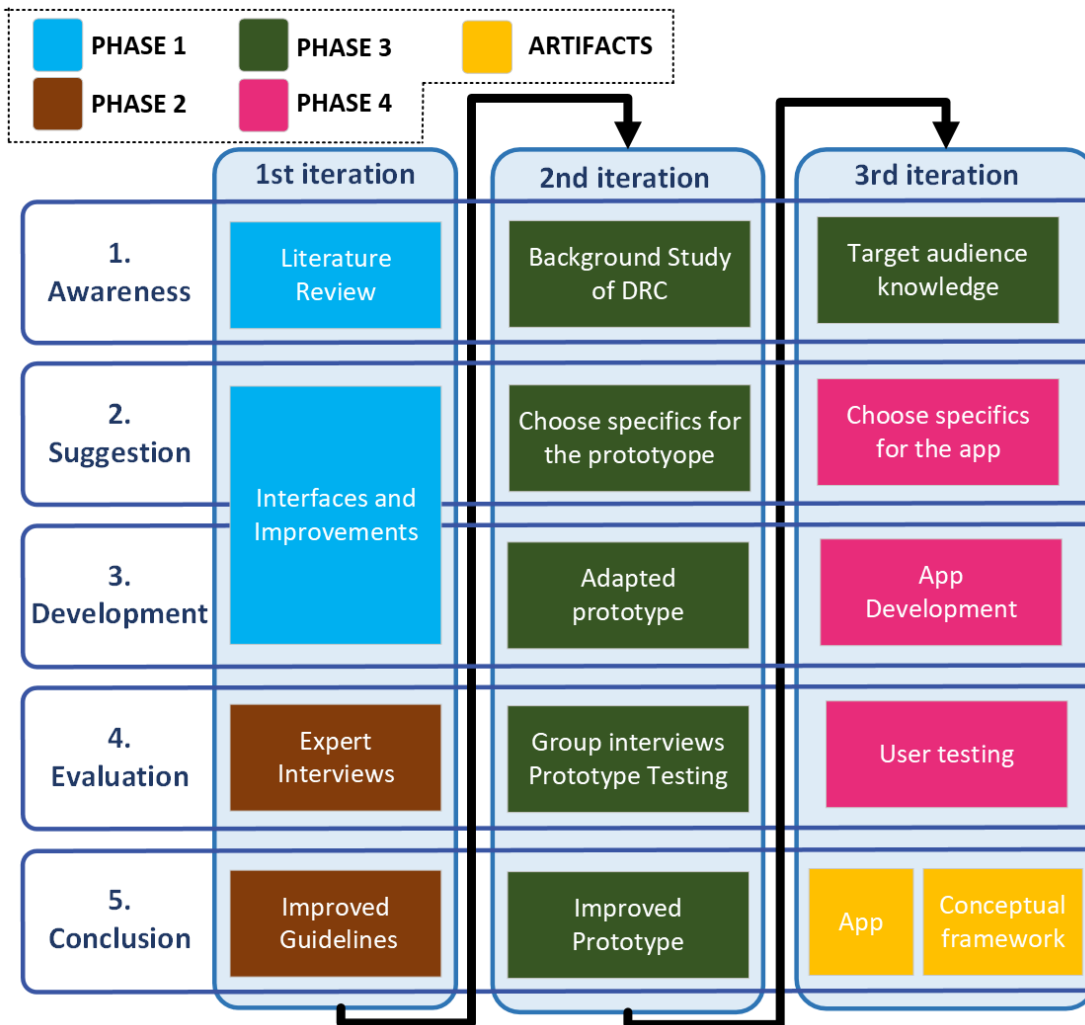
Figure 2.2: Application of design and creation method

**Output**

The analysis of the documents permitted to have a deep knowledge of CEFM and it was found that mobile applications are usable in developing countries even if they are not much diffused yet. Moreover, it brought to the finding of 6 interfaces proposed by a previous research and the definition of some improvements based on the literature.

## 2.2.2 Phase 2: Expert Interviews

The main focus of this phase was to understand what experts think about the usage of an app to help fighting CEFM and hear their thoughts about the proposed interfaces and improvements. It is necessary to involve experts as their experience represent a valuable source of information for this project.

The expert interviews were designed as semi-structured interviews to always have the same general questions and favor follow up questions based on the answers. This method was chosen because it allows to interact directly with the people and have a conversation that can bring new ideas and debates on the different questions, and for the same reason questionnaires have been excluded. All the interviews were carried out online and recorded with the participant's consent.

The experts were recruited within an internal network of contacts or contacting relevant NGOs or companies in the field of CEFM fighting and software development for women. It was applied a purposive sampling technique, contacting many people or organizations meaningful for the research, and interviewing all the respondents. A total of four people were interviewed. The people chosen for the expert interview were:

- Employees in NGOs with experience in fighting CEFM

- Employees in a companies with experience in ICT4D

The questions were about their experience in fighting CEFM, the usage of technology in developing countries and the features and interfaces to put in the app. As the interviewees had a different background, the questions about the usage of technology and their knowledge about apps for developing countries were tailored to their work and experience, while the questions about the proposed designs and improvements were the same for all the interviewee. The question list is included in section A of the Appendix.

**Data analysis**

The expert interviews' data have been analyzed with thematic analysis that was considered the most appropriate methodology. Quantitative methods have been excluded as the data generated were textual and representing concepts.

All the interviews have been transcribed and different themes have been identified. All the themes have been coded using a qualitative analysis software and the experts' answers on the different themes have been compared using a table and finally summarized.

**Output**

The second phase led to the design of a prototype for the app and contributed to the definition of a conceptual framework with guidelines for designing mobile apps with an educational purpose for girls and women in developing countries.

## 2.2.3 Phase 3: Prototype Testing

The main focus of this phase was to understand the perception of girls living in developing countries of an app to fight CEFM and to perform user-centered design by asking the girls what they thought of the prototype and the various functionalities before developing the app.

One of the experts interviewed provided the contact of a Congolese non-profit organization that operates in supporting women and girls in Eastern DRC. This organization was available to organize group interviews with girls aged 15-20.

As for the experts, the group user interviews were designed as semi-structured to favor follow-up questions. Interviews were chosen over the questionnaire to interact directly with the girls and adapt the questions to their understanding and knowledge during the meeting, as the girls' technological background was unknown.

The first part of the interview comprehended questions about the girls' thoughts about marriage and their usage of mobile phones while the second part focused on showing and explaining the prototype asking for feedback about the different features and contents. The questions list is included in section C of the Appendix.

All the interviews were carried out online and the audio was recorded with the participants' consent and later transcribed.

**Data analysis**

As for the expert interviews', data obtained through group interviews have been mainly analyzed with thematic analysis. Some of the questions about the background have been analyzed with quantitative methods as they represented statistics.

All the interviews have been transcribed and different themes have been identified. All the themes have been coded using a qualitative analysis software and the girls' answers on the different themes have been compared. Some graphs have been drawn to visualize the statistics about the background of the participants.

**Output**

The third phase brought to the definition of an improved prototype, ready to be implemented and to a deeper knowledge of the target audience of the app.

### 2.2.4 Phase 4: App Development and Testing

The goal of this phase was to realize the app and understand if it was usable by girls in developing countries. To do so, another testing session has been organized with the same NGO that participated in the previous phase.

This time the participants had to perform some task on the app and fill in a questionnaire. The questionnaire was divided in 3 parts: preliminary questions about the girls' background, the app testing in which the girl had to perform 3 tasks and answer to some questions after each task and some final questions that comprehended the SUS, questions about the features and the style of the app and some open questions for comments. The questionnaire is attached in Section D of the Appendix.

**Data analysis**

The data collected through the questionnaire have been transcribed on a excel sheet and then analyzed through quantitative methods such as charts and graphs, tables, Spearman's correlation matrix and the SUS.

**Output**

This phase brought to the definition of a conceptual framework that is applicable when developing apps that target girls in developing countries. Moreover, the app has been improved throughout the girls' feedback and a first version of the app is ready to be released in DRC.

## 2.3 Beneficiaries

The beneficiaries of this project are multiple. Firstly, all the researchers working in HCI4D and ICT4D, as the conceptual framework can be applicable in the design of app for developing countries that target girls to spread information about different topics. Secondly, those who are interested in the development of an app to combat CEFM in different areas will have a conceptual framework and guidelines to do so as well as a platform that they can use. Finally, people leaving in developing countries and NGOs' workers that will use the app created with the developed platform will benefit from this study.

## 2.4 Research Paradigm

The research paradigm followed in this project is interpretivism as the interest is in the social context of the app and it can change from place to place. The project

will try to define requisites and guidelines for an app to fight CEFM and develop a platform that can be adapted at a local level. Nevertheless, all the requisites are strongly dependant on the cultural and social background, so some of them may not be universally applicable.

## 2.5   Ethical issues

As the target of this project includes underage girls in developing countries, it is necessary to follow ethical standards. An application to the Norwegian Centre for Research Data (NSD) has been sent and gained approval for both expert interviews and user testing.

All the participants, both the expert and the users, have been informed about their rights and have signed a consent form that agreed to the collection of personal data. About the experts, they gave approved the recording of the video for transcribing the interview, while for the users only the audio recording was collected for the same purpose. The NSD application and the consent letter are respectively attached in section B.1 of the Appendix. The ones for user testing are analogous.

### 2.5.1   Data storing

All the information and personal data were processed only on Microsoft OneDrive and not stored on personal devices. Microsoft OneDrive was used to store interviews and other personal data, and Microsoft Teams was used for conducting. NTNU has a data processor agreement with Microsoft, and all services are password-protected. The student who conducted and transcribed the interviews was the only one with access to the interview recordings.

All the data have been anonymized as soon as possible and the personal data was deleted at the end of the project.

# Chapter 3

# Background

Since only one article has been published about a mobile app to combat child marriage, it was not significant to perform a systematic literature review. As a result it was decided to look at the most important literature in different areas relevant for this research. This chapter is organized into four main sections, as shown in figure 3.1. Section 3.1 analyzes child, early and forced marriage, its causes, consequences, and methods of prevention; Section 3.2 covers the previous approaches in fighting child marriage with an app; Section 3.3 looks at the usage of technology in developing countries and at the state of the art in designing software, in particular mobile applications, for developing countries; Section 3.4 focuses on the guidelines to follow when designing apps for girls and women in developing countries. Finally, section 3.5 summarizes the most important findings.
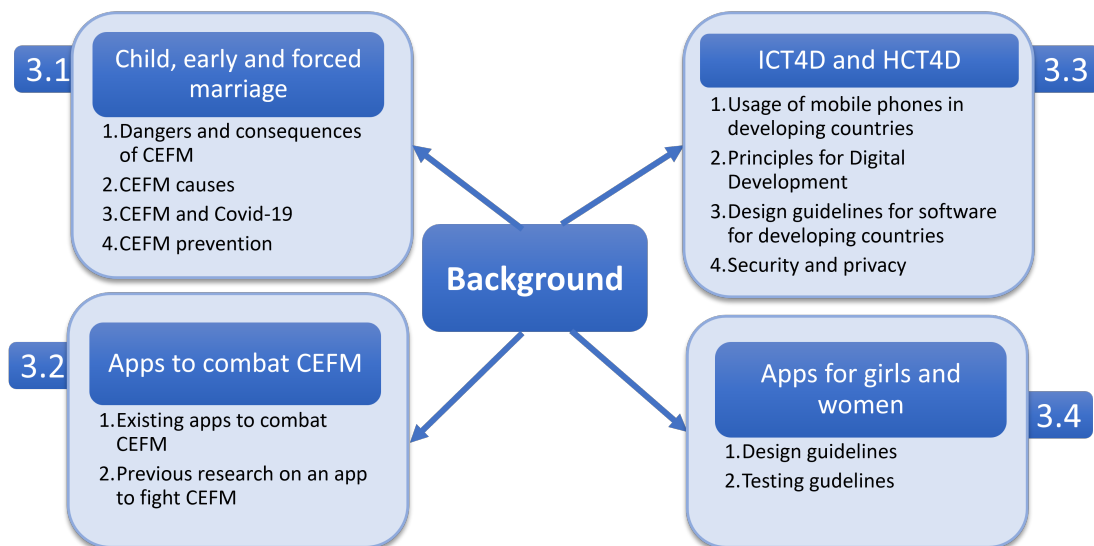


Figure 3.1: Organization of Background chapter

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## 3.1 Child, early and forced marriage

**Child marriage** is defined by United Nations (UN) as "any marriage where at least one of the parties is under 18 years of age", while **forced marriage** is defined as "a marriage in which one or both parties have not personally expressed their full and free consent to the union". Plan International also uses the term **early marriage** [35] that refers to unions where at least a party is under the age of 18 but is considered an adult according to the laws or norms of the country in which they live.

Child, early and forced marriage (CEFM) is considered by the UN: "a human rights violation and a harmful practice that disproportionately affects women and girls globally, preventing them from living their lives free from all forms of violence" [60].

According to one of the last UNICEF reports [66] regarding CEFM, this practice has been decreasing during the last 20 years, but still, the 20% of the worldwide girls between 20 and 24 was married before turning 18. Although this decline, 100 million children are predicted to marry before 2030 and the COVID pandemic has put 10 million additional girls at risk.

CEFM is diffused worldwide, but the higher percentages are found in the less developed countries, where the 36% of women aged 20-24 was married before the age of 18 and the 10% before the age of 15 [67]. Table 3.1 illustrates the diffusion of CEFM by region: West and Central Africa has the highest rate (37%), followed by Sub-Saharan Africa (34%) and Eastern and South Africa (31%). Among the single countries, the highest rates are found in Niger (76%), Central African Republic (68%), Chad (67%), and Bangladesh (59%), followed by Mali, Mozambique, Burkina Faso, and South Sudan that still have a percentage higher than 50% [67].

| Region | Women aged 20 to 24 married before the age of 18 | Women aged 20 to 24 married before the age of 15 |
|---|---|---|
| West and Central Africa | 37% | 13% |
| Sub-Saharan Africa | 34% | 11% |
| Eastern and Southern Africa | 31% | 9% |
| South Asia | 28% | 7% |
| Latin America and Caribbean | 22% | 4% |
| Middle East and North Africa | 15% | 2% |

Table 3.1: Diffusion of child marriage by region [67]

### 3.1.1 Dangers and consequences of CEFM

CEFM has a great impact, not only on the victims but also on the society and economy of the places where it is practiced.

First of all, school and marriage are exclusive options which means that when a girl marries, she is very likely to leave school and the lack of education may result in difficulties in finding a well-paid job and economical stability [53, 71]. Moreover, marriage usually brings to adolescent pregnancy which puts at risk both the mother and her children. In fact, adolescent pregnancy has higher rates of maternal mortality and birth complications while the children often suffer from poor health and malnutrition [53] and are more likely to die in the first 5 years of their life [71]. In addition, in some countries, young brides are also more likely to suffer from partner violence [71] or contract sexually transmitted infections such as HIV [13].

In general, CEFM has a great impact on fertility and population growth, and ending it could limit the population growth[71]. Also, due to the impact on fertility, it reduces household welfare [71]. Furthermore, CEFM has a great economic impact due to the effects stated before, for example, the welfare benefits of stopping CEFM are estimated to be globally $566 billion in 2030 [71].

### 3.1.2 CEFM causes

The factors that lead to CEFM are extremely heterogeneous between the different countries and also between different areas of the same country [50]. However, the most common factors can be identified and studied to try to combat this practice. Kohono et al. [42] and Psaki et al. [54] have identified the most usual causes of CEFM as the following:

- **Poverty and economic factors** [54]: when a family is poor and cannot feed their children or spend money for their daughters' education, marring them off is a way to reduce the economic burden. Moreover, the dowry can be determinant in the decision about marriage.

- **Human insecurity and conflicts** [42]: conflicts are considered a primary cause for CEFM because when the parents feel that their daughters are at risk of violence prefer to marry them off, so if something happens to them, they are more probably going to be pardoned. Moreover, conflicts create overcrowded houses and poverty. Finally, some people are afraid that if they refuse an offer, they may not be able to find another suitable candidate, and in some countries it is diffused the belief that for an older girl it is more difficult to marry.

- **Lack of opportunity** [54]: In many rural places there are not many opportunities for women to participate in the labor force or to continue their education, nor education is considered a value for them, so marriage is seen as the only possible path for them to be independent from their families.

- **Social norms** [42, 54]: CEFM is widely influenced by social norms regarding the female figure. For example, many communities have a strict patriarchal ideology and if the older relatives decide that a girl has to marry, she would follow their decision because it is a sign of respect. Or, in some societies marriage is seen as a protection against having sex outside of marriage, which is illegal in many places, and so it protects the girls from public disgrace. Finally, in some areas, the children are engaged soon after birth for various reasons and then they are married off as soon as they are considered ready.

- **Legal issues** [42]: even in those countries where there are laws to forbid marriage under the age of 18, often they are not followed or it is possible to circumvent them in some way. Moreover, in some cases, it is difficult to investigate the age of the bride and groom or if they are getting married because of their choice or if it is due to pressure from family or social context.

- **Lack of agency**[42, 54]: in some situations, girls do not have enough autonomy and rely on their parents for taking important decisions such as getting married, or if they try to resist they are sent away from the family.

- **Family values and circumstances**[42]: some families teach their child that marrying early is a virtue and girls are very much influenced by the older member of their family and trust them. On the other hand, a girl with a difficult situation at home can see the possible marriage as a way to escape from her house.

- **Religious beliefs and fear for girls' pregnancy**[42, 54]: sometimes religion is used as justification for CEFM, even if the religion does not always accept this practice itself. Moreover, having sex out of marriage is often considered a religious and social taboo, so marriage protects girls from unwanted pregnancies and social disgrace when they are found to have pre-marital sexual relationships.

- **Individual circumstances, beliefs, and knowledge**[42]: In other situations, the girl themselves pursue marriage in order to get rid of loneliness, for example, in case they do not have the opportunity to go to school or to work, or to follow their social and sexual needs.

Another study by Bhan et al. [9] evidenced that the relationship between parents and children can influence the decision around child marriage. In particular, when there is a good relationship, it is more difficult to have a marriage before the age of 16, protecting the girls from very early marriages. Moreover, it showed that when parents are not educated, they do not put much value in the education of their children. This means that when parents are educated, marriage is delayed, as it is often seen as not compatible with education [54].

### 3.1.3 CEFM and Covid-19

The Covid-19 pandemic has worsened the condition of women and girls all around the globe and this has an impact on the number of CEFM performed every year. United Nations Population Fund (UNFPA) predicts 13 million more CEFM due to the pandemic before 2030 [62] while Yuckich et al. [73] estimate 10 million more CEFM within 2035 in the worst-case scenario, and UNICEF estimates 10 million more CEFM before 2030 [66].

UNFPA [62] also predicts that due to lockdowns all around the globe 47 million women may find it impossible to retrieve contraceptives, bringing to more unwanted pregnancies and 31 million more women may be subject to gender-based violence. And these numbers would increase depending on the duration of lockdowns.

Yuckich et al. [73] identify five main reasons for which the Covid-19 pandemic could impact CEFM through the analysis of other previous crises with similarities:

- **Income loss**: poverty is one of the primary factors for CEFM and lockdowns may lead to unemployment or reduction of income. Moreover, if a family needs to pay for health assistance, this would lead to an economic shock for them. Poverty increases the number of marriages most of all in those areas where the groom's family pays a price to the bride's one, and this amount of money may be the one to save a family from hunger.

- **Interruption of education**: interruption of education due to school closure could raise the number of children not returning to school after the pandemic, and as the schools are closed, there is no more necessity for a girl to wait finishing school before marrying

- **Adolescent pregnancy**: the number of unwanted pregnancies is expected to grow due to a lack of reproductive health programs, inability to get contraceptives and much more time spent outside of school. Nevertheless, the highest number of premarital pregnancies happens between existing unions so this factor is not expected to have a great influence.

- **Access to programs and services**: the pandemic has led to an interruption of prevention programs and this may increase the number of CEFM.

- **Death of a parent**: the death of a children caregiver is a factor that rises the risk of CEFM. Despite that, Covid-19 victims are more likely to be advanced age people that usually do not provide directly for the children; for this reason, this is considered to have a little impact on the marriage decision.

### 3.1.4   CEFM prevention

In the last ten years, many studies have tried to analyze the interventions to prevent CEFM and their effectiveness. Some of them [43, 39, 54, 45] identify five main categories of intervention:

- **Empowering Girls with Information, Skills, and Support Networks**: these programs aim to increase girls' information to allow them to take knowledgeable decisions and their aspirations in finding a job instead of marring.

- **Educating and Mobilizing Parents and Community Members**: these programs aim to change the social norms related to family giving information about the drawbacks of child marriage to adults.

- **Enhancing the Accessibility and Quality of Formal Schooling for Girls**: these programs focus on increasing girls occasions to continue their education to a higher level or to raise the quality of basic education. Education allows girls to aspire to a job in life and increases their competences and knowledge.

- **Offering Economic Support and Incentives for Girls and Their Families**: these programs gave a direct or indirect economic support to girls' families if their children continued their education.

- **Fostering an Enabling Legal and Policy Framework**: these programs try to enhance laws and policies against CEFM and their application.

Some of the analyzed programs utilized more interventions at the same time.

Of the five categories, the most effective seem to be the joint empowerment of girls and education of families, and the offer of economic incentives [43, 54]. Nevertheless, all the programs that have been designed following these methods are not scalable in terms of costs and people involved.

## 3.2 Apps to combat CEFM

The strategy of using mobile apps to tackle CEFM and empower girls with information is not new and different apps have been developed with this focus. All the apps have been developed by NGOs and therefore are not linked to any academic research. Only one academic study has been published and it has brought to the design of some interfaces for an app to combat CEFM.

### 3.2.1 Existing apps to combat CEFM

Plan International Asia-Pacific Regional Hub has published a report [35] collecting most of the technological approaches to fight child marriage in Asia and other apps have been found by looking on the internet. The most relevant to notice are illustrated in the following paragraphs.

**Bandhan Tod** This app has been developed by Gender Alliance and UNFPA and has the goal to empower girls with information and to support them through an SOS button in case of necessity. The app has educational content around the themes of child marriage consequences and ways to stop it, dowry-related violence, girl empowerment, and role models for girls. [5] Even if only a few girls have access to a mobile phone, they can act as intermediaries for those who do not have it. Figure 3.2 shows the main page of this app.



Figure 3.2: Main page of Bandhan Tod

**Girl Power**   This app has been developed by Accenture and the NGO CINI (Child in Need Institute)in some West Bengal districts. The purpose of the app is to register information regarding girls at risk and analyze the data in real-time to identify the most vulnerable girls. The registration is made by a community of teachers and facilitators in the villages [2, 1].

**Marriage registration app**   This project has been developed in Bangladesh in 2017 and consists of a system that allows the people that perform the marriage ceremonies to check the age of the bride and groom and, if the marriage is allowed, to register it. If the marriage has irregularities the National Helpline will be called [30]. According to Plan International, this app has prevented 3700 CEFM during the trial [37].

**Stop violence**   This app has been developed by APDEL, a local association in Cameroun, and aims to fight child marriage and sexual harassment in schools. The app provides information regarding those themes, quizzes, and a list of contacts in case of necessity. [6]

**Freedom Mobile App**   This app has been developed by Freedom Charity to help young people in the UK at risk of violent crimes, Female Genital Mutilation, and forced marriages. It targets the people subjected to violence as well as their friends that can detect it, and professionals who can learn to recognize signs of violence [19].

### 3.2.2   Previous research on an app to fight CEFM

In 2018, Brevik started designing an app to fight child marriage [11, 12] inspired by the Bandhan Tod app. In particular, he proposed six different designs for the app and tested them in Malawi with interviews with village leaders and adolescent girls. All the participants affirmed that a mobile application is a good way to try to fight CEFM.

The interfaces proposed by him and redesigned after the interviews when needed are visible in figure 3.3:

1. **Informational**: this interface gives general information about themes such as education, laws, health problems, common questions, and agriculture. In particular, agriculture was added to increase the number of people interested in the app. Moreover, icons and audio support should be included to allow low-literate people to use the app.

2. **Argumentative**: this interface is designed to disrupt the false superstitions and believes around child marriage and health themes and to explain the danger of such practices to parents.

3. **Story based**: this interface brings personal stories of young girls in the app to motivate girls.

4. **Video**: similar to stories, it wants to include videos to increase the emotional content. Videos gained a great success in the testing phase, as many people were fascinated by them. The participants pointed out that local videos would have even a greater impact.

5. **Contact**: this interface provides the contact of people and organisations to contact in case of necessity.

6. **Links**: this interface collects useful links to NGO publications to deepen the topics related to CEFM.

The interviews showed that the preferred interface was the video one, probably because the participants were not used to videos. Despite this, videos require a good internet connection and probably are too expensive for the users. The other interfaces, in particular informational, contacts, and links, were also appreciated by the participants.

## 3.3   ICT4D and HCI4D

Information and Communication Technologies for Development (ICT4D) comprehends all the "research that deals with the challenges of designing, developing, and sustaining ICT systems that are suitable for the conditions in developing regions" [34]. Ho et al. then define with Human-Computer Interaction For Development (HCI4D) the "subfield of ICT4D that focuses on understanding how people and computers interact in developing regions, and on designing systems and products specifically for these contexts"[34].

Chipidza et al. [20] conducted a literature review of many ICT4D studies to map their effectiveness and noticed that mobile devices overcome traditional technologies when looking at the impact possibilities of the proposed developed artifacts. Furthermore, mobile phones are the most diffused technology in developing countries [23], making them the preferable device to bring services between the citizens.

ICT4D and HCI4D research regarding mobile technologies is mostly focused on Interactive Voice Response (IVR) and Short Message Service (SMS) technologies
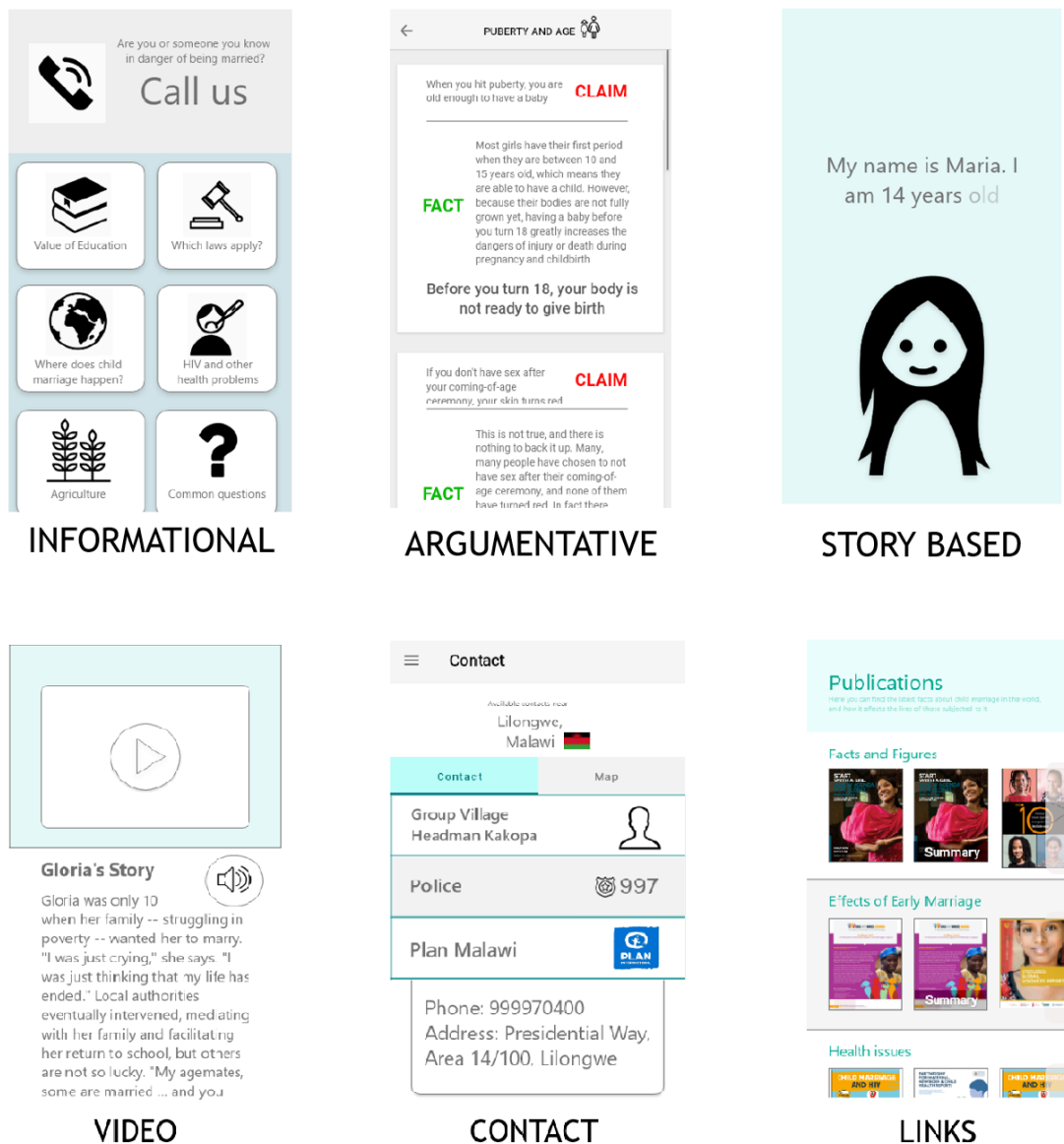
Figure 3.3: Designs developed by Brevik

as the majority of devices owned by people in developing countries is not a smartphone [32]. However, these technologies allow only text messages and voice calls creating many limitations to the artifacts that are not able to offer many of the wanted functionalities [40]. Mobile applications are defined as "software that runs on a mobile device and perform certain tasks for the user" [38], they can offer more services than plain IVR and SMS, as they are not limited to communications, work

without connection and be free. Furthermore, a mobile app has the advantages of being portable, the possibility to offer many different user experiences in the same place and to tailor the content to the person that is using it. Finally, it can offer emergency support with contacts to relevant people and organizations as long as different learning experiences, from reading plain text to serious games. Moreover, smartphones' diffusion and usage is expected to grow in the near future due to the fast advance of technology that decreases the costs of devices and services [40, 32].

Studies of ICT4D and HCI4D that regard mobile applications are still not a lot and most of them focus on finding design guidelines for technology illiterate people. Few of them try to estimate the impact of produced mobile applications, and they show that apps can be successfully used by people in developing countries: some examples could be a mobile banking app in Kenya [47], a gamified app for education in Sri Lanka [33], an entrepreneurship development app for women in Tanzania [40] and an app to provide information on community resources to patients of a clinic closed due to COVID-19 [21].

### 3.3.1   Usage of mobile phones in developing countries

As stated in the previous section, mobile phones are the most diffused technology in developing countries [23]. Table 3.2 illustrates the percentage of people in developing countries that have a mobile service subscription and the percentage of smartphones between the subscribers in 2021 and previsions for 2025 according to GSMA [32].

| Region | Mobile services subscribers | | Smartphone adoption | |
|---|---|---|---|---|
| | **2021** | **2025** | **2021** | **2025** |
| Sub-Saharan Africa | 46% | 50% | 64% | 75% |
| South Asia | 59% | 62% | 74% | 84% |
| Latin America and Caribbean | 69% | 73% | 77% | 82% |
| Middle East and North Africa | 66% | 68% | 79% | 82% |

Table 3.2: Diffusion of internet connection and smartphones in developing countries [32]

Even if mobile phones seems to be very diffused in all the countries, a digital divide phenomena is visible worldwide. The digital divide is defined by Rogers as "the gap that exists between individuals advantaged by the internet and those individuals relatively disadvantaged by the internet" [55]. The digital divide is further characterized as *digital access divide*, that refers to the gap in accessing

the technology, and *digital capabilities divide* that refers to the gap in the ability of using of technology [70].

The digital divide differs in each country and is strictly related to demographic characteristics such as age, education, sex, place of residence and socio-economic factors as income, culture and public policies [69]. The gender-based digital divide is diffused across all the countries, with the biggest gaps in those countries where women are less likely to own a mobile phone. [69]. The marital status has also been found to have an impact on the digital divide, that can be both positive and negative depending on the country [69].

Moreover, International Telecommunication Union (ITU) data [68] shows that there is not a great digital access divide between urban and rural places in developing countries, but urban places are much more advanced in the use of internet-based applications (71,7%) than rural areas (33,8%).

### 3.3.2   Principles for Digital Development

The principles for digital development are a set of nine principles that aim to be a guide for projects that focus on applying digital technologies to development programs [27]. These principles want to drive digital development programs that should aim to implement them as much as possible. The principles are:

1. **Design With the User**: get to know the target population through frequent meetings and redesign the tools to meet the users' needs. This allows to address the specific needs of future users.

2. **Understand the Existing Ecosystem**: Spend time analyzing and study the cultural and social background of the target population to build relevant products.

3. **Design for Scale**: Do not focus too much on the pilot but build the product in a way that allows widespread adoption, in a whole country or region.

4. **Build for Sustainability**: The projects need to be long-term sustainable to have a long-term positive impact, and be adaptable if the context changes.

5. **Be Data Driven**: The impact of a program should be continuously measured, and data should be collected with rigorous methods and shared when possible. When there are existing datasets they should be used and if data is collected, international norms should be respected.

6. **Use Open Standards, Open Data, Open Source, and Open Innovation**: Being open allows to avoid duplicate work and taking advantage

of existing investments. The new software developed should be open source and should use open platforms, and non-sensitive data should be shared.

7. **Reuse and Improve**: Try to adapt and improve existing solutions instead of starting from scratch to reduce time and costs. The product should be developed in a modular way to enhance reusability.

8. **Address Privacy and Security**: Take into consideration which kind of data is collected and how it is used, stored, and shared. The collection of sensitive data should be minimized and security implemented.

9. **Be Collaborative**: Share information, findings, strategies, and resources to increase the efficiency and the impact of good tools and ideas. Collaborate with other projects involved in digital development.



Figure 3.4: Principles for Digital Development

### 3.3.3 Design guidelines for software for developing countries

Literacy level in low-developed countries is assessed to be around 77% according to the UNESCO Institute for Statistics [61], with some countries with a much lower percentage. As CEFM is diffused in low developed countries, it is necessary to develop an app that is also usable by low-literate people. On the other hand, people may not be used to mobile applications as shown in section 3.3.1 and this is another factor to take into consideration when designing for least developed countries.

In 2021 Svaristava et al. [57] conducted an extensive systematic literature review about design guidelines for apps that target low-literate and digital illiterate people and developed the SARAL framework that consists of the following guidelines.

**G1. Utilize multiple modes of interaction**: to engage users with different levels of literacy it is necessary to include different modes of interaction, such as text, audio, and graphics. In this way, the users themselves can decide which modality they prefer.

**G2. Leverage numerical literacy**: numbers can be used in the interfaces, as studies show that even illiterate users can usually understand numbers.

**G3. Keep a minimalist, clean interface**: the interface should not contain too much visual effects, graphics, or text.

**G4. Incorporate visual cues**: colors, fonts, and bold can be used as an effective way to highlight the most important information and help the user in understanding the content. Moreover, it is better not to eliminate all the text but to provide methods to comprehend it such as audio, as literate users prefer to have text.

**G5. Avoid jargon**: the language in the app should be very simple and non-technical so that all people can understand it.

**G6. Break down information within and across screens**: the number of elements and concepts in a single screen should be scarce to improve the understanding and avoid confusion in the user.

**G7. Simplify navigation structure**: linear navigation seems to be easier for user to understand compared to hierarchical navigation, on the other hand also scroll bars should be limited as it is not easy to understand if there are objects hidden on the screen.

**G8. Provide assistance in using the application**: the application should have instructions on the first page for the users to understand what the app is about and how to use it. Moreover, a help function should be reachable by all the interfaces of the app.

**G9. Include short, simple instructions in Help menu**: The instructions should be very simple and only given when they are needed, without anticipating future situations.

**G10. Adopt audio and video help tutorials**: Providing the help and the instructions through audio and video allows also low literate user to understand them.

**G11. Adopt culturally responsive design**: icons should be adapted to the local culture of the user and usually semi-concrete icons should be preferred to avoid links to real objects. Furthermore, all the other graphical cues should be also adapted to the culture and it is also fundamental to provide support in the local language.

**G12. Leverage human facilitators**: a human person that helps and explains how to use the app at first usage contributes to reducing the fear of technology and understanding how the application works.

**G13. Enable customization**: customization can be used to engage more the users as they can set up their preferences and find the app more pleasant.

Moreover, people not used to smartphones can manifest a fear to break the device because they do not know what happens when pushing on a button [48]. Another thing to take into consideration is that sharing devices is common between people in developing countries [48], and this creates the requirements of keeping the privacy of the user and on the other hand, making the application usable by more people on the same device.

### 3.3.4 Security and privacy

Designing an app for people in developing countries needs to take into consideration also the security and privacy of the users. Mare at al. [46] have selected four factors that must be considered when developing for these regions.

- **Cultural differences**: People's wanted privacy may be different depending on their culture, so strategies to grant the desired privacy need to be used.

- **Knowledge gap**: users may not have experience in using technology and so their behavior could create risks for themselves because they do not fully understand the technology. It is necessary to instruct the users about the risks without making them afraid of using technology.

- **Unintended use**: it is common that technology is used in an unintended way and people do not know that their data are not protected as they think.

- **Low-profit user group**: when designing and programming for low literate people the profits are very low and so programmers are not incentivized in boosting security policies.

## 3.4 Developing apps for girls and women in low and medium developed countries

The design and implementation of software to improve health for women and girls in low and medium developed countries could bring many benefits, such as improved health of the children, reduction of maternal and child mortality, social and economic empowerment [31]. Nevertheless reaching women in developing countries is difficult and presents many challenges [31], such as:

- **Costs**: women usually have less income than men and so the cost of mobile phones and airtime is often too high for them;

- **Social Norms**: if the woman owns a phone, its usage could be controlled by a man;

- **Coverage**: people leaving in rural areas may have bad coverage;

- **Digital Literacy**: women usually have lower digital literacy than men;

- **Security and harassment**: sometimes people believe that having a mobile phone could put a woman at risk of being harassed online;

- **Operator trust**: mobile operators are believed not to be trustworthy in some communities.

Due to all these challenges, some more detailed guidelines should be followed when creating software for women. The only reports found that express some guidelines for designing and testing software for women are two reports from UNICEF ([64, 65]) and a report from GSMA ([31]). The guidelines they propose are as follows.

**Design guidelines**

- Build for a variety of handset types, operating systems, and devices;

- Keep instructions clear, with main messages at the beginning of the system;

- Use audio;

- Keep the system simple;

- Do research to understand what is relevant advice and what female users have the power to act on;

- Do research into what content is appropriate to both female users and to their wider communities;

- Use local languages that the female audience understands;

- Partner with organizations that already deliver gender-sensitive content;

- Have female voices;

- Use entertainment and stories to increase appeal;

- Use a mix of positive male and female characters and role models;

- Build in group interactions to encourage retention and to increase appeal, such as audio content to be played aloud in groups;

- Appeal to men as well or create a complementary content channel for husbands or fathers, with specific information;

- Design group listening activities and interactions for husbands and wives to listen to content together;

- Design for users who share devices;

- Consider female user's privacy and security needs;

- Design for a variety of digital literacy levels;

- Offer offline functionalities.

**Testing guidelines**

- Work with partners that the women trust, such as NGOs;

- Consider that who is in the room could influence the answers of the women, it is better to conduct the tests individually or in pairs and have female facilitators;

- Meet girls where they can;

- Treat the test as a conversation;

- Bring devices to test the app on;

### 3.4.1 Examples of apps that target girls and women

The development of applications that specifically target girls and women in developing countries is quite recent and there are not many examples of it. Nevertheless, two apps have been found that successfully respect design guidelines. Of the two, Oky is the most complete and respectful of the design recommendations.

**Oky** Oky is an app developed by UNICEF to help girls aged from 10 to 19 in tracking their period and giving them information about menstrual hygiene. Among its features, it has a calendar to track the period, an encyclopedia for information, a diary to trace the mood, and a virtual assistant to help in using the app. The development of the app has followed the principles of user-centered design, a gamified approach, it is lightweight, it does not require an internet connection, it is possible for different users to log in on the same phone protecting the data with a password and it is localized. [63]

**Reprodutiva** This app has been developed in Timor-Leste with the goal of empowering adolescents with reproductive information and health services. Teenagers can find in this app answers to their questions about sexual health confidently and securely. Moreover, they can participate in group chats, have personal consultations and book medical appointments. [36]

## 3.5 Findings and Conclusion

CEFM is still a big issue in developing countries and more interventions need to be actuated to fight it. Between the interventions that seem to work more there is the empowerment of girls with information combined with the education of

parents, and creating an app to fight CEFM could accomplish this in a scalable way. Moreover, as the Covid-19 pandemic has stopped many traditional programs that aimed to fight CEFM, new technological approaches that can work even during a pandemic are needed.

Even if the technological penetration in developing countries is still low, it has seen enormous diffusion in the last years, the predictions are promising, and studies about mobile apps in developing countries show that they are usable. A mobile can become a new approach to help fight CEFM on the side of traditional methods.

To make the best app possible it is necessary to follow as much as possible the principles of digital development and the design guidelines for low-literate and digital illiterate people. Additional efforts need to be put into following the guidelines for developing for girls as they will be the main target audience of the app.

Many NGOs have developed apps to combat child marriage with successful results, but they seem to not have done or published any study about them. The only research published on this topic is Brevik's. It has been decided to embrace the designs proposed by Brevik and improve them based on the ICT4D and HCI4D literature.

Based on the documents searched, some improvements to Brevik's designs have been proposed:

1. **Audio feedback**: it is a vocal response present in every page that explains what the user can do on each page and what happens when pressing the different options to reduce the fear of technology. It also reads the text for those users who are low-literate;

2. **Help button**: in every interface, there is be a button that the users can press if they are stuck where they can read what they can do from that page;

3. **Tutorial**: it is a set of instructions on the first page of the app that explains what the app is about and how it works. It can be in the form of a video or as written text with audio;

4. **Localization**: the content of the app and the language need to be localized;

5. **Unlock new functionalities with usage**: to avoid too much confusion for the users when they start using the app, in the beginning, they will only have access to a limited set of functionalities and information. Other functionalities may be unlocked after some time or after passing a quiz;

6. **Registration and login**: if the app offers personalization and the phone is shared, a login and registration system would allow to keep the user's privacy and to have more users on the same phone with different preferences.

Moreover, other proposed improvements, not based on the literature, are:

8) **Gamification**: Usage of quizzes and games to make the learning funnier and engage the user;

9) **Links to other learning platforms**: links to learning websites or other apps for those who want to learn more about general topics;

10) **Content personalization**: showing different contents to girls and parents tailored to their needs.

# Chapter 4

# Expert interviews

The goal of this phase was to perform a preliminary study about an app to combat CEFM by interviewing some experts from different parts of the world. The focus was to understand if an app could be effective in fighting CEFM according to the experts, who would need to be the main target of the app, and if they thought that the designs developed by Brevik with the proposed improvements could be a good way to frame the app.

## 4.1   Interviews

Four experts have been interviewed, two of them (P1, P2) in a group interview, while the others individually. P1 and P2 are employees in Norway of a worldwide NGO, P1 works on children's participation and right to express themselves, P2 works on gender equality and sexual and reproductive health and rights. P1 and P2 agreed on all the questions and had the same ideas about all the improvements and designs, so their common answers will be further referred with P1-2. P3, based in South-East Asia, is a gender and technology specialist, she works for a famous child aid organization and she is the product leader of a period tracker app for girls. P4, based in DRC, is the chairman of the board of a Congolese NGO in the water consumption sector and has worked as a humanitarian and journalist in the past. Table 4.1 shows detailed information about participants' background.

P1 and P2 are following some programs that fight child marriage in 5 countries of the world, but they are not working in the field. P3 has no experience in fighting child marriage, while P4 spent 3 years in the past working in combating child marriage and other forms of gender-based violence.

|  | **P1** | **P2** | **P3** | **P4** |
|---|---|---|---|---|
| **Area** | Norway | Norway | South-East Asia | Democratic Republic of Congo |
| **Job** | Advisor in a worldwide NGO foucused on children. Works with child participation and children's rights to express themselves and influence their situation. | Gender equality and SRHR advisor, involved in supporting the NGO's child marriage projects | Gender and technology specialist. Working on digital literacy for women and girls, developing digital products and solutions for women and girls, research around the gender digital divide for girls under the age of 18. Product leader for a period tracker app for girls. | Chairman of the board of a Congulese NGO working mostly in the water consumption sector. In the past he has been humanitarian and journalist |
| **Experience in fighting CEFM** | 5 countries where they are working in fighting child marriage. Trying to dialogue with local communities and establish dialogues. With children they raise awareness about their rights, try to make them able to say no to child marriage and at the same time work with parents to change their views on child marriage | | No experience | Three years working in fighting CEFM and gender based violence |

Table 4.1: Participants' background

### 4.1.1  Usage of mobile phones in developing countries

Regarding the usage of technology and mobile phones, all the interviewees agreed on the presence of a gender digital divide in developing countries, with broad differences from place to place.

P3 marked that the gender gap in terms of mobile access is closing, as women have more access to mobile phones than in the past, but the bigger difference is in usage, as women usually have older devices. *"I think the gender gap in terms of mobile access is closing. Not so much in smartphone ownership and access, but where we're kind of seeing a bigger gap is in use. So you see women and girls and lower middle income countries use technology in different ways to men and boys. This is sweeping generalizations. Often, much less frequently, often for fewer use cases, they have much more barriers to access and use in terms of social norms and gatekeepers, often have lower end phones slower. A lower and slower operating system, screen sizes, etc. Which means they don't really get the full force or the power of technology in the same way as men and boys."*

P4 also argued that in his country women have more access to telephones in urban areas, especially young girls, while in the countryside is less common, and if they have a device, it is not a smartphone. This happens because women have less access to jobs and consequently they do not have enough money to buy a mobile phone on their own.

Moreover, P3 explained that a lot of women and girls are staying offline because they have been harassed online and they are afraid of it, so they do not want to use the internet anymore. P4 pointed out that people are only used to calling or

sending SMS because they are afraid of what happens if they push other buttons. P3 and P4 also affirmed that the progress in terms of smartphone ownership in the last years has been huge, thanks to the advance in technology and the possibility to buy used devices at a very limited price. P4 reported: *"We have seen so many differences because in my country, for example, you can see a woman selling chapos, but she has a telephone next to her. You can see a woman selling potatoes, but she has a telephone. So it has become a tool of business, and it has also become like a woman who has no telephone, she's no value in the community."*

Both P3 and P4 confirmed that in south-east Asia and Congo is very common between women and girls to share devices, but everyone pays for his airtime. P4 clarified that women share phones between them, but they are usually not allowed to touch their husband's telephone.

## 4.1.2  Target for the app

All the experts said that an app could help in fighting child marriage, but its target should be chosen based on the digital divide in the deployment place. P1-2 for example thought that could be a good idea to target also volunteers or teachers, that could show the app during meetings with girls or parents and make them use it, in those places were less people have access to smartphones and so it is not possible to reach them directly, P1 said: *"I think that quite often when our colleagues in the different countries or partner organizations when they meet children at school, for example, they would maybe bring a couple of tablets and then they would sit together and kind of do stuff on the on an iPad or similar, and let them try. … And so maybe taking that into consideration that maybe it would be an app that would facilitate for a conversation where an adult would be present and children would gather around or maybe have some sort of suggestions for how you can organise a conversation.".* P2 also added: *"it would be good if such an app both targets the children but also adults, so that the parents or another adult also received some of the same information, but it might be tailored in a bit different way the information we give to young people and children and adults. "*

P3 argued that before deciding how to build a solution for a place is necessary to study what the gender digital divide is in that place, if girls have access to smartphones and which kind of smartphones they have. And after that, design for how they use technology.

P4 said that the app should target directly girls and the best usage scenario would be with two girls of almost the same age and one of them acts as a facilitator in case she's not able to use the phone by herself, because *"such girl can speak more because she knows she's in front of someone who is of her age, who can understand their language, who can understand what she thinks, who can understand what she feels."*

### 4.1.3   Interface Designs

All six designs developed by Brevik have been shown to the experts asking for their feedback. A summary of the answers is shown in table 4.2.

About the **informational** design, P1-2 reported: *"Its important to come out with information, if that could help us reach more girls and boys in remote places with information about their rights, or about laws or about child rights in general, about rights related to child marriage, implications of child marriage, etc."*. P4 argued that the emergency call function is very important because if a girl risks being abused, they can use it as an alarm. Moreover, this functionality can also be easily used by illiterate people.

On the **argumentative** design, P1-2 said that it could be useful for teachers or health workers but not for girls, but it would need to be very localized as these beliefs could change even within the country. P3 did not think this design could be effective and P4 said it could work when a girl has a question and wants to get assistance but does not want to show up, but this would need to work as an anonymous message service, that is not how the design was thought.

The **story-based** design was approved by all the interviewees, and all reported that girls usually like story-based content. P4 explained: *"The story or the experience of someone can help some other people to find a solution to what they are maybe experiencing. Let's say a girl who got married at 14 years old or 15 years old, but she knows she can tell her story and the story can help other girls to stand or to know how to behave in case a given situation occurs. So yeah, that's why this story is also important and can help people to learn from others."*. Moreover, P1-2 reported that is easier to discuss about other people than speak about themselves when the conversation covers delicate topics. P2 added: *"I think that maybe the video and the story based maybe could be as a discussion starter. But the stories would also have to be made locally in the context, for them to be relevant."*

**Videos** received very similar feedback, and in general, videos could be even more interesting than only plain stories, as the images can bring more emotional content. Nevertheless, speaking about their app, P3 added: *"Video is always really popular, right, but as you said the challenge is working offline and having a light app. So, the kind of girls that you'd need to get that information to, would probably not be the girls who have unlimited storage space and Internet, but it's a toss-up. It's what we struggle with as well because we know that users say they want videos. But the moment we add videos, we are taking away the kind of core principles which are lightweight and offline."*

Regarding **contacts**, all interviewees agreed that it is a really important interface because often girls want to talk to someone, P3 suggested putting only contacts of organizations, not singular people, and to call it "Get help". P4 claimed that in DRC people would not call because of the high cost of airtime, as due to

| | P1-2 | P3 | P4 |
|---|---|---|---|
| **Informational** | Give information about rights and laws and the legal situation. It need literate people. Content could be: information about children's rights in general and related to CEFM, laws, implications of child marriage, etc. | Prefers the story based on the informational | Important if people can call when there is a problem, like an alarm, and call the police or some emergency service showing exactly the location of the person who's calling. |
| **Argumentative** | Teachers or health workers could benefit from this design. It has to be very localized. | Don't think that argumentative would be the best approach. | Can work in situations where there are some girls who don't want to show up |
| **Story Based** | It's easier to talk about other people then own experiences and it could be a basis for discussion. The stories would also have to be made locally in the context to be relevant for the audience. Suitable for young people and children. | Likes the story based because it's a hook. Often see girls wanting story based content. | Stories are very effective because the experience of someone can help other people to find a solution to what they may be experiencing. |
| **Videos** | Already using videos and stories as a basis for disussion when working on CEFM themes, easier to talk about other people. Suitable for young people and children. | Video is always really popular but the challenge is working offline and having a light app. So if you add videos it is not lightweight and offline anymore. | It's the best way of communicating and showing what is happening. It can show the testimony of the person and make the spectator understand clearly how this affected people. |
| **Contacts** | Importanto to have contacts if they want to talk to someone. | Girls constantly want contacts of people able to help them. Not put individual people, organisations are better. Call it get help. | Phone calls in DRC would not work because they would require airtime that is expensive. The location is very important to show people where they can go. |
| **Links** | Don't think reports from NGO could help girls and parents, maybe they can be useful for local health workers. | Not interesting for girls | Not effective for girls, publications are made for internal use of the NGOs |

Table 4.2: Participants' feedback on Brevik's designs

corruption there is a lack of specific emergency numbers that can be called for free supported by the government, even if there are some supported by NGOs but not very spread. On the other hand, the address of a place where to go to get help would be much more effective, as it would be free.

Finally, all the experts rejected the **links** design as they affirmed it is not interesting for young girls and NGOs' reports are mainly published for internal use. P1-2 said that they use these reports to learn but it is what parents or girls need, they could be interesting if the target was for example local health workers.

### 4.1.4 Proposed improvements

The proposed improvements had, in general, positive feedback. P3 and P4 gave detailed answers on every improvement, shown in table 4.3, while P1-2 suggested: *"Look very closely at how people use technology and use that. Is it low (usage)? Why would you then use technology? I mean, because it can be personalized, because...? And then boost that part because people are not used to using technology. Maybe that's a good thing. Maybe we could use that as a sensational event. If they*

*are used to using technology, then you could look into functionalities and passwords and etc".*

**Audio feedback** has been said by both P3 and P4 to be a great idea to involve people with low levels of literacy and digital illiteracy and reduce the fear of technology. P4 specified: *"It can explain the person what to do and if people don't want to touch different applications on their telephones, it's because they don't know exactly what's going to happen. When you touch a button, what's going to happen later so such audio feedback is very important because it can tell you what you are going to do".*

P4 said that the **help button** may be effective as well for those who are afraid of technology, as the **tutorial** if it does not contain a very long message, otherwise the user would forget it. He clarified: *"A tutorial in the beginning is good because it can tell you what can be, what is going to happen, and what is the achievement. Ah, but this can be good if it can be combined with this audio feedback. Because the audio feedback will be across the time, it will be telling you what is very important, what to do and what not to do. And of course, in case if one is lost he come back to help the help button. So this combination is very important. If can be possible to use the combination of the 3, it is really good".*

All the interviewees also agreed that **localization** is really important, both in terms of content and language. P4 for example said: *" We spoke about different places. Even if we can speak about DRC, but we have also some locations differences in the country. When we are in town and when we are in the countryside, the behavior or the situation is quite different".*

All interviewees agreed that **content personalization** is a good improvement because parents and girls need the information to be tailored in different ways, even if they reported that parents would want to know what their children would read on the app. In particular, P4 said: *"when parents speak about their case, they say "when we were girls, when we were boys." But girls say "your time has gone away. It's no longer updated." So you understand that already there is a kind of misunderstanding. Today for example, we can see girls using telephones, smartphones, etc. But sometimes we tell them that when we were child, we did not have a telephone, we didn't use it and etc. They say "yeah, you see, because you are not well educated, you are not..." So, the information that can be given to girls and parents must be different. Because the time is different, the age of users is different. What parents experienced in the past when they were girls or boys is quite different from what guests are experiencing today, and that's why the content also must be quite different".*

P3 and P4 also explained that having a **registration and login** procedure is necessary to keep the privacy of users in case they share the phone and at the same time it allows more people to use the same app with different preferences.

On the other hand, P3 claimed that there are strict regulations to respect when collecting data, in particular in their app they never know who the users are and never link a username to a person, but this can also lead to complications. She explained that, for example, they do not collect email, but it is a drawback when users forget their password because they cannot reset it through it. They have a secret question with a secret answer to reset, but they do not show the question as it could be guessable so sometimes the users do not remember it.

Supporting the possibility of having **multiple users on the same phone** is very interesting for P4 because it allows parents to save money as they do not need to buy a phone for each daughter, even if it could create some privacy issue between the girls. P3 explained that they have this feature in their app, and to deal with this, their app logs the users out every time they close it.

P3 and P4 agreed that **quizzes and games** are a good way to engage the users in learning and motivate them. P4 specified that the user is more focused in learning if he knows that there is a quiz where they have to prove themselves in the end. Moreover, the user should be allowed to take the quiz several times to have the opportunity of getting better at it.

**Unlocking new functionalities with usage** is a good improvement according to P3: *"I like the idea of unlocking the new functionalities, because it brings users back. Because one of the challenges with content platforms like this is once they've read it, then what? And you may find that like your monthly active users to climb over time. So you definitely want something to bring people back"*.

They also approved the possibility to have **links to other learning platforms**, P4 said that people would require training on how to use them because most of the people are not accustomed to open links as they are afraid of what it might happen, P3 agreed that it could be a good idea even if people may need internet again.

### 4.1.5 Other comments

When asked if they had other ideas for improvements, P1-2 said that it could be a good idea to provide print-outs in case the app is made for being used during community meetings. P3 disagreed with them, affirming that if people have print-outs they would not use the app.

P3 suggested that an app designed to reach girls and women should fit old phones, a variety of screen sizes and operating systems, and work offline. She also argued that is very important to use user-centered design to be sure that girls get what they want and can use the app: *"you really have to talk to people to see what they want and what their features are, right and what they want to see in the app or the product, right. So I would say the most important thing is to make it user centered."*

| | P3 | P4 |
|---|---|---|
| **Audio feedback** | Really great for catching people with low levels of literacy and low levels of digital literacy. | Very important. It can explain the person what to do and make people not afraid of using the app and the telephone. |
| **Help button** | - | Very important |
| **Tutorial** | - | Good if the message is not long because people forget, needs to be combined with the audio feedback and help button. |
| **Localization** | - | Even if we speak only about DRC there are differences in locations. Behaviour or situation in town or countryside is quite different. |
| **Content personalisation** | Probably a good idea, but the parents definitely want to know what their daughters are reading. | There are some contents which girls can prefer. It must be different because girls themselves would like to have a content which responds to their needs and their age. For parents, they would like to understand exactly what happens in term of how behaviour has changed since their time. |
| **Login and registration** | It requires very strict data governance processes to make sure that you never know who the users are. In our app, we use hashing and collect minimal data. Do not ask for emails, many girls don't have one. We use a passcode and then the backup is a secret question and answer, but we don't display the secret question as the answer can be guessed. | Very important to keep something secret. This is very common, especially for young people. But, sometimes also it's not good, because if a parent does not know exactly what is happening with their daughter is also a problem. |
| **Multiple users** | Girls share a lot the phones so it's necessary to design for sharing. Every time you close the app it logs you out. Annoying but necessary for privacy. | Allows parents to save money if the children can share the phone. There may be some privacy issues. |
| **Gamification** | Gamification is good as a hook, it engages people. | Very effective for learning and encouraging people. People pay much more attention if they know there is a quiz in the end. They need the opportunity to make the quiz several times to become better. |
| **Unlock functionalities** | Good idea because it brings users back | - |
| **Links to learning platforms** | It is not offline but it is a good idea | Very good because the person can learn more, but training on how to use it is required. |

Table 4.3: Participants' feedback on the proposed improvements

P1-2 argued that is necessary to take into consideration the traditions, culture, ans socioeconomic background of each place where the app aims to be used and so it would need to look very different from audience to audience.

## 4.2 Discussion

Even if smartphones are not much diffused nowadays among girls, the gender digital divide is closing and the previsions show that smartphones will be more and more accessible to everyone in the next years. In addition, in those places where it is not possible to reach directly girls and parents, NGO volunteers can show the app during meetings. Because of this, almost everyone can get access to a smartphone and so to the app. Moreover, girls should be the primary target of the app, but it is also important to involve parents and community workers to reach a greater audience.

It is also necessary to analyze the usage of technology in the place where such an app has to be implemented and use user-centered design to meet the user's needs and their ability to use mobile phones. Furthermore, the app should fit old phones, a variety of screen sizes and operating systems, and work offline.

As a result of these expert interviews, the following decisions over the interfaces have been made:

- **Keep**: Informational, Story-Based, and Contacts. The first two seem good to inform the user about the topic and the third should be kept because often girls want someone to speak with. Information and stories should be localized to be effective.

- **Further evaluate**: The Video design has great communication potential but requires either enough storage space on the device or good internet connection, so it can be added in the app depending on the situation in the chosen deployment place.

- **Delete**: Argumentative and Links. They have been disrupted as all the experts agreed they don't seem interesting to girls or parents.

All the proposed improvements have gained positive feedback from the experts. Some of them are considered to be necessary while others depend on the ability of the users. In particular:

- **Audio feedback, help button, tutorial**: they help illiterate and low literate users to be able to interact with the app so they should be introduced;

- **Registration and login**: it is necessary to keep the user's privacy and allow the sharing of devices. It should be added if the mobile phones are shared, otherwise is not necessary for the first version of the app;

- **Localization**: it is considered very important and so it should be included. If the same app is developed to be used in different places, it should be able to show different content based on the position;

- **Quiz and games**: it makes the learning more engaging so it should be added if the target audience is able to use it;

- **Links to other learning platforms**: could be interesting if the users want to learn more about different themes, but it is not considered a priority;

- **Unlock new functionalities with usage**: it is a good idea to keep the user active on the app, but it is not a priority from the beginning;

- **Content personalization**: it is very important to show different content to girls and parents, so if the app is developed for both target groups, it should be added.

**Limitations**   It is very difficult to define general guidelines valid at a global level and the experts had a view limited to their experience in local places. Moreover, the experts interviewed were only 4, so the findings may be different if a greater sample is taken into consideration.

## 4.3   Prototype Design

Based on the expert interviews' findings a prototype for the app has been designed.

The tool used to design the prototype is Figma[26]. This tool has been chosen because it allows designing user interfaces in an easy but complete way and permits navigation between the screens as in a real app. Moreover, it offers the possibility to build the prototype online and makes it accessible everywhere through a link, allowing the possibility of remote user testing.

It has been decided to put a welcome page with the tutorial and a home page that contains all the resources: four main sections have been put, three of them recalling Informational, Story-Based, and Contact designs, and one new section with the games. Each page has a help button and audio feedback. Moreover, two versions of the prototype have been developed, one without login and one with it. For this first version of the app it was decided to target only the girls, the features of unlocking new functionalities with usage and content personalization have not been included and the localization regards only the contents for the moment.

The flow of the prototype's user interface is shown in figure 4.1. Each interface is examined in detail in the following sections.
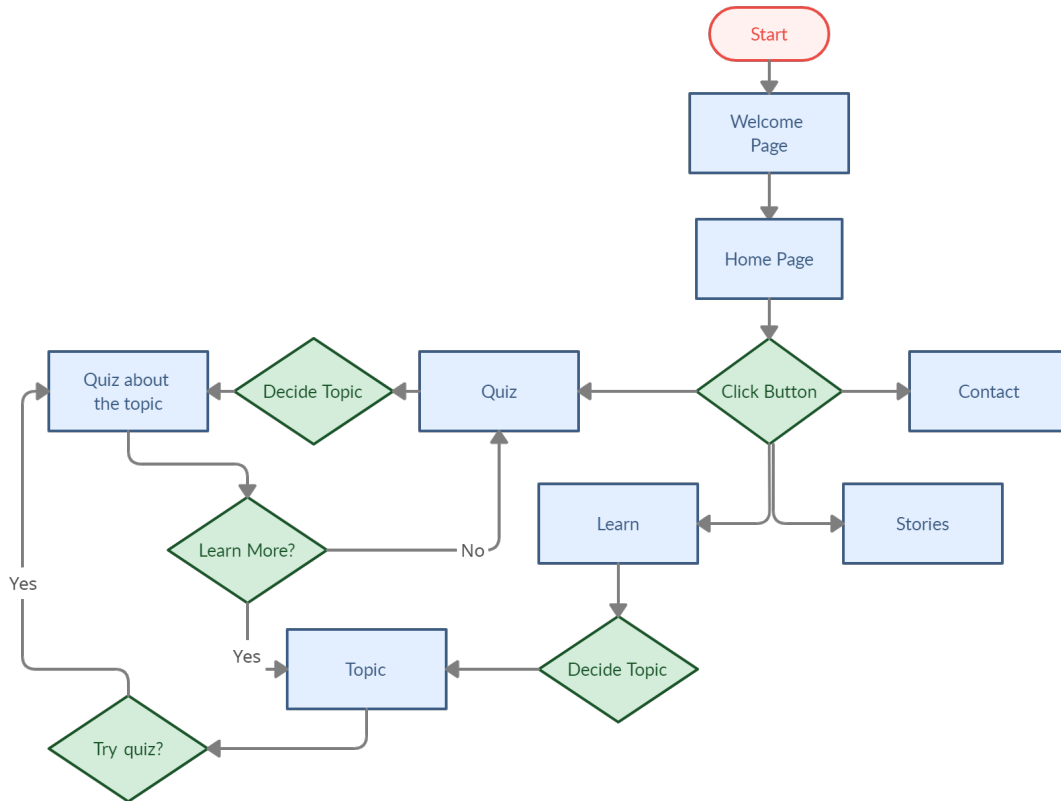


Figure 4.1: Flow of the prototype's user interface

**Welcome Page**   The welcome page contains the tutorial for learning how to use the app, as shown in figure 4.2. The tutorial is written and also spoken without any additional command, because illiterate people would not know how to start listening to it.

In the upper part of the screen there is the emergency call button. It has been decided to put this button in this page because in case of emergency the user does not have to navigate through the app to start the emergency call.

**Home Page**   The home page is the main page of the app that contains all the resources. Four main modules are accessible from this page: *Learn* where the user can learn about different topics, *Stories* where the user can read or listen to some
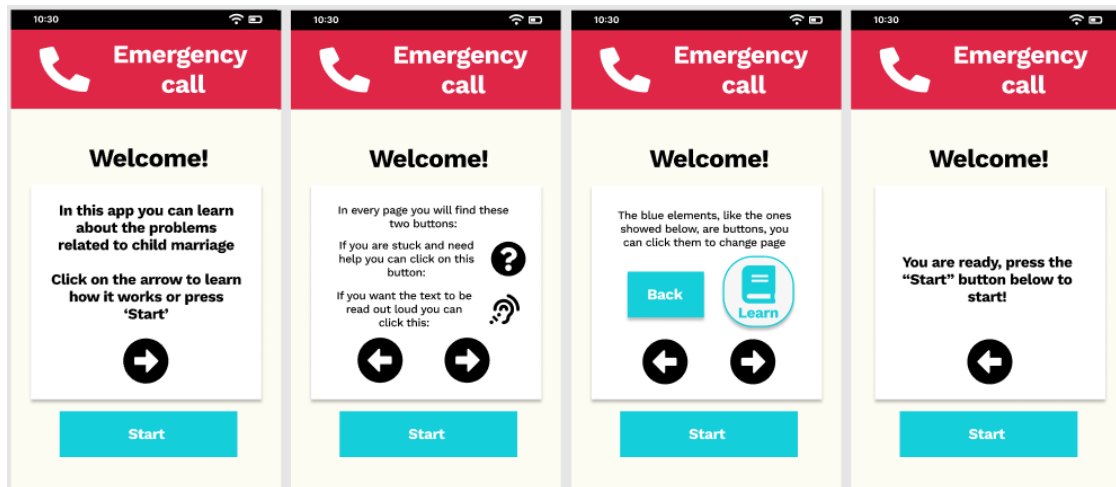
Figure 4.2: Welcome Page

girls stories, *Get help* where they can find contacts of organizations in case of need and *Play* where they can play some quizzes to check what they have learnt.

As in all the next pages, on the top right there is the help button that explains what to do if the users are blocked and on the top left the audio feedback that reads the text and explains how to use the different buttons.
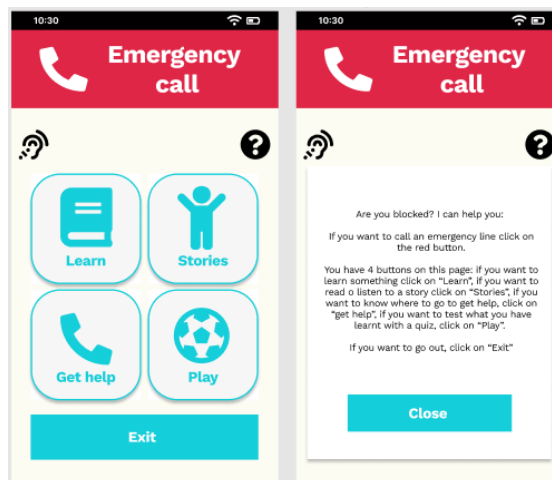
Figure 4.3: Home Page

**Learn**   The Learn page is shown in figure 4.4 and is inspired by the Informational design. It contains information about three main different topics: "Education", "Laws", "HIV and health issues" and a section with some Common Questions that

girls cannot ask their parents. The topics are purely illustrative and need to be tailored to what the users want to learn.

Inside the page dedicated to each topic, the user can get the information and take a quiz about that topic.
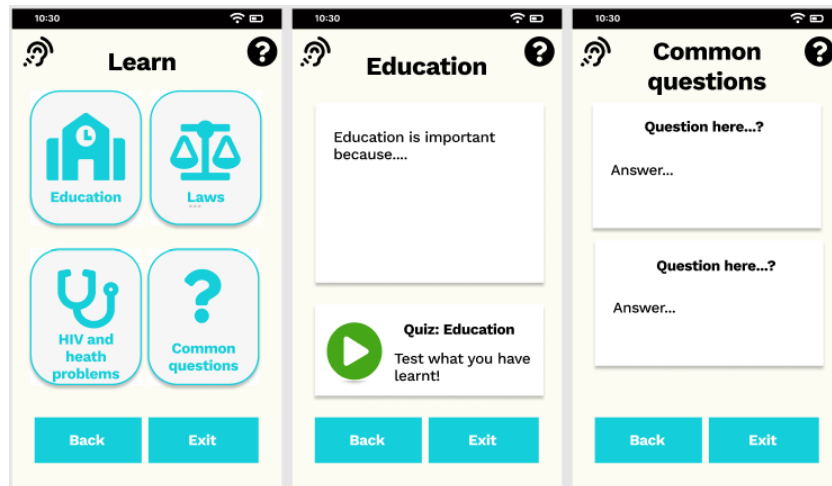


Figure 4.4: Learn Page

**Quiz** The quiz interface is visible in figure 4.5 and contains the quizzes about the different topics. The user can take the quiz answering true or false to the questions and in the end there is a link to the learning section if they want to go back to the learning section to learn more about that topic.
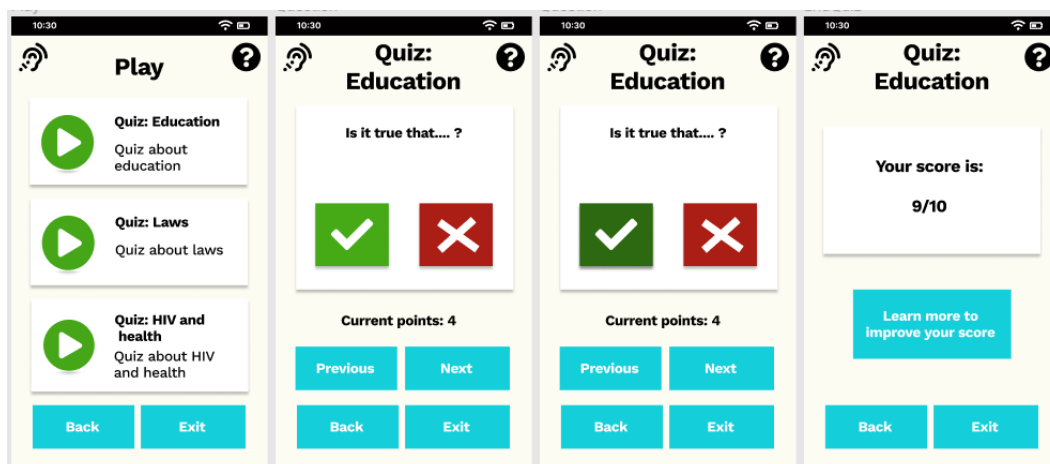


Figure 4.5: Quiz Page

**Contact**    The contact page is shown in figure 4.6 and inspired by the Contact design. It has been decided to put both address and phone number because the users can have complete information and decide what to use to contact the organizations. As P3 suggested, the name was changed in "Get Help".
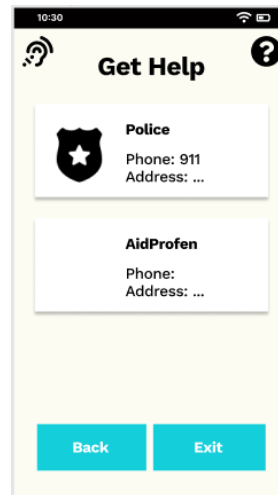


Figure 4.6: Get Help Page

**Stories**    The stories interface recalls the Stories design but also wants to include the possibility of having videos. It is shown in figure 4.7. Each story has his own page and the possibility to listen to the story or watch the video if it is available and there is internet connection.
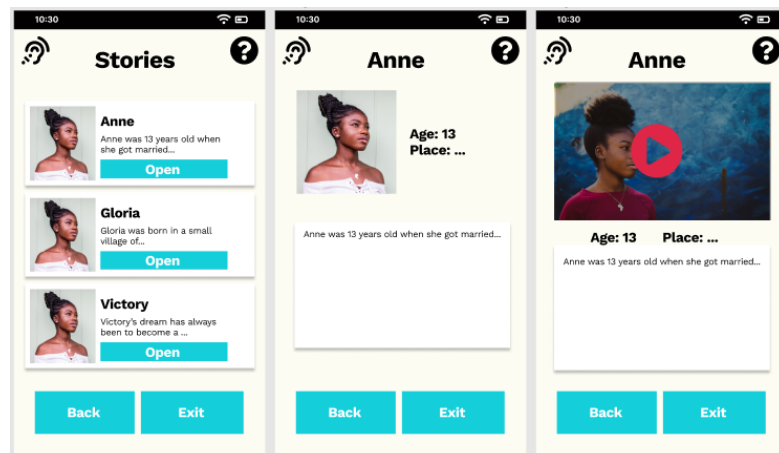


Figure 4.7: Stories Page

**Login**   Finally, a version of the app with login has been designed. The user can log in or register in the welcome page and a setting page is necessary to change the personal settings. This version has been designed in case the users share the device to allow privacy and personalization.
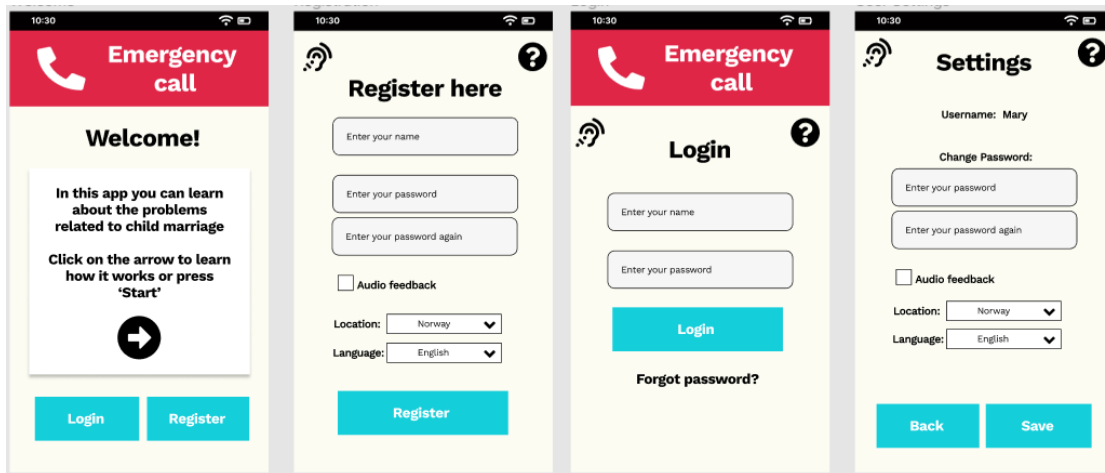


Figure 4.8: Login Page

# Chapter 5

# Prototype testing

The goal of this phase was to understand if the app could be usable by people in developing countries and if the prototype built after the expert interviews was appropriate. It was decided to focus only on a version for girls due to the lack of time.

To do so, some group interviews have been performed with girls from DRC. This was the first step of a collaboration with a local Non-governmental Organization (NGO) that is interested in developing this project in the future.

To tailor the prototype to the chosen country, a short preliminary study about DRC was conducted to investigate the situation of women and girls and the usage of technology. After that, the interviews focused mainly on getting to know the target group, and on showing the prototype and asking for feedback.

## 5.1 Democratic Republic of Congo

The Democratic Republic of Congo (DRC) is the second largest country in Africa and it is located in central Africa. The country counts a population of 105 million inhabitants, of which 55.5% live in rural area while 44.5% live in urban area [15]. DRC is one of the richest countries in term of natural resources but still over 70% of the inhabitants are currently under the poverty threshold [3].

DRC has been a Belgium colony until 1960. After gaining independence, it was ruled for a long period (1971-1997) by Mobutu Sese, until a coup d'état ended his regime. From 1998 a devastating civil war between the government and groups of rebels started. The conflict was officially ended in 2003 with the formation of a new government. Nevertheless, some rebel groups continued to fight in the eastern part of the country until 2010. The situation of the country was critic as a result of the war and the new government had to cope with the destroyed economy and society [15].

The continuous war caused the diffusion of gender-based violence as well as food insecurity, displacement and poverty [22]. This situation has also incremented the school dropout [14].

In addition to the conflicts, the country suffered from frequent epidemics of cholera, measles and Ebola that its weak healthcare system is not able to contain, and Covid-19 added another challenge [22].
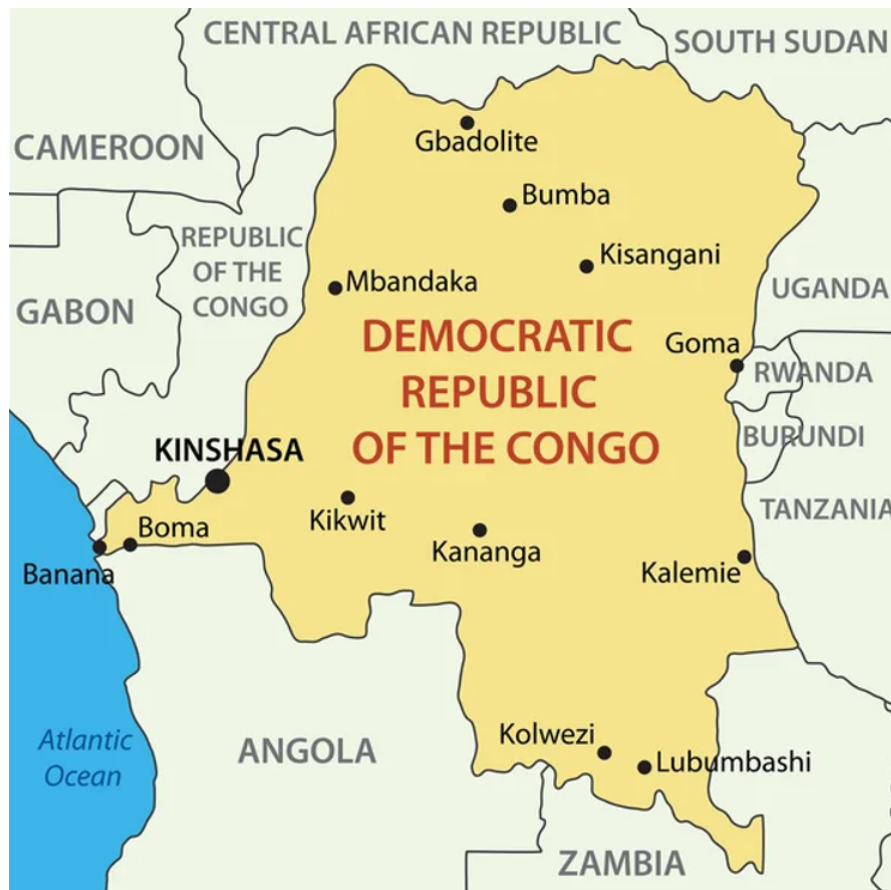


Figure 5.1: Democratic Republic of Congo

### 5.1.1   Situation of women

According to the Congolese Constitution, women have the right to marry whomever they want, but the law demands a dowry payment from the groom's to the bride's family [18]. Moreover, polygamy for men is spread and it is a way for men to prove their power [18].

In general, the laws places women in an inferior place compared to men, as they

are obliged to obey their husband and have the burden of child care and domestic responsibility [18].

Violence against women is widespread, and in conflict areas it is even more exacerbated as sexual violence is used as a weapon of war, and there are beliefs according to which having sex with a virgin can protect from death or bring wealth [17]. Domestic violence is diffused and accepted by the society [18], "up to 52% of women in DRC are survivors of domestic violence and 39% of Congolese women report having been threatened or injured" [3].

Moreover, it is very difficult for women to find decent work positions [3] and there are great differences in salary derived from the stereotype of women that should not work [3].

**Education of girls**   The data for school attendance of girls is shown in figure 5.2 [28]. Around 90% of the girls aged 10-14 is in school but 40% of them is in the wrong grade, which means that they have lost years of school. Between the girls aged 15-19 the number of girls out of school dramatically increase reaching the 40%.

The school dropout is much more accentuated in rural areas where less than the 50% of girls 15-19 goes to school and only 30% of them is in the right grade.

The data for boys are quite different and this shows a gender divide, with much more boys going to school compared to girls, in fact, only the 19% of boys aged 15-19 is out of school [28].
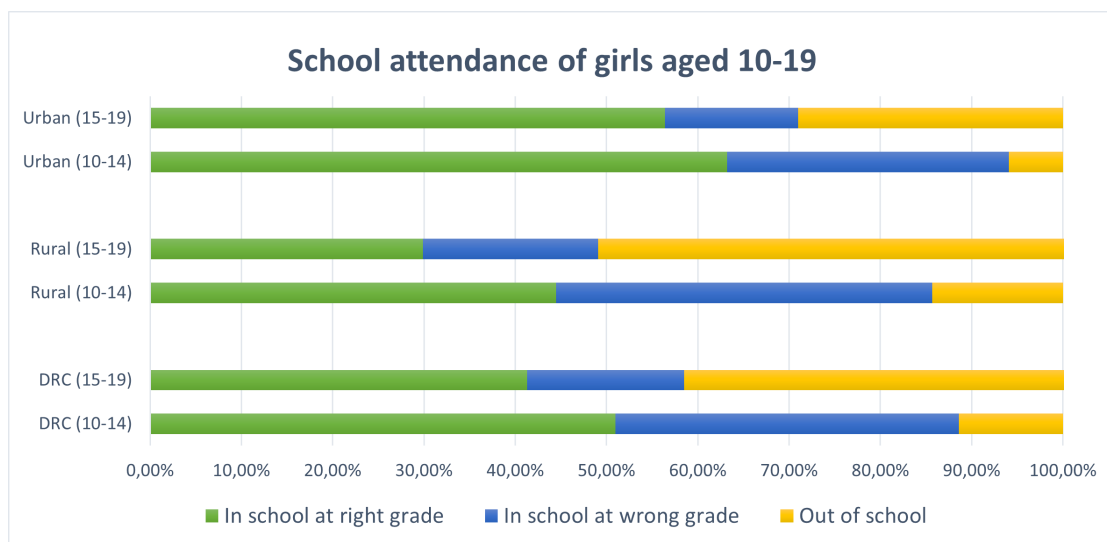


Figure 5.2: School attendance

### 5.1.2   CEFM in DRC

The legal age to get married in DRC is 18, without exceptions. Nevertheless 37% of girls currently aged 20-24 were married before the age of 18, and 10% before the age of 15 and the 26.7% had a child while underage [28].

The major drivers of CEFM in DRC are [14, 49]:

1. **Poverty**: as it is in place the dowry payment from the groom's family to the bride's, some girls are married off due to the family's necessity of money.

2. **Traditional attitudes**: There are traditions, most of all in rural areas according to which a girl should marry as soon as she menstruates.

3. **Level of education**: Girls without or with a low level of education are more likely to be victims of child marriage.

4. **Adolescent pregnancy**: As contraception methods are not widespread among adolescents, adolescent pregnancies are common and they can lead to child marriage.

5. **Armed conflict**: DRC has been involved in armed conflicts since 1996 to 2003 and this has incremented the vulnerability of women and children. Many girls were also forced to marry their rapist because of the pregnancy.

6. **Displacement**: Ethnic fights can lead to the displacement of children that becomes victims of CEFM

### 5.1.3   Usage of technology in DRC

Mobile phones are the most diffused technology in DRC, with 43.6% of the population that has a mobile phone and the 23.2% that is an internet user [41]. The usage of both mobile phones and internet is increasing, with an annual growth of respectively 5.3% and 29.3% between 2020 and 2021 [41].

The lower level of girls' education compared to boys often cuts women out from using technology [29]. Moreover, many girls are afraid to be harassed and harmed if they go online, and this results in few girls that want to use the internet [29].

## 5.2   Interviews preparation

All the participants of the testing session have been recruited by AIDPROFEN [4], an organization based in DRC that defends the rights of women and children in East DRC located in Goma. AIDPROFEN has developed various programs that

aim to promote human rights, fight sexual and gender-based violence, increase women's participation in politics, and the progress of peace and democracy [4].

Three sessions of 1h30 were planned with 7 girls aged 15-20 invited for each session, all the group interviews were carried out online on Microsoft Teams.

Each meeting was organized into three parts: general questions to understand the background of the girls, a prototype explanation where each page was explained and questions about the features were asked, a prototype trial where girls could try the prototype.

The preparation for the interviews required extensive work because the girls were not able to speak English, so all the material was translated to French. One of the workers of AIDPROFEN was available to participate as translator and also as local expert as she daily works in helping girls and women.

As the level of expertise of the girls in using mobile phones was unknown, a very basic introduction to mobile apps and the prototype were prepared.

As this was the first meeting, it was decided to use the simplest version of the prototype without the login and registration functionality, as it can be added in the future if needed.

## 5.3 Interviews

All the sessions were planned recruiting 7 girls each, but more girls showed up at the first two sessions and were allowed to participate, reaching a total of 26 participants. The resulting number of participants was: 12 girls for Session 1 (S1), 8 girls for session 2 (S2), and 6 girls for session 3 (S3).

The girls from S1 and S2 did not know each other before the meeting and were from Goma, while the girls from S3 knew each other and were from a rural area called Nyiragongo.

### 5.3.1   General questions

**Age**   The distribution of the age of the girls for each group is visible in figure 5.3. The participants were between 15 and 19 years old. One girl from S1 is not included in the data as she joined the meeting after this question.

**School**   Most of the girls were going to school, with some exceptions, as visible in figure 5.4. Only 5 girls reported they were not going to school at the moment, 3 from S1 and 2 from S3. All the girls that were not going to school reported that they would like to go back to school but it was not possible for their parents to pay the school fee.
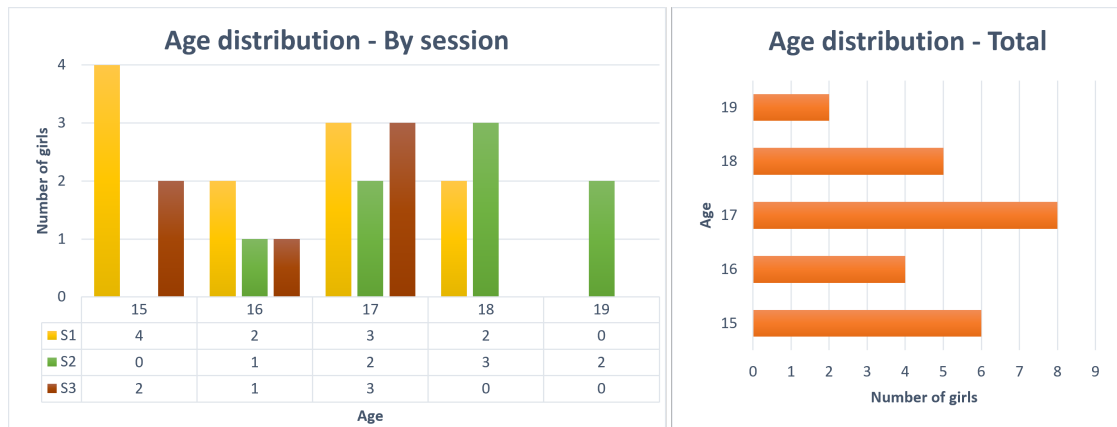
Figure 5.3: Age distribution

When asked for the reason they were not going to school, the translator reported that the girls from S1 were not comfortable answering the question and this is probably because the girls did not know each other.

Four of the girls from S3 reported that they were going to school but later in the interview two of these four said that they were going but without paying the school fees: *"Most of the time she goes to school, but sometimes she has to go back home because she has not paid school fees and this is really a little bit difficult for her"*. The two girls not going to school said that they really would like to continue their education but the families were not able to pay the fees at the moment.
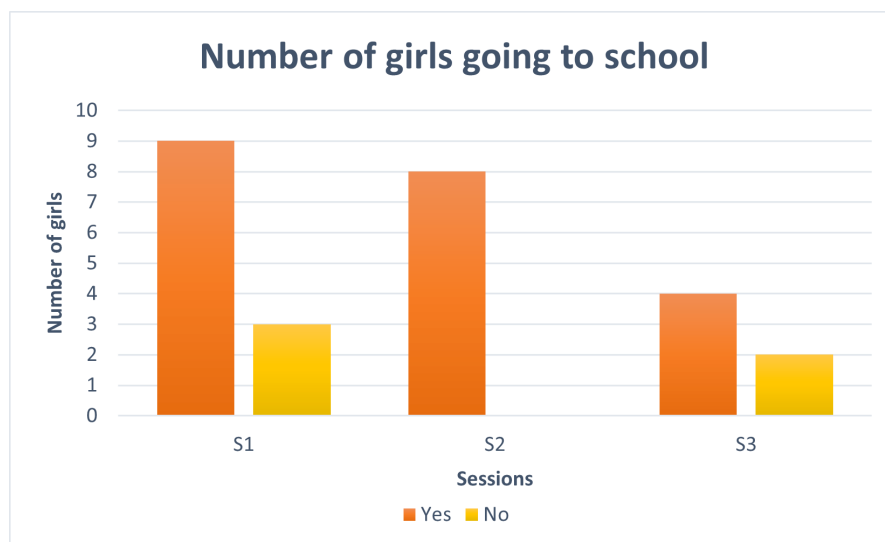


Figure 5.4: School attendance

**Marriage** First, the girls were asked what is marriage for them. Most of the girls who answered defined it as *"an engagement/union between two people of different sex"*, two added *"who have decided to live together all their lives"*, another added *"in the condition of the country law"*. Only one girl, from S3, mentioned the word *love* defining it as *"a legal union between two people who love each other"*.

Secondly, it was asked when they planned to get married, if they wanted to get married, the answers are reported in figure 5.5. The three sessions had different trends. Most of the girls from S1 said that they would get married as soon as they find a suitable husband because it is an opportunity and they do not want to lose it. Girls from S2 chose different answers, many of them said they wanted to finish with school and get a job or start a small business to be economically independent before getting married. One girl said that she did not want to get married and all the other girls in the room were surprised by this answer. After, another girl said she would get married if she founds someone she really loved, and the girl that did not want to get married changed her answer in *"if she find someone she really love, she may get married"*. Most of the girls from S3 said that they would finish with school first and then decide about marriage, they did not mentioned any job.
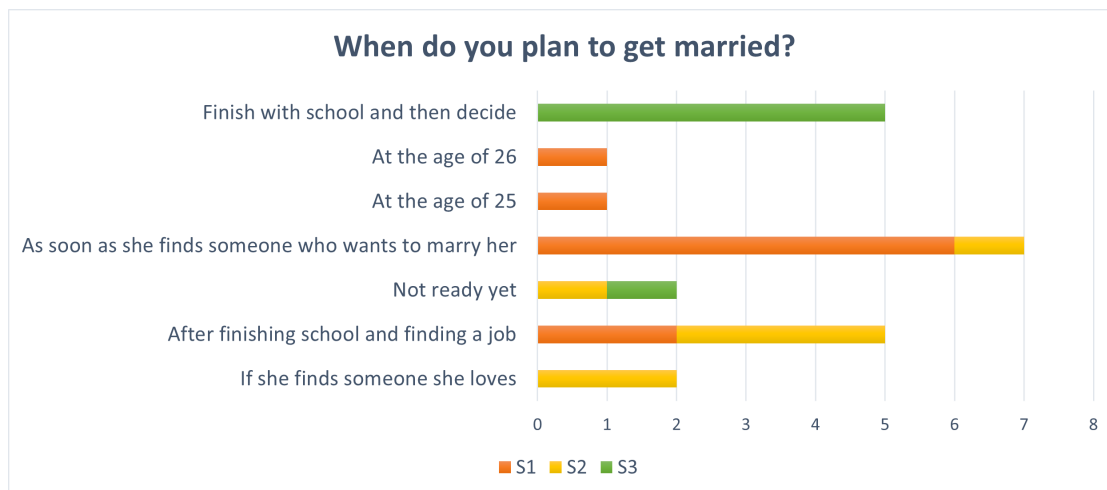


Figure 5.5: Marriage planning

After, it was asked which age they thought was the legal age to get married in DRC, with 18 being the correct answer. In S1 and S2 most of the girls answered 18 and one girls answered 25. A girl from S2 said: *"The normal age is 18, but there are some parents who are not passionate and because there are also some girls who grow up quickly and for some parents to protect their girls, they can marry them just to avoid that they can be exposed to different exploitation or something like that. So, some parents can marry their girls, even when they are under 18"*. Girls from S3 answered: 23, 22, 21, 25, 25.

When asked if they knew someone married underage, they reported to know many girls married under the age of 18 and a girl from S3 said: *"Most of girls they know who got married under the age of 18, they never stay long in that marriage because they are still very young to take care of the family and their husband. So most of girls who get married under the age of 18 sometime they think that life is really easy and you know, it's usually happy. But, you know, life is not like that. There are some times when you have to suffer so many problems. When girls get married early, they face those kind of problems in their marriage and they leave the marriage.".*

Lastly, it was asked if they knew a place where to get information about marriage and sexual and reproductive health. They all answered no, except a girl from S3 that said at AIDPROFEN and one from S1 that mentioned youth groups and church. A girl from S2 said that she had never heard about sexual and reproductive health and child marriage before the meeting.

**Usage of mobile phones**    The distribution of phone ownership is visible in figure 5.6. Most of the girls from S1 and S2, living in urban area, have a personal mobile phone. Among the girls from S1 and S2, 10 girls out of 22 have a smartphone while 3 do not have a personal phone. On the other hand, only 2 of the girls from S3 had a telephone, and it was not a smartphone, but all the girls said they have people at home with phones that they could use and they reported using the internet to access Facebook.

The girls that had phones said they use the phone mostly to communicate with family and friends both with phone calls and messages. Other usages are: Facebook, school research and homework, download and watch videos, get information about politics and what is going on in the country, find the meaning of some new words, online courses, take pictures, and listen to music.

None of the girls said that their phone was shared with someone else.

## 5.3.2   Prototype testing

The prototype have been shown to the girls and an explanation about all the parts of the app was given. Different questions have been asked to see if they liked the prototype and would have been able to use it.

**Welcome page**    About the welcome page, two main questions were asked. The first question was if they thought that the tutorial would have been important or not necessary, and all the groups agreed that the tutorial was really important.

The second question was about the emergency call button, and all the girls said it is really important to have that button to call if needed: *"The emergency one*
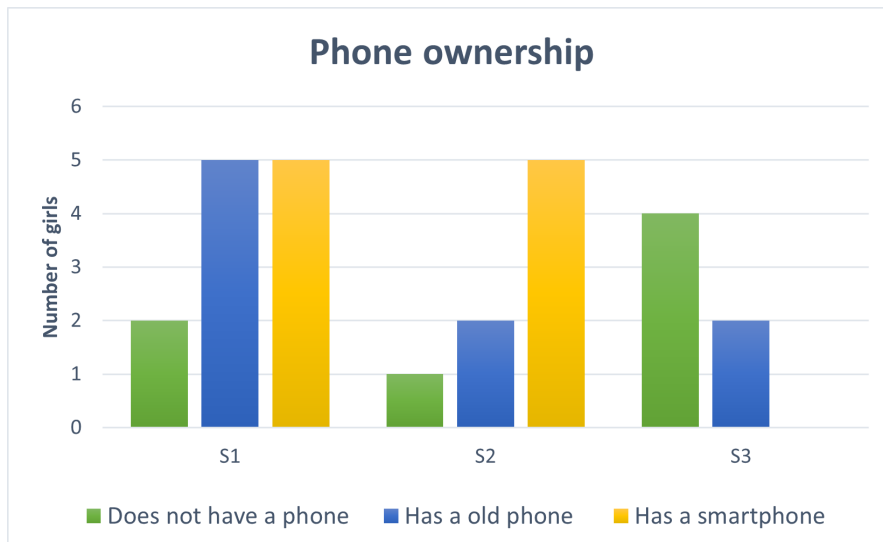
Figure 5.6: Mobile phones ownership

*is really important as you can alert people when there is a case of child marriage in the community, or if a girl is forced to get married. She can also ask for help by calling through that button so yeah it's important".* During S2 a girl asked who would be called when pressing the button and it was decided that the user should set the emergency number.

**Home page**   About the home page, it was asked if they desired both audio feedback and help button or only one of the two. All the girls said that the help button is really important because it can help people to understand how to use the app. About the audio feedback, all the girls except from one agreed that is a good function to have.

**Learn**   About the Learn page was asked to the girls what they would like to learn about and if they liked the proposed topics. They liked the current topics and also proposed the followings:

- How to protect themselves from child marriage

- Consequences of child marriage

- Sexual and reproductive health

- Sexuality

- How to behave when you would like to go to school but it is not possible because of the fees

In particular, it was said that it is challenging for them to find information about sexual and reproductive health because it is very difficult for them to speak about these topics with their parents or relatives.

**Stories**   It was asked if the girls were used to stories for education and only two girls said yes, but the other reported that stories can be useful to learn from other people's experience.

Moreover, they all thought that a button that reads the stories would be useful for those who cannot read and also to those who want to listen to the story while doing other activities.

In general, they said to prefer videos over plain stories, but as videos require internet, girls from S2 said that they could not be accessible from everyone and so the story with audio would be enough. Girls from S3 said that they believe that from the video it is possible to learn so much more than from plain stories, that they would try their best to find an internet connection to watch them.

**Contacts**   All the girls agreed that having a contact page is very important to be able to find help. All of them agreed that the best option is having both the phone number and the address to be able to choose the one they preferred.

Girls from S2 affirmed that they do not want to have the police in the app: *"they said that because of the reputation of the police here, so most of the time police never protect people or they come drunk and when they see police, it's like you are arrested and they are afraid. And they said if they have to call someone they will call me or AIDPROFEN, not police"*.

They also suggested putting different organizations which are involved in the protection of women and girls such as child parliament, women house, Caritas and UNICEF.

**Quiz**   About the quizzes the girls said that they are important as a learning process, only one girl said that they were not necessary. P said that she is not sure that people would do quizzes but she thought it was fine to keep them and see if they are used or not.

**General improvements and suggestions**   General improvements and suggestions that the girls gave are the following:

- One girl suggested that she would like to have the possibility to report a case of child marriage in a less urgent way than the emergency call. And this functionality could be used not only by victims of child marriage but also by other people that can report the case: *"someone can be a victim of*

> *child marriage, without having information that it's not good, child marriage is not good for girls. But within the community, we can have people who have information about that and who can report this to other members of the community or different organizations so that they can do an action to stop child marriage".*

- Another girl suggested having an interactive button that allows communicating with someone else that can answer their questions, and that it would be even better if they can get the opinions of different people on the same topics.

### 5.3.3 Limitations and observations

Holding the meetings online has brought some limitations. It was difficult to interact with the girls online as they only had one computer in the room. As they did not speak English, it was also not possible to interact directly with them and the translator always had to mediate. The necessity of a translation also probably brought to a loss of the shades of the language as the interpreter was not proficient in English and always tended to use basic words.

Moreover, most of the times they answered the questions as a group after a small discussion. Only the final answer was reported and sometimes it was not possible to know who answered what.

In addition, the meetings lasted more than expected, in particular the first two, due to the high number of participants so it was not possible to make the girls try the prototype as they had to go home. It was decided to prioritize the questions as it was the first meeting and they could have the possibility to try the app in successive meetings.

Finally, it was discovered that some girls were not able to speak French and this led to the necessity to prioritize the multi-language support to translate the application also in Swahili.

## 5.4 Discussion

Most of the girls interviewed were under the age of 18, but a great number of them said that they would marry as soon as they found someone. This shows that even if they are not forced to marry by the parents, they would still marry underage and this can put them at great risk in case of childbirth and make them abandon school.

Most of the girls defined marriage as a union between people of different sex that decide to live together, and only few of the girl referred to the sentiment of love that is the main driver of marriage in developed country.

The majority of the interviewee said they did not have any place where to get information about marriage and sexual and reproductive health and the app could help them by providing that kind of information.

The number of girls with a smartphone overcame the expectations and this shows that the technology penetration is growing in the country. None of the girls from rural had a personal smartphone, as expected, but they said having access to the internet from someone else device as they are on Facebook. This shows that most of them could have access to the app.

Based on the collected data an the observations, the following decisions about the app have been taken:

- Keep tutorial at the beginning, audio feedback and help button, as the majority of the girls considered them important;

- Add multi-language support to have the Swahili translation as some of the girls are not able to speak French;

- Give the possibility to customize the number of the emergency call;

- Have both written stories with audio and videos as some girls said they would prefer a lot videos but others were concerned about the internet connection;

- Add the suggested organizations in the "Get Help" page and remove the police;

- Keep the quiz but not prioritize them;

- Add a section to report a case of CEFM;

- Add a section where girls can ask questions in an anonymous way and get answers;

- Add the suggested topics to the learn section;

- Keep the version without login as the phones are mainly personal and not shared, girls without a phone could have the app on some family member's phone but having a login would complicate a lot the process for the users and it is not strictly necessary for now.

## 5.4.1   Changes in the prototype

To actuate the decisions, some modifications have been made to the prototype, as shown in figure 5.7.

First of all, a settings page has been added to be able to change the language and set the emergency number.

Secondly, in the home page, the two sections *Report a case* and *Ask questions* have been added, even if those sections cannot be used if there is no internet connection.

Finally, the *Learn* page has been restructured with the following topics: Education, laws, Sexual and Reproductive Health, Sexuality, Child marriage, and Common questions.
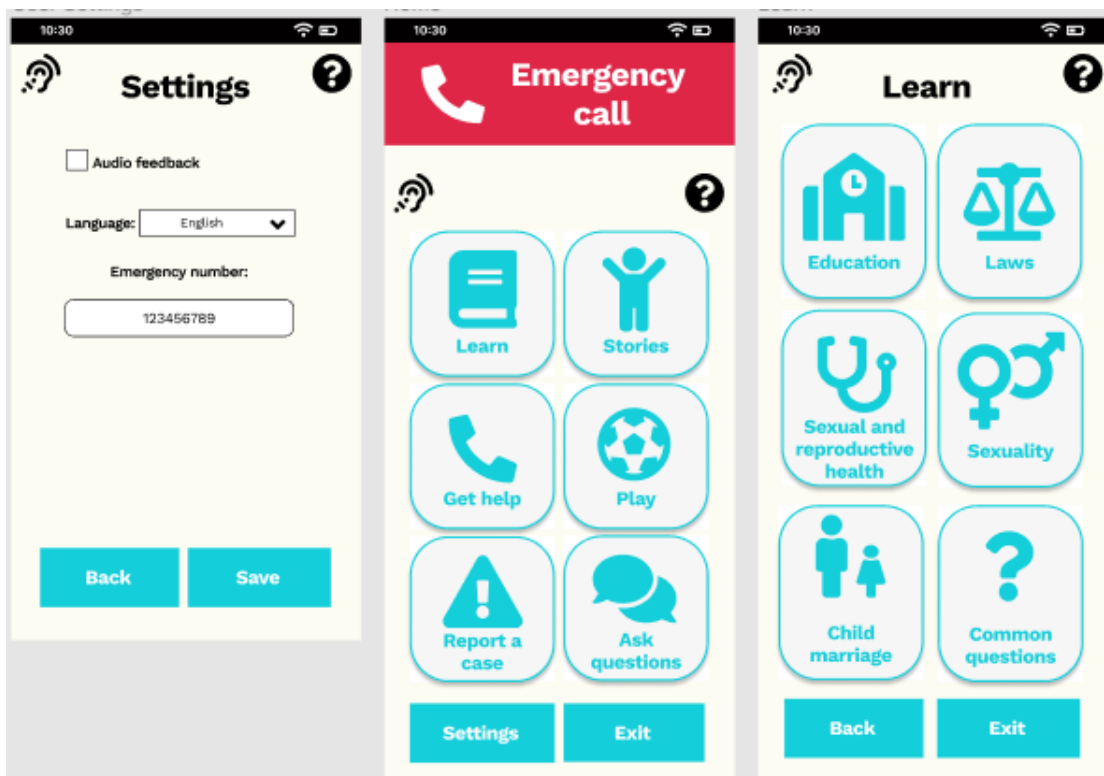


Figure 5.7: Changes in the prototype

# Chapter 6

# App development

This chapter will cover the development process of the app, which consisted of the implementation of the realized prototype. The project was realized in an incremental way using the agile methodology.

## 6.1 Choice of Technologies

The framework chosen for the development of the app is React Native with Expo. As for now, the system does not require any remote storage service, and the only settings to save are the language and the emergency call number, which are saved in a local file.

### 6.1.1 React Native

React Native is an open-source framework written in JavaScript to develop mobile applications for both Android and iOS by writing mostly cross-platform code [24].

React Native uses Facebook's React library to build the interfaces and a mixed code of JavaScript and JSX (a markup language similar to HTML) to design them. The application is rendered using native APIs that map the code in real mobile UI components, not webviews, that permit to have high performances [24]. React Native is a young technology launched in 2015, but it is already used by successful companies such as Meta, Discord, Shopify, and Skype [51] and the developers community is huge, which means that there are numerous third-party libraries that can be used to achieve advanced functionalities in very little time.

This framework was chosen because it gives the possibility of writing mostly cross-platform code and deploy it to both iOS and Android, it is open source and really easy to use and the developer had previous experience and knowledge of the framework and JavaScript. For these reasons React Native overcame the other

choice of developing directly an Android/iOS app with code in Java/Kotlin for Android and Swift/Objective-C for iOS.

### 6.1.2 Expo

Expo is a framework to build React Native applications and it offers a managed workflow that allows to not write any platform-specific code letting the developer spend little time in the configuration of the system [25].

Moreover, this framework allows testing the app in real-time while working on it through a mobile application. This facilitates the testing on real mobile devices as it is possible to see the changes of the application in real-time without needing to build the apk file and transfer it on the phone. This app also works remotely so it was perfect to run the testing with the people in DRC.

Expo has some limitations as it does not support yet some functionalities such as Bluetooth, but looking at the list of not supported functionalities, there was nothing that was needed for this project. As there were no drawbacks, it was decided to use this framework.

## 6.2 Features

Not all the features present in the prototype were developed. As some of the users may not be used to technology, an initial simplified version of the app was developed to understand if it was usable by the users and if they liked it. It would have not made sense to spend a lot of time developing the whole app to find that it was too difficult to use for girls in developing countries. As a result, some of the features have been prioritized, while others were left for future development. The features prioritized and realized were:

- **Tutorial**: the tutorial at the beginning of the app is necessary to help the users to understand how the app works.

- **Help Button**: as the tutorial, the help button helps the user in all the pages of the app and so it is really important.

- **Emergency Call**: during the interviews, the girls highlighted the importance of the emergency call, so it was realized in a way that the phone number to call can be set by the user.

- **Multi-language support**: as in the interviews was found that even with such a small sample two languages were already required, the multi-language support was prioritized.

- **Learn section**: the learn section is the core of the app, whose main goal is to spread information to prevent CEFM, so it was prioritized.

- **Get help section**: this section is very important as well if the girls need to speak with someone so it was included in the app

- **Stories section**: from the interviews, the girls seemed to like stories, and as it was an easy section to implement, it was added.

- **Quiz section**: quizzes were not considered a priority after the interviews, but it was an easy section to implement as well, so it was added.

In regards to the **audio feedback**, the support for it was implemented in the app, but the audio files are lacking as it was not possible to find someone to record the audios in french in such a limited time.

The features left for future work were **report a case** and **ask questions**, that were not prioritized for three main reasons. Firstly, for both of them, the user could contact any of the organizations in the get help section; secondly, it is necessary to find a local organization that would be available to answer the requests and decide with them the modalities; thirdly, it would be necessary to have an internet connection to send the requests.

## 6.2.1 Multi-language support

The multi-language support has been realized using the `i18n-js` library and `expo-localization`.

The `i18n` library allows to creating an app completely independent from the language: all the written content is not hard-coded in the app but read from a JSON file and dynamically inserted when each screen is rendered. In this way, adding the support to a new language requires only adding the new translations files.

The `expo-localization` package is only used to retrieve the starting language for the app, so that the app starts using the same language of the phone,if it is available, or a fallback language otherwise.

In the app, each language is organized in a folder and composed of multiple files, to separate the translations of different sections in different files and avoid having enormous files. As for now, only English and French are included, but when someone will be available to translate the text into Swahili, adding the files will require very little effort.

A singleton object `i18n` has been created and each screen uses it when it has to render some text. When a screen is rendered, this object retrieves the translation from the JSON file and inserts it.

## 6.3 Process view and Screens

The graph in figure 6.1 shows how the user can transition between the different states of the application.

The user starts from the welcome screen, where they can watch the tutorial or directly press "Start" to reach the Home page (HomeScreen). From the Home page, the user can access the 6 sections of the app and the settings. Each screen and section will be further explained in the next paragraphs.

From every screen is possible to go back to the previous screen and from the main page of each section is possible to go back to the Welcome screen. These paths are not shown in the diagram to make it more readable.
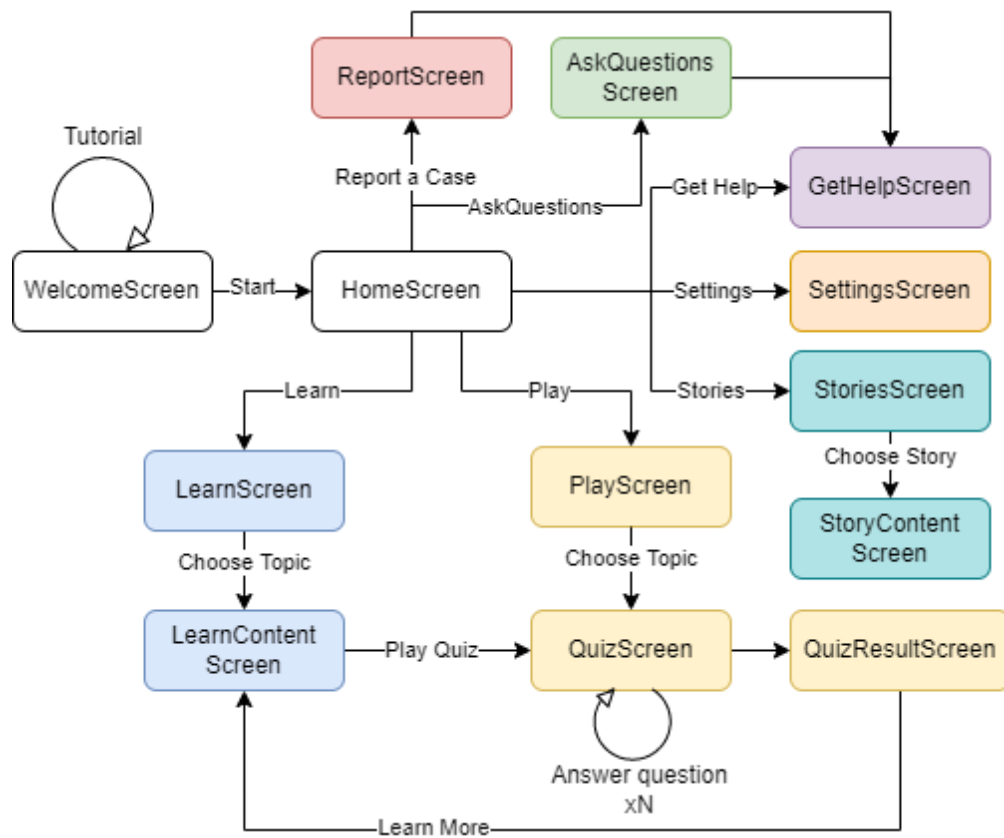


Figure 6.1: Process View

**Welcome Screen**    The welcome screen is very similar to the one in the prototype. The tutorial has a higher number of pages as more instructions were necessary to

understand how to use all the features of the app. All the pages are visible in figure 6.2.

The emergency call button is structured as an external component as it is used in other parts of the application as well. When the user presses the emergency call button it triggers a function that opens the phone call screen with the saved number and the country code. The library `react-native-phone-call` has been used to support the integration with the phone's call application.
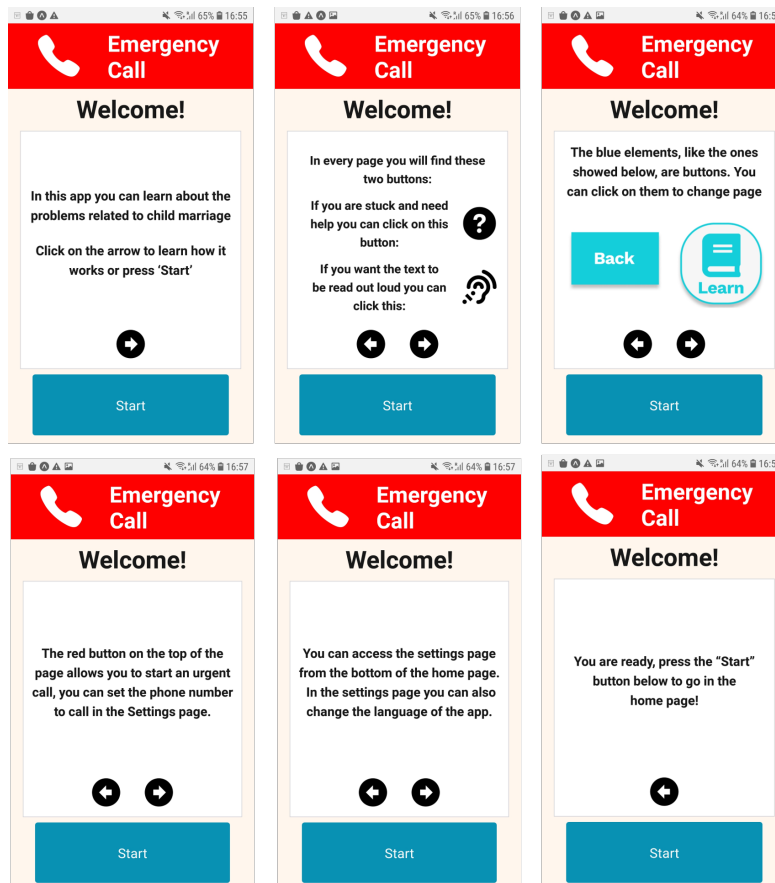


Figure 6.2: Welcome Screen

**Home Screen and Settings Screen** The home screen, visible in figure 6.3a is also similar to the one in the prototype. It uses the `Emergency call` component as well, and also the `HelpBar` component that contains the audio feedback and the help button.

The HelpBar takes the name of the page as a parameter and so it is rendered with the page and has different text content and audio for every page. When

clicking on the ear icon on the left, the audio starts, while when clicking on the question mark on the right an overlay with the help button text appears.

The Settings Screen, showed in figure 6.3b allows to update the emergency number and to change the language of the app.

When the *Save* button is pressed, it triggers a function that checks if the language and the emergency number have been changed and updates the two global variables. Concerning the emergency number, a regex function checks that it is a correct phone number, giving an alert in case of failure.



(a) Home Screen                                (b) Settings Screen
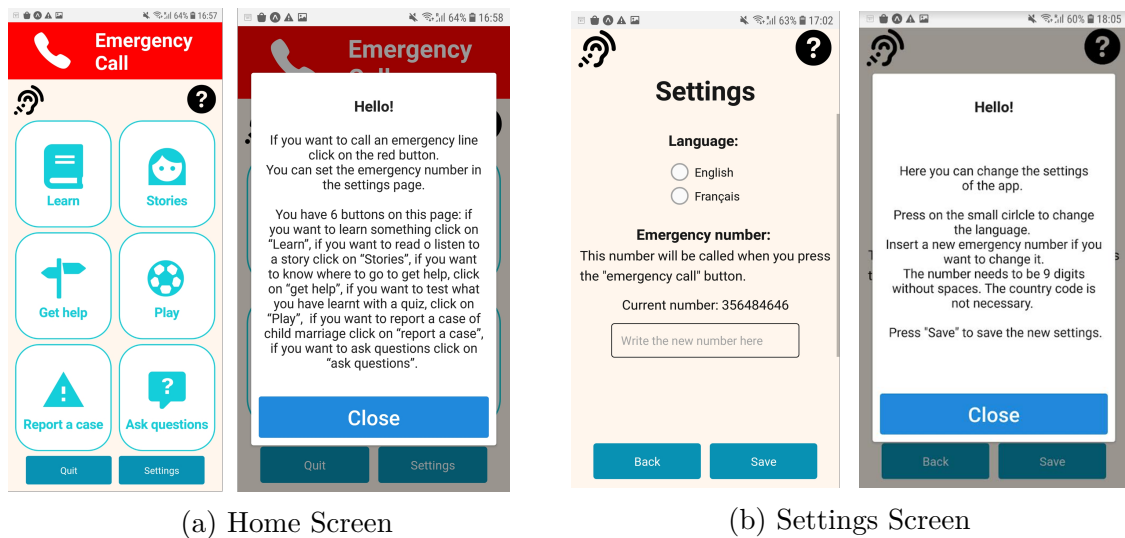
Figure 6.3

**Learn Section**   The learn section is composed of two screens: Learn and Learn-Content.  The Learn Screen is the menu where the users can decide the topic they want to learn about, and when they press the topic button the LearnContent screen is rendered.  The LearnContent Screen uploads the content dynamically when it is rendered as it receives the topic as a parameter and so it shows the information about that topic. Initially, in the LearnContent Screen, the users see only the questions and if they click on a question they can read its answer, as showed in figure 6.4. From the bottom of the LearnContent page it is also possible to play directly the quiz about that topic.

**Play Section**   The play section is composed of three screens: Play, Quiz and QuizResult.

The Play Screen contains the list of the Quiz that the users can play. They can start a quiz by clicking on any part of the button.
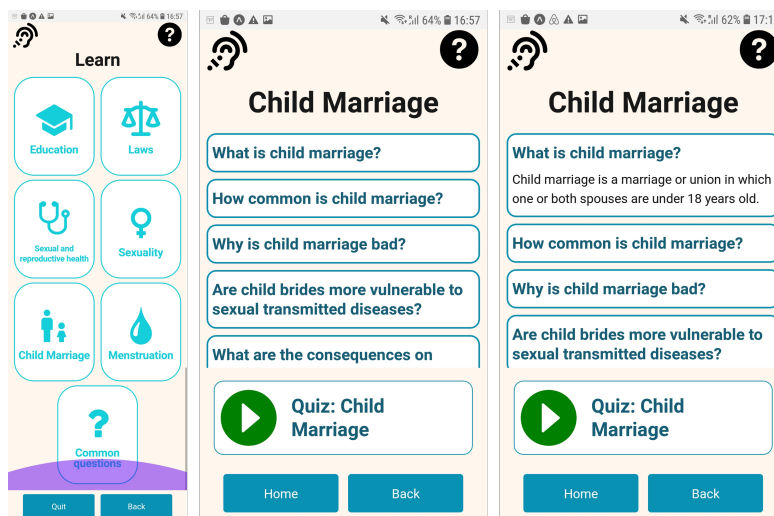
Figure 6.4: Learn Section

The quiz is rendered through the Quiz Screen, that shows the questions. When the users press on the green or red button the answer is checked and points are given if it is right. Then, the screen is reloaded with the new question.

After the last question, the app shows the QuizResult Screen with the total score, and the users can press on the link to the learn section if they want to learn more about that topic.

As for the learning section, all these screen are not content-specific, but they dynamically load the content based on parameters.
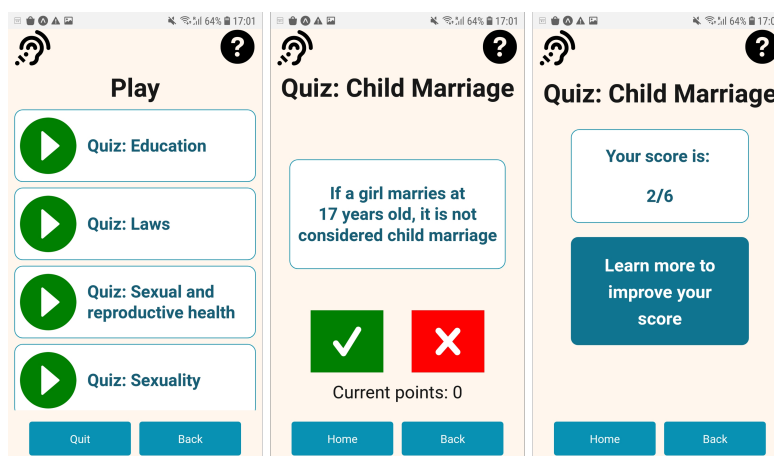


Figure 6.5: Play Screen

**Stories Section**   The stories section is composed of two screens: Stories and StoryContent. The Stories Screen has a list of stories and the users can read them by clicking on *Open*. When this happens, the StoryContent is populated with the requested story.
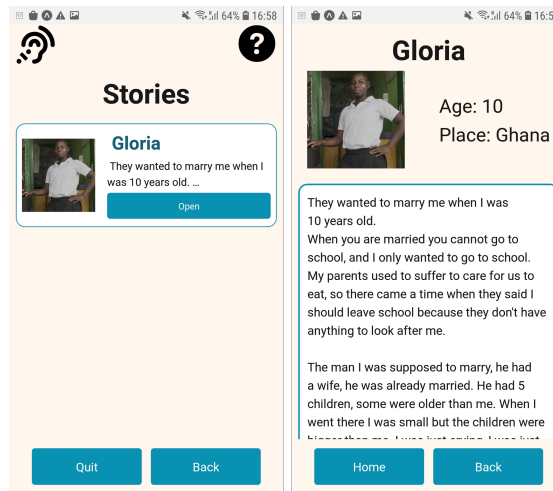


Figure 6.6: Stories Section

**Get Help Section**   The get help section is only composed of the ContactScreen that contains the contacts of local organization. The possibility of directly starting a phone call has been added.
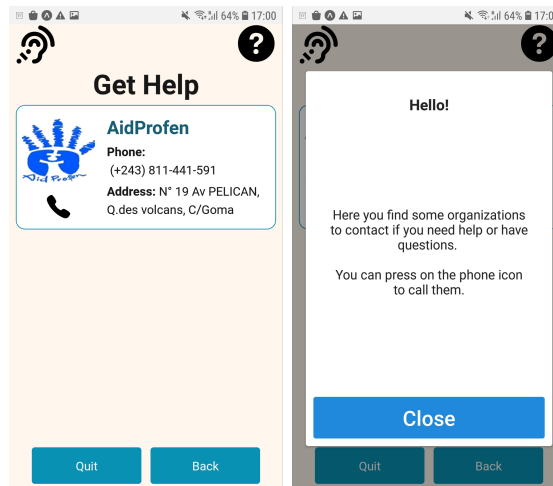


Figure 6.7: Get Help Section

**Report a Case and Ask Questions Sections**   As it is showed in figure 6.8, these two Sections have been put in the app but they are not complete yet. In fact, they would need a back-end support that required too much time to be implemented. Moreover another app for the community workers that can answer the questions and the reports should be developed.

For the moment, if users need help they should contact some of the organizations listed in the Get Help section.
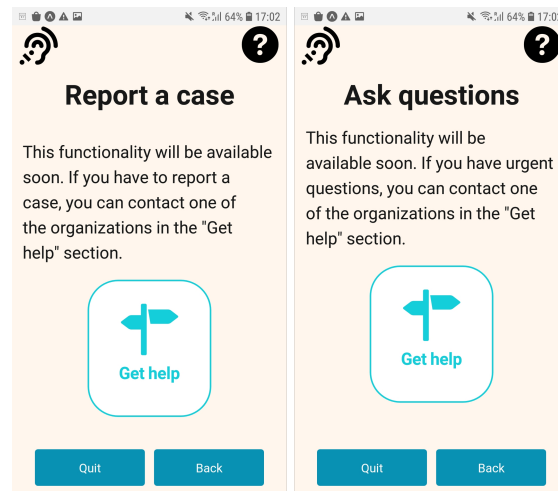


Figure 6.8: Report a case and ask questions Screens

# Chapter 7

# Application testing

A second part of the case study in the DRC was conducted to test the developed app and see how it was perceived by the girls. The participants were 14 girls aged 15-19 from Goma, recruited by AidProfen. Part of the sample participated in the prototype testing while part of it was new to the project. During the session the girls had to fill in a questionnaire. A copy of the questionnaire is attached in section D of the Appendix. The questionnaire was divided into 3 parts:

- **Preliminary questions**: age, if they participated in the prototype testing, questions about their usage of mobile phones and questions related to how they get information on topics such as marriage, pregnancy, sex...

- **App testing**: in this part, they had to perform 3 tasks on the app and answer some questions after each task.

- **App evaluation**: Questions about their general experience during the app testing, with: SUS, questions about the functionalities and the style of the app.

The questionnaire was printed and all the girls filled it in on paper. They only had one mobile phone to use for the testing, so all the girls tried the app on the same phone. After the testing, all the answers were copied on an excel sheet and analyzed. The results are shown in the following sections.

## 7.1   Preliminary questions

The distribution of the age of the girls is shown in figure 7.1. The majority of the girls were between 15 and 17 years old, while two girls were older.

Moreover, 6 girls out of 14 participated in the prototype testing while the others were never exposed to this app before.
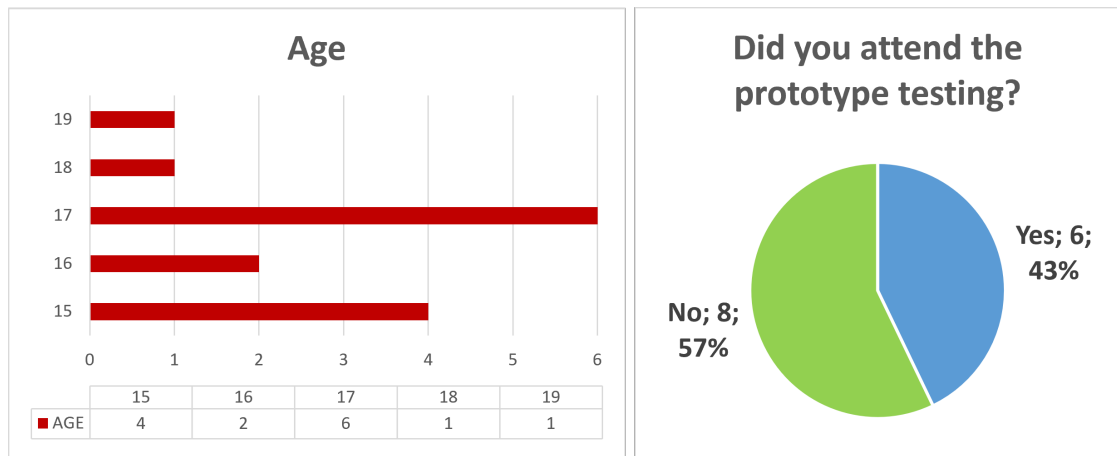
Figure 7.1: Age and attendance to the prototype testing

### 7.1.1   Usage of mobile phones

The question *"Do you have a personal mobile phone?"* had 5 possible answers: Yes a smartphone, yes not a smartphone, yes a shared smartphone, yes a shared phone but not a smartphone, no. The answers are shown in figure 7.2. 4 girls (29%) reported to have a personal smartphone, 2 girls (14%) reported to have a personal older phone and 1 girl has a shared older phone. 6 girls (43%) did not have a personal mobile phone and 1 girl marked multiple answers, so is counted as not answered (NA).
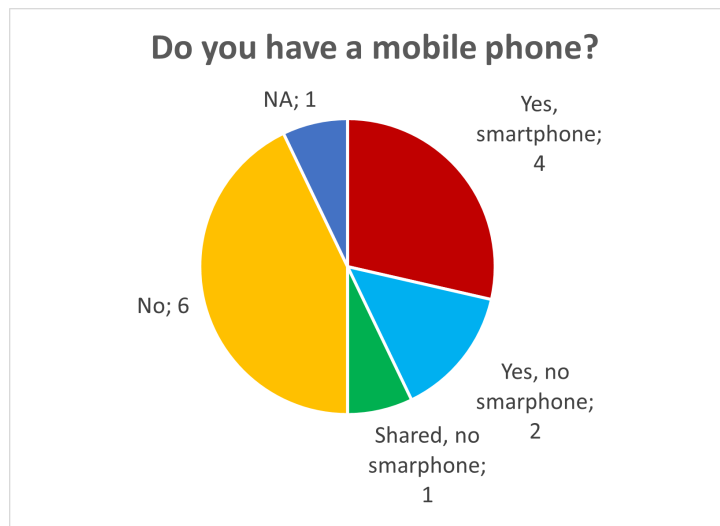


Figure 7.2: Mobile phones ownership

The girls that did not have a phone were asked if they had access to some other people's (friends, family...) phones. Two girls reported having access to a smartphone and one to an older phone, so in total 43% of the participants had access to a smartphone, 14% only to an older phone, and 43% did not have access to any phone.
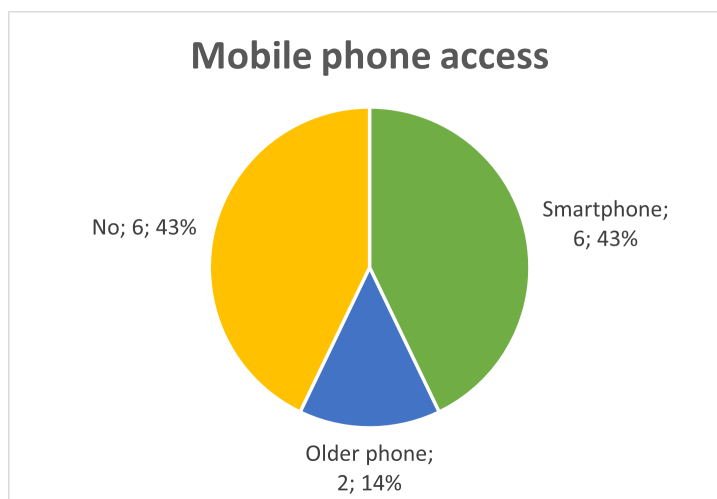


Figure 7.3: Mobile phone access

The data about mobile phone usage are shown in figure 7.4. All the girls that have smartphones use various apps on their phones, and apart from Whatsapp and Facebook, some of them reported using also Snapchat, TikTok, and Instagram.

Those who only had access to an older phone reported to using also Facebook, camera and Internet research, which means that either they did not well understand the question about the access or they have a computer, but the first hypothesis is more probable as the facilitator reported that many girls found those questions difficult to understand and computers are not much diffused in developing countries. The same applies to those girls who answered not having access at all to a mobile phone, but then marked they use phone calls, SMS, and internet research.

In the questionnaire, they had to choose how frequently they used those functionalities but in general, if they used it, they marked mostly *"3-5 times a week"* or *"daily"*.

## 7.1.2 Getting information

As the app mainly wants to empower girls with information, it was necessary to investigate how they could get information on topics such as laws, menstruation, sexual health, sex and contraception, and pregnancy.
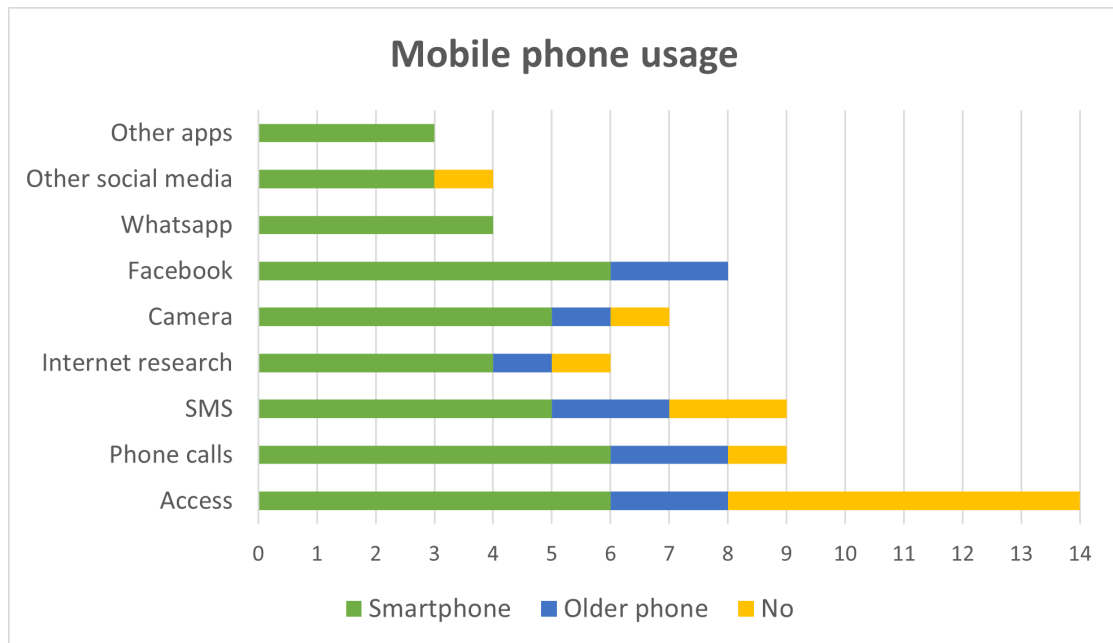
Figure 7.4: Mobile phone usage

**Internet research**  It was asked if they ever searched for such information on the internet and the answers are shown in figure 7.5. Most of the participants never looked at any of those topics on the internet, even if in the previous question they reported using internet research sometimes.

About laws and pregnancy, only 2 girls answered having looked at that on the internet once, while all the others never looked at it. Menstruation is the most searched topic, with 8 girls that searched it on the internet one or multiple times. About sexual health, 6 participants searched it once, and only one participant 2-3 times. Only one girl reported having looked for information about sex and contraception on the internet.

This data shows that even if participants had access to smartphones with internet connection, they did not look for this kind of information on the web.

**Speak with people**  Secondly, it was asked if they speak about those topics with other people, and the participants could put multiple answers for each topic. The results are shown in figure 7.6.

About marriage, most of the participants (10) speak with their mother, 2 do not have anyone to speak with and some girls reported speaking about it with other figures such as their father, other female family members, friends, teachers, and people in the church.

Regarding sex, 3 girls answered to not have anyone they can speak with, while

**Have you ever searched information about the following topics on the internet?**
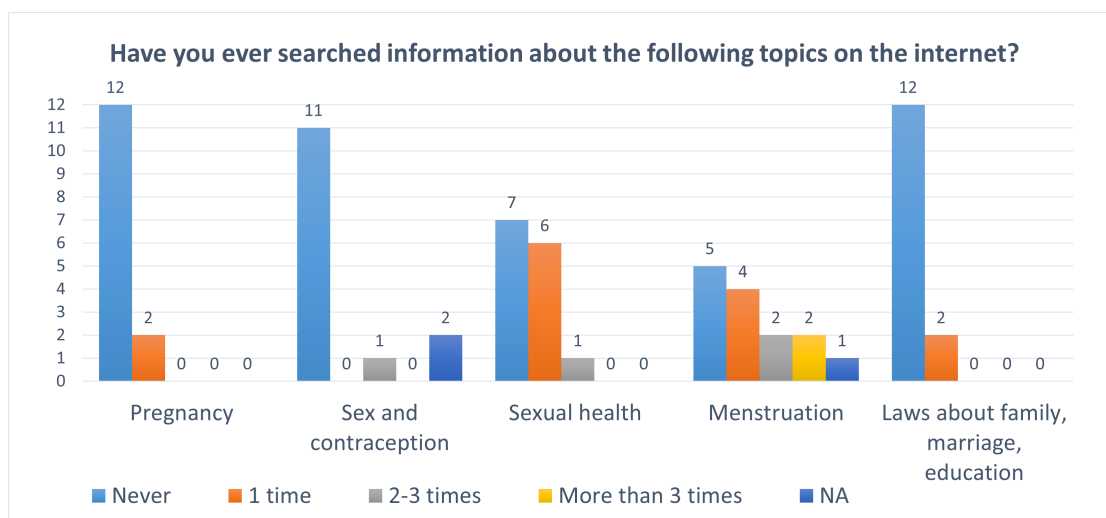
Figure 7.5: Internet research

the others are distributed between their mother, friends, and teachers. Similar results apply for sexual health, and one girl reported speaking also with the doctor.

Concerning menstruation, 10 participants answered they could speak with their mother, and only one said to not have anyone to speak with. 5 girls reported speaking with friends, 2 with teachers and female adults of the family, and 1 with the doctor.

About laws, 5 girls said not having anyone to speak with while 6 answered their mother and 1 her father.

**Do you have someone you can speak about these topics?**
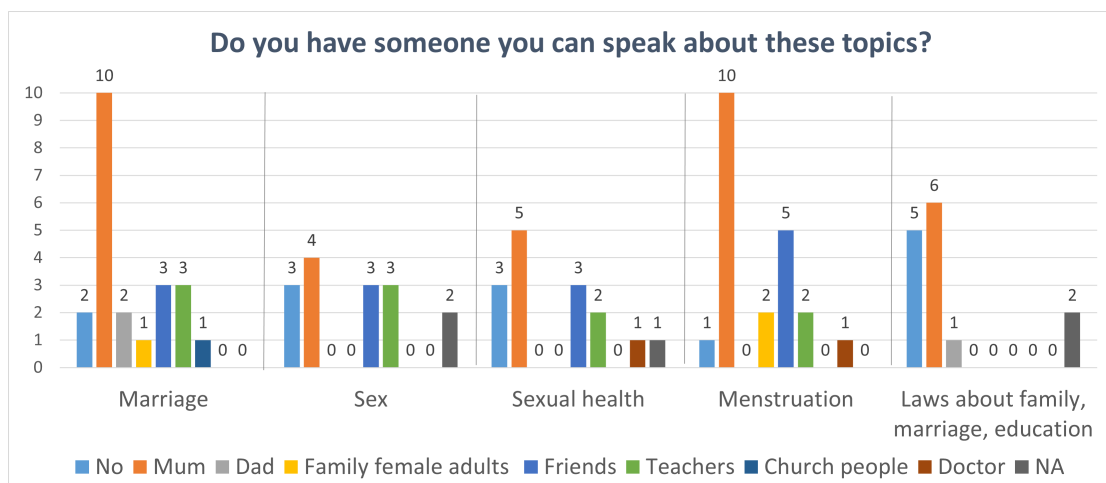
Figure 7.6: Speak with people

## 7.2    App testing

In this part of the questionnaire, the participants had to try the app on the phone to perform some tasks and then answer questions about the single tasks.

### 7.2.1    Task 1

The first task focused on the emergency call functionality. The instructions were the following:

> *First of all, read the tutorial of the app. Then, set "123456789" as the new emergency number, save the new settings, and press the button to call.*

To perform the task correctly, the participants had to: read the tutorial, where they could find information about the emergency call functionality and how to set the emergency number; go in the settings page; set the new number and save; press the emergency button to call.

**Difficulty of the task**    When asked if they had found the task easy, 5 of the girls answered *Easy*, 2 answered *Normal* and 7 answered *Difficult* or *Very difficult*. So, the task was more difficult than easy for the participants. Nevertheless, almost all of them reported that they did not feel frustrated while doing the task.



Figure 7.7: Difficulty of the task

**Help button**    Half of the girls asked for help from the facilitator, as illustrated in figure 7.8. Moreover, almost all of them used the help button to understand what to do and 9 girls in total reported that the instructions given in the help button were *Easy* or *Very easy* to understand.

Figure 7.8: Help button in task 1

**Correlation**   Figure 7.9 shows the Spearman correlation coefficient between the previous questions and the possibility for the girls to have access to a mobile phone. It is possible to see that there is a moderate correlation between the possibility to have access to a phone and question 2.1 which asked how easily could they do the task. Also, 2.2 and 2.3 have a strong correlation, which means that those who needed to ask for help are those who used the help button more.



| 2.1 | Could you do this task easily? |
|-----|-------------------------------|
| 2.2 | Did you need to ask for help? |
| 2.3 | Did you use the help button (black button with question mark) to understand what to do? |
| 2.4 | If you used it, are the instructions given by the help button easy to understand? |
| 2.5 | Did you feel frustrated while doing this task? |
| phone | Do you have access to a smartphone |

Figure 7.9: Spearman correlation for task 1

**Settings page**   Finally, almost all the girls found the settings page *easy* or *very easy* to understand, as shown in figure 7.10.
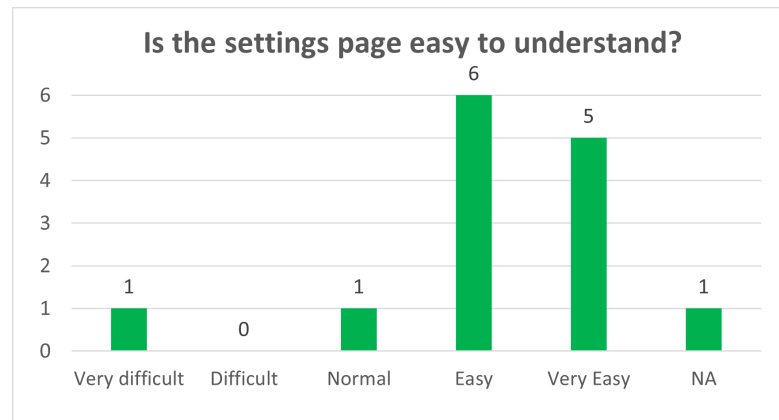
Figure 7.10: Difficulty of the settings page

## 7.2.2 Task 2

Task 2 focused on the get help and stories sections. First, they had to find answers to some questions in the app and then fill in a small questionnaire. The instructions were the following:

- *You want to report a case of child marriage, so you decide to call AidProfen. Find the phone number in the app. Which one is correct?*

- *Read Gloria's story.*

    - *How old was she when she was supposed to marry?*
    - *Who helped Gloria in going back to school?*

To perform the task correctly the participants had to open the "Get help" page and find the number of AidProfen, then go back to the Home Page, open "Stories", select Gloria's story and finally read it.

**Questions**  For the first question there were 4 possible answers: 3 phone numbers between which one was correct and *I did not find it.* As displayed in figure 7.11, only 3 girls (21%) found the answer in the app, and this may mean that the instructions about the get help section were not clear.

About the story section, all the girls found the correct answer, which means that the instructions about it were clear.

**Difficulty of the task**  When asked if they had found the task easy, 7 of the girls answered *Easy*, 4 answered *Normal* and 3 answered *Difficult* or *Very difficult*. So, the task was more easy than difficult for the participants, even if most of
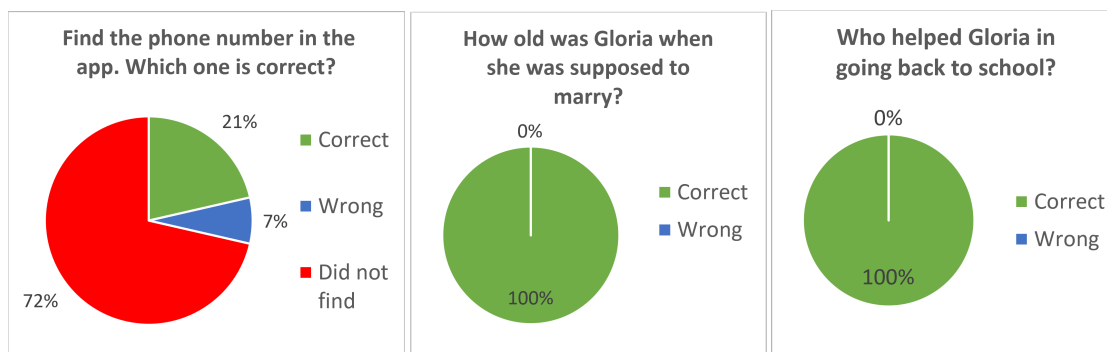
Figure 7.11: Questions

them could not find the phone number of AIDPROFEN. Despite they thought this task was easier than the previous one, there is a higher number of girls that felt frustrated while doing it than in Task 1.
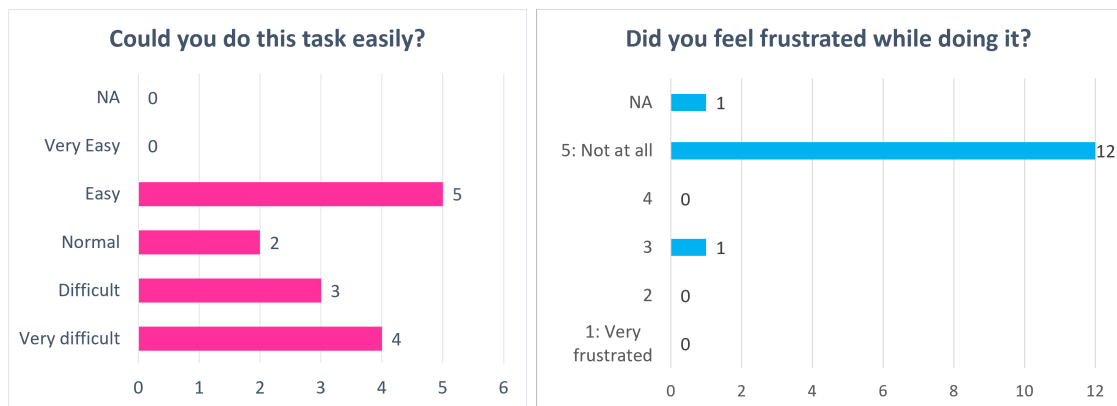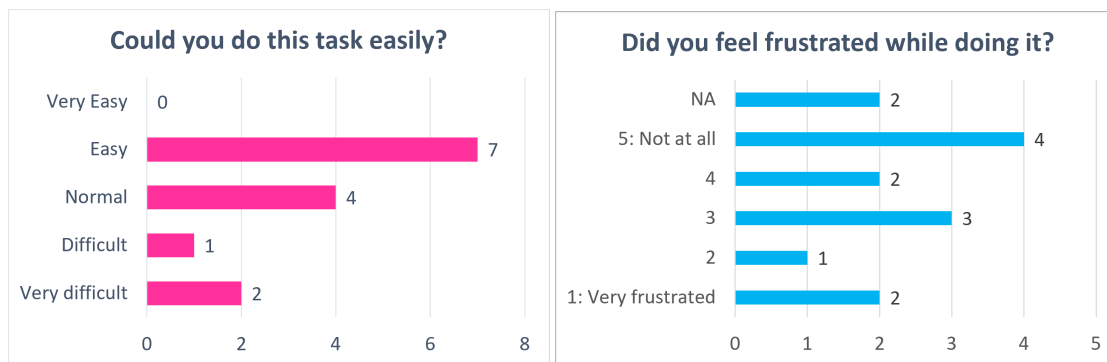


Figure 7.12: Difficulty of the task

**Help button**  Only a few of the girls asked for help from the facilitator, as illustrated in figure 7.13. Moreover, they reported they did not use the help button a lot to understand what to do, but 10 girls in total reported that the instructions given in the help button were *Easy* or *Very easy* to understand.
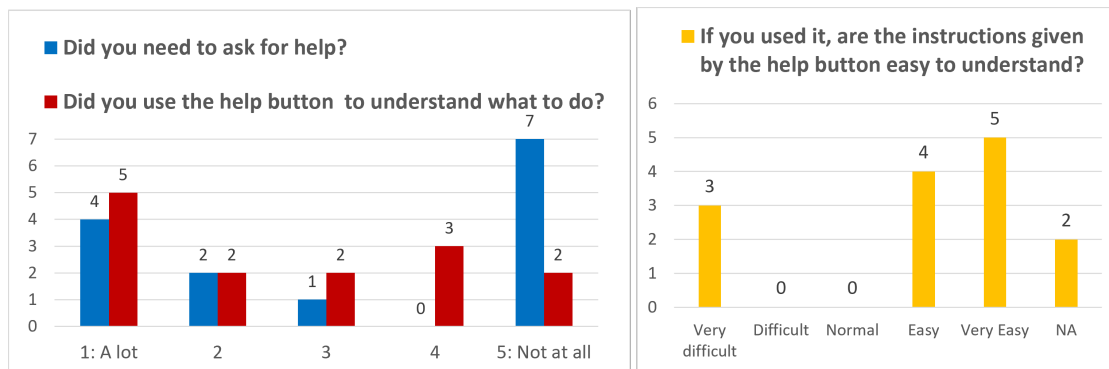
**Correlation**  Figure 7.14 shows the Spearman correlation coefficient between the previous questions and the possibility for the girls to have access to a mobile phone. That is no relevant correlation between the possibility to have access to a phone and how easy they found the task. As for the previous task, 3.5 and 3.6 have a strong positive correlation, which means that those who nee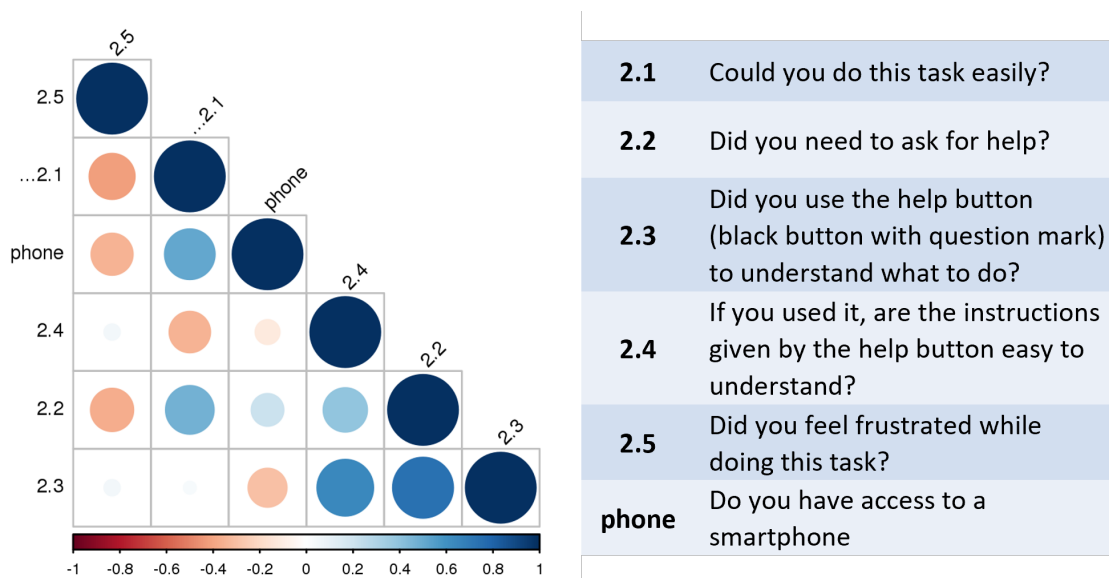ded to ask for help are those who used the help button more. Finally, there is a strong negative correlation between question 3.1 and most of the other variables, which means
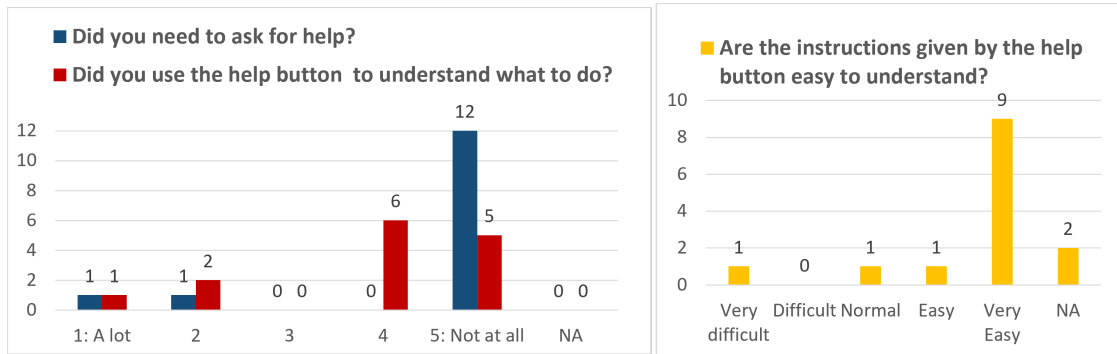
Figure 7.13: Help button in task 2
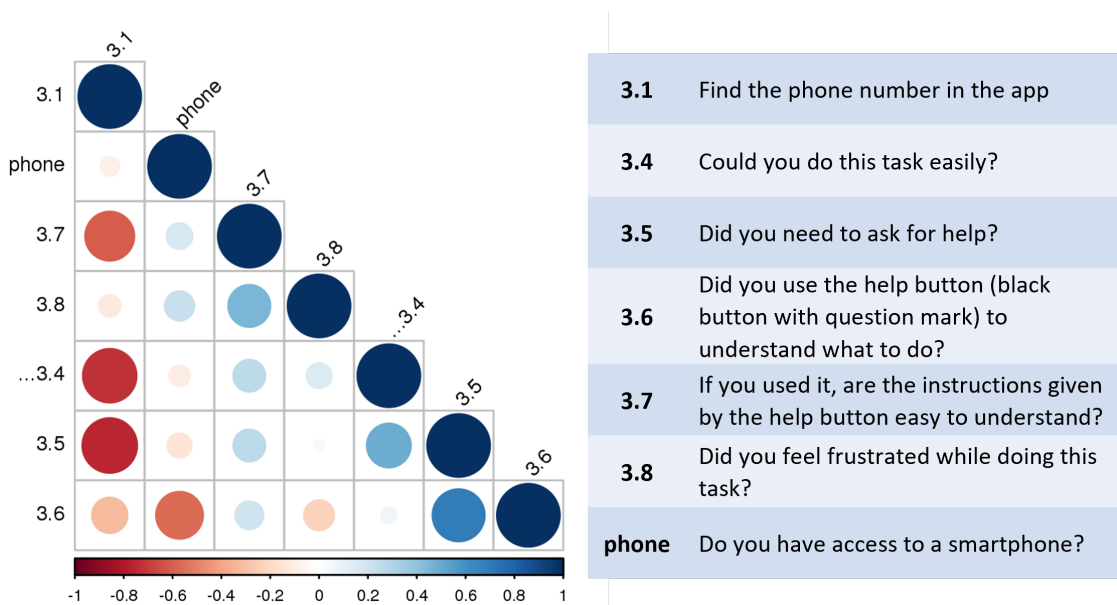


Figure 7.14: Spearman correlation for task 2

that many participants reported that everything was easy even if they could not find the phone number of AidProfen.

**Get help and Stories pages**   Finally, almost all the girls found both the get help and stories page *easy* or *very easy* to understand, as shown in figure 7.15. Concerning the stories page, the answers to this question are believable, while for the get help section, there are some discrepancies between what the participants answered to this question and the fact that most of them did not find AidProfen's phone number.
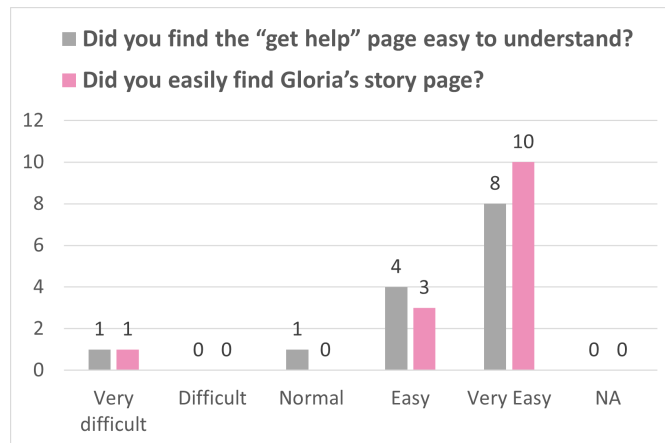
Figure 7.15: Difficulty of the get help and stories page

## 7.2.3 Task 3

The third task focused on the learning and quiz sections. The instructions were the following:

*Read the information about child marriage in the learning section, then play the quiz about child marriage.*

To perform the task correctly the participants had to open the "Learn" page, select "Child marriage", read the information, press the quiz button, and play the quiz.

**Difficulty of the task** This task seemed to be the easiest and less frustrating for the girls. In fact, almost all the girls found the task very easy and not frustrating.
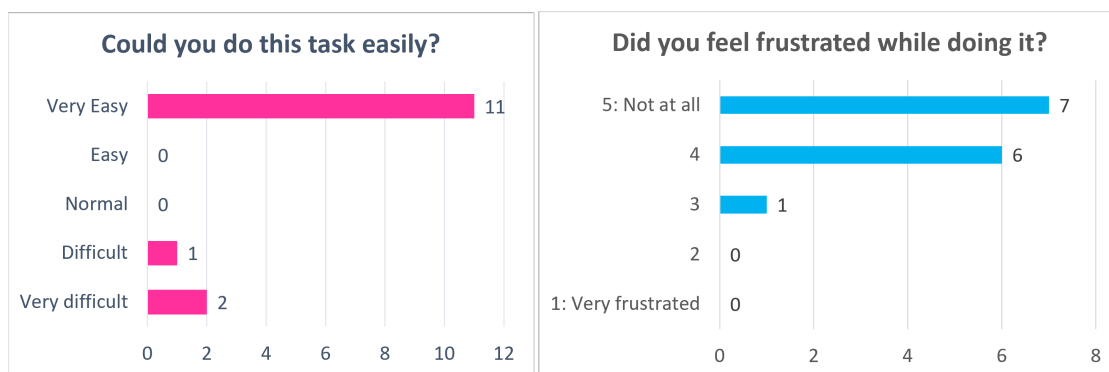


Figure 7.16: Difficulty of the task

**Help button**    Almost none of the girls asked for help from the facilitator and did not use too much the help button. Most of them also reported that the instructions in the help button were easy to understand.
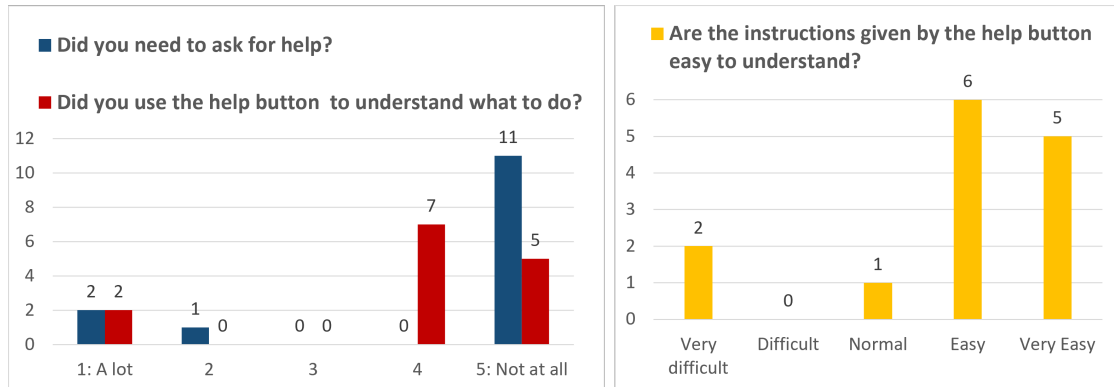


Figure 7.17: Help button in task 3
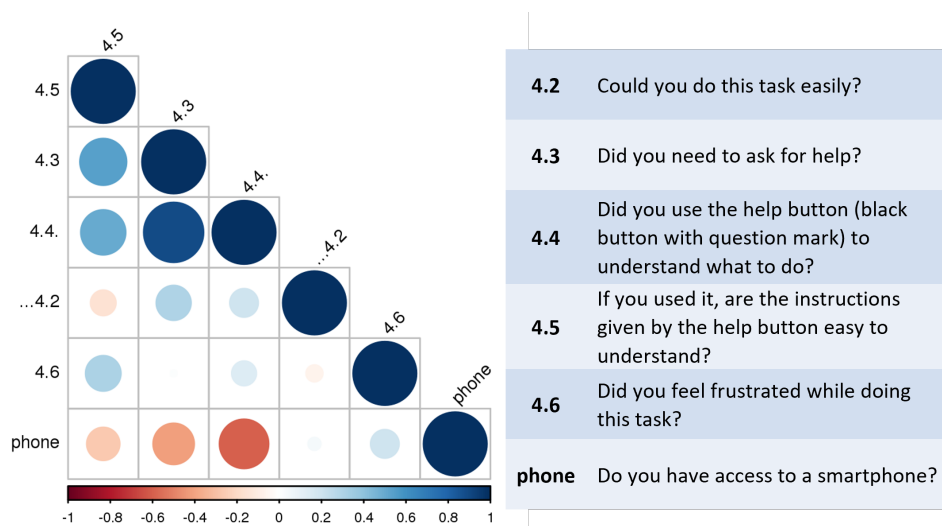


Figure 7.18: Spearman correlation for task 3

**Correlation**    Figure 7.18 displays the Spearman correlation coefficient between the previous questions and the possibility for the girls to have access to a mobile phone. That is no relevant correlation between the possibility to have access to a phone and how easy they found the task, and seems that those who have access to a mobile phone needed more help from the facilitator and the help button. As for the previous tasks, those who needed to ask for help are those who used the help button more.
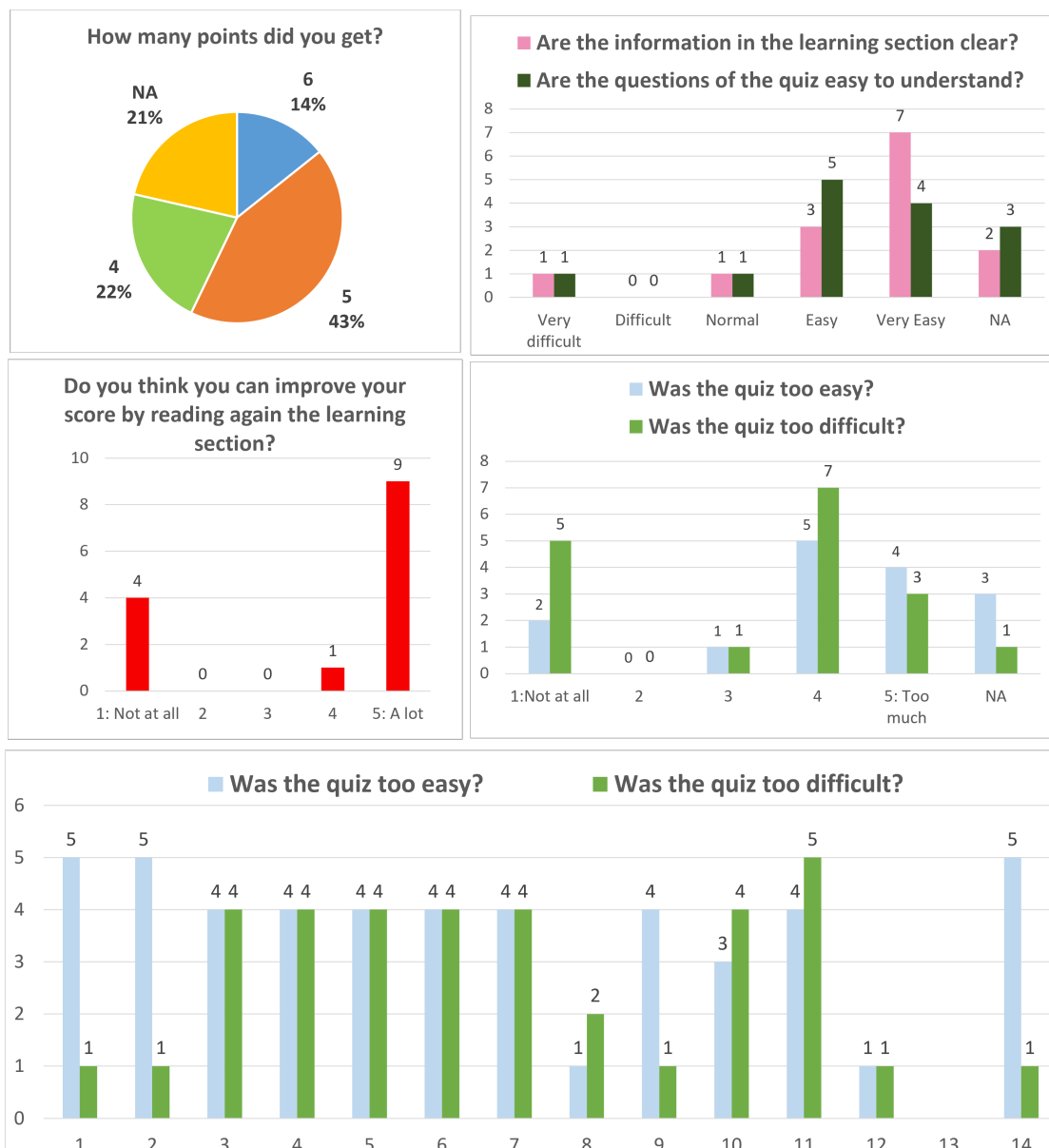
Figure 7.19: Quiz and learning section

**Quiz and learning section** Most of the participants did quite well in the quiz obtaining from 4 to 6 points out of 6 and the majority thinks that they can improve their score by reading again the learning section, as visible in figure 7.19.

The girls reported that the information in the learning section was clear and the questions of the quiz were easy to understand.

Regarding the difficulty of the quiz, some think that the quiz is too easy while

others that it is too difficult. If a closer look is taken to see how every single girl answered this questions, it is possible to see that half of the girls answered that it is both *too difficult* and *too easy* as they gave high scores to both questions. This may be due to the fact that in all the other questions of the questionnaire higher values were always associated with the idea of a *well-built app* while lower scores with the idea of a *badly-built app*, while for these two it was the opposite. So, some of the girls may have not read what the scores meant for these two questions.

## 7.3   System Usability Scale

The facilitator reported that the questions of this part of the questionnaire were really difficult for the girls to understand, and so some of them did not answer many of the questions or put clearly random answers. All the blanks were replaced with a 3 as suggested in [44]. The results of the System Usability Scale are shown in figure 7.20.

Considering all the participants, the total score is *63,39*. This score is between *OK* (50,9) and *Good* (71,4) according to [7], meaning that the base is good but there are things to improve to make the system more usable.
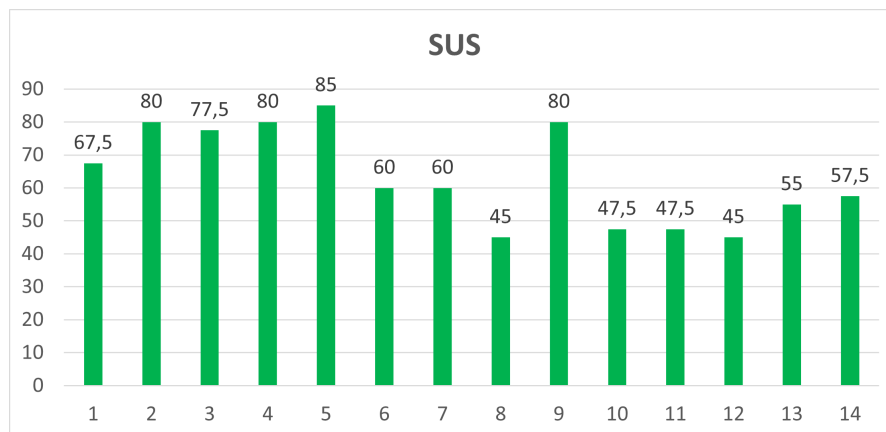


Figure 7.20: System Usability Scale

However, participants number 10 and 11 gave clearly random answers. Participant number 10's answers formed a shape on the paper that suggests she did not even read the questions, for example, she said that she did not find the app complex and difficult, but that she would need the support of a technical person and that most of the people would not learn to use it quickly. Participant number 11 agreed with *I found the app unnecessarily complex, I thought the app was easy to use, I would imagine that most people would learn to use this app very quickly* and

disagreed with *I found the app very cumbersome to use* and *I felt very confident using the app* clearly showing inconsistency between the answers.

Excluding these 2 participants from the score, it increases up to *66,04*, still between *OK* and *Good* but much more near to *Good*.

Moreover, participants 6 and 7 left five answers empty that have been replaced with a 3. Excluding also these participants, the total score would be *67,25*, very near to the threshold value of 68, but the participant number decreases under the number of 12. Tullis and Stetson [58] found that SUS can be considered reliable with at least 12 participants, and that it has an accuracy of 80% with 10 participants.

After having excluded these participants, only five of the 10 participants left answered question number 6 (I thought there was too much inconsistency in this app) and this may be because probably the girls did not understand the question because of the word "inconsistency", and so left it blank. Lewis [44] found that excluding one question from the SUS does not affect its reliability. Excluding question 6, the score of the SUS is *68,89* which is above the 68 threshold but still has only an accuracy of the 80%.
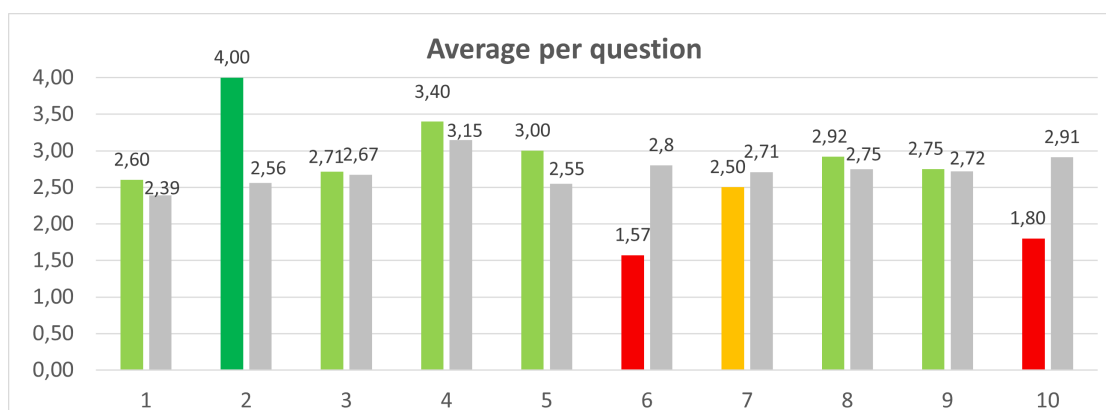


Figure 7.21: Analysis of SUS single questions

**Analysis of the single questions**  Figure 7.21 shows the scores that the single questions received compared to the average value requested to reach a SUS score of 68 according to [44] in grey. The scores are calculated doing the average of the values for each question and rebasing on a 0-4 scale, only the answers given by the girls were considered, and participants 10 and 11 were excluded.

Most of the questions are around the average. Particularly positive was question 2, *I found the app unnecessarily complex* meaning that none of the participants found the app unnecessarily complex. On the other hand, questions 6 and 10 received quite a negative score. Question number 6 has already been discussed in

the previous paragraph. Question number 10 was *I needed to learn a lot of things before I could get going with this app*, this may mean that the app could be still too difficult for the girls to use without a facilitator.

## 7.4   Final questions

The final questions were divided into questions about the functionalities, the style, and other comments.

### 7.4.1   Functionalities

It was asked if they thought the tutorial and the help button were useful and how clear are the information in the help button.

As shown in figure 7.22, most of the participants think that the tutorial is medium-useful or useful, while almost all the participants believe that the help button is very useful and the instructions very clear.

Moreover, almost all of the participants reported that both quizzes and stories are useful ways to learn apart from reading the content, as is visible in figure 7.24.
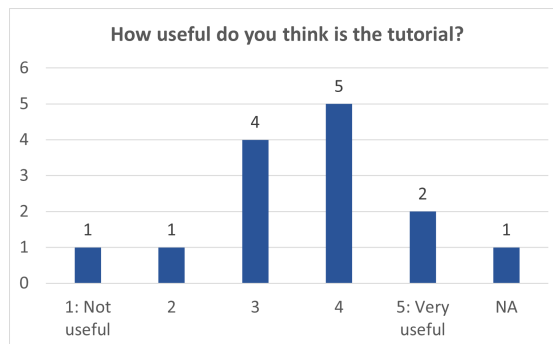


Figure 7.22: Tutorial

### 7.4.2   Style

Then, some questions about the style of the app were asked. Most of the participants liked the colors, but an alternative was not provided.

64% of the girls reported that all the items looked very good on the phone's screen while 36% that there were many problems, and nobody put an answer in the middle. However, this is very strange because all the participants used the same phone to try the tasks, so all of them should have found problems. As a result, it is necessary to further investigate this issue.
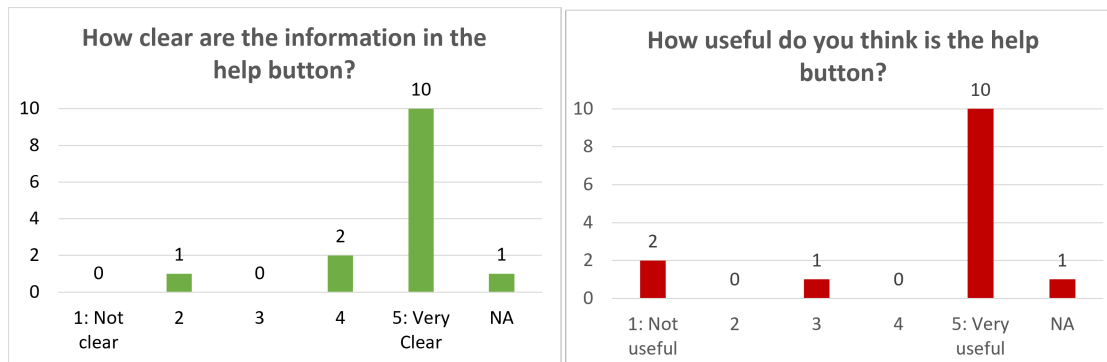
Figure 7.23: Help button
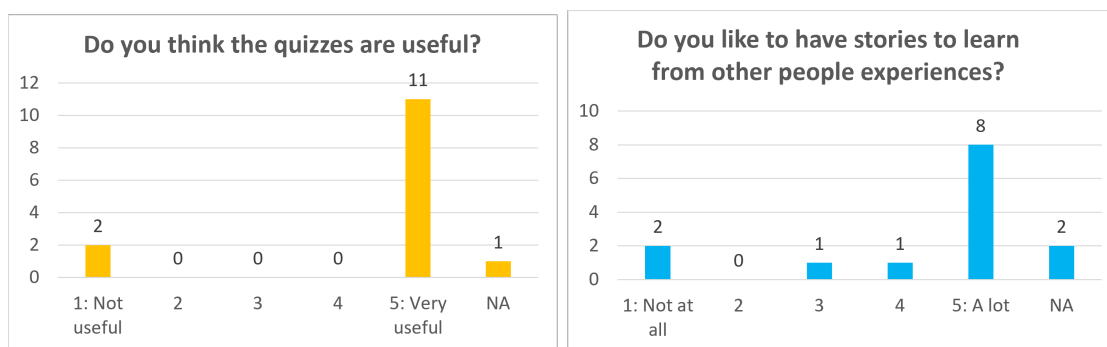


Figure 7.24: Quiz and stories

About the size of writings and images/icons almost all the participant thought that they are too big and so they should be reduced.

### 7.4.3 Other comments

Only one girl left a comment, and she only said that when it will be released, the app should be free.

## 7.5 Correlation

Figure 7.26 shows the Spearman correlation matrix for some of the variables, girls 10 and 11 have been excluded from this calculation because of their SUS.

The figure shows a strong negative correlation between the participation to the prototype testing, which means that girls that did not participate in the prototype testing found the tutorial more useful than those who participated, and the same applies for how easy they found task 2.
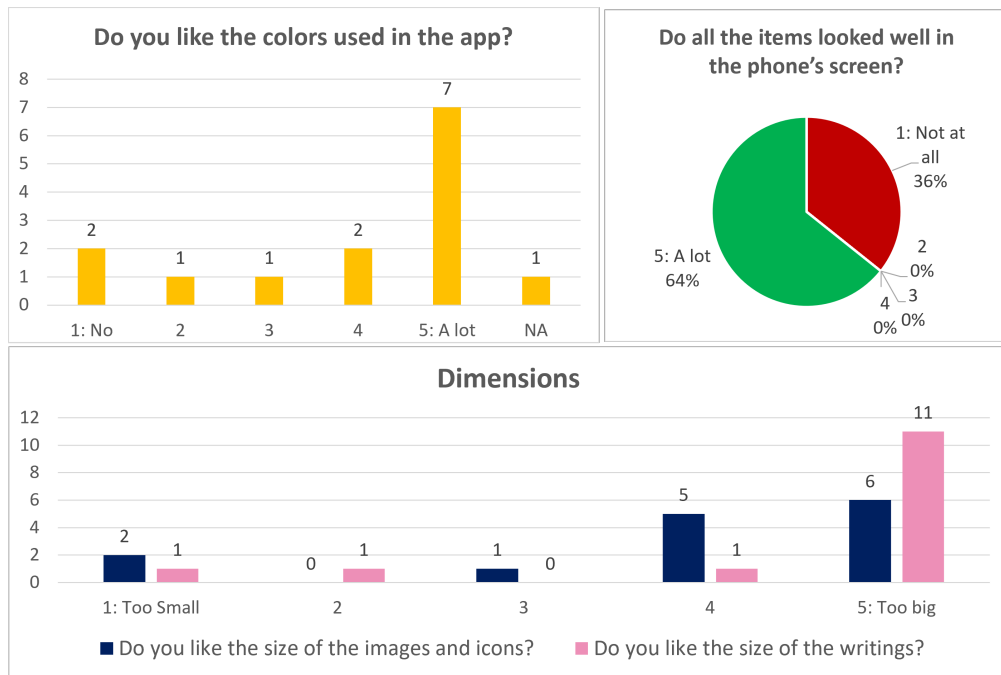
Figure 7.25: Questions about style
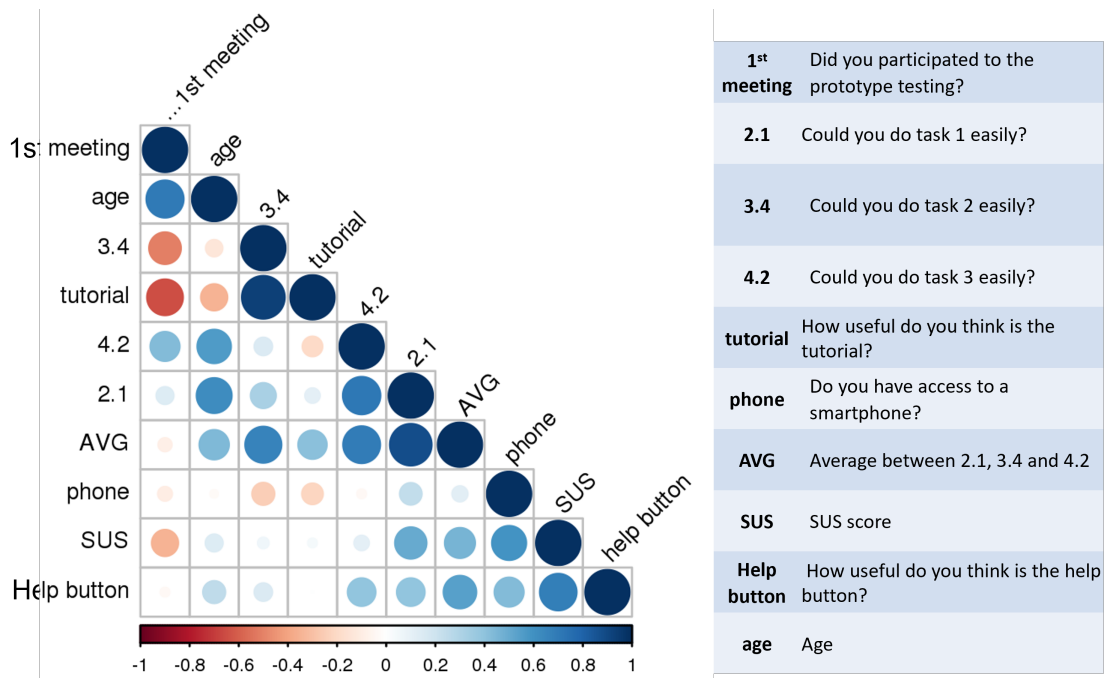


Figure 7.26: Spearman correlation

The phone ownership does not seem to be correlated to how easy the participants found the various tasks, but it is positively correlated to the SUS score and to how useful they found the help button, and also SUS and help button have a strong positive correlation. This means that girls that have access to a smartphone in their daily life found the app more usable and used the help button more than the others, and the participants who found the help button useful are those who gave a higher score in the SUS, showing that the help button increases usability. Moreover, task 1 also seemed to have an impact on the SUS as girls who found it easy have a higher SUS score, and unexpectedly girls that participated in the prototype testing had a lower SUS score than the other girls.

In addition, there is a moderate positive correlation between the average of how easy the participants found the various tasks and how useful they found the help button and the tutorial. Also, there is no relevant correlation between the AVG and the participation in the prototype testing.

Finally, there is a very strong positive correlation between how useful they think the tutorial is and how easy they found task 2.

## 7.6 Discussion

The testing session was organized with 6 of the girls who participated in the prototype testing and 8 who did not, to see if the previous exposure to the app influenced the results. Data shows that there is no correlation between how easy they found the various tasks and their participation in the previous meeting, meaning that a previous experience with the app did not influence their user experience.

Regarding mobile phones' ownership and access, the trend from the prototype testing for girls living in urban areas is confirmed: almost half of the girls have daily access to a smartphone. Moreover, data shows that those who have a smartphone use various apps and social media on it, and their experience is not limited to calls and SMS, in contrast with what was reported by the expert from DRC in the interview.

However, even if they have access to a smartphone and internet, most girls do not use it to search for information about topics such as pregnancy, sex and contraception, laws about family, marriage, and education. Some of the participants did search for information about sexual health once, and the topic that is more searched is menstruation. The participants reported that the person with whom they can mostly speak about these topics is their mother. However, not many of them can speak with her about sex and sexual health. Surprisingly, they do not speak so much about these topics with their friends. Moreover, the quality of the information they have should be further examined to tailor the content of the app to cover the gaps they have and to correct eventually wrong information.

Of the tasks, number 1 seemed to be the most difficult for the girls and this may mean that information about how to set the emergency number and its purpose need to be detailed more in the tutorial and the help button. The same applies to information about where to find organizations' contacts as most of the participants did not find AidProfen's phone number in task 2. The girls reported to have mostly used the help button in task 1 and not much in the other tasks. However, they said that the information was always clear and easy to understand and that this feature is very useful. In general, settings, get help, and stories were easy to understand according to the answers, but the get help page should be further investigated. The participants did quite well in the quiz and most of them think that they can improve their scores by reading again the learning section. The questions of the quiz were easy to understand and the text in the learning section was clear for most of the girls. Nevertheless, the difficulty of the quiz needs to be further investigated as most of the answers are inconsistent as they answered that it was both too difficult and too easy. Most of the participants thought that both quizzes and stories are very useful way to learn.

The results from the SUS, both considering all the participants and the eventual exclusions, are deemed satisfactory as this was the first version of the app and many participants were not used to mobile phones. The fact that the users that have a mobile phone have a higher score, indicates that the accessibility features for digital-illiterate users should be enhanced. For example, the full implementation of the audio feedback should be prioritized in the future steps of development, as well as an improvement for the text in both the tutorial and the help button.

Finally, even if the participants mostly liked the colors of the app, more versions with different colors could be developed to see which one they prefer. The fact that not all the items looked well on the phone screen for some participants should also be investigated, as they all used the same phone so it is not clear why 64% of the participants thought that everything looked very well and the 36% reported that there were many problems. Moreover, the size of the writings and images should be reduced.

This testing session wanted to investigate if an app could be usable by girls in developing countries and the results are positive. Further testing is necessary to understand if it is an effective way to fight child marriage and increase girls' knowledge about sex education after having included the contents.

**Limitations**   The testing session was organized remotely as it was not possible to go in the DRC. Because of this, the researcher's supervision to the testing was very limited and left to the facilitator, that was not en expert of technologies and this kind of testing.

The facilitator reported that the participants found some questions really dif-

ficult to understand, so a easier version of the questionnaire should be produced for future testing sessions.

## 7.6.1   Improvements in the app

The text in the help button and audio feedback was improved to explain better how the app works, and the size of writings and images was reduced.

Now, the highest priority is to add the audio content for the audio feedback, but it is necessary to find native french speakers available for recording them. Furthermore, Swahili translation and audio should be also added to include the non-french speakers as well.

The app is already quite usable by the girls according to the data, and at this point the content should be integrated. The contents require localization and should be developed by experts in the various topics.

# Chapter 8

# Results

The results produced with this project are two: the developed app and a conceptual framework for designing mobile learning apps for developing countries.

## 8.1 The mobile application

The mobile app developed lacks only the content, the audio, and the translation in Swahili and then a first version is ready to be released.

The app itself is built in a very modular way and is not content-specific. This means that the same code can be used to develop an app for a different place choosing which sections to include, and more sections can be developed and easily included in the project. The multi-language support allows to have a high number of languages without any effort apart from the plain translation and a very similar mechanism could permit the showing of different content based on the localization.

The effectiveness of the mobile app has not been tested yet, because the content is still missing and because of time constraints. To count a girl as a girl that escaped child marriage, ages are needed, as she has to turn 18 and still be not married. Moreover, before running this kind of test, is necessary to develop the version of the app for parents and community workers to reach the broader audience possible at the same time.

### 8.1.1 Principles for Digital Development

The project embraced the Principles for Digital development explained in Section 3.3.2 as much as possible. Each principle was addressed as follows:

1. **Design With the User**: the meetings with the girls in DRC had the goal of following user-centered design as this principle asks.

2. **Understand the Existing Ecosystem**: The cultural and social background of the target population was studied both through documents and by speaking directly with the girls.

3. **Design for Scale**: The product has been designed in the most modular way as possible, all the content is not hard coded in the app but loaded from files, which means that it would be really easy to adapt the platform to any other place or add another language.

4. **Build for Sustainability**: As for now the project is built with free tools only, so it does not require any business plan and it is sustainable by default.

5. **Be Data Driven**: There are no existing data about the target population and the project is not built to collect any data at the moment to keep the maximum privacy for the user.

6. **Use Open Standards, Open Data, Open Source, and Open Innovation**: All the frameworks and the digital tools used are open source, and the code of the project is available in a public GitHub repository.

7. **Reuse and Improve**: No suitable existing code was found to reuse so it was necessary to create a new product. What was reused and improved are the interfaces designed by Brevik. Moreover, the app is built in a modular way to incentivize the reuse of single sections.

8. **Address Privacy and Security**: The app does not collect any data from the users and, as for now, login is not required either.

9. **Be Collaborative**: The code is available for anyone to reuse and collaborate, as well as the thesis document itself with the description of all the data.

## 8.2   The conceptual framework

Based on the expert interviews and the case study in the DRC, a conceptual framework for designing mobile learning applications for developing countries has been proposed. The framework, shown in figures 8.1 and 8.2 can be used as an inspiration for developing any type of learning application, also not related to child marriage, but it has been used and tested only in this context.

The first step is the **context study**. It is very important to study the context of the place where the app is going to be used. In particular, this study needs to find out what are the characteristics of the usage of smartphones in the deployment
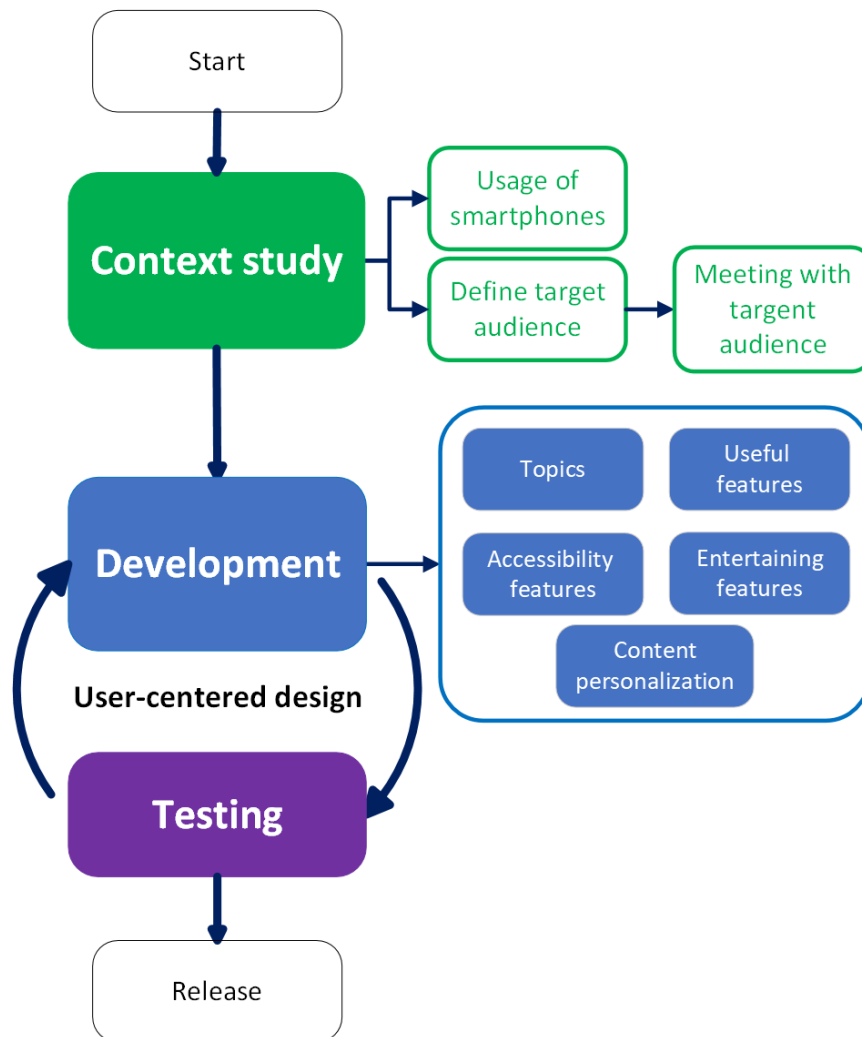
Figure 8.1: The conceptual framework pt.1

place, because if nobody has smartphone or mobile apps are not used, then it would be difficult that the project would work. Secondly, it is necessary to define the target audience, based on the smartphone ownership and the project's topic. In the case of an app to fight CEFM, the target audience can be girls, parents, and community workers (teacher, volunteers, village chairmen...). To have the higher probability of success for an app to fight CEFM, all three categories should be targeted either in the same app or with different complementary products.

Once the target group has been chosen, a preliminary meeting with them should be run to get to know better the target audience and understand their needs.

Then, a user-centered design cycle made of **development** and **testing** itera-

tions follows until the final release of the app.

For a learning app that targets developing countries, there are five components that should be considered when designing the app: topics to learn about, accessibility features to make the system usable by illiterate or digital illiterate people, useful features for the learning or related to the purpose, entertaining features to engage the user in the app, content personalization to tailor the content to the target population. Each of these five categories needs to be addressed and inserted in the app if it is appropriate to the chosen context.

The testing phase should always be done with the target population in developing countries and not in a different environment, otherwise the results are not reliable.
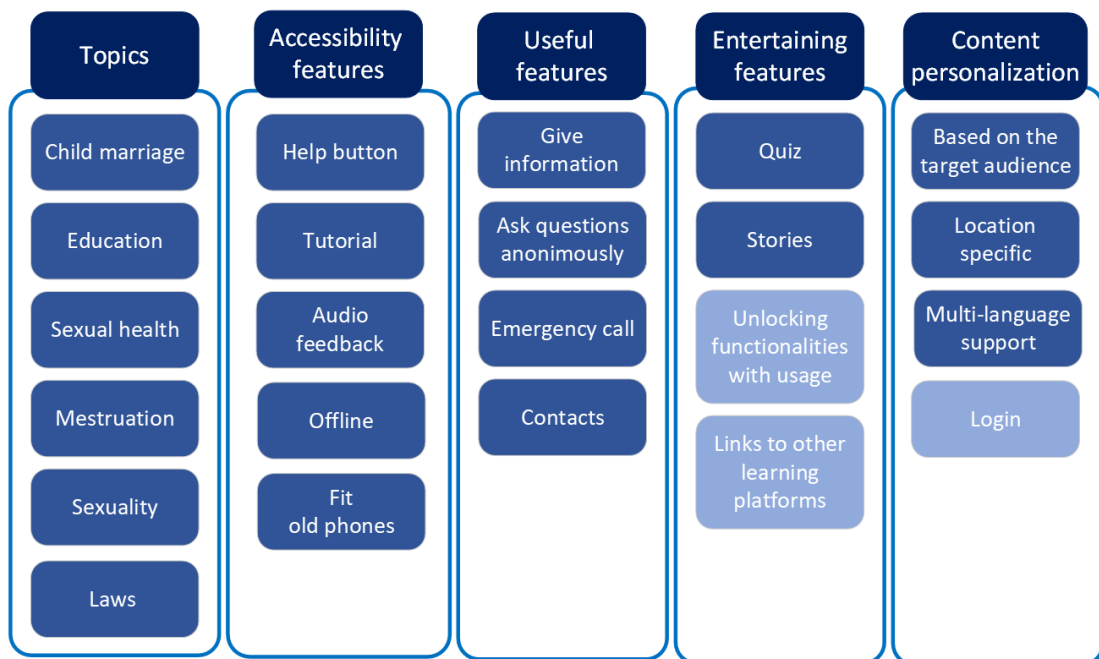


Figure 8.2: The conceptual framework pt.2

Figure 8.2 analyzes each component for an app to fight CEFM in developing countries that target girls and includes all the guidelines that were found and tested in this research. All these features should be considered when building an application with this purpose and based on the context and on the target group's thoughts each of them can be included or excluded. The development of these guidelines has been based on expert interviews and on a case study in the DRC.

The **topics** that should be put in the app are: child marriage, education, sexual health, menstruation, sexuality, and laws (human rights, laws about education, women, family...).

Moreover, the app should have **accessibility features** that allows low literate people or digital illiterate people to use the app, such as help button, tutorial, and audio feedback, or features that permit to people to access the app, such as the fact that the app should be offline as much as possible and fit old phones.

Then, there are the **useful features** that are: the app should have a learning section where the information is given, a section where girls can anonymously ask questions, the emergency call functionality, and a contacts page.

To increase the engagement of the users, **entertaining features** can be added, such as quizzes and stories. The experts also approved the possibility of unlocking new functionalities with usage and links to other learning platforms, but these functionalities were not tested with the girls.

Finally, the **content personalization** is very important and includes personalization based on the age and role of the target audience, personalization based on the location, and multi-language support of the app with contents in the local languages, which can be more than one. Personalization can be obtained through a login if necessary, which would also allow keeping the privacy of the users in case they share a phone. Nevertheless, this functionality has not been tested with the girls.

In case the target population is not girls, but parents or community workers, this part of the conceptual framework should be taken as inspiration but some of the features may not be appropriate and new ones should be developed.

# Chapter 9

# Conclusions

This project showed that there are people in developing countries that own smartphones, so an app can be an additional tool to fight CEFM on the side of the traditional ones. For sure this instrument cannot be used everywhere as there are still many places where access to smartphones is limited. Nevertheless, even if only a single girl is saved from child marriage thanks to this app it should already be considered a success.

Even if not all the girls have a smartphone, those who have it can use the app to learn about the topics and maybe share the information with their friends. None of the instruments used to fight child marriage is meant to be global, so it is not a great drawback that this is not. Moreover, when the versions of the app for parents and community workers will be developed, a broader audience will be reached.

The background related to child marriage and ICT4D was studied, and a first version of the design guidelines was proposed based on it. The guidelines were tested with 4 expert interviews with people from Norway, South-East Asia, and the DRC. After, a prototype for an app that targets girls was proposed based on the results. Successively, a case study in the DRC was run through a partnership with a local organization that recruited girls aged 15-19. The user-centred development process included two sessions with girls from the DRC, one where they were asked to provide oral feedback about the prototype and one when they had to test the app by performing some tasks and filling in a questionnaire. It resulted in the development of the first version of the app. The local organization, AidProfen, is eager to continue working on this project in the future.

It was shown that the developed app is usable by girls from the DRC, as most of them could easily complete most of the proposed tasks, and even if the SUS did not get a high score, it is satisfactory considering that many girls had never used a smartphone before. It was not possible to test if the app helps in preventing child marriage as years are needed to do this and the content is still missing.

The developed app is easily adaptable to other contexts and places as it is built in a very modular way and it respects as much as possible the principles for digital development as explained in section 8.1.1.

Furthermore, a conceptual framework to develop learning apps for developing countries and a specific version for apps that target girls have been proposed. As it was built based on the expert interviews and the case study in DRC, it is valid at least for those places where the experts live or had experience with or countries with a similar social and technological setting to the DRC. Different studies run in different places could lead to different findings.

## 9.1   Answers to the research questions

The answers to the research questions are as follows.

### RQ1: How can a mobile application be effective in fighting child marriage in developing countries?

One of the interventions to prevent child marriage that seem to work most is empowering girls with information combined with the education of parents and communities. A mobile application can be designed as a learning application to inform people.

To increase the possibilities of being effective, it is necessary to target the greatest audience possible, which means girls, parents, and community workers, and each category needs different information tailored to their needs.

Furthermore, the mobile application needs to be localized, which means that it should address the drivers of child marriage in the specific region, have localized content, for example regarding laws and stories, and be in the local language. Moreover, as the percentages of low-literate and digital-illiterate people are high in developing countries, accessibility features to allow those kinds of people to use it should be included. Moreover, as in general the smartphones that people in developing countries have are old and internet connection is expensive, the app should fit old phones and be partially or totally offline. Finally, the design process should follow a user-centered design methodology.

### RQ2: How should a mobile application that targets girls in developing countries to fight child marriage be designed?

It should be designed following the conceptual framework proposed in section 8.2 and by following the Principles for Digital Development as much as possible.

The app should have not only CEFM-specific content but also sex education content as it is difficult for girls in developing countries to receive correct information about these topics.

It is really important to run preliminary research about the context in which the app will be deployed and have meetings with the girls throughout the development process following a user-centered design methodology.

All the testing should be done with girls from developing countries. It is not meaningful to test the app in non-developing countries as the girls would be much more used to smartphones and apps.

The app should have the features displayed in section 8.2 to be usable, useful and engaging.

## 9.2 Future works

The developed app needs to be completed with the missing content and the first version released in the DRC. More feedback should be collected and the app improved following the user-centered design method. In particular, the usability of the app for the digital-illiterate people should be increased.

Moreover, complementary platforms for community workers and parents should be developed. The one for community workers would be particularly important as it pairs with the one for the girls for answering their questions and dealing with the case reports.

Then, the effectiveness of the app should be tested, for example, using action research methods, with one group that is exposed to the app and another group that is not to see if the CEFM trend diminishes. But, as already explained, this kind of testing takes years.

Finally, the validity of the framework could be increased by interviewing more experts from different countries and more people in developing countries, and a version for community workers and parents of the features should be developed.

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# Appendices

# A Expert interviews' questions

- Can you present yourself and your role in your company/NGO?

- Do you have experience in fighting child marriage?

- From your experience, how do people in developing countries use technology?

- Have you/your company ever developed an app that targets low-literate people in developing countries or has an educational purpose or aims to create a better society?

  - What do you think is the most important feature in these kind of apps?
  - How do you test this kind of app?

- Have you/your company ever developed an app that targets children, in particular girls, aged 10-18? Can you tell me about the process?

- Do you know about any app that helps to combat child marriage?

- Who should the app target? Girls, parents, NGO volunteers, teachers? What content would be appropriate?

- Now I will show you some interfaces designed by another student, do you think they are effective? Would you change something?

- What do you think about the following features: Registration and login to personalize the content (Different content for: village leaders, girls, parents, NGO volunteers); Unlock new functionalities with usage; Support multiple users in the same phone, links to other learning platforms, Audio feedback, Help button, Tutorial in the beginning, Quiz and games.

- Do you have any other suggestion regarding an app to combat child marriage?

- Could your company/NGO provide any support to me in involving people for testing?

- Do you have any general advice or tip for the project?

- Do you have any other comment?

- Do you know any person do you think I should speak with?

# B NSD application

## B.1 NSD application for expert interviews

## NSD NORSK SENTER FOR FORSKNINGSDATA

## Notification Form

**Reference number**

721719

**Which personal data will be processed?**

- Name (also with signature/written consent)
- Address or telephone number
- Email address, IP address or other online identifier
- Photographs or video recordings of people
- Sound recordings of people
- Background data that can identify a person

**Type of data**

**You have indicated that you will be processing background data that can identify individual persons, describe which**

working company or organisation, working role

**Will you be processing special categories of personal data or personal data relating to criminal convictions and offences?**

No

**Project information**

**Project title**

Software for a better Society - Development of an app to combat child marriage

**Project description**

Early marriage is still a reality for many children, in particular girls, in different parts of the world. When children are forced to marry at an early age, they are more probably going to stop their education and suffer from bad health. Between the common reasons for child marriage there are poverty, family honour, financial incentives, low education, non-enforcement of laws and traditions.

Previous studies show that an app could help in reducing the number of children involved in an early marriage by spreading information about the dangers of getting married so early, providing contacts to reach in case of emergency and giving answer to common questions and superstitions regarding health and marriage. Therefore, we want to develop an application with the aim of fighting child marriage by

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empowering girls and parents with information and education.

**Explain why the processing of personal data is necessary**

As most child marriages are performed between low-literate and illiterate people in developing countries, we want to interview people with experience in creating or using applications that targets children and/or low-literate people and/or developing countries.
Who best knows what type of content would help more, are the potential users of the app and NGOs that work in the field. We want to gather information about the best content and to do so, we want to conduct some interviews. Due to the ongoing pandemic we will conduct all the interviews over video call.

**External funding**

**Type of project**

Student project, Master's thesis

**Contact information, student**

Ilaria Crivellari, ilaric@stud.ntnu.no, tlf: +393395745173

**Data controller**

**Data controller (institution responsible for the project)**

Norges teknisk-naturvitenskapelige universitet / Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og informatikk

**Project leader (academic employee/supervisor or PhD candidate)**

Letizia Jaccheri, letizia.jaccheri@ntnu.no, tlf: 91897028

**Will the responsibility of the data controller be shared with other institutions (joint data controllers)?**

No

**Sample 1**

**Describe the sample**

NGO or companies employers that have previous experience in app that targets low literate people and/or children and/or developing countries.

**Recruitment or selection of the sample**

Companies, NGOs and individuals will be contacted by email. This will be done via its own network, and through public contact on the organisations' own website.

**Age**

18 - 80

**Will you include adults (18 years and over) who do not have the capacity to consent?**

No

**Personal data relating to sample 1**

- Name (also with signature/written consent)
- Address or telephone number
- Email address, IP address or other online identifier
- Photographs or video recordings of people
- Sound recordings of people
- Background data that can identify a person

**How will you collect data relating to sample 1?**

**Personal interview**

**Legal basis for processing general categories of personal data**

Consent (art. 6 nr. 1 a)

**Information for sample 1**

**Will you inform the sample about the processing of their personal data?**

Yes

**How?**

Written information (on paper or electronically)

**Sample 2**

**Describe the sample**

NGO or companies employers that have previous experience in fighting child marriage and/or have contact with childre and families in developing countries

**Recruitment or selection of the sample**

Companies, NGOs and individuals will be contacted by email. This will be done via its own network, and through public contact on the organisations' own website.

**Age**

18 - 80

**Will you include adults (18 years and over) who do not have the capacity to consent?**

No

**Personal data relating to sample 2**

- Name (also with signature/written consent)
- Address or telephone number
- Email address, IP address or other online identifier
- Photographs or video recordings of people
- Sound recordings of people

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- Background data that can identify a person

**How will you collect data relating to sample 2?**

**Personal interview**

**Legal basis for processing general categories of personal data**

Consent (art. 6 nr. 1 a)

**Information for sample 2**

**Will you inform the sample about the processing of their personal data?**

Yes

**How?**

Written information (on paper or electronically)

**Third Persons**

**Will you be processing data relating to third persons?**

No

**Documentation**

**How will consent be documented?**

- Electronically (email, e-form, digital signature)

**How can consent be withdrawn?**

Contact Ilaria Crivellari by e-mail or telephone

**How can data subjects get access to their personal data or have their personal data corrected or deleted?**

At the end of the interview, everything that has been noted will be sent to the person in question for approval. Necessary changes must be specified and those responsible will make the changes.

**Total number of data subjects in the project**

1-99

**Approvals**

**Will you obtain any of the following approvals or permits for the project?**

**Processing**

**Where will the personal data be processed?**

- External service or network (data processor)

**Who will be processing/have access to the collected personal data?**

- Data processor
- Project leader
- Student (student project)
- Internal co-workers

**Which data processor will be processing/have access to the collected personal data?**

Microsoft OneDrive is used to store the interviews, and Microsoft Teams is used for conducting. NTNU has a data processor agreement with Microsoft, and all services are password protected. The student who conduct and transcribe the interviews will be the only one with access to the interview recordings.

**Will the collected personal data be transferred/made available to a third country or international organisation outside the EU/EEA?**

No

**Information Security**

**Will directly identifiable data be stored separately from the rest of the collected data (e.g. in a scrambling key)?**

Yes

**Which technical and practical measures will be used to secure the personal data?**

- Restricted access
- Personal data will be anonymised as soon as no longer needed

**Duration of processing**

**Project period**

07.02.2022 - 31.12.2022

**Will personal data be stored after the end of the project?**

No, the collected data will be stored in anonymous form

**Which anonymization measures will be taken?**

- The identification key will be deleted
- Personally identifiable information will be removed, re-written or categorized
- Any sound or video recordings will be deleted

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**Will the data subjects be identifiable (directly or indirectly) in the thesis/publications from the project?**

No

**Additional information**

# B.2 Consent letter for expert interviews

## Are you interested in taking part in the research project
### *Development of an app to combat child marriage*?

This is an inquiry about participation in a research project where the main purpose is to develop a mobile application or website to help fighting child marriage in low-developed countries. In this letter we will give you information about the purpose of the project and what your participation will involve.

**Purpose of the project**
Early marriage is still a reality for many children, in particular girls, in different parts of the world. When children are forced to marry at an early age, they are more probably going to stop their education and suffer from bad health. Between the common reasons for child marriage there is poverty, family honour, financial incentives, low education, non-enforcement of laws and traditions.

Previous studies show that an app could help in reducing the number of children involved in an early marriage by spreading information about the dangers of getting married so early, providing contacts to reach in case of emergency and giving answer to common questions and superstitions regarding health and marriage. Therefore, we want to develop an application with the aim of fighting child marriage by empowering girls and parents with information and education.

Our main research question is "How to develop app to combat child marriage?" and we identified the following subquestions:
- What is the current state of the art of using software to combat child marriage?
- What is the current state of the art in developing apps with an educational purpose for low-literate people?

This project is developed in a Master Thesis at NTNU (Trondheim, Norway) within "Software for a better Society" research group under the Department of Computer Science.

**Who is responsible for the research project?**
Norges Teknisk-Naturvitenskapelige Universitetis (NTNU), Department of Computer Science is the institution responsible for the project.
The leader of the research group is Letizia Jaccheri, professor at NTNU.

**Why are you being asked to participate?**
As most child marriages are performed between low-literate and illiterate people in developing countries, we want to interview people with experience in creating and/or testing applications that target those subjects in order to create the best application possible. Moreover, we also want to gather information about apps with educational purposes and that addressed to children.
Your contact details have been obtained through the professor Letizia Jaccheri.

**What does participation involve for you?**
- If you chose to take part in the project, this will involve that you will participate in an online interview through Microsoft Teams. It will take approx. 1 hour.
- The interview will include questions about developing software for low-literate people, developing countries, children, education and software for a better society. You will receive the questions list before the interview so you can prepare yourself.
- The interview will be recorded on Microsoft Teams and later transcribed

**Participation is voluntary**
Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

**Your personal privacy – how we will store and use your personal data**
We will only use your personal data for the purposes specified in this information letter. We will process your personal data confidentially and in accordance with data protection legislation (the General Data Protection Regulation and Personal Data Act).

- Only the student conducting the interview and the supervisor will have access to the interview recording and to your personal data.
- The other participant in the research group will have access only to your anonymized data.
- The recording will be stored on Microsoft Teams and deleted after the transcription that will include only anonymous data.
- The transcription will be sent to you to have your approval.
- Contact details will be stored separately from the rest of the collected data.
- A summary of the interview will be included in the final publication of the thesis, you will not be recognizable in this publication.

**What will happen to your personal data at the end of the research project?**
The project is scheduled to end 31/12/2022. At the end of the project the recordings and all your personal data will be deleted. Only the anonymous transcriptions of the interview will be kept.

**Your rights**
So long as you can be identified in the collected data, you have the right to:
- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data

**What gives us the right to process your personal data?**
We will process your personal data based on your consent.

Based on an agreement with NTNU, NSD – The Norwegian Centre for Research Data AS has assessed that the processing of personal data in this project is in accordance with data protection legislation.

**Where can I find out more?**
If you have questions about the project, or want to exercise your rights, contact:
- NTNU via student Ilaria Crivellari (ilaric@stud.ntnu.no) or professor Letizia Jaccheri (letizia.jaccheri@ntnu.no).
- Our Data Protection Officer: Thomas Helgesen (thomas.helgesen@ntnu.no)
- NSD – The Norwegian Centre for Research Data AS, by email: (personverntjenester@nsd.no) or by telephone: +47 55 58 21 17.

Yours sincerely,

Project Leader                   Student
Letizia Jaccheri                 Ilaria Crivellari

--------------------------------------------------------------------------------------------------------------

## Consent form

Name: _____

I have received and understood information about the project *Development of an app to combat child marriage* and have been given the opportunity to ask questions. I give consent to:

- ☐ to participate in an online interview
- ☐ store the video recording of the interview until the transcription is done
- ☐ for my anonymised data to be stored after the end of the project for further studies
- ☐ for the summary of the interview to be published in a way I am not recognizable

I give consent for my personal data to be processed until the end date of the project, approx. 31/12/2022.

--------------------------------------------------------------------------------------------------------------
(Signed by participant, date)

# C  Prototype testing questions

**General**

- What is your name?
- How old are you?
- Where do you live? Is it a rural area or urban area?
- Are you going to school? How long have you been to school?

**Marriage**

- What is marriage for you?
- When do you plan to get married?
- What is the normal age to get married?
- Do you know at what age you are allowed to get married?
- Is there a place (library, school, or similar) where you can go to find information about marriage?

**Mobile phones**

- Do you or someone you live with have a mobile phone?

    - If yes, what do they use that phone for?
    - Is it a smartphone?
    - Are you allowed to use it? If yes, how do you use it?
    - Do you use any app?
    - Is the phone you can use shared?

- If no, what would you use it for if you had one?
- Do you use the internet?
- What do you use/would use the internet for?

**Designs**  Now I will show you some designs and I would like to know what you think about them.

  **Welcome page**:

- Do you know what a tutorial is?
- Do you think is important to have a tutorial?

- Would you like to have this emergency call button?

- When would you use it?

**Home page**:

- Would you like an help button that explains you what you can do in each page?

- Would you like to have audio feedback, which is a voice that explains you what you can do in every page?

**Learn**:

- Do you think these topics are good?

- What would you like to learn in the app?

**Stories and videos**:

- Are you used to stories being used for education?

- Have you ever used stories to learn about child marriage? What kind of stories?

- Would you like to have videos in the app?

**Contacts**:

- Would you like to have a contacts page?

- Do you prefer phone number or place or both?

- There are other organization you would like to have?

**Games**:

- Would you like to have some quiz in the app to see what you know and what you have learnt?

**Conclusion**

- Do you have any other suggestion regarding an app to combat child marriage?

- Is there something else you would like to have in an app with this purpose?

- Do you have a suggestion for the name of the app?

# D   App testing questionnaire

**Tester number:**

**Questionnaire – 2nd Testing**

Age: _____

Did you attend the meeting in April?     [   ] Yes          [   ] No

**Please write your tester number on the top of all the pages**

**Previous experience:**

1.1   Do you have a mobile phone?

    [   ] Yes, I have a personal smartphone        [   ] Yes, I have a personal phone (no smartphone)
    [   ] I share a smartphone with_____        [   ] I share an older phone with _____
    [   ] No

1.2   If you don't have a phone, do you have access to a phone that you can use? (For example of a friend, family member….) How frequently?

|  | Never | Less than 1 a month | 1-3 times a month | 1-2 times a week | 3-5 times a week | Daily |
|---|---|---|---|---|---|---|
| Smartphone |  |  |  |  |  |  |
| Older phone |  |  |  |  |  |  |

1.3   If you have access to a phone or smartphone, how frequently do you use the following things?

|  | Never | Less than 1 a month | 1-3 times a month | 1-2 times a week | 3-5 times a week | Daily |
|---|---|---|---|---|---|---|
| Phone calls |  |  |  |  |  |  |
| SMS |  |  |  |  |  |  |
| Search information on the internet |  |  |  |  |  |  |
| Camera |  |  |  |  |  |  |
| Facebook |  |  |  |  |  |  |
| Whatsapp |  |  |  |  |  |  |
| Other social media: _____ _____ |  |  |  |  |  |  |
| Other apps: _____ _____ |  |  |  |  |  |  |

# Tester number:

1.4   Have you ever searched information about the following topics on the internet?

| | Never | 1 time | 2-3 times | More than 3 times |
|---|---|---|---|---|
| Pregnancy | | | | |
| Sex and contraception | | | | |
| Sexual health (sex transmitted diseases) | | | | |
| Menstruation | | | | |
| Laws about family, marriage, education | | | | |

1.5   Do you have someone you can speak about this kind of topics? Who?

| | No | Mum | Dad | Other female adults in the family | Friends | Teachers | Church people | Other (write who) |
|---|---|---|---|---|---|---|---|---|
| Marriage | | | | | | | | |
| Sex | | | | | | | | |
| Sexual health | | | | | | | | |
| Menstruation | | | | | | | | |
| Laws about family, marriage, education | | | | | | | | |

# Tester number:

## APP TESTING

Now you are going to try the app. You will have a series of task to perform. You can take your time and ask help in case of need. Don't worry if you need help, this will make me understand that the app is too complex and that I have to make it simpler. At the end of each activity, you will need to compile a questionnaire.

## TASK 1:

**First of all, read the tutorial of the app. Then, set 123456789 as the new emergency number, save the new settings, and press the button to call.**

|     |                                                                              |                    | 1 | 2 | 3 | 4 | 5 |                |
| --- | ---------------------------------------------------------------------------- | ------------------ | - | - | - | - | - | -------------- |
| 2.1 | Could you do this task easily?                                               | Very difficult     |   |   |   |   |   | Very easy      |
| 2.2 | Did you need to ask for help?                                                | A lot              |   |   |   |   |   | No             |
| 2.3 | Did you use the help button (black button with question mark) to understand what to do? | A lot   |   |   |   |   |   | No             |
| 2.4 | If you used it, are the instructions given by the help button easy to understand? | Very difficult |   |   |   |   |   | Very easy      |
| 2.5 | Did you feel frustrated while doing this task?                               | Very frustrated    |   |   |   |   |   | Not at all     |
| 2.6 | Is the settings page easy to understand?                                     | Very difficult     |   |   |   |   |   | Very easy      |

## TASK 2:

**You want to report a case of child marriage, so you decide to call AidProfen.**

3.1  Find the phone number in the app. Which one is correct?

[  ] 847-039-083        [  ] 811-441-591        [  ] 975-834-485        [  ] I could not find it

**Read Gloria's story**

3.2  How old was she when she was supposed to marry?    [  ] 10        [  ] 14        [  ] 16

3.3  Who helped Gloria in going back to school?

[  ] A family member      [  ] Her teacher    [  ] Local authorities    [  ] A priest

## Tester number:

| | | | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|---|
| 3.4 | Could you do this task easily? | Very difficult | | | | | | Very easy |
| 3.5 | Did you need to ask for help? | A lot | | | | | | No |
| 3.6 | Did you use the help button (black button with question mark) to understand what to do? | A lot | | | | | | No |
| 3.7 | If you used it, are the instructions given by the help button easy to understand? | Very difficult | | | | | | Very easy |
| 3.8 | Did you feel frustrated while doing this task? | Very frustrated | | | | | | Not at all |
| 3.9 | Did you find the "get help" page easy to understand? | Very difficult | | | | | | Very easy |
| 3.10 | Did you easily find Gloria's story page? | Very difficult | | | | | | Very easy |

3.12   Is there some other local organization you would like to have on the app? _____

### TASK 3:

**Read the information about child marriage in the learning section, then play the quiz about child marriage.**

4.1   How many points did you get? ____

| | | | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|---|
| 4.2 | Could you do this task easily? | Very difficult | | | | | | Very easy |
| 4.3 | Did you need to ask for help? | A lot | | | | | | No |
| 4.4 | Did you use the help button (black button with question mark) to understand what to do? | A lot | | | | | | No |
| 4.5 | If you used it, are the instructions given by the help button easy to understand? | Very difficult | | | | | | Very easy |
| 4.6 | Did you feel frustrated while doing this task? | Very frustrated | | | | | | Not at all |
| 4.7 | Are the information in the learning section clear? | Very difficult | | | | | | Very easy |
| 4.8 | Are the questions of the quiz easy to understand? | Very difficult | | | | | | Very easy |
| 4.9 | Was the quiz too easy? | No | | | | | | Too easy |
| 4.10 | Was the quiz too difficult? | No | | | | | | Too difficult |
| 4.11 | If you didn't get the maximum, do you think you can improve your score by reading again the learning section? | Not at all | | | | | | A lot |

# Tester number:

**FINAL QUESTIONS**

## Part 1:  System usability

Rate how much do you relate with the following sentences from 1 to 5.

|  |  | 1: Strongly Disagree | 2 | 3 | 4 | 5: Strongly Agree |
|---|---|---|---|---|---|---|
| 5.1 | I think that I would like to use this app frequently. |  |  |  |  |  |
| 5.2 | I found the app unnecessarily complex. |  |  |  |  |  |
| 5.3 | I thought the app was easy to use. |  |  |  |  |  |
| 5.4 | I think that I would need the support of a technical person to be able to use this app. |  |  |  |  |  |
| 5.5 | I found the various functions in this app were well integrated. |  |  |  |  |  |
| 5.6 | I thought there was too much inconsistency in this app. |  |  |  |  |  |
| 5.7 | I would imagine that most people would learn to use this app very quickly. |  |  |  |  |  |
| 5.8 | I found the app very cumbersome to use. |  |  |  |  |  |
| 5.9 | I felt very confident using the app. |  |  |  |  |  |
| 5.10 | I needed to learn a lot of things before I could get going with this app. |  |  |  |  |  |

## Part 2: The app functionalities

Give a rate from 1 to 5 for the following questions by putting a cross in every line.

|  |  |  | 1 | 2 | 3 | 4 | 5 |  |
|---|---|---|---|---|---|---|---|---|
| 6.1 | How useful do you think is the tutorial? | Not useful |  |  |  |  |  | Very useful |
| 6.2 | How useful do you think is the help button? | Not useful |  |  |  |  |  | Very useful |
| 6.3 | How clear are the information in the help button? | Not clear |  |  |  |  |  | Very clear |
| 6.4 | Do you think the quizzes are useful? | Not useful |  |  |  |  |  | Very useful |
| 6.5 | Do you like to have stories to learn from other people experiences? | No |  |  |  |  |  | A lot |

**Tester number:**

## Part 3: App Style

|     |                                                      |            | 1 | 2 | 3 | 4 | 5 |         |
|-----|------------------------------------------------------|------------|---|---|---|---|---|---------|
| 7.1 | Do you like the colours used in the app?             | No         |   |   |   |   |   | A lot   |
| 7.2 | Do you like the size of the images and icons?        | Too small  |   |   |   |   |   | Too big |
| 7.3 | Do you like the size of the writings?                | Too small  |   |   |   |   |   | Too big |
| 7.4 | Do all the items looked well in the phone's screen?  | Not at all |   |   |   |   |   | A lot   |

## Part 4: Other comments

8.1  Did you experience any problem in using the app? Is there something that does not work?

_____
_____
_____

8.2  Do you have any question you would like to find the answer in the app?

_____
_____
_____

8.3  Is there anything else you would like to have in the app?

_____
_____
_____

8.4  If you have any other comment or suggestion, you can write it here:

_____
_____
_____
_____
_____
_____