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# A MOBILE LANGUAGE LEARNING APPLICATION: LEARN TO SIGN

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How could we assist hearing and deaf individuals in communicating with each other using a mobile application, in Sub-Saharan Africa?

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# ABSTRACT

"Communication is Key" - Unknown

The way that deaf people communicate is through sign language, a language that is visual and different in every country as well as region opposed to common belief there is only one sign language in the world. Cultural beliefs around deafness has a great impact on how deaf individuals take part in society and how they feel about themselves as individuals. Especially in regions such as Sub-Saharan Africa were the beliefs very greatly. From acceptance to rejection, from seeing them as no different to completely isolating them from the outside world. Hearing individuals in regions such as Sub-Saharan Africa tend to have a limited knowledge of deafness and do not always have a means of communication with deaf individuals. There is a communication barrier, this project aimed to find a way to assist hearing and individuals in communication with each other through the use of a mobile application. Specifically, an educational mobile application that hearing individuals as well as deaf individuals can use to learn basic signs and phrases through means of a game. The usefulness and value of this application was tested amongst basic users and experts in Sign Language, whereby each iteration improved on the next based on the feedback and results. Learn to Sign (Zambian Sign Language) – an application that aims to be the stepping stone or foundation for hearing people to learn sign language.

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# 1 | INTRODUCTION

## 1.1 BACKGROUND CONTEXT

‘Communication is key’ a phrase known worldwide, it is how people exchange ideas, knowledge, feelings, thoughts and much more. Communication between people comes in all different forms: verbal, visual or electronic to name a few. For many choosing which form of communication they wish to communicate in is an option. However, when someone suffers from hearing loss, “the result of sound signals not reaching the brain” [1], be it since birth, an accident or due to old age, they tend to lose the option to choose.

Depending where you are in the world, the support and care that is available to those who are deaf can vary greatly. “Deaf people in the developed areas of Europe, North America and Oceania have greater opportunities through language accessibility, interpreting services and disability rights” [2]. By having these opportunities “it allows them to contribute to society on par with members of the hearing community; they can attend college and [...] follow any profession they please” [2]. However, in developing regions such as Sub-Saharan Africa (SSA) “beliefs around deafness (in African societies range) from acceptance and protection to rejection and infanticide” [3]. Similarly, to developed countries, when the beliefs around deafness are that of acceptance and protection deaf individuals have the opportunity to feel part of the community and have equal rights as hearing individuals. Some deaf children say “they were raised on equal footing with their hearing siblings...” [4]. Whereas on the other end of the spectrum, the negative connotation, deaf varies from being seen as a form of punishment from God, a bad omen, familial shame, act of fate and/or burdensome [5] and can lead to neglecting, abusing, isolating and even abandoning the deaf individual.

### 1.1.1 DEAF CULTURE

In Sub-Saharan Africa, being sent to school for deaf individuals is, for them, an opportunity to be free from their own minds. Being able to express themselves and be around other deaf individuals makes them happy and ultimately makes them feel accepted. A great example of the ups and downs of being deaf was portrayed on the TV Program Unreported World. Specifically, the episode ‘15 and Learning to Speak’<sup>1</sup> “where sign language teachers are transforming the lives of deaf children and adults in Uganda” [6]. The episode's main story was about a fifteen-year-old boy named Patrick Otema, who had no form of communication with his family apart from some basic home-made gestures i.e. waving for his attention and pointing. His day consisted of doing minimal chores and then sitting at home doing nothing as he had no one to converse with. However, with the help of Raymond Okelo, who himself is deaf and a teacher, Patrick learnt how to sign<sup>2</sup>.

Additionally, during the episode, other deaf individuals were interviewed and were asked to tell their story. Many of them attended the only primary school in the south region. Where students ranged from a fifteen-year-

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<sup>1</sup> <https://www.youtube.com/watch?v=CNCpgrm8Gu4>

<sup>2</sup> [https://www.youtube.com/watch?v=5f31\\_UbCPq4](https://www.youtube.com/watch?v=5f31_UbCPq4)

old to a seventeen-year-old in one class. The head teacher, Grace mentioned that when it is time for the holidays many of the children do not want to go home [6]. This was later iterated by Jacqueline (Age 17) who said she felt sad when she was not in school, David (Age 15) who suffered at home, and Edwar (Age 11) who had no one to communicate with at home.

## 1.2 PROBLEM STATEMENT

None of these children have an incentive to go home, because what awaits them at home is either abuse from the community or silence, because they have no one to communicate with. Edwar unfortunately experiences both at home, he would get beaten up by local boys who would hit him with branches with thorns as well as by grown adults just because Edwar is deaf and he could not do anything about it.

Another incident was that of Joseph who lost his hearing after falling ill. At the time, in Uganda being deaf was a curse which meant that Joseph's life became ten times more difficult. To earn money, he did some carrying of goods, however one day the goods he was carrying were stolen goods. When the police stopped to question him, Joseph could not understand them and did not nor could he respond, the police interpreted his silence as guilt. "He was beaten and burnt" [7].

Without a common language or form of communication a divide is created between deaf and hearing individuals. The stories above and in the previous section are to showcase the good and the bad surrounding deaf culture in Sub-Saharan Africa, and that there is a need for change. Be it through raising awareness about deafness, supporting and providing for deaf individuals, or by teaching deaf individuals and hearing individuals how to communicate amongst each other.

## 1.3 RESEARCH DIRECTION

The aim of this project was to develop a mobile application that will assist hearing and deaf individuals in communicating with each other. We were able to conclude during our initial research that a communication/language barrier existed, which was mainly due to the varying beliefs around deafness. However, by raising awareness on deafness this has changed the attitudes of many countries in Sub-Saharan Africa. This is largely due to the presence of organisations and the involvement from each countries governments. The biggest focus for many of these organisations is on the equal education for deaf individuals in hearing schools, and being able to attend special schools. Yet, this does not eliminate the communication/language barrier that we identified between hearing and deaf individuals, which is why this project's focus was on that.

### 1.3.1 RESEARCH QUESTIONS

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***"How could we assist hearing and deaf individuals in communicating with each other using a mobile application?"***



During the research phase we delved deeper into supporting the fact that there is a need for change, and from that concluded that to make a positive change the communication/language barrier needed to be tackled. However, to be able to develop an effective mobile application we had to identify sub-research questions that we could answer to satisfy a useful educational mobile application. How we did this was by answering the following:

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***"What are effective teaching methods that can be implemented into a mobile application?"***

***"Is there a simplistic way of conveying a sign, which does not require an individual to know how to read or write?"***

***"Which form of media is the better fit when learning a new sign? i.e. images, images + captions, videos"***

### 1.3.2 PROJECT APPROACH

This project followed the Evolutionary Prototyping as a design approach. Evolutionary Prototyping (EP) aims to develop a system through a series of prototype iterations [8]. The iterative phases allowed us to narrow down the core requirements the application needed.

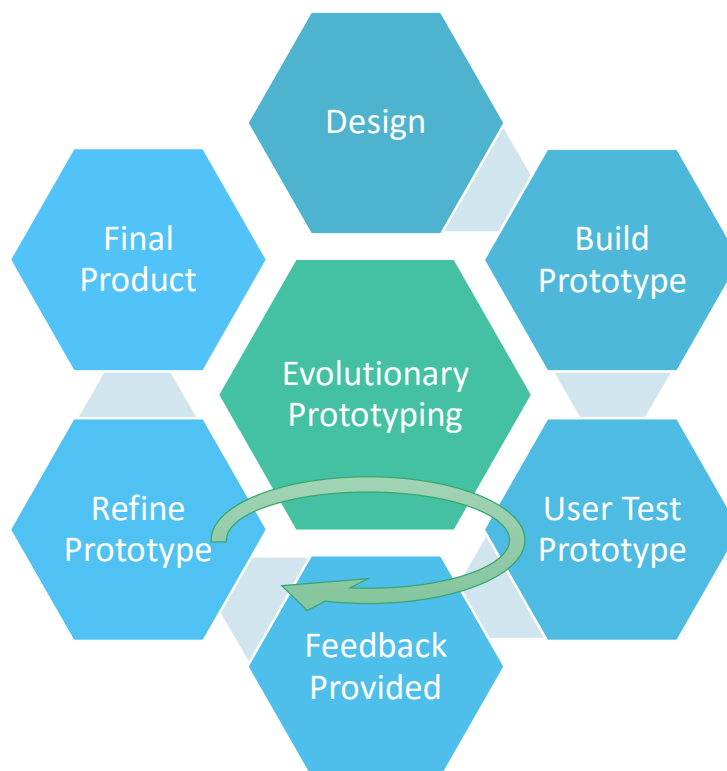
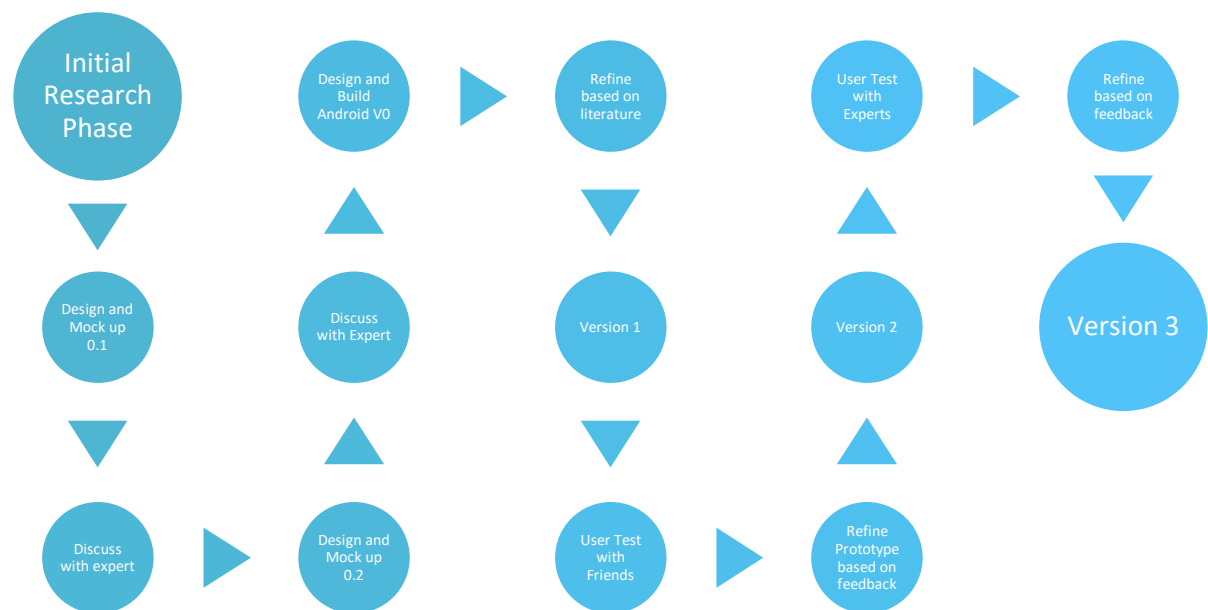


FIGURE 1: EVOLUTIONARY PROTOTYPE

ADAPTED FROM:

[HTTP://WWW.TEACH-ICT.COM/AS\\_A2\\_ICT\\_NEW/OCR/A2\\_G063/331\\_SYSTEMS\\_CYCLE/PROTOTYPING\\_RAD/MINIWEB/PG3.HTM](http://www.teach-ict.com/AS_A2_ICT_NEW/OCR/A2_G063/331_SYSTEMS_CYCLE/PROTOTYPING_RAD/MINIWEB/PG3.HTM)

The above figure depicts the standard EP model, whereas below a more detailed and adapted version of the EP model is depicted tailored to this project.



**FIGURE 2: DETAILED EP MODEL OF THE PROJECT**

Throughout the project we did research to gain an understanding of the topic areas that needed to be covered and initial contact with potential domain experts that could be helpful during the project. By understanding the culture around deafness in Sub-Saharan Africa, the need for the application becomes clearer. Researching the current mobile penetration in Sub-Saharan Africa aided us in discover how best to implement the application and on what device. Identifying the current teaching methods allowed us to use them as a stepping stone in developing the application i.e. what is the best to convey a sign. The relevant literature gathered for this project is discussed in Chapter 2.

This was followed by two mock ups of the application, Version 0.1 and Version 0.2, created in PowerPoint, which was presented informally to one of the domain experts that we had contacted. With suggestions and the feedback given we went on to develop the first functional prototype, Version 0, this allowed us to gain a better understanding of the program we were using and how we wanted the application to be laid out. This is discussed in more detail in Chapter 4. Based on the newer findings we refined Version 0 into Version 1 which was tested on a set of seven people known to me, each user was given a questionnaire to fill out before and after the evaluation of the application. The main focus of this evaluation was to reveal any usability flaws and overall first impressions. Design and implementation as well as the feedback gathered is expanded on in Chapter 5. With the information gathered from the evaluation the refining of Version 1 into Version 2 was done. This too was followed by an evaluation phase, however, for this evaluation round we contacted three domain experts to take part. This phase focused on the experts' opinion, about the overall package of the application: usability, layout, idea, game implementation, etc. Chapter 6 discusses the design and implementation as well as the feedback for

Version 2. Likewise, with Version 1 and 2 we took the feedback from the evaluation round and refined the application to create the final prototype for this project, Version 3, which is presented in Chapter 7.

## 1.4 STRUCTURE OF THE DOCUMENT

TABLE 1: OVERVIEW OF THE DOCUMENT

Chapter	Brief summary
<b>1 – Introduction</b>	Gives a brief introduction to the background context of this project followed by the problem statement and research direction this project took. Lastly, the project approach summarises the steps and milestones in short of the project.
<b>2 – Literature Review</b>	This chapter elaborates on the relevant topic areas that were explored during the project.
<b>3 – Sign Language Learning Application Review</b>	This chapter explores different sign language learning web and mobile application, listing potential features and must avoids for this project based on the applications reviewed as well as literature.
<b>4 – Learn to Sign (Zambian Sign Language)</b>	This chapter discusses the decisions that were made during the initial requirements, design and implementation of the first three prototypes and the features that we were aiming to implement into the final product.
<b>5 – Version 1</b>	Presents Version 1 of the application, including the design and implementation, the evaluation phase and the summary of improvements for the next Version.
<b>6 – Version 2</b>	Presents Version 2 of the application, including the design and implementation, the evaluation phase and the summary of improvements for the next Version.
<b>7 – Version 3</b>	Presents the final Version of the application with the last improvements made.
<b>8 – Conclusion</b>	This chapter concludes the project, with a discussion on each iteration of the application as well as future development for the application.

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## 2 | LITERATURE REVIEW

### 2.1 A REVIEW OF RELEVANT LITERATURE

Owed to the fact that this project focuses on developing a mobile application, research was done on mobile penetration to better understand the current situation in Sub-Saharan Africa, the concept of mobile learning as the project is on a mobile device, and teaching methods used to teach sign language. Additionally, we explored the ICT support already available in Sub-Saharan Africa, and elaborate on any projects that focus on technology for educational purposes.

#### 2.1.1 MOBILE PENETRATION

From a statistic recorded on January of 2016 approximately 3.790 Billion out of 7.395 Billion, in the world, are unique mobile users in the world [9]. If we specifically look at Africa whose population is stated to be at 1,201 Million, 82% of its population has a mobile connection [9].

In many Sub-Saharan countries “mobile is for many, the only form of technology Africans have access to” [12], and the reasons they have a mobile phone is not just for the social aspect of it. Mobile phones to people living in regions such as Sub-Saharan Africa are more than just keeping in contact with relatives and friends it has become a productive tool.

In a video posted by PBS NewsHour, there was an emphasis on the fact that virtually everyone, no matter where in Kenya be it rural or urban, had a mobile phone [11]. In many Sub-Saharan African countries i.e. Kenya, people do not have bank accounts or credit cards for their finances, but with the high presence of mobile phones started an alternative way of paying which was trading air-time for services. This idea is now known as M-Pesa, it is basically your wallet but digital, with M-Pesa you can “send, receive money, pay for bills and transact easily, safely and conveniently” [12] with your mobile phone, it has even expanded to other areas in the world.

M-Pesa is one of many mobile services that have been developed and frequently used in Sub-Saharan Africa. Other examples are M-Farming and M-Birth which are both text-based services. M-Farming is an application that farmers can use to keep track of the change in price of the market in town by simply opening the application and sending a request i.e. price of bananas and awaits a reply, which will entail the answer to their request within their area [11]. Whereas, M-Birth allows pregnant women to have access to a mid-wife in the area, who monitors their progress based on the update texts that she receives. Additionally, the mid-wife's phone is connected to a system which is monitored 24/7 by a doctor [11].

M-Farming and M-Birth are text-based services, this allows any mobile phone to be used, from basic mobile phones to smartphones. Even though the application for this project would not be text-based, having it be compatible on a range of different phones was the main goal. Knowing that the increase in smartphones last year was 66 percent [13] and “the prevalence of inexpensive smartphones, aided in part through partnerships

between mobile network operators and handset manufacturers, has helped fuel recent growth" [13] our application was to be developed for smartphones.

### 2.1.2 M-LEARNING

For the development of an educational mobile application we have to introduce the concept of m-learning. The exact definition for m-learning varies amongst individuals and companies. For this project we resonated with this definition written in a blog post for a company called Aurion Learning<sup>3</sup> "Delivering learning content and experiences to learners when and where they need it. It is learning that can be accessed at any time and any place to support performance" [14]. Specifically, we focused on the fact that m-learning can be done on mobile devices.

To build an application that can be effective and full of information, yet displayed on a small device like a mobile phone, we need to consider the best ways to develop the application. This is why we explored a variety of different sign language learning applications i.e. websites and mobile applications. This is discussed in full in Chapter 3.

### 2.1.3 TEACHING METHODS

During our research we came across a two important methods of teaching, where we took those methods and adapt them for our mobile application. By taking the existing teaching methods and adapting them to fit the m-learning approach, allowed us to create a mobile application which reflected the way deaf children were taught in schools or in their community, for hearing individuals.

Repetition, we saw that when students or parents were being taught a lot of repetition was done, signing a word multiple times and coming back to the sign. In [6] the way a teacher would typically teach a sign was through repetition, they would present a word, on the blackboard or an image of it on a poster and they would sign that specific word a few times. After which they would encourage the students to repeat after them several times over. Based on this, we concluded that for our application, in the game, we would have signs that would keep coming back, testing the user after being presented with other signs.

The use of images, posters, charts, drawings and pictorial books were all different ways that we saw students would use to learn signs. In a video of St. Anthony's School for Deaf Children [15] we saw students creating their own drawings of the signs with the written word in their notebooks, which they could use for future learning. Another example, was a boy who created his own simple memory game through the use of a pictorial book [6], he would look at an image with its associated word and sign it. Raymond Okelo taught the students through the use of posters: pointing at an image, signing the word and having the students sign it as well [6]. Additionally, we found that MangoTree, an organisation which provides educational tools developed a learning kit, with deafchild worldwide<sup>4</sup> aims at parents [16] where they created flashcards that depict a picture with the

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<sup>3</sup> <http://www.aurionlearning.com/>

<sup>4</sup> <http://www.deafchildworldwide.info/>

corresponding sign on the back. All these ways of teaching are all done visually, which in return allowed us to establish that the application we created had to be visual, specifically, using images and captions. Furthermore, taking the flashcard idea and switching up how an individual has to answer it allowed us to develop the different levels in the game, given individuals a way of learning a sign visually but also through the written word.

However, the unfortunate truth is that “education tends to end at primary level with no incentive or opportunity to continue into secondary or higher education, except a few” [3]. Speaking in numbers that is “approximately 56 million people aged 15-24 [who] haven't completed primary school...” [17]. However, with the high presence of mobile phones, as seen in Section 1.2.2 the implementation of mobile applications for technology has been seen as a solution to allow individuals to continue their education or gain knowledge about other subject matters.

#### 2.1.4 ICT FOR EDUCATION

Technology as a whole is being introduced into education as a tool for learning around the world, be it through a computer, iPad or use of a mobile phone, at school or at home. This does not exclude Sub-Saharan African countries. This section explores the presence of ICT which supports education, to gain an understanding of how receptive they are to ICT when learning.

An episode of Innovate Africa, Tech teaching<sup>5</sup>, introduced innovators who are implementing technology into education and emphasize that technology skill should be a fundamental skill, and shows that people are willing to learn and use technology that is being introduced to them.

For example, Nivi Mukherjee developed Elimu, which is an integrated learning system, specific for Kenyan students. Elimu is an application that is used on low-cost tablets. The application has condensed learning materials into short interactive animations which students can learn from in the classroom, at their local library or out and about, indicating the presence of the m-learning concept in education. Furthermore, the use of the low-cost tablets also allows students to access the internet, which the teacher is seen integrating into the daily learning materials. Additionally, it has also seen an increase in improved test scores, with the help of the visual interactive application Elimu [18].

In Tembisa, South Africa a primary school is taken part in a project that has repurposed a shipping container into a fully operational solar-powered classroom and an ICT Hub. It was designed by AMBIT technologies<sup>6</sup> and is called EDI, education delivered intelligently. They developed it to be mobile and simple to set up, so that it can be deployed quickly and easily. The classroom is fitted with tablets which holds all learning materials for the students, and smartboards which is used for interactivity. The curriculum they follow would be no different to the curriculum given in a normal classroom, it is just using technology as part of it [18].

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<sup>5</sup> <https://www.youtube.com/watch?v=mxelnxW2A2E>

<sup>6</sup> <http://www.ambittech.co.za/solar-it-solutions/>

Technology is not only being a tool they are integrating in educational systems but it is also a way for deaf individuals to gain access to education. A brief example, Tendakayi Katsiga, the innovator of Deaftronics developed "the first rechargeable hearing aid battery, which lasts for 2-3 years and can be used in 80% of hearing aids on the market today. It is solar powered and can be charged via the sun, household light, or a cell phone plug" [19]. This has allowed hearing impaired student Tapiwa (17 years old) in Zimbabwe to be able to attend a hearing school without the batteries running out on her and not being able to go anymore.

Overall, we can establish that there is a willingness to use technology to learn, be it through the use of technology as a learning aid or as a learning tool.

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## 3 | REQUIREMENTS ANALYSIS

### 3.1 A REVIEW OF SIGN LANGUAGE LEARNING APPLICATIONS

This section will evaluate a few sign language learning application, from web applications to mobile applications. Listing features that were potential features to be implemented into the application, where initial features /requirements for the application are discussed in Chapter 4, based on this chapter and literature found.

#### 3.1.1 A LANGUAGE LEARNING APPLICATION – DUOLINGO

Duolingo<sup>7</sup> is a well-known language learning application that works on multiple different platforms from web browser to an application you can download on your laptop or a mobile application. The reason Duolingo is so well known is how it teaches users a new language. You are presented with daily goals, depending on how eagerly you want to learn that specific language, there are different phases which you can unlock by gaining the points to unlock it. You are taught a word or a category of words in a repetitive way, and in different forms. Which allows users to build independence for the exercises as well as their word database as words or categories get added. Furthermore, you are given feedback no matter if you got the answer correct or wrong. All these features are indicators of good user engagement and motivation to want to continue to unlock those levels and reach that daily goal. Instead of following a lesson plan where you read and then do an exercise, Duolingo creates a game out of it, presented the user with different forms of learning a specific work.

There were many elements that Duolingo had, that this project's application tried to incorporate.

TABLE 2: POTENTIAL FEATURES BASED ON DUOLINGO

Feature	Why it would be a good feature to implement
Different levels	Allows for progression
Categories	Gives users the option to learn specific words or phrases
Feedback for both correct and wrong answers	Providing feedback will allow the user to understand what they did right and what they did wrong
Presenting/teaching a single word in a variety of different ways, creating repetition	By mixing up how a user has to answer a question, makes them think rather than associate i.e. a picture with a word

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<sup>7</sup> <https://www.duolingo.com/>



### 3.1.2 SIGN LANGUAGE LEARNING WEB APPLICATION

There are a variety of sign language learning web applications available whereby the following four were chosen to explore further: ASL University<sup>8</sup>, Start American Sign Language<sup>9</sup>, Sign Language 101<sup>10</sup> and LessonTutor<sup>11</sup>, as these were the first few links that came up when researching how to learn sign language. Table 3 is a collection of features these web applications had in common or individually stood out, which were potential features for the application.

TABLE 3: POTENTIAL FEATURES BASED ON WEB APPLICATIONS

Feature	In which application	Why it would be good feature to implement
<b>Different links to different levels</b>	ASL University	It allows for a whole range of users to be able to use the application
<b>Mixed media</b>	ASL University Start American Sign Language Sign Language 101 Lesson Tutor	It accommodates different levels of literacy
<b>Repeatedly present signs</b>	Start American Sign Language Sign Language 101	Is an effective way of learning as seen by the popularity of Duolingo

Based on these web applications we identified the following guidelines and features for our application:

1. The use of mixed media is a good option
2. Repeatedly present the signs
3. All instructions/caption should be as clear as possible

Same goes for images and videos, they should be as clear as possible.

### 3.1.3 SIGN LANGUAGE LEARNING MOBILE APPLICATIONS

Similarly, to the previous section we explored a variety of different sign language learning mobile applications, as this project focused on developing a mobile application. The applications that were chosen to be explored

<sup>8</sup> <http://www.lifeprint.com/index.htm>

<sup>9</sup> <http://www.start-american-sign-language.com/>

<sup>10</sup> <http://www.signlanguage101.com/>

<sup>11</sup> <http://www.lesstutor.com/ASLgenhome.html>

further were ones that had a good rating on the google play store. Table 4, is a collection of features presented by the seven mobile applications.

**TABLE 4: POTENTIAL FEATURES BASED ON MOBILE APPLICATIONS**

Feature	In which application	Why it would be a good feature to implement
<b>Different categories</b>	Sign Language for Beginners	Gives users the option to learn specific words or categories of their choosing, making it less restrictive
<b>Teaches you different sign languages</b>	Sign Language for Beginners	With the project aim to help deaf and hearing individuals in Sub-Saharan Africa having a feature which changes what language you are taught in would allow for more users to access it
<b>Mixed Media</b>	ALL	It accommodates different levels of literacy
<b>Game element</b>	ASL Learn ASL Play2Sign	An effective way of keeping learners/users engaged
<b>Different levels</b>	Learn ASL	It allows users to different levels to use it as well as beginner users to know they are progressing
<b>Clear instructions on how to sign</b>	LearnSignLanguage2 Play2Sign Sign ASL Sign Language for Beginners	If instructions on how to sign a word is not clear, a user will not be able to learn or progress

What we can gather from using these applications is similar to what we found when we were going over web applications:

1. Instructions need to be present and clear

2. How to use the application should be clear → Tutorials
3. Separates words into categories gives a better overview
4. For the game element, have it be clear what is being asked, and given the user proper feedback.

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## 4 | LEARN TO SIGN (ZAMBIAN SIGN LANGUAGE)

### 4.1 APPLICATION DEVELOPMENT

As mentioned this project aimed to develop a language learning application, specifically sign language in Sub-Saharan Africa. This was due to the fact that we saw that there was a communication barrier between the deaf and hearing individuals, caused by cultural difference regarding deafness. Due to the range of different countries in Sub-Saharan Africa we had to narrow it down for one particular sign language as a proof of concept for the application. Through research we found there was a lack of documentation and information on Sub-Saharan Sign Language, however we were able to gather the necessary information<sup>12</sup> i.e. videos to start building the application for *Zambian Sign Language*. In *Appendix C*, are the emails exchanged with the owner of the website and videos, where we asked permission to use the resources they had for our application.

As previously stated the development of the language learning application was to be developed on a mobile phone instead of building a web application. This was supported by the fact that that mobile phones could be a potential solution for students and individuals to continue their education as concluded in Section 2.1.3. This was also iterated in two articles, where one stated that "with an estimated 635 million mobile phone subscriptions currently in the region, many are pinning their hopes on mobile technologies such as free online learning materials, math apps and offline encyclopaedias to help tackle the problems [of not being about to continue their education]" [17] and the other stated that with the growing mobile communication, "where some countries have more mobile subscriptions than inhabitants...people are connected...[and]...these connections offer an opportunity for education" [20].

For the purpose of this project we decided to develop the application on a smartphone first, with the thought of being able to downgrade it to other phones. However, due to the time frame of this project the implementation of the application on other phones was not explored, but is discussed in short in future developments, Chapter 8. Specifically, the application was developed for an Android smartphone, as "Android currently has the largest global platform share, with a particular prominence in lower income areas and developing nations" [21].

We develop the application using Android Studio, which is "the official IDE for Android app development" [22]. Android studio was chosen due to the fact that it was well documented but most of all it was chosen because it allowed us to select the Minimum Required SDK, which "is the earliest version of Android that your app supports, indicated using the API levels" [23]. By being able to select an API level we were able to see with the information provided by Android Studio, which would support the most devices and have the necessary core features for the application.

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<sup>12</sup> <http://www.zambian-signlanguage.de/>

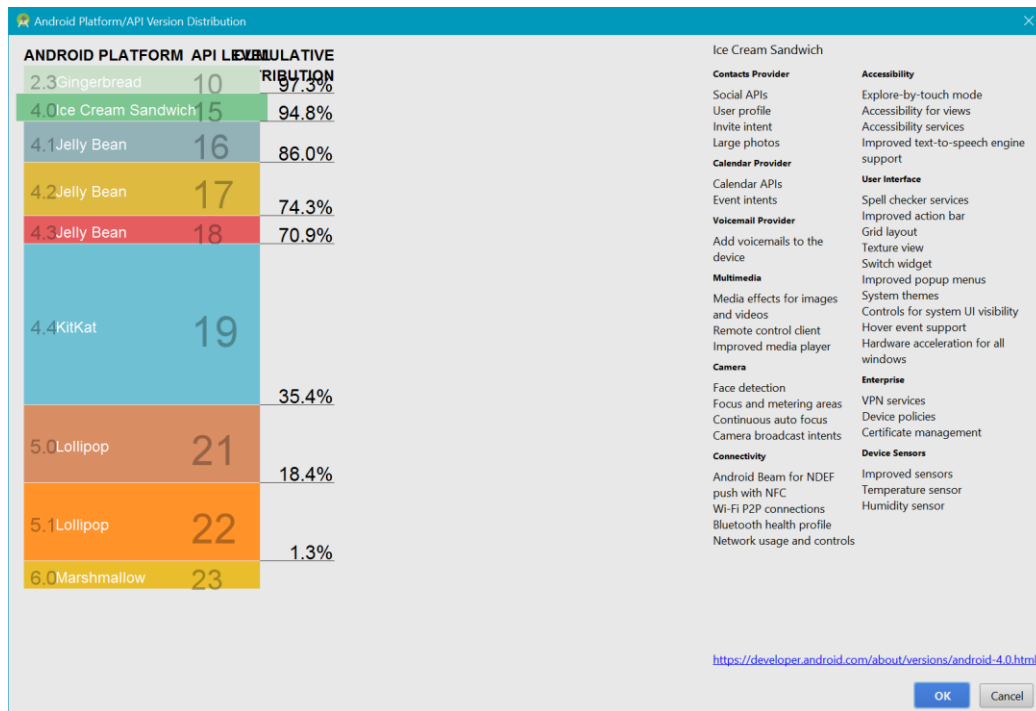


FIGURE 3: API VERSION DISTRIBUTION TAKEN FROM ANDROID STUDIO

## 4.2 APPLICATION FEATURES

Table 5 presents a detailed list of features/requirements that we set out to incorporate into our application based on findings in Chapter 2 as well as during our research. Due to the scope of this project not all features were implemented or fully functional. The problems that were encountered during the development are discussed in the following chapters.

TABLE 5: SUMMARY OF FEATURES/REQUIREMENTS WE WANTED TO INCORPORATE WITHIN THE DICTIONARY AND GAME

Dictionary	Game
Different categories	Different levels
Presenting same signs differently	Different categories
Mixed media	Feedback system
Clear instructions	Presenting signs repeatedly
Different languages	Presenting same signs differently
Search function	Mixed media
	Unlocking mechanism

The application was split two parts, it would feature a dictionary and a game, as it was a standard set up from the application we explored in Chapter 2. Knowing the features and the elements that were to be developed for the application a diagram of the screen relations was made, Figure 4, which gives an overview of the workflow of the application.

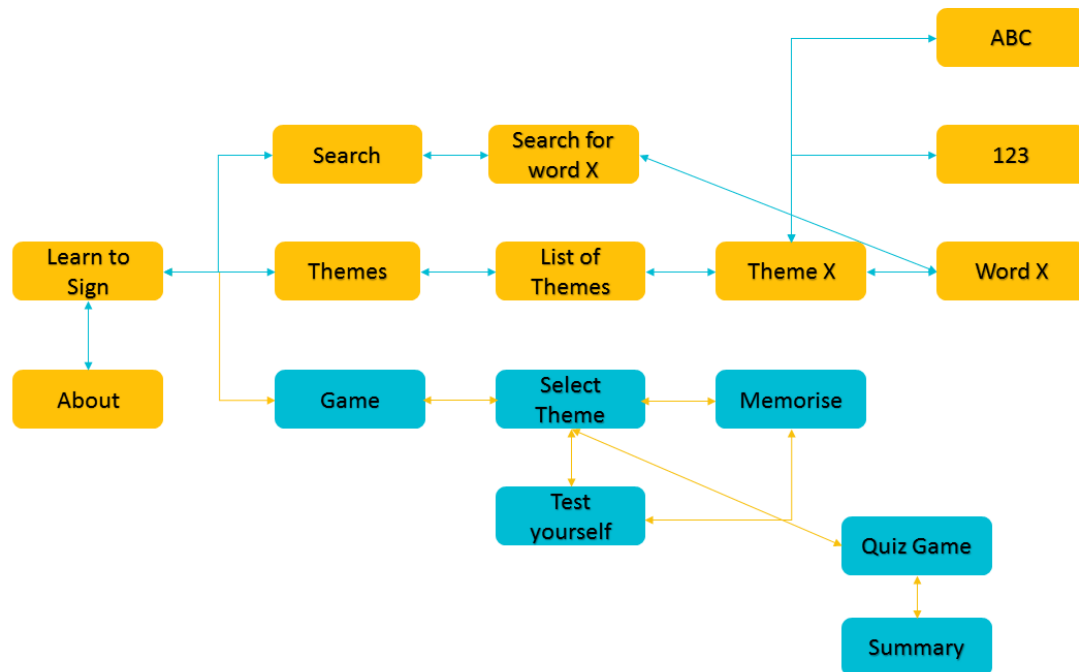


FIGURE 4: INITIAL SCREEN RELATION DIAGRAM (WORKFLOW)

### 4.2.1 DICTIONARY

By adding a dictionary element to the application the user has a place to go back to the words they encountered or will encounter during the game, giving them the option to learn them or go over them in their own time. The dictionary would present a list of different categories a user could pick from, which then presented them with a list of words. The selected word is presented in two different forms, a video form and then a breakdown version, step-by-step, using images from the video and captions. The reason we decided to give two options was due to the fact that individuals learn in different ways, this was also seen in the user testing of the application as well as the fact that we found that “the lowest literacy rates are observed in sub-Saharan Africa and in South and West Asia” [24]. Which was also a reason to have a visual application, over an overloaded with information and text application. Additionally, a search function was to be implemented to allow a user to find a specific word without having to go through the category list and the word list.

### 4.2.2 GAME

The other element of the application is the game, specifically, a matching game. Where a user would choose a category and then get given questions that ask them to look at the given sign, word or video and find the corresponding sign, word or video. Where, as the user progressed through the game, different levels would be

unlocked with a higher difficulty which as stated in [25] is amongst the preferred gamification strategies. Furthermore, the questions that were asked, changed per question for the same sign, this allowed the user to be exposed to a sign repeatedly but in different forms. Figure 5, presents the eight different questions forms a user could encounter.

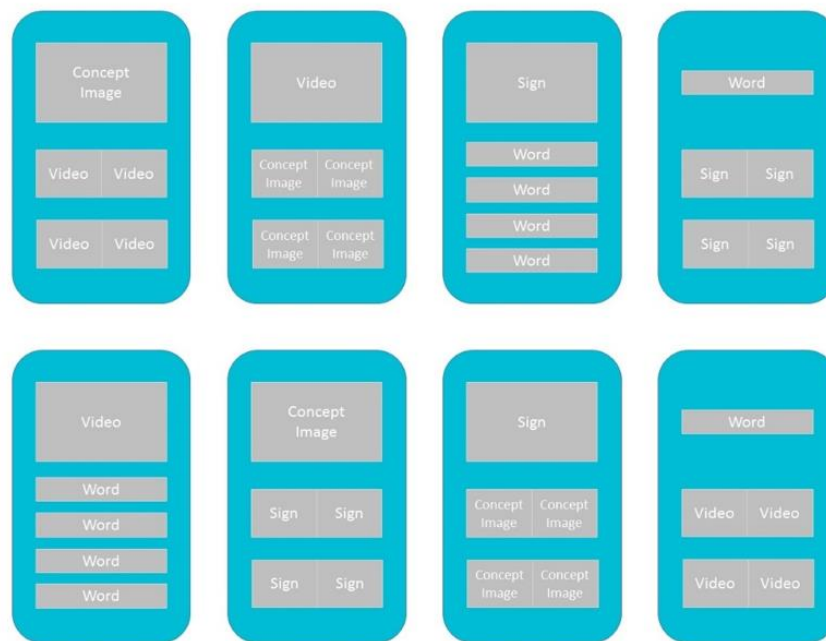


FIGURE 5: QUESTION FORMS IN THE GAME

### 4.3 MOCK-UPS

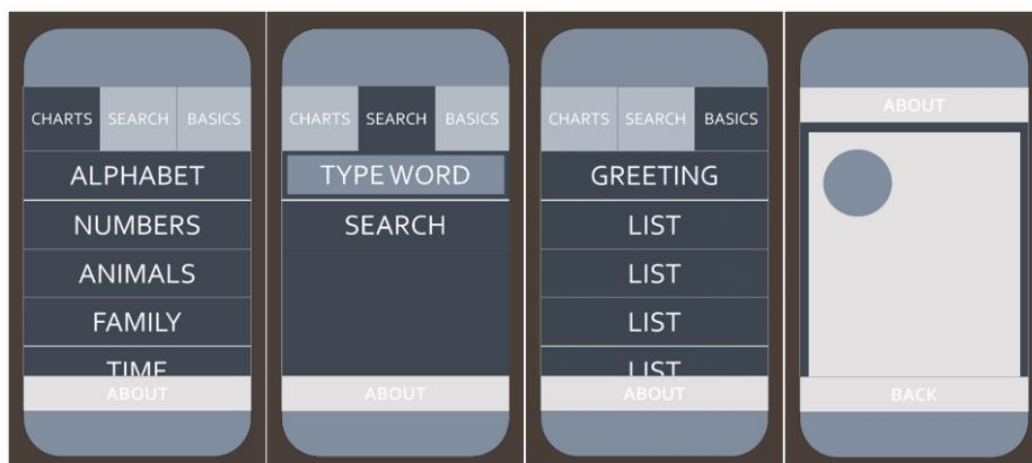


FIGURE 6: SCREENSHOT OF FIRST MOCK-UP

Initially, one mock-up was created to present to a Sign Language Expert<sup>13</sup>, which solely based on the yellow boxes in Figure 4. The second mock-up was created based on the initial feedback from the Sign Language Expert and ideas that were discussed during the meeting. The second mock-up was an expanded version of the first,

<sup>13</sup> Victoria Nyst

blue boxes in Figure 4, with the additional of a game. The mock-ups were created as a starting point, and as a reference for the development of the application on Android Studio. Figure 6 presents four screenshots of the first mock up, whereas Figure 7 shows the second mock-up with the game element added to it.



FIGURE 7: SCREENSHOTS OF SECOND MOCK-UP

## 4.4 VERSION 0

With the mock-ups as references we developed the first prototype of the application in Android Studio. Where the design and the general framework of the application took precedent over full functionality. Figure 8 displays two screenshots of the first prototype created in Android Studio. Version 0, did not have a formal testing and evaluation phase.

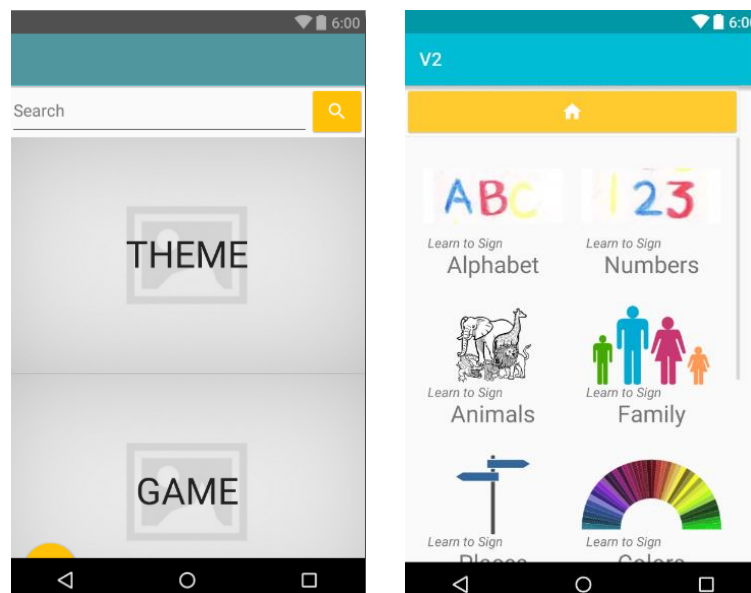


FIGURE 8: SCREENSHOTS OF VERSION 0 – MAIN SCREEN (LEFT) AND CATEGORY (RIGHT)

The functionality at this point was simply Buttons and ImageButtons leading to other pages/screens in the application. The first category that was fleshed out was the alphabet and the numbers as we were able to find images online, that were free to use. We created an overview page of the alphabet and respectively the



numbers. The user was free to select any letter or number, which would direct them to a bigger image of the sign and the option to move back and forth between letters, Figure 9 reflects this.

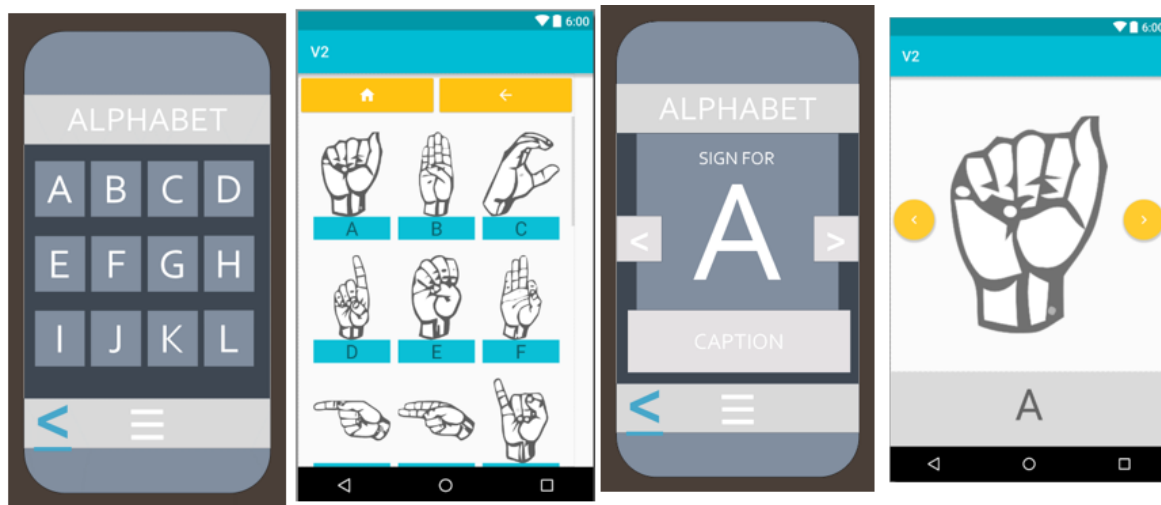


FIGURE 9: SCREENSHOT OF ABC PAGE FROM SECOND MOCK-UP AND VERSION 0

However, with the initial feedback and ideas that were discussed during the meeting with the Sign Language Expert changes were made as the development of Version 0 was undergoing, which lead to the development of Version 1.

## 5 | VERSION 1 - PILOT

### 5.1 VERSION 1

The development for Version 1 focused on usability, creating an application that is easy to use and one that does not have a steep learning curve, i.e. user-friendly. Transitioning from Version 0 to Version 1 meant that the workflow of the application underwent a few changes, Figure 10 displays those changes.

The first thing that we changed was the screen relations, the updated version is seen below. We changed the home page to now consist of a dictionary, categories, the game, and the about page. We also went into more detail on the workflow of the game. Lastly, we decided to call our application: “Learn to Sign”.

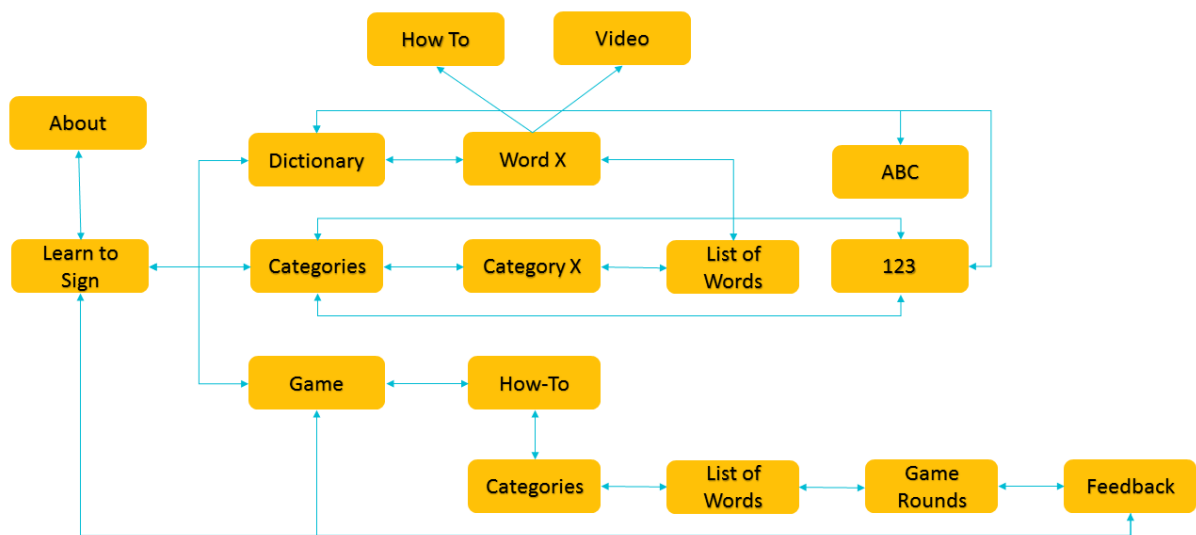


FIGURE 10: UPDATED SCREEN RELATIONS

#### 5.1.1 DESIGN ALTERATIONS AND IMPLEMENTATION

The workflow was not the only changes that were made when transitioning from Version 0 to Version 1. The page “Themes” was changed to “Categories” and with the images concepts and icons finished the placeholder images could be replaced. The image concepts and icons were kept simple nevertheless each image concept and/or icon was captioned. Additionally, instead of the search function we created a dictionary page which displayed all the words currently available in a list. However, the search function is a feature that will be implement as the dictionary increases.

The dictionary page consisted of the list of words, which when a user selected a word would display that specific word page. As previously stated we wanted to present each word in two different forms, which is why we had two tabs for each word. One explaining how to sign the word based on still images taken from the video, and the other tab which had the video.

To create the dictionary page which would display a list of words we had to create an array that consisted of our word list, which then would automatically be placed into the ListView that was put into that page<sup>14</sup>. Figure 11, shows the two different tabs that each word page had side by side. In the first tab, "How-to", we had still images with captions that explained to the user what to do.

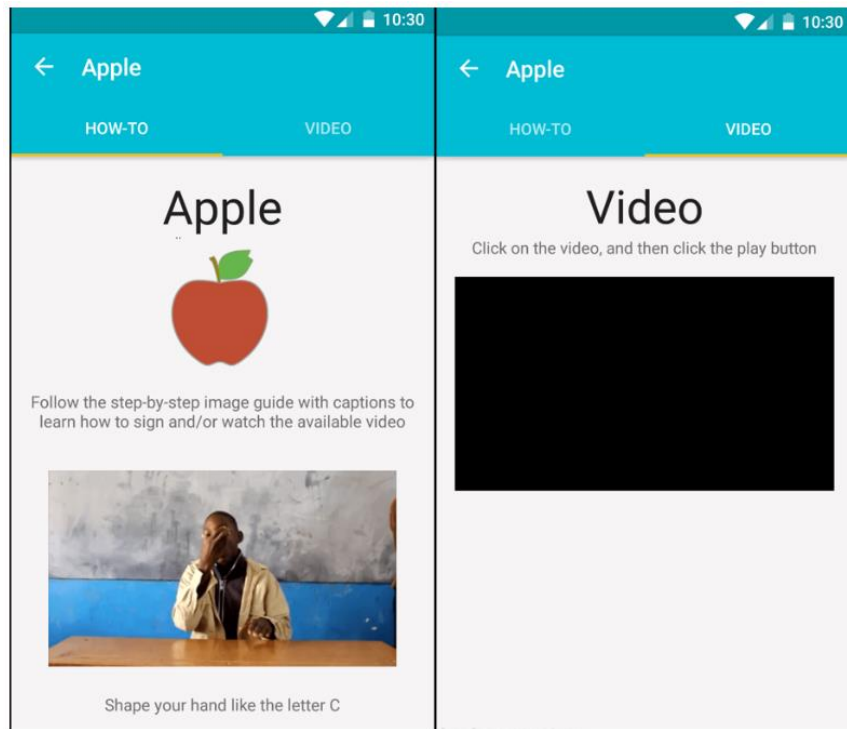


FIGURE 11: APPLE PAGE FROM VERSION 1

Setting up that page was not that difficult as we could use the design feature that Android Studio had. However, to implement the video in the second tab we had to do a bit more work. Firstly, we had to add the video in,

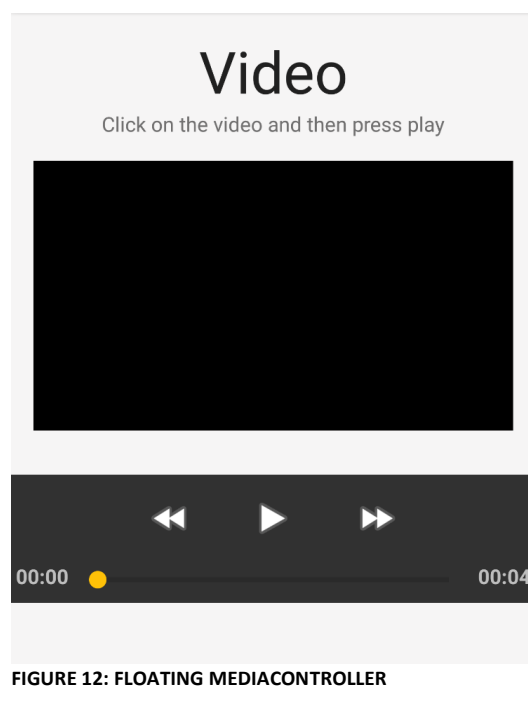


FIGURE 12: FLOATING MEDIACONTROLLER

<sup>14</sup> Specific code not used in the final version

which was done simply with a VideoView, but that did not display the video or play it. For this reason, we had to add a media controller which would give the user the option to replay, play and forward the video, Appendix A, Section 8.1 has the code used. An issue that we came across at this point was that the media controller did not sit at the bottom of the screen, even when the position was set it. The media controller would shift up the screen, which in some cases would mask the video itself.

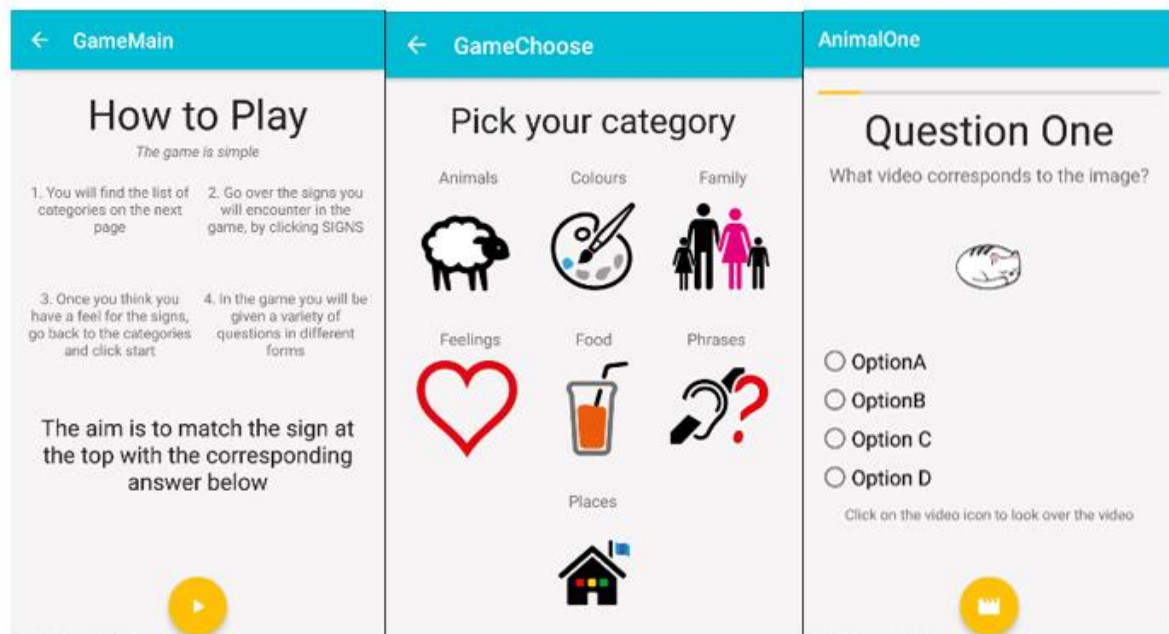


FIGURE 13: GAME SCREENSHOTS

The biggest difference was that we added the game into the application. Following the screen relations, a user clicked on the game icon and would be presented with the how-to page, which had instructions on what the game was and what they were expected to do. At this point the screen was overloaded with information in text form, however later in the development this changes. The user was then given the option to choose from the different categories. After selecting the category users had the option to go over the signs in the corresponding category or start the game. When a player started the game they would be prompted with a range of different questions, based on the question forms, shown in Figure 5. Depending on the category, the rounds differed in length, as not all categories had the same number of words. However, we did want to make sure that there was some repetitiveness in game, so every sign was presented twice in each round. By given the users the different question varieties, we established that in turn it would make them remember the sign more effectively.

Due to the fact that we did have such a variety in questions, we had to create a layout for each and their respective code. Each question page, considered of a progress bar, the question number, the written question (instructions) and underneath that, depended on the different form, the question content and available options. The progress bar was added into the game as according to [25] this too was a gamification strategy that users preferred.

The available options to select from ranged from: option A, B or C, image concepts or stills, where we either used RadioButtons in RadioGroups, or ImageButtons. We had to create two different classes in our java code that would let the application know which option was correct and which was wrong based on what the user had clicked and display the appropriate feedback, refer to Appendix A, Section 8.2. At the end of each round the last question's DialogApp gave the users the option to go back to the game menu or the main menu.

## 5.1.2 TESTING AND EVALUATION

For this iteration we focused solely on 'does the application work' so we asked seven friends and relatives, to test out its usefulness, satisfaction and ease of use. The evaluation was done in three parts: (1) generic information and any information on their prior knowledge of educational application, (2) do various tasks within the application, and (3) fill out the questionnaire, which was broken into two different sections where questions were asked about the application itself and then the game. The full questionnaire and tasks each individual had to do can be found in *Appendix B*.

### 5.1.2.1 PART I

Each individual was asked to fill out the first page of the questionnaire, which asked the users to answer generic questions i.e. gender, age. Then some questions followed to gain information about their knowledge on educational application, and mobile educational applications.

### 5.1.2.2 PART II

The second part of the evaluation the individual was presented with the application and was asked to perform four tasks: searching for a specific work, a specific page, learning to fingerspell their name, and play the game. As they were carrying out the tasks, observations and notes were made to keep track of how the person interacted with the device, where they struggle and their thoughts as they are using it. After the first few simple tasks they were asked to play the game, first they were asked to play a round of the game with the family category and then they were given the freedom to choose their own category.

### 5.1.2.3 PART III

The last part of the evaluation, individuals had to fill out the remainder of the questionnaire, which was set up to have questions in a Likert Scale, as it would allow us to get an understanding of their attitude towards the applications. We covered: usefulness, ease of use, ease of learning and satisfaction. Where, usefulness, satisfaction and ease of use were based off of Arnold M. Lund's paper Measuring Usability with the USE Questionnaire <sup>15</sup> [26]. Within the questionnaire two sets of the same questions were asked, first about the application in general and secondly about the game. Lastly, some open questions where the individual could give their opinion on positive and negative aspects of the application.

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<sup>15</sup> <http://garyperلمان.com/quest/quest.cgi?form=USE>

### 5.1.3 RESULTS

Part II of the evaluation phase had the users perform four tasks, where the first task was to learn how to fingerspell their name in sign language. All seven users were capable of figuring out where to find the alphabet, where five of them struggled to figure out how the alphabet page actually worked. It was also clear that some people struggled with figuring out how to hold their hand and in what shape when they were signing a letter, making us assume that some of the images were unclear or the instruction available was not adequate enough.

The second task was to find three different words/phrases, an easy, medium and difficult word and a whole category i.e. and learn it. Based on the observations all users found it self-explanatory to go to the dictionary to search for the specific word and to go to category respectively. When users were on a word page, six of the users did not see the video tab. Additionally, four of them struggled on the how-to of the word, as they did not know that you were able to scroll for more explanation and images. This in turn meant some people did not know how to sign a word fully. Another observation made was that over half of them did not have the patience to read the captions and used the images to figure it out. In general, users were about to find words and categories seemingly quickly and easily, without additional help. Due to the fact that all but one did not see the video tab, we interfered, after being made aware of the video tab, all seven users went for the video instead of the images, as it was easier and they did this for the remainder of the evaluation.

The users were then prompted to go to the game section, without further instructions, so we could observe if people would read the "How to Play" which was only text, all but two read the instructions without being told. However, there was one case that one person still did not understand the aim of the game, meaning the instructions had to be revised for Version 2. As mentioned the game had a variety of different forms of questions, as seen in Figure 5. Every single person struggled with the multi-video form. This was mostly because they did not read the instructions, and did not see the video icon button and even when they did many did not understand what was being asked. Five out of seven people took the time to go through the game and were able to do it without any additional help, whereas two started frantically clicking away just to finish the round. Before every game people are given the option to go over the signs and it was clear that people, as seen throughout the evaluation phase, would immediately go to the video, as it required less reading.

After the users were given the time to interact with the application they were asked to fill out the last part of the Questionnaire which asked them about four key aspects: usefulness, ease of use and ease of learning and satisfaction. Table 6 is based on the first part of the questionnaire regarding the application itself, and Table 7 refers to the game element of the application, but had similar questions.

TABLE 6: RESULTS FROM THE QUESTIONNAIRE - PART ONE

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
Usefulness						
A					7	
B				5	2	

C			2	3	2	
D		1		3	3	
<b>Ease of use</b>						
A				2	5	
B				2	5	
C				4	3	
D		1		2	4	
E			1	4	2	
F				6	1	
G			2	4	1	
H			1	2	4	
<b>Ease of Learning</b>						
A				4	3	
B				3	4	
C				2	5	
D				3	4	
<b>Satisfaction</b>						
A		1	1	1	4	
B		1		6		
C				4	3	
D				4	3	
E				3	4	
<b>Open Questions at the end</b>						
1				5	2	
4			2	3	2	
5			1	3	3	
6				2	5	
<b>Open Question – Which form of media did you prefer to use?</b>						
	Image	Image + Caption	Video	All		
2			4	3		

One of the sub-questions for this project is in regards to users not needing to know how to read or write. However, for this version of the application there was a lot of written information and instructions, which is also reflected in the Table 6, where there was no consensus on the statement of it is suited for all levels. Yet, the users that were testing the application, with the ability to read and write did all believe it was a useful application.

During the user testing and evaluation all users had to have additional help from us to proceed with the tasks or the game, however. Apart from one person, all others' feedback was positive in regards to the ease of use. We also asked users to give their feedback on the ease of learning i.e. it is easy to learn to use it. Again, the feedback was positive, the application was user-friendly and easy to learn to use. What needs to be noted was that these questions were in regarding the dictionary, which meant the tasks that the user was required to do during testing was repetitive. Due to the repetitive nature of the tasks, regarding the dictionary, once a user understood the steps they needed to take to find a specific word it became easy.

The last section of the questionnaire before the open end question was on satisfaction. Here we can establish that the instructions that we had provided was not sufficient. For our next iteration during the re-design we had to revisit the instructions for the application. There was one case where someone did not feel there was adequate information, which was due to the fact that some of the captions for the signs were not sufficient enough for him/her to understand the sign, this too will be revisited during the re-design. The last question that was asked was "I would recommend it as a learning tool for sign language," this was asked to gain an understanding of how well people believed this application could be as a learning tool, and from the results we can see that people did feel it was an application they could learn from.

The last three rows in Table 6, indicate the users prefer in learning the new sign. This was also one of the sub-questions we aimed to answer. Based on our findings, video is the preferred method for the majority of the users. However, there were 3 of the users who used all of the forms provided. One said it was due to the fact that they themselves enjoyed reading, whereas those who preferred the video form, did not have the patience for that. Concluding that users learn in different ways, where one form may not be better than the other. Users should be able to choose which form is easier for them to learn from.

**TABLE 7: RESULTS FROM THE QUESTIONNAIRE – PART TWO**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
<b>Usefulness</b>						
A			1	1	5	
<b>Ease of Use</b>						
A				4	3	
B				3	4	
C				4	3	
D				6	1	
E				4	3	
F			1	4	2	
<b>Ease of Learning</b>						
A				2	5	
B				3	4	
C				4	3	
D				2	5	
<b>Satisfaction</b>						
A		1		3	3	
B				3	4	
C			1		6	

In regards to the game element of the application, six out of seven believed it is useful, one felt it was an application that would be better suited as an application where you could test how well you did and not learn from it. However, with the game being a simple matching quiz game, a familiar format, the users, all but one, believed it was easy to use and effective way of learning. Due to one of the users not agreeing with that statement we had to re-think and refine the game element of the application. Giving users a greater incentive to want to play i.e. progress bar, different levels, etc.



With the main focus of this user evaluation phase was usability the feedback that we gained was important. With the information that we gathered and the feedback we concluded that not all users were able to use the application without additional help, meaning there were still some usability issues.

However, in general, the results and feedback that we got were positive, where the main issues raised were based on the instructions provided in the application. Additionally, we were able to establish that people thought that the game brought value to the application. However, there was room for improvement. With the very last section on the questionnaire being open-ended questions we were able to get more information about what people thought were positive and negative aspects of the application as a whole. Based on the results from the questionnaire and the open-ended questions we had a list of changes that need to be addressed, Table 8.

## 5.2 LIMITATIONS OF THE DEVELOPMENT OF VERSION 1

Even with the images and the videos that we had obtained there was still an issue of being able to explain how to sign that specific word or phrase. This was and still is a big limitation as we are not at all experts in sign language, and have no real knowledge of how to explain to someone how or where to hold their hand. This made creating the word pages difficult as for each how-to we had to create captions explaining what was happening in each still, but due to the lack of knowledge we did not know what the best way was to explain it. Nevertheless, we decided to explain it as plain and simple as possible, and relate a sign to actions to options or motions. For example, for the sign BIRD, we knew that we could explain it as your hands are your wings, which you are flapping.

Furthermore, regarding the written content, the issue we had was how to present the information. We identified during the application evaluation of language learning application that instructions are a very important part of the application being a learning application. If the instructions are not clear a user will not be able to use your application effectively. Unlike web applications, mobile applications do have the limitation that it is displayed on a smaller screen. This in turn meant that we had to have instructions that were concise, however there were some cases where this was difficult and resulted in a whole lot of written text, as we thought that that was the best way to explain it, which was also why we had a how-to. Additionally, due to some activities needing more information the text size would decrease, which was not effective. This was later echoed by one of the users during the evaluation.

Due to the fact that we were limited by the screen size and the game had eight different forms. There was a lot of information that was being given to the user. Mostly, because we had to introduce each of these forms as they appeared and due to the constant changing of the questions, we could not have created an overall how-to that would cover all the forms and still fit on one screen. Hence we had the concise how-to before the game, however due to it being only text people did not seem to want to take the time to read it.

## 5.3 IMPROVEMENTS FOR VERSION 2

From what we were able to gather from the testing and evaluation phase we identified a list of issues that we had to adjust for the next iteration for this application.

TABLE 8: IMPROVEMENTS FOR VERSION 2

Issue	Improvement
Only 1 out of 7 people saw the video tab	1) Switch the video and the how-to around 2) Add more instruction to tell the user there are two different tabs
4/7 struggled with the how-to page. Did not intuitively know to scroll down the page	1) Add more instructions to tell user they can scroll
Confusing text	1) Go over all the instructions and captions <ol style="list-style-type: none"><li>Rephrase</li><li>Add</li><li>remove</li></ol>
Alphabet and Number in the dictionary caused confusion as 3 of the users did not understand to look for the word Alphabet/Number but tried to find the individual letters	1) Create separate pages for Alphabet and Numbers
Multi-Video Question form, no one understood how to answer the question when it came up	1) Add more instruction for clarification
Make a distinction between the stills and the videos, as all users thought the stills were videos	<i>Did not have a solution at the time</i>

## 6 | VERSION 2 – EXPERTS

### 6.1 VERSION 2

For Version 2, we aimed to fix all the issues that we observed during the first evaluation. Based on Table X in Chapter 5 we refined our application and created Version 2.

#### 6.1.1 DESIGN ALTERATIONS AND IMPLEMENTATION

There were six issues that we observed and gathered from our feedback that we took into consideration and attempted to fix. Firstly, we took out the Alphabet and the Numbers pages from the dictionary and created their own section on the home page. Next we switched around the tabs, as a lot of people suggested it and the fact that more people were inclined to look at the videos over the images and their captions. Additionally, we revisited all the written instruction that we had, and altered them to be more clear. Lastly, in the game everyone struggled with the second question Figure 14. This, was due to the fact that they did not read the question, or that they did not see the video icon. For this reason, we decided to add more instructions, guiding the user to read it to understand what the question was asking.

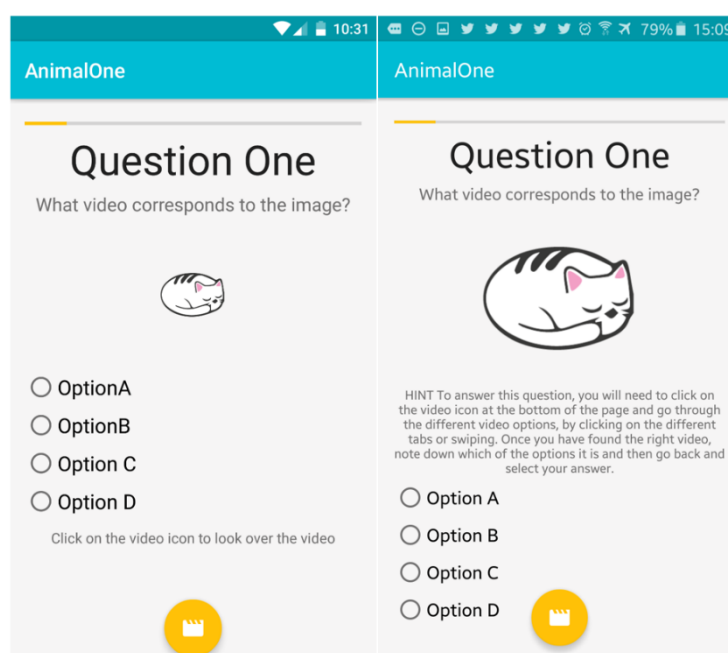


FIGURE 14: QUESTION FORM USERS HAD DIFFICULTIES WITH

#### 6.1.2 TESTING AND EVALUATION

For this evaluation phase, we did not follow the same three-part evaluation as we did for Version 1. As the tasks that were given to the users in Version 1 was created for users that did not know sign language. Instead they were given the freedom to explore the application, where they were asked before the evaluation if they could say whatever came to mind, and have it be recorded. Nevertheless, we did use the first page of the questionnaire for generic information, where we also specified them to say what their specialisation was.

### 6.1.3 RESULTS

Due to the fact that this evaluation phase was less structured the following table summarised the positive and negative aspects of the application as well as suggestions that the experts had and were noted down as they were exploring the application. Below each table we briefly discuss the main points.

TABLE 9: SUMMARY OF POSITIVE ASPECTS FROM EXPERT USER TESTING

Positives
The alphabet and numbers pages as separate sections
The image concepts are nice
The separate tabs are nice, having the video first and the how-to second
Likes the video questions (Video and then 4 options)
Likes the concept of having it be an application that can be localised
Likes the different question forms
Likes the overall application
Looks very pretty
Category is nice to find words
It is user-friendly
You navigate it easily
Like the repetition

Overall, the changes that were made from Version 1 to Version 2 seemed to be received quite well. All experts liked the separate sections, and the different tabs for each word. Aesthetically they all thought it looked very nice, and the application was user-friendly and easy to navigate through. Even though it was seen as a positive, the different question forms, it was still said to be overwhelming by all of them, and the idea of separating them and instead creating levels within the game came about, which we implemented for the next iteration.

TABLE 10: NEGATIVE ASPECTS FROM EXPERT USER TESTING

Negatives
Media controller masks the video
Too much text
Question form of video is unclear
Scrolling too much in game
Image stills
No feedback
No skip button
Abstract words

The negative aspects that we gathered were in general regarding the amount of text that was in the application, where one said it was a lot of unnecessary text. Furthermore, one mentioned that it was probably best to limit the amount of times a user would have to touch the phone, this was regarding the game, where you had to scroll through the different options to find the right one. At the time, there was still no real distinction between the still images and the videos, however, for the last iteration they only appeared in the how-to. Lastly, there was a point made that there was no real feedback for the users, telling them how good or bad they did, which made the game lose value and did not create an incentive to want to play.

**TABLE 11: SUGGESTIONS FROM EXPERT USER TESTING**

Suggestions
Immediately play video
Switch the image concept with the video, so media controller masks the image not the video
Transcribe in American GLOSS
Have video instructions → in ZAMSL
Get rid of unnecessary text → Option A = A; Question One = 1
Separate the different question forms → Easy   Medium   Hard
Add tutorials
Give feedback
Captions could be done better
Move game icon to the top
YouTube style replay button
Add Hand formations

Many but not all of the suggestions mentioned correlated with changes that had to be made from the negative aspect's table, Table 10. Refer to Table 12 below will show the improvements and suggestions that will be made for Version 3 based on the feedback and observations made.

#### 6.1.4 LIMITATIONS OF THE DEVELOPMENT OF VERSION 2

As mentioned one of the issues that we had was that the media controller kept moving after the user would click on the play button. However, due to the fact that we switched the video and how to tab around, the issue was worse as when the user clicked on the play button the media controller moved to right on top of the video. The only fixable solution at the time was that we told user to click on the screen again and the media controller would disappear. Until the last iteration, we did not have a proper solution for this issue. Another issue that we had was with the scrolling of some of the pages, even with the correct code, the pages did not scroll on some words. Specifically, words that had two images, if a user tried to scroll the page would stop scrolling and obscure the caption underneath the image, making it hard to read the caption.

Furthermore, Android Studio had a feature which would allow us to view a preview of what it would look like on a mobile phone. However, it did not have the biggest range of screen sizes making the preview different to what it would actually look like on the emulator and the actual phone. This was an issue that we only became aware of when we were developing the game, where the game was in portrait mode, and we were trying to get all the necessary information onto the screen. When we pushed it onto the emulator the layout was different making the preview in Android Studio unreliable when we were developing.

### 6.1.5 IMPROVEMENTS FOR VERSION 3

From what we were able to gather from the testing and evaluation phase we identified a list of issues that we had to adjust for the next iteration for this application.

TABLE 12: IMPROVEMENTS FOR VERSION 3

Issue	Improvement
<b>Too much text</b>	<ol style="list-style-type: none"> <li>1) Remove as much unnecessary text as possible</li> <li>2) Create tutorials for the different sections of the application</li> </ol>
<b>Video is an issue because of the media controller and having to interact with the screen too much to make it work</b>	<ol style="list-style-type: none"> <li>1) Re-design the video player</li> <li>2) YouTube style replay button</li> <li>3) Automatically start</li> </ol>
<b>No feedback</b>	<ol style="list-style-type: none"> <li>1) Tell the user if the selected answer is correct/wrong</li> <li>2) Display their score at the end of each round</li> </ol>
<b>Users cannot use it if they cannot read or write</b>	<ol style="list-style-type: none"> <li>1) Reduce the amount of text</li> <li>2) Replace text with images as much as possible</li> </ol>

## 7.1 LEARN TO SIGN

For Version 3, we took the feedback given by the experts and compiled them into the two tables 11 and 12 presented in Chapter 6. Where we attempted to implement as many of the suggestions and eliminate as many of the issues as possible with the improvements.

Due to the time frame of the project we had decided that this would be the last iteration, where we would not have an evaluation phase followed by the design and implementation. However, for future development, more iterations of the application would take place, to keep narrowing down the requirements till it satisfies all the needs.

### 7.1.1 DESIGN ALTERATIONS AND IMPLEMENTATION

The following few images are screenshots from the final iteration of the application, “Learn to Sign”.

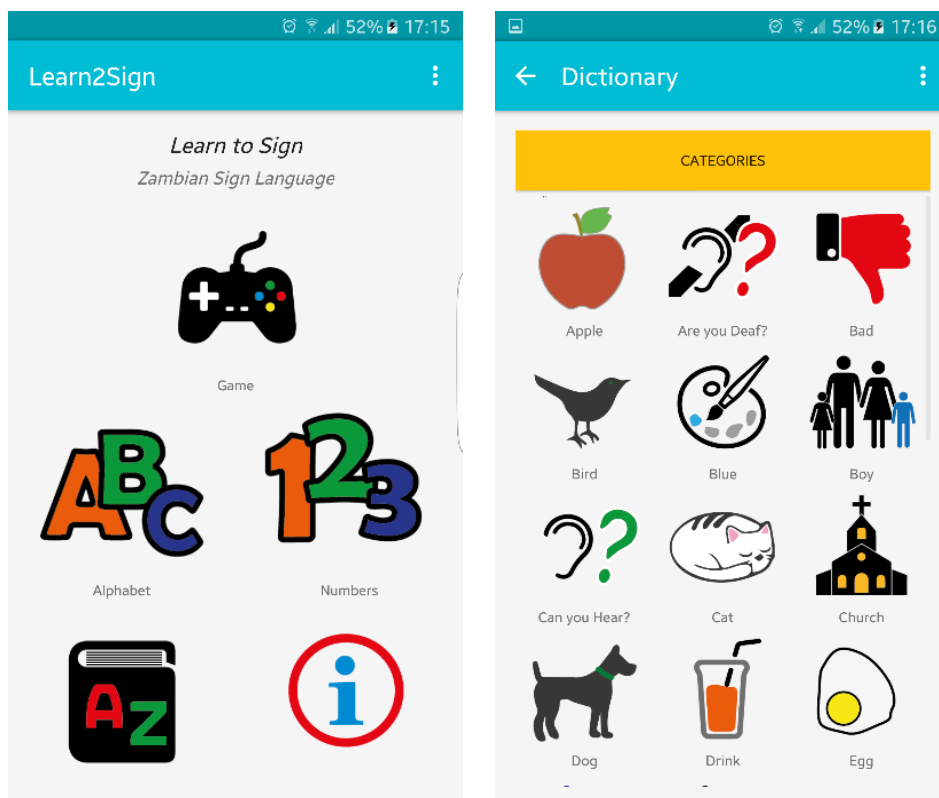


FIGURE 15: SCREENSHOTS OF FINAL VERSION

We first moved the game icon to the top of the home page, as that is an important feature of the application as well as the fact that we changed the order of the other icons. Furthermore, we decided to remove the categories icon, and give users the option to look up by category in the dictionary itself. Additionally, one can see that we added 'Zambian Sign Language' as this had not been made clear when people were testing it.

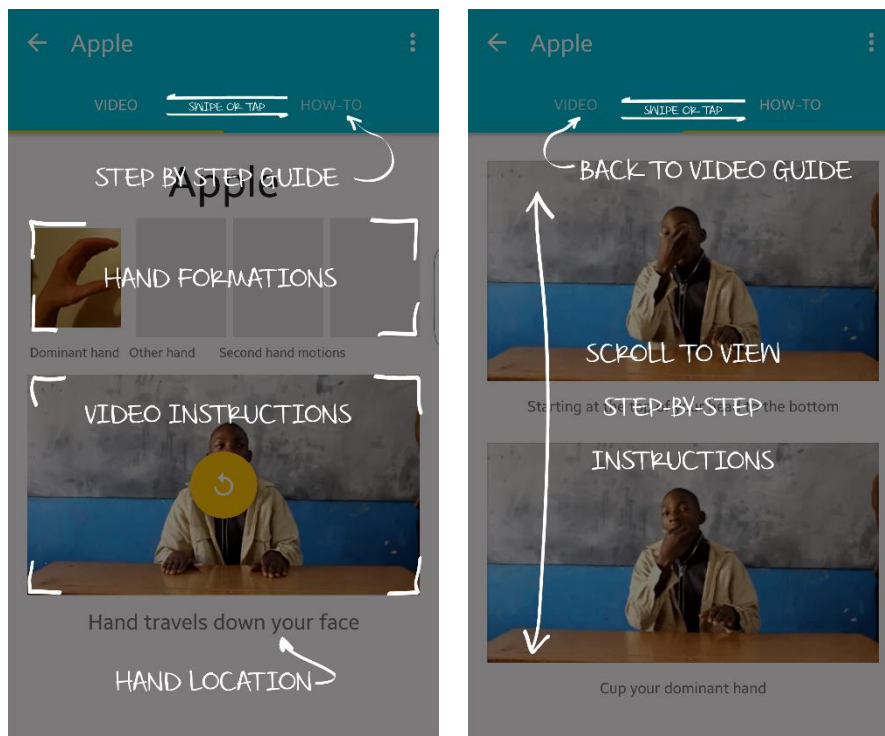


FIGURE 17: TUTORIALS FOR DICTIONARY

The next new feature that we implemented was the tutorials. In total there were five tutorials added to the application, the first one was after the user clicked on the dictionary they would be presented with the tutorial that would explain how the dictionary worked, which in turn meant that we did not have to have all the additional written instructions on each of the pages. After going through the tutorial, the users are presented with a grid layout of the wordlist, as well as the written word underneath it. This allowed us to remove the image concept from the word page, and minimise the information that is on the screen. Once the user has chosen a word to learn, the dictionary displays Figure 17, where the hand formation where added, and the media

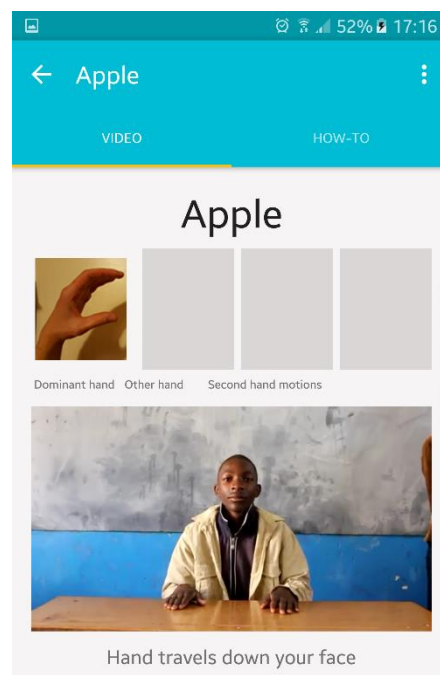
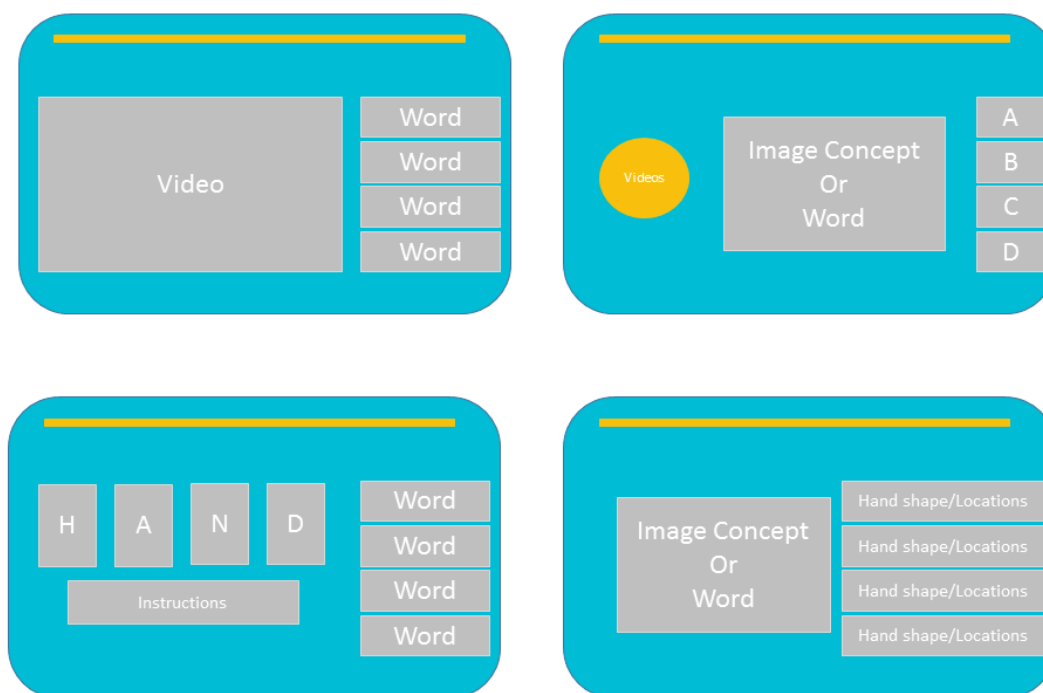


FIGURE 16: NEW WORD LAYOUT



controller was removed and replaced with the place button. In addition to that, we decided to add an instruction at the bottom of the video, which told the user the movement of the sign.

Next we went on to re-designing the game, where the biggest difference was that we rotated the whole game. To rotate the game, we just had to add the orientation that we wanted it to be in the manifest, code snippet in Appendix A, Section 8.3. Furthermore, we decided to change the question forms, even though having the range was a positive aspect we decided to start off with implementing four levels. Each level had a different question form, Figure 18 shows the questions forms that we decided to use, where some were altered and some taken from the previous eight.



**FIGURE 18: NEW QUESTION FORMS**

The code used for the questions, were previously discussed. In addition, when a player clicked on a level they were presented with a tutorial of that question form, once again allowing us to remove a lot of the unnecessary text. Figure 19 and 20, shows the difference between Version 1 and the final version, where one can see how much text was removed.

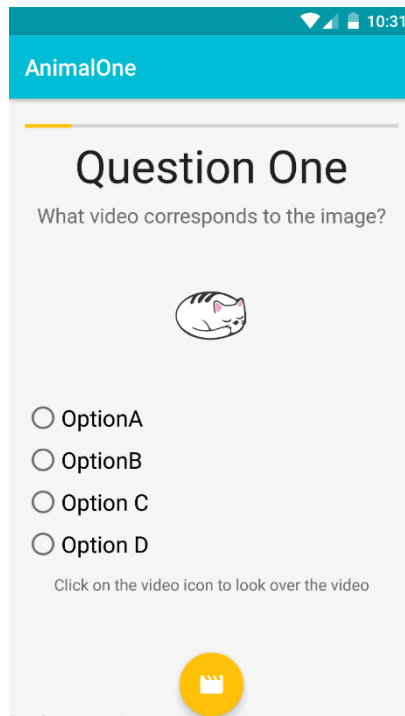


FIGURE 19: QUESTION IN VERSION 1

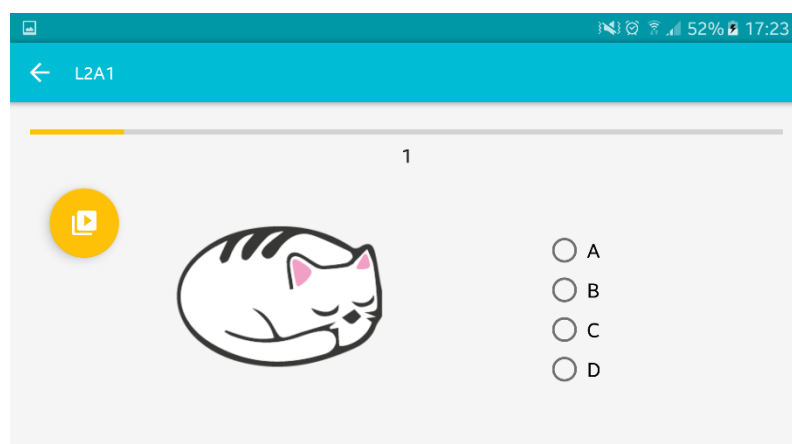
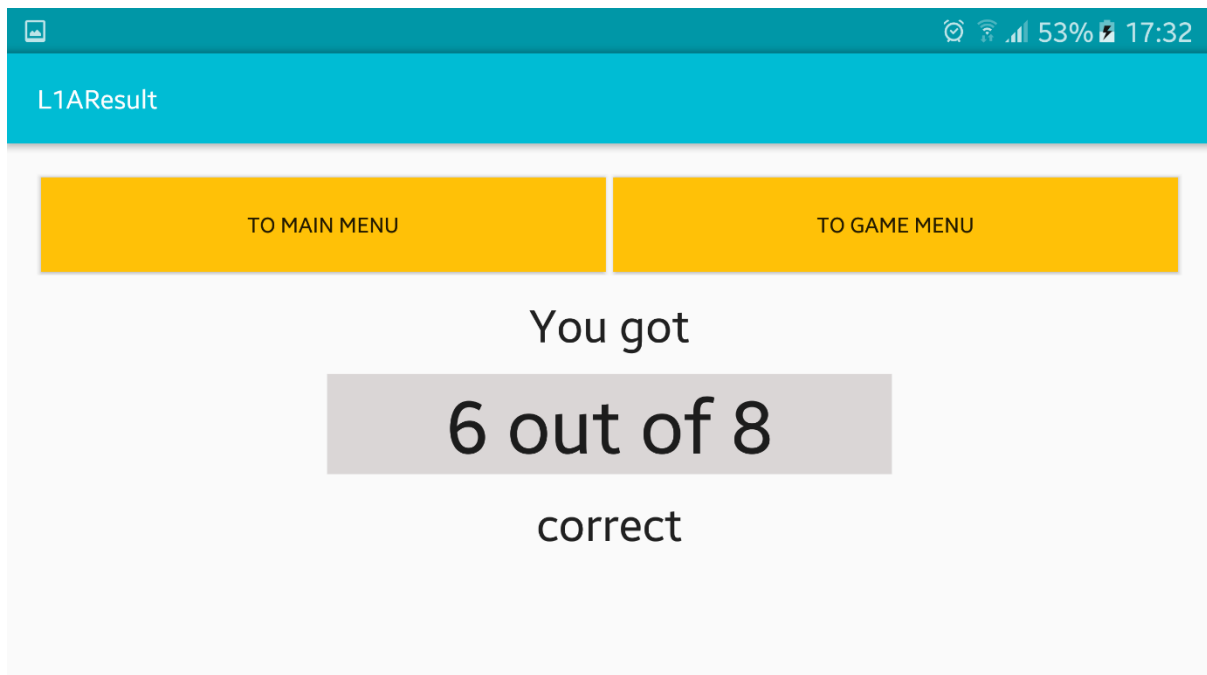


FIGURE 20: QUESTION IN FINAL VERSION

As before a user would then have the option to choose which category to play, and were then lead into the game. Where the number of questions in a round depended on the category chosen. Due to the fact that we did not want people to frantically select every option till they found the right one, we decided that even with a wrong answer the user would be guided to the next question. The dialog box that popped up was the same as in the previous versions.

At the end of each round the user is presented with their score, Figure 21. Due to the fact that we had set out to create an unlocking mechanism for the game, we wanted to implement the necessary code to achieve this. The temporary solution that we came up with was by implementing a few lines of code into each question, refer to Appendix A, Section 8.4 where when a user clicked on an answer (if correct: +1, if wrong: +0). A counter would

either increase or stay the same, until the end and then it would be displayed. It reset after a user exited the feedback page.



**FIGURE 21: SCORE DISPLAY**

### 7.1.2 DISCUSSION

This being the last iteration we did not have an evaluation phase. However, for the purpose of this project, we discuss the possible evaluation that we would like to do in the future. Currently, the testing and evaluation phases that we had done were with hearing people and experts that were hearing, hearing people are our targeted audience. Yet, it would be a good idea to test the application on a group of individuals who are deaf. As this would give us a better understanding into how deaf people would use such an application, and it would be useful to get feedback from them to learn what changes could be made to the application, where that feedback would primarily be focused on the content of the application.

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## 8 | CONCLUSION

### 8.1 CONCLUSION

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***"How could we assist hearing and deaf individuals in communicating with each other using a mobile application?"***

As mentioned during the literature review across Sub-Saharan Africa people's beliefs and views on deafness was not all unified. Many deaf individuals struggled to be accepted by their communities, and even with acceptance there was little to no communication between deaf and hearing individuals apart from home-made gestures that were limited. Based on the literature review and the requirements analysis we developed a mobile application. We established an educational mobile application would be the best option for this. However, one cannot simply transform learning materials which are taught in a classroom to a mobile device, this is why we wanted to answer the following three sub-questions:

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***"What are effective teaching methods that can be implemented into a mobile application?"***

***"Is there a simplistic way of conveying a sign, which does not require an individual to know how to read or write?"***

***"Which form of media is the better fit when learning a new sign? i.e. images, images + captions, videos"***

These sub-questions were identified to be able to gather user requirements that would be a good foundation in developing a useful educational mobile application. Where the first one we focused on being able to translate learning material to a mobile device by adapting the teaching methods of sign language. The second sub-question was formed as we knew that not all our targeted users would be able to read and/or write meaning we had to develop an application that was suited for all. This was done by developing a simple but visual application, using as little text as possible but still having enough information presented to convey a sign. Lastly, based off of the second sub-question and the research analysis we knew that the mobile application had to convey the information visually. To do so we had to establish which form of media would be best suited for the application, where in the end keeping all the different options seemed to be the best solution as everyone learns differently. Be it through images and captions, if they can read, using the videos provided or even using both.

#### 8.1.1 VERSION 0 DISCUSSION

Version 0 started off with two mocked-up PowerPoint versions of an application, to create a start and a visual representation of what we wanted our application to do and what we wanted it to include. The first mock-up was only a dictionary based mobile application, whereas the second we had changed the design to also hold a game element. Solely based on the second mock-up did we develop our first prototype. The first prototype was

merely a more visual mock-up of the PowerPoint version 0.2, as we did not have a set database of resources that we could implement into the application.

On the development side, for Version 0, there was nothing special as said it was only a few activities connected to each other, this was due to the inexperience in coding and the learning curve that is associated with learning to code.

### 8.1.2 VERSION 1 DISCUSSION

Unlike Version 0, at this stage of development we focused on create a working prototype, the usability as well as the visual aesthetics of the application. With our word list we were able to expand our application to more than a few activities connected to each other, we were able to implement associated videos and image stills from the videos into the application, for both the dictionary and the game feature. The image stills were created by taking snippets of the video, whereas the corresponding concept images were created by Pete Hunt. By having all the components needed to create a working prototype we first focused on the dictionary. By knowing the layout for one of the words in the dictionary it was only a matter of copy-and-paste for each other word in the word list, time-consuming. An issue that we did encounter during the development of the dictionary was that we did not have enough knowledge of sign language to be able to caption the still images with appropriate instructions that made sense and were deemed correct. However due to the fact we did not have any experts in ZAMSL, we had to make do with the captions we created at this stage of the development by half teaching ourselves by looking at other language learning applications, sign language dictionaries and literature papers on sign language.

The game element for the application proved to be more difficult, we had to figure out how we wanted our game to look, what type of game it was going to be, and how it was going to work. This is why we created a variety of different question forms, however this also meant that each question form had to have a different layout, and different bits of code. Additionally, we split up the word list into categories where the number of words in each category varied as well. However, due to the small word list that we had, splitting it up into categories would in turn create a very short game. To avoid having a 3 question quiz we decided to double to number of words of the category chosen, to allow users to see each word twice. With the working prototype we presented it to a group of people known to me, as we just wanted to observe and establish if the application worked, and to see if people struggled to use it or if people thought it was easy to us. We were able to conclude that the application was received well, however there were many improvements and suggestions gathered, which we attempted to change during the development of Version 2.

Even though the user testing gave us a general idea of what people thought of the application and how well they worked with it, it would of been more interesting to be able to user test the application on people that had knowledge of Sign Language in general as it would give me a better indication if the way we presented and laid out the information was done well. This is what we did during the user testing for Version 2.

### 8.1.3 VERSION 2 DISCUSSION

Based on the results from the first round of user testing we knew that gathered a list of things that needed improving for Version 2. This also made it easier during the refining stage of the prototype, as the changes that we had to make had more to do with the layout of the application than it did with the functionality of the application

With the creation of Version 2 we went into our second round of user testing, as mentioned we wanted it to be testing on users that had more knowledge of sign language as for this Version we wanted to make sure that the information that we were presenting was good enough to be able to learn a sign. Unlike the first user testing the three experts were given the freedom to use the application and give us feedback when they had a thought or a comment. This also allowed the experts to be able to explore the whole application, and find flaws that could be fixed and improvements that could be made. Two important and frequently pointed out issues were that the media controller was not working properly and that there was too much text, these two issues were due to the limitation we have, the inexperience in coding made it difficult to fix the media controller issue and the lack of knowledge in Sign Language created an overloaded screen of information.

#### 8.1.4 VERSION 3 – LEARN TO SIGN (ZAMBIAN SIGN LANGUAGE)

The final version of the application took everything that was gathered from both user testing and the continuous research done throughout the development to create 'Learn to Sign – Zambian Sign Language' Even though we are calling it the final version it is not really the final version; it was the version that we decided to stop at for this time frame of the project. The biggest changes that were made for this iteration, was getting rid of the overload of text in the application, the rotating of the game, creating levels in the game, fixing the media controller, as well finally being able to get a score to display at the end of each round.

Due to the fact that there was no evaluation for this iteration, we were not able to collect any new information on positive or negative aspects for the application as it stands.

## 8.2 FUTURE DEVELOPMENTS

There are still many improvements and features that we would have wanted to implement into the application, but due to the time frame we were not able to. This section will go over those improvements and features that we would integrate into the application in the future.

During the language learning application evaluations, we saw that having an overview of the alphabet and the numbers was a good way of showing the different signs for each letter and numbers. However, due to our focus being primarily on getting the game element to work we did not have time to change the layout of the alphabet and the numbers. At the moment the user only has the option to click on the alphabet and numbers where they will be sent to the letter A or the number 1. From there users can swipe through the alphabet and the numbers. In the future we would want to create an activity which gives an overview of the alphabet or numbers and then have the user be able to click on any letter or number and swipe through them.

Secondly, due to our lack of knowledge when it comes to sign language we would want to be able to sit down with a sign language expert, preferably one that knows Zambian Sign Language for this particular application and go through each word in the word list and create suitable captions for each. As at the moment the captions were created by ourselves, and may not be the most appropriate way of convey a sign. Additionally, the word list for the application only consists of 30 signs, for future development and improvements we would want to word list to increase, as well as the fact that we would want the addition of words to be simple. Which at the moment it is, as we would only need to create a few new activities and copy-and-paste the necessary code and change the associated video or image to the new word. However, this method is tedious, and we would want to create an easier way of adding words on the back end of the development as well as possibly integrate a feature that would allow users to add their own signs to the dictionary.

Furthermore, this project set out to create an educational mobile application for the region of Sub-Saharan Africa. However, due to sign language not being universal as well as the lack of resources creating an application that was unified in such a region was not easily attainable. Which is why for future developments for this application we would want the code and the application itself to be simple enough that other developers or users could take the code and adapt it to other languages. Yet, the captions would have to be changed manually however with it being hardcoded into a separate file, changing the captions would also be easy.

As mentioned we did not have a good enough knowledge when it came to coding, which is why for future developments we would want to gain more experience regarding coding so that we can improve the overall structure of the application i.e. getting rid of redundant code. Additionally, there were features to the application that we were not able to implement into the application due to our inexperience. One of them being creating a game with an unlocking mechanism, currently the game is fully open and the user can click on each level and choose each category. The unlocking feature that we would have wanted to implement would give the user an added incentive to keep playing the game, as they would keep unlocking new levels and new categories as they are playing the game. During the development, we had persisted in to trying to implement this feature however we were not able to get the necessary code working to be able to implement this. Furthermore, to be able to implement the unlocking feature the game would have to be able to remember where the user last left off, making it a more personal game but similar to the unlocking feature understanding the code need to save the game information was difficult. All these features all use the same bit of code which keeps track of a user's progress in the application. Lastly, the application currently presents the user with a tutorial each time they enter the dictionary or a level in the game, for future development this would be eliminated by using that bit of code that remembers if a user has used the application before and have an added feature that allows a user to go over the tutorials whenever they please.

Overall, by gaining a better understanding of code all these improvements and features would be implemented into the application as well as having access to a bigger word list and the appropriate experts.

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## 10 | APPENDIX A | CODE

The whole code for the application is accessible from: <https://learn2signsite.wordpress.com/>

### 10.1 IMPLEMENTING VIDEOVIEW AND MEDIACONTROLLER

```
<FrameLayout
    android:layout_width="match_parent"
    android:layout_height="wrap_content">

    <VideoView
        android:layout_width="match_parent"
        android:layout_height="200dp"
        android:id="@+id/bird_video"
        android:layout_centerHorizontal="true"
        android:layout_centerInParent="true"
        android:layout_marginTop="10dp"
        android:layout_marginBottom="10dp" />

    <android.support.design.widget.FloatingActionButton
        android:id="@+id/repeat"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center"
        android:layout_margin="16dp"
        android:src="@mipmap/ic_replay_white_24dp" />

</FrameLayout>
```

```
@Override
public View onCreateView(LayoutInflater inflater, ViewGroup container, Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    View view=inflater.inflate(R.layout.bird_video, container, false);
    final VideoView video = (VideoView) view.findViewById(R.id.bird_video);
    final FloatingActionButton replay = (FloatingActionButton) view.findViewById(R.id.repeat);
    String videoPath = "android.resource://com.example.julia.learn2sign/"+R.raw.bird;
    Uri videoUri = Uri.parse(videoPath);
    video.setVideoURI(videoUri);
    replay.setVisibility(View.INVISIBLE);
    video.start();

    video.setOnCompletionListener((mp) -> {
        replay.setVisibility(View.VISIBLE);

        replay.setClickable(true);
        replay.setOnClickListener((v) -> {
            video.start();

            if (video.isPlaying()) {
                replay.setVisibility(View.INVISIBLE);
            } else {
                replay.setVisibility(View.VISIBLE);
            }
        });
    });
    return view; }
```

## 10.2 CORRECT/WRONG ANSWER CODE

```
public void onRadioButtonClicked(View view) {  
    // Is the button now checked?  
    boolean checked = ((RadioButton) view).isChecked();  
  
    // Check which radio button was clicked  
    switch(view.getId()) {  
        case R.id.optionA:  
            if (checked)  
                wrongAlert(view);  
            break;  
        case R.id.optionB:  
            if (checked)  
                correctAlert(view);  
            break;  
        case R.id.optionC:  
            if (checked)  
                correctAlert(view);  
            break;  
        case R.id.optionD:  
            if (checked)  
                wrongAlert(view);  
            break;  
        case R.id.optionE:  
            if (checked)  
                wrongAlert(view);  
            break;  
        case R.id.optionF:  
            if (checked)  
                wrongAlert(view);  
            break;  
    }  
}
```

Depending which option is clicked  
either correctAlert or wrongAlert will be  
executed.

Depending which option is clicked  
either correctAlert or wrongAlert will be  
executed.

```
private void correctAlert(View view) {  
    Score.score = Score.score + 1;  
    AlertDialog.Builder alertDialogBuilder = new AlertDialog.Builder(L2Fo1.this);  
  
    alertDialogBuilder.setTitle("Correct!!!");  
    alertDialogBuilder.setMessage("Well done!");  
    alertDialogBuilder.setPositiveButton("Continue", (dialog, id) → {  
        startActivity(new Intent(L2Fo1.this, L2Fo2.class));  
    });  
    AlertDialog alertDialog = alertDialogBuilder.create();  
    // show alert  
    alertDialog.show();  
}
```

```
private void wrongAlert(View view) {  
    Score.score = Score.score + 0;  
    AlertDialog.Builder alertDialogBuilder = new AlertDialog.Builder(L2Fo1.this);  
  
    alertDialogBuilder.setTitle("Oops");  
    alertDialogBuilder.setMessage("Next time you'll get it");  
    alertDialogBuilder.setNegativeButton("Continue", (dialog, id) → {  
        // go to a new activity of the app  
        Intent next = new Intent(getApplicationContext(),  
            L2Fo2.class);  
        startActivity(next);  
    });  
    AlertDialog alertDialog = alertDialogBuilder.create();  
    // show alert  
    alertDialog.show();  
}
```

## 10.3 ACTIVITY ORIENTATION

Screen Orientation set to landscape

```
<activity
    android:name=".L1A6"
    android:label="L1A6"
    android:screenOrientation="landscape"
    android:theme="@style/AppTheme.NoActionBar" />
```

## 10.4 DISPLAYING SCORE

Start out with a score of 0

```
public class Score {

    public static int score = 0;
}
```

---

+1 if correct and +0 if wrong

```
private void correctAlert(View view) {
    Score.score = Score.score + 1;

    private void wrongAlert(View view) {
        Score.score = Score.score + 0;
```

---

Score is displayed using the last line of code. And when the user goes back to main menu or the game menu the score is reset to 0.

```
Button main = (Button) findViewById(R.id.main);
main.setOnClickListener((v) → {
    startActivity(new Intent(L2FoResult.this, MainActivity.class));
    Score.score = 0;
});

Button gamemenu = (Button) findViewById(R.id.gamemenu);
gamemenu.setOnClickListener((v) → {
    startActivity(new Intent(L2FoResult.this, LevelTwo.class));
    Score.score = 0;
});

TextView endScore = (TextView) findViewById(R.id.endScore);
endScore.setText(Score.score + " out of 12");
```

---

# 11 | APPENDIX B | QUESTIONNAIRE

## Master's Thesis Questionnaire

### Gender

☐ Male ☐ Female

### Age

☐ <18 ☒ 18 - 24 ☐ 25 - 34 ☐ 35 - 44  
☐ 45 - 54 ☐ 55 - 64 ☐ 65 +

#### 1. Have you used a mobile application for learning purposes before?

☐ Yes ☐ No

1a. If answered yes, please list what you have used:

---

---

---

---

---

#### 2. Have you used a mobile application for LANGUAGE learning purposes before?

☐ Yes ☐ No

2a. If answered yes, please list what you have used:

---

---

---

---

---

2b. If answered no, please list what you DO use:

---

---

---

---

---

**3. If answered yes to Q1 and/or Q2: What was your experience using them?**

*Was it efficient and effective? Did you learn from it?*

---

---

---

---

---

**4. If answered no to Q1 and/or Q2: Do you know of any mobile applications for language learning purposes?**

*Can you list them?*

---

---

---

---

---

## Usefulness, Satisfaction and Ease of Use

*About the application itself (excluding content and game)*

### 5. Usefulness

5a. It is useful

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

5b. It does everything you expect it to do

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

5c. The app is suitable for all levels of users

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

5d. The app is suitable for parents (TARGET AUDIENCE)

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

### 6. Ease of use

6a. It is easy to use

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

6b. It is simple to use

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

6c. It is user friendly

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

6d. Using it is effortless

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

6e. I can use it without additional help

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

6f. I don't notice any inconsistencies as I use it

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

6g. I can recover from mistakes quickly and easily

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

6h. I can navigate through the app easily

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

## 7. *Ease of Learning*

7a. I learned to use it quickly

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

7b. I would easily be able to remember how to use it

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

7c. It is easy to learn to use it

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A



7d. I quickly became skillful with it

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

## 8. *Satisfaction*

8a. The application has adequate instructions

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

8b. The application has adequate information

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

8c. The information is presented well

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

8d. I am satisfied with it

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

8e. I would recommend it as a learning tool for sign language

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

## Usefulness, Satisfaction and Ease of Use

*About the game*

### 9. Usefulness

9a. It is useful

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

### 10. Ease of use

10a. It is easy to use

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

10b. It is simple to use

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

10c. It is user friendly

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

10d. Using it is effortless

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

10e. I can use it without additional help

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

10f. I don't notice any inconsistencies as I use it

- 
- ☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

## 11. Ease of Learning

11a. I learned to use it quickly

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

11b. I would easily be able to remember how to use it

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

11c. It is easy to learn to use it

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

11d. It is an effective way of learning

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

## 12. Satisfaction

12a. The game has adequate instructions

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

12b. I am satisfied with it

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

12c. It was fun to use

☐ Strongly Disagree   ☐ Disagree   ☐ Neutral   ☐ Agree   ☐ Strongly Agree  
☐ N/A

## Open Questions

*About the content of the app*

**13. When asked to find a specific word what did you do?**

---

---

---

---

---

13a. Finding specific words was easy

☐ Strongly Disagree ☐ Disagree ☐ N/A ☐ Agree ☐ Strongly Agree

**14. Which did you prefer to use?**

☐ Images ☐ Images and Caption ☐ Video ☐ Both

**15. Would you take the time to read the written instructions of how to sign?**

*Or would you go straight to the video?*

---

---

---

---

---

**16. The written instructions (on how to sign) were clear?**

☐ Strongly Disagree ☐ Disagree ☐ N/A ☐ Agree ☐ Strongly Agree

**17. The images are relatable to their corresponding words**

☐ Strongly Disagree ☐ Disagree ☐ N/A ☐ Agree ☐ Strongly Agree

**18. I would be able to learn basic words and phrases using this application**

☐ Strongly Disagree ☐ Disagree ☐ N/A ☐ Agree ☐ Strongly Agree

*19. Did anything about the application confuse you?*

---

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---

---

---

*20. Negative Aspects*

---

---

---

---

---

---

*21. Positive Aspects*

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---

---

---

---

---

*22. Improvements on current features/Potential future features?*

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---

---

---

---

---

# Open Questions

About the content of the game

23. The written instructions (for each question) were clear?

☐ Strongly Disagree

☐ Disagree

☐ N/A

☐ Agree

☐ Strongly Agree

24. Did anything about the game confuse you?

25. Negative Aspects

26. Positive Aspects

27. Improvements on current features/Potential future features?

In the expert questionnaire we added:

Job Title/Specialization

---

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## 12 | APPENDIX C | EMAIL

**Zambian Sign Language**

To: uta.simons@googlemail.com

Hello Uta Simons,

I am student at the Vrije Universiteit in Amsterdam, doing my Masters in Computer Science.

I stumbled upon your website, during my research. I am currently working on creating an educational mobile application for sub-Saharan Africa, specifically deaf and hard of hearing users.

The concept of the application is to make available a simple application which has three features:

1. Search Function
2. Categories with different signs
3. A simple game element

It is to be easily usable in the different countries in sub-Saharan Africa, adapting accordingly to the sign language.

It has been a difficult task finding a database of videos/signs as it is not documented very well. However I believe what you have done in Zambia, I lived there during my childhood, and your website is a great start in getting it to be more accessible to the world. Hence I was wondering if it would be possible to use your videos and take stills for images of the sign for my Masters Project.

Kind Regards

Julia Lulong Salomons

---

**Re: Zambian Sign Language**

To: Julia Salomons; Katja Stepputat

Hello Julia!

Nice to hear from you about your interesting project. I just sent your mail to my friend Katja, the photographer, to ask her if she also agrees to use the fotos for your program. I am happy about your plans and gladly give my allowance to use fotos and videoclips. as soon as Katja answers my mail, I'll send you another mail.

Best wishes for today

Uta

---

**Re: Zambian Sign Language**

To: Uta Simons

Hi Uta,

Thank you for getting back to me so quickly.

Hope to hear from you soon, when Katja emails back.

Kind Regards

Julia Lulong Salomons

---



Re: **Zambian Sign Language**

To: julia\_lulong@hotmail.com Cc: Uta Simons

Dear Julia,

I think this is a wonderful project, it sounds great.

I am happy that my films and fotos can be useful furthermore.

So I give you my allowance to use videos and pictures for your Master Project.

Please mention the copyright of the material with my name.

We will be happy to receive your information about the app and website that you are creating, when it is finished.

Best wishes,

Katja

Katja Stepputat

Am Mühlebuck 19

79249 Merzhausen

Telefon 0761-2172772

Mobil 0176-84181909