UNIVERSIDAD POLITÉCNICA
DE MADRID

ESCUELA TÉCNICA SUPERIOR DE INGENIEROS INFORMÁTICOS
MASTER EIT DIGITAL IN HUMAN COMPUTER INTERACTION AND DESIGN

Developing a Language Learning Application for the Blind

Master Thesis

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Madrid, 06 2019

This thesis is submitted to the ETSI Informáticos at Universidad Politécnica de Madrid in partial fulfillment of the requirements for the degree of Master EIT Digital in Human Computer Interaction and Design.

Master Thesis
Master EIT Digital in Human Computer Interaction and Design
Thesis Title:The Development of a Prototype from a Language Learning Application for Blind People
Thesis no:
06 2019
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Abstract

The goal of this thesis was to help Lesson Nine GMHB(Babbel) to make their products available to a broader audience through the use of accessible design. Making Lessons Nine GHMB products more accessible, can help reduce the shortage of accessible language learning materials for people who are blind. We used qualitative research methodologies and the WCAG 2.1 accessibility guidelines to redesign and test one type of exercise from Babbel, to discover opportunities and technical solutions. We succeeded in building and testing a more accessible prototype for blind users that improves the instructions, navigational structure and information, so they can better understand what is happening on the screen. Further research is necessary to make the prototype fully accessible. However Lesson Nine can already improve the accessibility of their web application with simple adjustments that may be considered 'low hanging fruit', such information structure of the page and the use of test of a webpage.

KEYWORDS: USER INTERFACE DESIGN, DISABILITY, ACCESSIBILITY, INCLUSIVE DESIGN, BLIND PEOPLE, LANGUAGE LEARNING, LANGUAGE LEARNING APPLICATIONS, E-LEARNING FOR BLIND USERS,DIGITAL INTERFACE, CREATIVE TECHNOLOGY FRAMEWORK, WEB ACCESSIBILITY OF E-LEARNING APPLICATIONS, INTERVIEWING BLIND PEOPLE,

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Acknowledgements

We want to express our appreciation to Elena Villalba and Mariet Theune for their constructive and valuable feedback while writing this research. We also like to express our sincere gratitude to Hanna Rademaker and Prasad Gupte. Hanna Rademaker for her weekly and dedicated (mental)support during this thesis and helping us to build the trust in ourselves we needed to be able to build the prototype. Prasad Gupte for making it possible for us to get this unique opportunity to do this thesis research with Lesson Nine. Further, we would like to express our special thanks to Noelia Cabana for her teaching and her help to finish the prototype in the last phase. Last and not least, we want to thank the R2D2 team, product design, instructional design, legal department and user research for providing us with their expertise, which helped to lift this thesis to a higher level than expected on the first instance.

Executive Summary

This thesis was made possible by Babbel because the company was interested in getting a better understanding of the accessibility of their product. This project was concerned with people that are blind that want to learn a language via the Babbel app. By focussing on the Vocabulary Write Trainer (VWT) we came up with a number of interesting and practical results that may have a broader applicability and value. The project made sure to comply with the newest Web Content Accessibility Guidelines (WCAG 2.1).

The research consisted out of two main parts. The first focused on developing an idea of what a Babbel application for a blind user could look like. We envisioned this by developing a persona and doing user studies with blindfolded and truly blind users. This resulted in detailed user stories and acceptance criteria for the new VWT prototype for the blind. It turns out that it is important to make a design with a minimum number of screen elements that are necessary for the training. These should be place in a logical order for a blind person and should all be provided with meaningful tags for a screen reader.

The second main part of the project consisted of actually developing and testing this prototype. It was developed for the most common practical context in which a blind person works, e.g. at home with a laptop computer, a braille-device and especially also a screen-reader that translates digital text into audio.

Here we came across a number of technical challenges for which we largely found solutions. A very specific and important challenge is making sure that the focus of the screen reader is always in the right place, and that it also notices all new content on the screen. This requires specific coding techniques.

Testing the prototype with blindfolded and blind subjects provided valuable feedback with which the requirements could be refined, and with which the prototype could be improved. The result of our work during a half year in two main sprints, has already resulted in what our main test subject described as a great improvement. It already comes close to meeting the WCAG 2.1 standard requirements, but there is of course room for improvement.

In our conclusions (chapter 10) we detail our work and results. Given the limitation of this project (chapter 11) some future work (chapter 12) is foreseen. In general we expect that working on accessibility for the blind will have a beneficial spillover effect on the visually impaired and other target groups.

1. Introduction

Babbel is a company that currently offers online language courses in 14 different languages. The courses develop the reading, writing, listening and speaking skills of the user. They are created by professional linguists, educators and authors (Support Babbel, n.d.).

The goal of this thesis is to help Babbel make their products available to a broader audience through the use of accessible design. The chosen target group this project specifically designs for are blind people that are interested in language learning. In business development practice accessibility is defined as the qualities that make an experience open for all, including people with disabilities (Inclusive Microsoft Design, n.d.). The Web Content Accessibility Guidelines 2.1 (WCAG 2.1) were published as an ISO/IEC standard in 2012 (ISO, 2018). The fact that EU laws require websites with public sector information to be built in accordance to these guidelines provides evidence that there is a trend towards more attention for accessibility (Eur-lex, n.d.). This thesis show how these guidelines can specifically be applied to Babbel products for blind people.

1.1.Relevance

In this chapter, we explain the relevance of accessible design for Babbel as a company. First we describe the Babbel product portfolio and then provide an argumentation why more attention for accessibility is beneficial.

1.1.1 Babbel as a product

Babbel is an online tool for learning languages rapidly, up to the proficiency level required for real life conversations. This is achieved by means of simulated conversations and vocabulary exercises. Courses are further facilitated by an online manager to review progress (Lesson Nine, n.d) and, for example, to adapt the course to the pace of the user.

The type of normal exercises varies, and each need to be assessed from the point of view of accessibility. For example, in the demo lesson - Spanish for English speakers - you (a student) starts with multiple choice options for a new word. First you translate from English to Spanish, and then from Spanish to English (see figure 1 and 2). After this you can review the words you learned in the lesson (see figure 3). Each of these normal exercises that can easily be done with people having sight, places blind people for challenges that make the application insufficiently accessible.

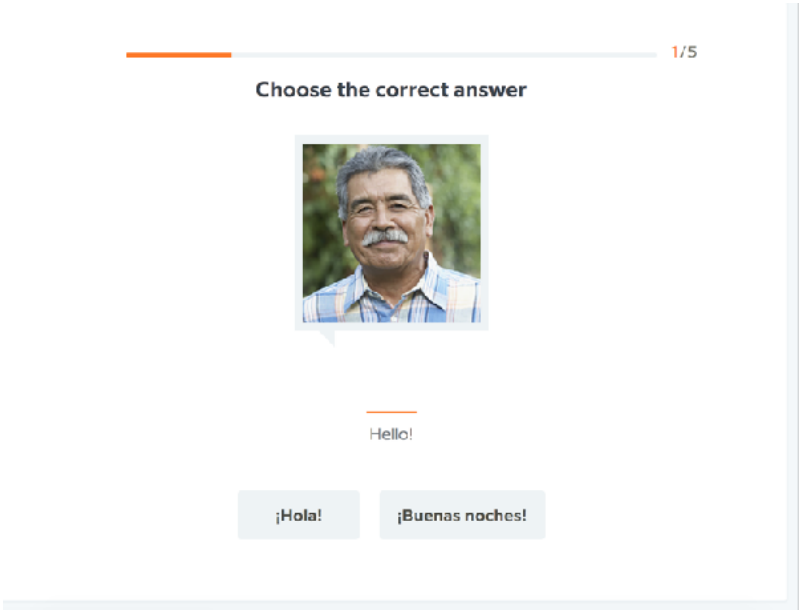

Figure 1: multiple choice options for new words

(Exercise on Babbel.com, Copyright 2019 Babbel)

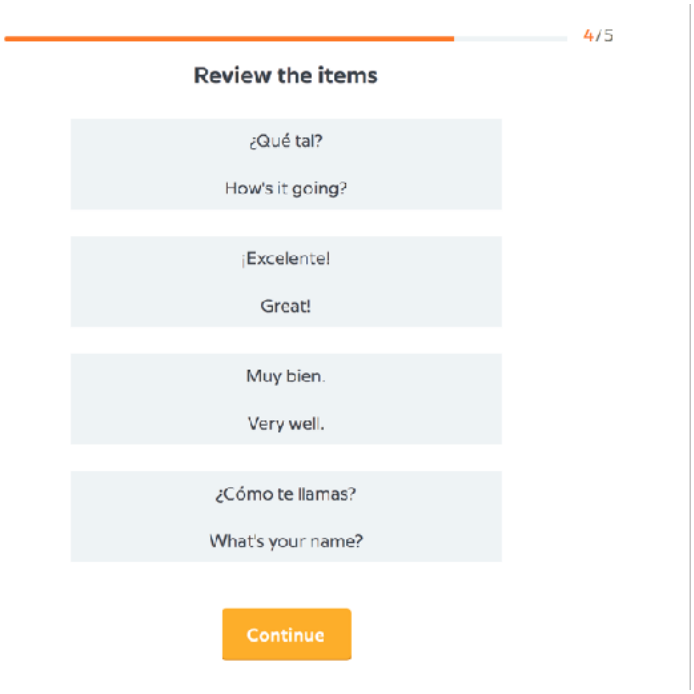

Figure 2: Matching the words with translations

(Exercise on Babbel.com, Copyright 2019 Babbel)

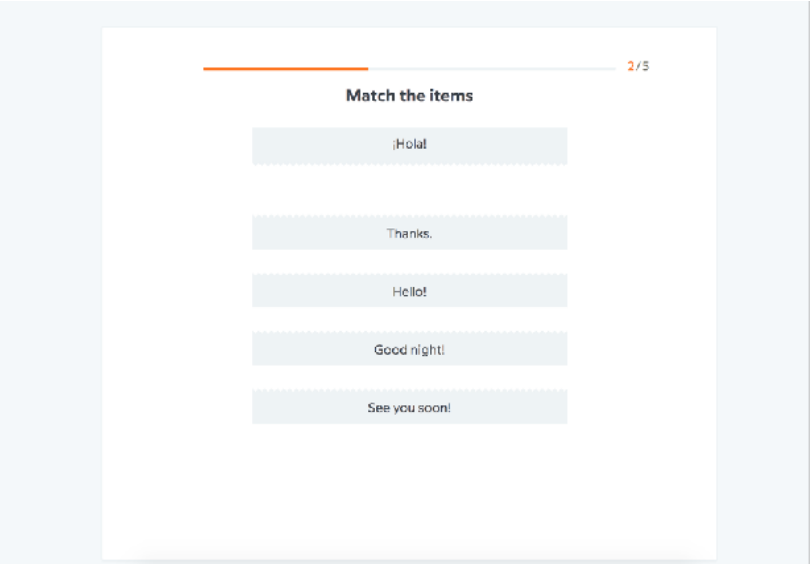

Figure 3: Reviewing the items of the just learned words

(Exercise on Babbel.com, Copyright 2019 Babbel)

To remedy the accessibility problems, some of the normal types of exercises have to be redesigned to be better accommodate blind users. In this thesis we will research the specific needs of this target group more in depth, and show how the acquire understanding impacts the actual design, prototyping and testing or improved exercises.

1.1.2 The benefits of accessibility to Babbel

Digital Accessibility means that digital media e.g. a website or mobile application can be used by a broader audience that includes people with disabilities. In the case of a website or application this means that the website is designed in such a way that it is compatible with various assistive technologies (Slatin & Rush, 2003). Lazar et al. (2003) compares a flexible website to that of the accessibility of a building. They state: "An accessible building offers curb cuts, ramps, and elevators to allow a person with disabilities to enter and navigate through the building with ease. An accessible web site offers similar functionality."

This type of accessibility can be evaluated by the Web Content Accessibility Guidelines 2.1. These guidelines explain how to make web content more accessible to people with disabilities. Web content usually refers to the information on a web page or web application, including text, images, sounds, code that defines structure of presentation and many other elements. Both Europe and the United States commit to this standard on a governmental level (W3C, 2018).

In this thesis we consider a design process to be an ‘accessible design’ when it keeps a broader audience in mind and makes use of WCAG 2.1 guidelines to ensure this. This thesis makes use of this standard guideline for both the accessibility and usability of the product. Accessibility is obviously a precondition for usability, for all types of users. Screening applications for accessibility may also provide improvements for the usability by users having sight.

According to a case study by Microsoft, complying with these standards can have the following benefits for a company (Velleman & van der Geest, 2011):

- Reaching more people

- Improved find-ability in search engines
- A website that performs well in all browsers, on all devices and in all operating systems
- Making clear agreement on web development quality
- A faster website at lower costs
- A sustainable and flexible website that is future ready
- A pleasant user experience for visitors

In the end, all of these benefits lead to lower costs and higher performance of the systems. Beside cost driven factors, Babbel can improve its image. By using accessible design, the company can demonstrate corporate social responsibility which captures the most important concerns of the public regarding business to society relationships (Carol, 1999).

1.2 Research proposition

This thesis aims to do research that enables Babbel to realize its vision to make it possible for everybody to learn languages, now also including blind users (Lesson nine, n.d). Web Content Accessibility Guidelines (WCAG) provide a standard for quality of code and positively impacts the the usability of the product. This thesis demonstrates how WCAG can be used for the accessible design of online language learning applications.

After discussing two different research proposals with stakeholders we formulated the following research questions:

- R1) What does an exercise for learning a new language within the Babbel platform look like for somebody that is blind?
- R2) What are the technical implications and opportunities for developing an interface for a language exercise with the Babbel platform for somebody that is blind?

1.3 Overview of this thesis

In this thesis, we will first discuss the methodology on how we would research the problem and how we would design a potential solution (Chapter 3). We will introduce the Inclusive Design Framework from Microsoft and the Creative Technology Framework from Mader & Eggink. Secondly, we will describe the two iterations we went trough. We will introduce the problem that blind people experience during language learning (Chapter 3.1 and 3.2). Then, we will describe who is the intended target group with a persona, Kyra, and the problem she encounters during language learning (Chapter 4.1). Furthermore we will describe in which context Kyra operates on a daily basis and how the Babbel product positions itself (Chapter 4.2). After this we show, based on our user research, how we redesigned the Vocabulary Write Trainer (one of the exercises of Babbel) (Chapter 5 to 8). In chapter 6 we will present the results of the test we conducted on the end of the first iteration. In chapter 9, we will report our results, about how the new design performed during a user test. Lastly we will answer the research questions in the conclusion, limitations and future work (Chapter 10,11 and 12).

2. Methodology

In this thesis we made use of two methodological frameworks: the Microsoft Inclusive Design Framework (MIDF) by Microsoft and the Creative Technology Framework (CTF) from the University of Twente (Mader & Eggink, 2014). The two frameworks have a lot in common, but also complement each other. The IDF framework was used to identify problems and to find fitting solutions. Because MIDF lacks an extensive description of testing and product development we also made use of the CTF framework for this purpose. Both frameworks are described in this chapter.

The CTF framework, designed for use within the study Creative Technology is a more general way of designing products with a user cantered approach. A weakness of CTF is however, that it misses the very specific and well explained techniques for designing for people with a disability. So, even though we will make use of the CTF development phases (Ideation, Specification, Realization and Evaluation) we will additionally make use of MIDF techniques for inclusive design within those phases such as techniques for Persona Networks and Persona Spectra.

The motivation to choose these two frameworks, out of many others, is that we are familiar with CTF and that it fit well to this project. Furthermore we wanted to use an up-to-date framework that is more specific for designing for people with a disability. The clear and elaborate MIDF framework was recently designed by Microsoft and seems to have been broadly adopted by the industry. It is therefore practically relevant and also exciting to make use of MIDF in addition to CTF.

2.1 Microsoft Inclusive Design Framework

The Microsoft Inclusive Design Framework provides guidelines on how to acquire an understanding of an end user who have a disability. The framework has three main principles:

- Recognize exclusion
- Learn from diversity
- Solve for one, extend to many

In the following we briefly describe the purpose of the framework, and then explain how we applied it in this project.

2.1.1 Recognize exclusion

Microsoft and the World Health Organization state that one should recognise an exclusion by analysing the whole context of a user. As stated by the World Health Organization and the MIDF (Microsoft, 2016):

“Disability is not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person’s body and features of the society in which he or she lives.”.

MIDF states that it is important to understand the interaction of the user in his or her natural environment. By finding out where mismatches occur, it becomes clear what types of exclusions occur, and where there are opportunities for accessible (re)design. Microsoft explains that the exclusion is not always permanent, but can also be temporary and sometimes situational. Examples of temporary exclusion are a short-term injury, loss of sight after looking into a bright light, or wearing a cast. An example of situational can be

that ordering food in a place where you do not speak the language, or not being able to use your hands for other purposes when driving a car.

In this thesis we have taken the context into account by observing end users in their full personal environment c.1. personal ecosystem. We tried to discover where exclusion occurs when the end user is using the Babbel application by conducting a pilot test with the current product.

In particular we compared the use of the mobile and desktop versions, and how this affects the target groups' capability to use the product. We used the obtained information to explore how to create a better user experience for the target group of blind people.

2.1.2 Learn from diversity

To develop an inclusive application it is important to consider end users with diverse capabilities. In this project we focused on the specifics of blind people learning a new language, and diversity within this target group. Even though we had to make do with a limited number of case studies, there was diversity in age, occupation, nationality and sex. By doing so we have put the end user at the centre of our design process. In our fieldwork we have therefore interviewed teachers who had blind children in their classroom and how they compensated for the special needs of blind people. Furthermore we performed tests with our intermediate product prototype with blindfolded people, but also tested it with a true blind person user in the end.

2.1.3 Solve for one, extend to many

Within this thesis tried to take a broad perspective on how the application Babbel application can be improved for end user in general, not only for the blind.

Design solutions for people with a disability can also be well suited solutions for other target groups. For example having captions in a movie for somebody who is has a hearing disability can be great, but can also have the benefit for somebody that is watching at a noisy airport, or a child that is trying to learn to read.

There are several types of disabilities, as shown in figure 4. The size of the target market of a product can be influenced by including people with various types of disabilities. For example, accessible design can be made suitable for users that are temporarily or situationally disabled. Exploring how a type of disability can occur within

different setting can be visualised in a Persona Spectrum, see figure 4.

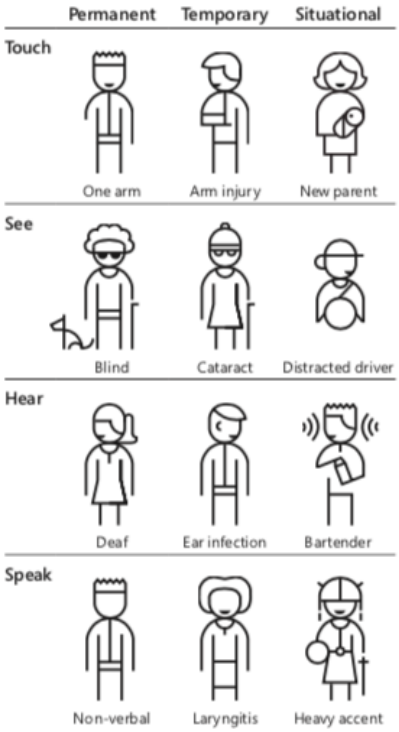

Figure 4: Persona Spectrum, Persona Spectrum from

Microsoft Inclusive Design (2018), Inclusive Microsoft Design [PDF]

2.2 Creative Technology Framework

We made use of the Create Technology Framework (CTF) to structure the design process (Mader & Eggink, 2014). It provides a very suitable approach for this project, since it has a lot of flexibility. The CTF method has three agile patterns which occur at every stage of the process: diverging and converging, and spiral models. In the diverging phase we are very open to any kind of ideas/concepts/inputs. The next phase is the converging stage. In this phases, we reduce the amount of choices we have, based on knowledge and requirements. Spiral Models suggest that parts of the process are not in a strict order, but that the order depends on the case (Bruijs, 2003) and the work at hand. Therefore we know that the phase structure does not necessarily have to be that linear.

The CTF method takes a dynamic environment, multidisciplinary cooperation and user centered design into account. It should be noted, however, that the method was originally intended for use in an educational setting. One could argue that a thesis by a company is still an educational setting, but that working as an intern on a thesis work is also part of the company business. It has been interesting to see how this approach works out in the context of a commercial company. It has proved to be fitting, but also requiring explanation in the context of the company work practices.

The methodology exists of 3 phases:

- Ideation
- Realization
- Evaluation

2.2.1 Ideation

According to Mader and Eggink, ideation is the starting point of the design process. Mostly this is in the form of a product idea, an order from a client or a creative inspiration. In the design context of Creative Technology, the starting point is also often an already existing technology. Typical activities during this phase are defining the problem, acquiring relevant information and idea generation. Inspiration in this period can be gained from:

- Flash of inspiration
- Lateral thinking techniques (Bono, 2010)
- State of the art
- Adaptation of existing solutions (Conceptual and/or Technical)
- Evaluation of earlier ideas
- Brainstorming with a conversation piece such as: mock-ups sketches, user scenarios, storyboards
- Interviews with clients
- Expert evaluation that describe the problem (with or without requirements)
- The outcome of this phase is a more elaborated project idea, with more refined requirements.

In our project we mostly tried to get inspiration by interviews with our potential target group, Babbel and talk to expert that describe the problem. Furthermore we conducted a “state of the art”, meaning that we read literature about the problem blind people experience during language learning, learning methods for language learning to blind, problems in current comparable tools and what is already known for designing for blind people. We evaluated earlier ideas that Babbel had on Accessibility and used mockups, personas to detect potential problems.

2.2.2 Specification

Mader & Eggink write that it is a feature of the specification phase that a number of prototypes are used to explore the design space. Here low fidelity prototypes are made rapidly, and each focus on a few aspects, rather than developing the entire product. They help to further refine user needs and functional requirements.

Activities during this period are typically:

- Rapid prototyping
- Testing low fidelity prototypes
- (Re)writing requirements=

After our extended study about the user, we started with formulating requirements (user stories and acceptance criteria), use cases, user scenarios and activity diagrams. We chose to style the requirements in user stories and acceptance criteria, since this was the style Babbel formulated their requirements as a part of the Agile framework. We thought this would help to communicate the requirements in way one was already used too and to avoid misconceptions. Also we designed the user stories and acceptance criteria together with a product owner of Babbel itself, to see if they formatted in the right way.

2.2.3 Realization

After specification, Mader & Eggink state that the realization phase can be started. Here a high fidelity prototype can be built and tested with regard to meeting the functional requirements.

Activities during this period:

- Specification of the technical design
- Prototyping
- Functional testing

In our project we build one high fidelity prototype that has been tested two times. The first one, was more functional and the second one had more focussed on the user experience. We built a high fidelity prototype in shape of web application, such that it was possible to test with a screen reader. Click-through prototype was for this reason not possible. There were no applications that fake the interaction with a screen reader. We tested functional by testing it our selves and using online tools that would check if there were errors encountered.

2.2.4 Evaluation

In the evaluation phase several aspects can be tested and addressed. Either a test is designed or an existing one is chosen for testing. Ideally, the technical functionalities are already tested in the realization phase, however this can also be a part of this evaluation phase. Secondly in the user test the requirements that were formulated (e.g. user stories) during the ideation phase are tested.

After the user testing, there can be reflection about how the current project positions itself related to existing work. Next to that new implications for the next iteration can be formulated e.g. future work and recommendations

In our project we did two test, one more functional and exploring on what type of instructions were needed. The last test we repeated the pilot test and tested with online tools. This test must gives us identification if we are accessible and if the user stories are met.

3. Ideation I

Within the ideation phase we did the user research upon which the design of the prototype was based. We conducted interviews with blind people, teachers and experts that worked with blind people and also analyzed complaints from blind people from the customer support department. We analysed the problem and possible requirements by thematically analysis.

3.1 Analyzing the problem

For an understanding of the problem, we started by interviewing blind people, teachers and experts that worked with blind people. We were interested in how these different target groups coped with their disability. We specifically asked them how they coped with this disability during language learning. Interviewing different people in the ecosystem of the blind persons helps to get the bigger picture of the problem. This is called the persona network according the Inclusive Microsoft Design framework from Microsoft (Inclusive Microsoft Design, 2016). Based on these interviews we were able to construct a persona and a context of use (including use cases).

3.1.1 Methodology for user interviews

The interviews and co-design were conducted from the headquarters of Babbel which is located in Berlin. The interviews were done remotely via Skype or Zoom. A few days ahead of time a consent form was sent to the participants so that they had an opportunity to ask questions and express their concerns (see Appendix B). If there were no issues a Skype meeting was planned. The interview was recorded with consent of the participant.

For the interview we interviewed the following people:

- An expert in designing for blind users from the Universidad Politecnica,
- A teacher that worked with partially blind people, and
- 2 blind people themselves.

The goals of the interview were to understand:

- how blind people learn languages,
- how blind users compensate for their disability in learning, and
- the barriers in online language learning for blind users.

We wanted to interview blind people remotely and several points of attention came up. First of all, we were wondering which ethical protocol to follow, since this was a cooperation between Universities and a company. Normally within a university, an ethical committee has to be involved if a master thesis is to be done with a target group with a disability. However, since we wrote the master thesis internally at Babbel, we choose to stick with Babbel protocols. The two most important guidelines are concerned with data protection and making sure the consent is done in a way that considers the needs of the participants.

In our project the consent form itself had to be in an accessible format. With accessible we mean that the document had to be in a language and format that a participant can understand. Not all blind people speak English well enough, and not all formats are usable with a screen reader/ braille display. Preferably, the consent form has a .docx format extension, since this is easy to read by assistive tools for blind people. An example of an inaccessible format would be a pdf which is often unreadable with assistive technology.

An issue we also had to deal with was how to let participants sign the consent form. Should this be done through pen and paper, or digitally? In agreement with Babbel's legal department, we concluded that an email and verbal statement on video/ audio that they agree with the terms set was enough. Also a lot of effort was put into taking the time to answer questions and build up trust with the participants. We realized that this target group cannot see us and did not know us, since we gathered participants through the internet and contacts. Before the interview, we emailed back and forth a few times to get acquainted and build up sufficient trust by exchanging some personal details.

The interviews via the internet were done with the tool that participants were most familiar with and that they preferred. This was usually Skype. During the call we made a screen and microphone recording with Quicktime. This can be done with: select File> New Screen Recording, see figure 5 .

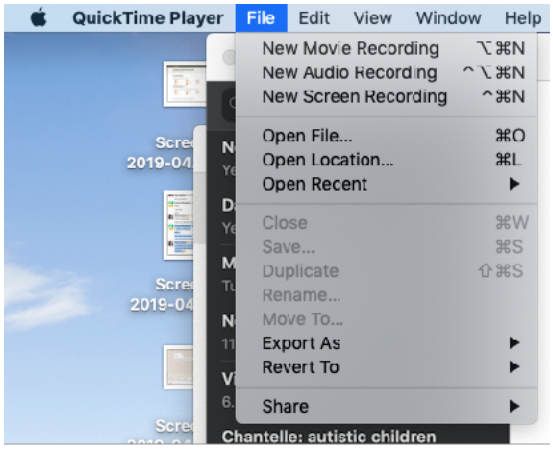

Figure 5: Make new screen recording quicktime player

After that it is important to make sure the recording makes use of the internal microphone, see figure 6.

Figure 6: Make new screen recording quicktime player

The recordings sound a bit sharp, but are understandable. During the interviews, there were two observers that took notes. This was done to have an extra check on which info would be relevant and to minimize the risk of bias (see Appendix C). The observers viewed the live interview or watched the videos later. We asked them to write down the most striking points in their opinion and filter out the most relevant information. This would help to evaluate the data quicker later on. The observers had different background, one was an engineer specialized in testing code, the second had a strong psychological background.

Some other interviews were done with a teacher who teaches people with a visual impairment and an expert that designed a navigation system for blind people. During the interview we found out that the audio was not recorded, because the settings in Quicktime were not correct. The microphone was not selected. We solved the issue, by writing out the transcript straight after the interview and asked the expert feedback on the transcript. We agreed that info that was in there was correct and therefor still usable. The interview with the teacher, mostly went through email correspondence, since she felt more comfortable that way.

During the interview process let the participants choose the media and a setting where they feel comfortable. We thought that it is important they they had a feeling they could trust us with the data and that they could take the time to think about which data they want to share or not. We believed that this would be a benefit for future communication and that misconceptions could be avoided. Of course this was also a requirement of the legal department.

3.1.2 Methodology on anonymization of qualitative data and evaluation

After the interviews we generated transcripts anonymized the data. We made use of advice by Customer Services how they anonymise qualitative data, and also consulted the literature.

In 3.1.2.1 we first discuss that the anonymization and protection is a common and important practical problem in qualitative research and what types of data are considered to be sensitive. Next (in 3.1.2.3) we discuss what solutions from the literature can be used. After that (3.1.2.3) we explain how we in fact dealt with the confidentiality of the data we used.

Problem of data protection in qualitative research

It is common practice to make use of interviews to get a better understanding user needs in their context of use. This includes interviewing caregivers, teachers and other parties around the type of user for which the design is being made (Martin et al, 2019). The quality of the data that is collected in this way can have a big impact on how well the end product meets the needs of the end user. However, such interview data can easily become quite personal and may even be damaging for the participants in the study if it is published. For example, if practices are medical or reveal sexual preferences, it can be damaging if the published data contains data from which the identity of the interviewees can be inferred. (Kaiser, 2006). Therefore we felt it is important to get a good understanding on how to handle this problem.

In data protection, it seems that the most important and most complex issues are consent and anonymity. At the same time it turns out that these topics are also the hardest to get a grip on (Kasper & Müller-Böker, 2006).

It can be hard to predict exactly what is going to happen with the data when details are published. Moreover it can be confusing to decide which data is sensitive. Data that a researcher does not expect to be harmful may be experienced very differently from the point of view of a participant (Kasper & Müller-Böker, 2006). The Swiss law on data protection states that the following types of data are sensitive (Swiss law, 1992):

- data referring to religious, political, union activities and opinions,
- data concerning a person's worldview,
- data referring to medical details, a person›s private sphere or ethnicity,
- data referring to social welfare provisions,
- data referring to administrative or penal sanctions.

As for the consent of a participant, this is something that should not only be acquired at the beginning of the research, but also during the entire research process, since situations and considerations may change (Parry, O. & Mauthner, N.S. 2004).

Proposed Solutions from the Literature

The predominant approach to protect data is simply to keep all data confidential in any case and at any stage. During data collection all identifiers should then be removed and all not important specific details kept vague. Techniques to do this are:

- Change unnecessary details (Kaiser,2006) (Weis, 1994).
- Make new identities in relation to the data you have (Hopkins,1993)
- Do not publish any data at all to avoid deductive disclosure (Willes,2008)

A weakness of this approach is that it focuses on external relationships and does not say anything about what is happening with the data inside the company. Here also, the researcher has the responsibility to decide which data is shared and which is left out. This all or nothing approach may unnecessarily constrain the usefulness of the data.

An alternative approach is proposed by Kaiser. Instead of only communicating in the beginning of the research with the participants about (all or nothing) confidentiality and anonymization this should be rather an ongoing process in every stage. For example, if the transcript of an interview/observation is ready, ask for feedback on the transcript from the participants. However this process can be very time consuming and is probably therefore not maintained so strictly.

Further Kaiser stresses that there should be a lot of attention for informing the participants as far as possible what could happen with their data in order to give them an opportunity to control this process by offering a range of confidentiality options. Moreover a post interview confidentiality form can be used. They further advise that no names and places are noted down during the interview and that all damaging information is deleted.

Taking all these things into consideration it is a process of balancing between different requirements. On the one hand we would like to protect the participants' privacy, and on the other hand the data should be useful. It is therefore important to carefully consider which data is really necessary, and which data may be anonymized or left out (Kasper & Müller-Böker, 2006).

How to protect the data in this thesis

From reading the literature we learned a few points we would like to use:

- Confidentiality should be a continuous process and participants should be informed about this
- Confidentiality agreements can be flexible
- Sensitive data is a subjective topic
- Confidentiality should apply both inside and outside the company

For all the research we have done, we tried to take these four guidelines into consideration. First of all we tried to include all the participants in every stage of project by informing them as much as possible about the consent form. We sent the consent form a few days in advance so that they had the possibility to read it in their own pace and ask questions. Also, during the interview, a moment was planned to ask questions about this topic.

After the interview we promised that the transcripts would not be shared with others, including Babbel and with supervisors from Universities, until we agreed on a final version that was useful for us and with which the participants also felt comfortable. Before sending the documents a few standard details were left out:

- Names of participants and companies
- Locations of living, universities of work
- Sometimes sexes
- Email addresses
- Specific dates

Non relevant data was also left out, so that only the data that was really necessary for the research was in the transcript. However, we kept the medical records and the world-views of our participants (see quote from Swiss government) were kept in the transcript. The latter was kept in because the perspective of the participants on their situation as a disabled person in society is relevant to this study. After we anonymized the documents they were sent back to the participants for feedback.

We furthermore discussed with how the data we acquired could be used with both the participants and their fellow stakeholders (see table 1). For the sharing of data we made a table on several types or levels of confidentiality to make clear what data may be used by whom (see table 1 below):

Confidentiality level (target-group)	**What does that mean: to share or not to share**
The university (supervisors)	Anonymised transcripts
Internal Babbel supervisors and observers	Everything
Company Babbel	Anonymised transcripts and the video material from the user testing for educational purposes

Table 1: confidential level with stakeholders

Thematic analysis of the qualitative data

After writing the transcript we started to analyse the interviews and the user quotes from the User Support department.

Customer Support has a database with comments from users on the system and we selected the ones that we were written by people that are blind. In total we went through 140 emails. Even though we did include this data in our analysis, we cannot publish any of the quotes in this thesis, because we would have had to ask permission from 140 people to publish their data, which would probably have taken too long for this project.

To analyse the gathered data from the interviews and the Customer Support database we used a thematic analysis (see Appendix E). This methodology is common in qualitative research, and it is used to discover common patterns in the data which are then categorized (Maguire & Delahunt, B, 2017). We used open coding, which consists in finding the broad common concepts within the data and grouped them under a specific labels (Ezzzy,2003).

The template elements we used per theme is as follows.

- Theme explanation
- List of Customer support quotes
- List of Interview quotes

Based on the themes a research question could be answered. In our case our main question was: R1:What does an exercise for learning a new language within the Babbel platform look like for somebody that is blind?

To answer this question we answered the following subquestions:

- Who exactly is going to use the design?
- Why would he use such an application ?
- Where would he use such an application ?
- What is the exercise he is going to use?
- When is he going to use such an application
- How is he going to use the application ?

These questions led to a problem description, a persona, a context of use and use cases.

3.2 Problem description

Out of our interviews and an assessment of the state of we found that the general problem that blind people have is that websites and learning materials are not sufficiently accessible (see chapter 2.1). In particular images and buttons are not well labeled. This limits which apps and websites blind people can make use of. More specifically, scanned books are often provided, but these often contain mistakes. Usually the blind users will try to work around the flaws of the websites or the mistakes in scanned material, but this is not always possible. For example, when they make use of a scanned book for learning a new language and a word in foreign language is not totally scanned they must guess. Guessing what the word might be is hard, since they have not yet mastered the language. Another common problem is that they are not able to understand the purpose of an exercise online, since they cannot access or interpret all the elements on the screen.

Sometimes it also happens that some applications are accessible, but when a software update is made this is not the case anymore. When for example new interfaces are used blind people have to learn over and over how to interact with them. It may also happen that some very necessary functionalities for blind people are scrapped from the application such as ways of navigating. (For support of this statement, see appendix E and F.)

The general conclusion is that there is a need for consistent accessible language learning materials and software that considers accessibility issues for blind people.

4. Specification I

Within the specification phase, we aimed to assess the accessibility and also usability of the current product, we conducted a test with a blind user and evaluated it based on WCAG 2.1 standards. Lastly we consulted literature to see if our results are recognized by other researchers.

Based on our findings we developed user stories (including a persona), that are presented at the end of this chapter. Such stories describe how a customer or user employs the product and experiences its usage. Within an agile framework this method is used to capture the functionality of a system. Every user story specifies acceptance criteria upon which the product is to be tested. Such acceptance criteria avoid technical solutions. They specify what the application should do, not how that is to be implemented. It is up to the technical team to figure out the best way to meet the requirements. To avoid specifying requirements that are not technically feasible, it is good practice to consult a technical team while writing up these stories. They can then give an indication of how long it would take to implement a desired feature (Picheler, 2018). In this project, where we work on both the requirements and the realization, we also considered the technical feasibility ourselves while writing up the user stories.

4.1 Persona

To better demonstrate this need we wrote up a persona, named Kyra. For the design of the persona of this project, we interviewed a teacher, an expert who designs for blind people and two blind people. Based on their data from the transcripts (see Appendix D), we composed this persona. To develop this persona we made use of several examples, of which the one from Rosenfeld was most useful: "Jacob: Blind paralegal and a bit of a geek"(https://rosenfeldmedia.com/a-web-for-everyone/meet-jacob/) .

4.1.1 Snapshot of Kyra

Kyra is 26 years old and works as a translator (see figure 7). She chose this profession because she studied languages at the university and because she can do a lot of work with the computer and some extra devices like a MacBook Braille display and the iPhone. She currently lives with 2 other blind people and has a number of hobbies next to her work. She likes to go to the theatre, especially musicals, and regularly listens to podcasts and audio books.

Figure 7: Kyra, a blind Babbel user

4.1.2 Technical failure

In Kyra's experience a number of problems have to do with technology. Sometimes she starts doubting herself, is it really the technology that inaccessible, or does she not put enough effort into understanding it. One problem is that it if course difficult to show images. That is ok when they are described, but it is a problem if it is necessary to actually see them in order to complete an exercise such as coming up with the right word for a figure.

In movies images are partially described when the dialogue does not provide enough information. The subtitles are also helpful when fictional languages are used like in the Game of Thrones. Unfortunately - for some technical reason - such subtitles can no longer be read out loud (which used to be the case) and entire scenes go by where she has no clue what they are saying.

More generally she finds it hard to find suitable material for language learning for blind people. Scanning normal books does not work well because still too many confusing mistakes are made when images of texts are used to create digital text documents. Because the scanned text is partially in a foreign language it is not possible to understand what was meant and to correct it.

4.1.3 Relying on your speech abilities

Kyra thinks that being able to speak a local (foreign) language is very important for blind people when they encounter a new situation. Especially when arriving at a new location it is essential to be able to communicate by speech. Getting acquainted with a new physical environment is an intensive and time consuming process, because a blind person has to develop and memorize a mental map of where she is to be able to navigate. Local language skills are of course of great help initially, but it is also her greatest wish to be as independent of other people as possible.

4.1.4 Writing flawlessly

When she makes contact with somebody that speaks her own language, she is a bit worried that she says the words wrong or she doesn't know how to express herself. Therefore, she would like to improve her pronunciation. Besides speaking, she also likes to improve her writing since she also uses languages for her job as a translator. She needs to read and write text and then translate them. She really likes her job, because she can do a lot with the computer and nobody can notice that she is blind. She feels that the internet makes everybody equal nowadays.

4.1.5 The A's: Ability, Aptitude and Attitude

Kyra's Ability: She is mostly blind but sees some light. However, she does not see some very intense lights. (The way people get blind can greatly differ, from being born blind to becoming vision-impaired or bind due to an illness).

Aptitude: She is good with technology and well trained to make use of it because of her general education, occupation and personal life. Because she is dependent on technology to compensate for lack of vision, she has invested in making good use of it.

Attitude towards technology: Kyra tends to to try out new apps and to try to adapt to issues she encounters with regard to visuals. Some applications turn out to be so dependent on visual information that they are not useful (such as Instagram). In other cases, like Netflix, enough entertainment value can be obtained through the audio track, subtitles and visual descriptions.

Attitude toward languages: Kyra reads foreign language texts in her work as a translator. She relies on being able to speak to others to ask for guidance and to make her way around in a new situation. She is motivated to be as normal and self reliant as possible. It makes her anxious when she makes mistakes in such situations, and therefore does not only want to rely on speech, but also wants to be able to write foreign languages well. She would greatly appreciate more suitable learning material.

4.1.6 How Kyra learned languages up to now

Kyra first attended a normal school, but later went to a school for blind people. In primary school she learned to perceive the world in her own way. By feeling objects such as blocks she could develop a mental image of them. For things like a (grey) spider web it helped to place a black piece of paper behind it so she could better see the contrast with the slight visual capabilities that she does have. She explains that learning a language is not only a matter of learning words and texts, but being able to associate them with a mental image, including perceptions of sound and movement. Teachers at special schools would describe what they saw other children in the class doing. When leaning her own language the teachers would make use of an auditory method of 'cutting and pasting' words. The children would cut up a word by pronouncing the letters and syllables separately, and then 'paste' them together again into one fluent word (https://www.youtube.com/watch?v=rI9lrTd8QB4).

4.1.7 The apps Kyra is currently using

Kyra uses for learning languages the following applications in her daily life:

- Passend lezen (daisy speler): a Dutch library for accessible books and audio books
- Babbel: language application
- Amazon audiobooks: an application where she can buy and listen to recordings of books that are read out loud:
- Dikke van Dale: A Dutch digital dictionary
- Dictations application: Applications where Kyra don't have to type, but where she can speak to create digital text documents.

4.1.8 The bigger picture

According to a census taken by the World Health Organization, 2.6 % of the world consists of people with visual disabilities (about 0.6% are blind). In the U.S, about 1.8 million people can't easily see printed words. Unfortunately, only about 10% of people who are blind can read and write braille.

4.1.9 Other target groups with the same traits

It should be noted that not only fully blind people have a visual disability. There are several categories of people that are visually impaired. Additionally people that are in some circumstance temporarily distracted from visual information, may also be considered visually impaired or 'blind'.

According to Microsoft also other target groups have the same traits (Microsoft, 2016). According to the accessible design method from Microsoft, also people with cataracts and distracted drivers may be considered to be 'blind' also. Furthermore, as noted, visually impaired users and blind people have common needs. Tackling the problems for blind people might lead to tackling those of other target groups as well.

We made a conscious decision to focus within this thesis only on blind people. The standard 301549 in Annex B (European Standard ETSI, 2014) shows that if most requirements for blind users and visual impaired users are met, a lot of issues are for people disabilities as well e.g. physical disabilities. In Annex B the relationship between the requirements and the type of disabilities is described. They do this via a table (see table 2). From Annex B, we conclude that meeting the requirements of the blind and visually impaired will also tackle problems for other users. We reproduced a part of the table down below here. For example, in table 2 you can see the guideline "5.1.3.2 Auditory output delivery including speech", which is primarily relevant for people who have no vision (WV) and a secondary relation for people for limited vision (LV) and limited cognition (LC). This indicates that this guidelines is mostly important for people with no vision at all, but can also be handy for people with other disabilities.

Function performance statement (what are people of/ or not capable of) make use of the following abbreviations:
- WV=Usage without vision
- LV=Usage without low vision
- WHC Usage without perception of colour
- WH= Usage without hearing
- LH=Usage without limiting hearing
- WVC= Usage without vocal capability
- LMS= Usage with limited manipulation of strength
- LR=Usage with limited reach

- PST= Minimise photosensitive seizure triggers
- LC= Usage with limited cognition
- P= Privacy

Relations:

- P= Primary relationship, is always used by the user with this disability
- S= Secondary relationship, might only used in specific situations

Requirements	WV	LV	WH	LH	WVC	LMS	LR	PST	LC	P
5.1.21 Closed functionality										
5.1.12 Assistive technology										s
5.1.3.1General	P	s							s	
5.1.3.2 Auditory output	P	s							s	

Table 2: Example of Annex B, Requirements in clause 5 to13 supporting the accessibility needs expressed in the function performance statements

Roughly counted, the amount of requirements that were unrelated to visually impairments were around 50 items. Around 150 requirements affect visually impaired users (including blind) and other disabilities aswell. In conclusion, if we meet the guidelines for the blind, we make sure that a lot of issues for other users will be solved as well. Because of the limited time for this project, we chose in our first iteration to design for people who are blind and if time allows us to take the requirements for lower visual impaired into account as well.

Last but not least, we think that improving the interface for blind people, could also have a beneficial effect on sighted users. Designing from an Accessibility point of view, makes you look different at your system, you will find mistakes that might have been otherwise not been discovered. Problems that might also affect other target groups.

All with all, we draw the conclusion that if we start designing for blind, we can create a snowball effect towards other target groups. We think starting here might be able to create the biggest impact, for the amount of time we have available for this thesis.

4.2 Context of use

In this chapter we will describe the context in which the user operates. We will describe what type of assistive technology blind people make use of. Assistive technology is used to support a person with a disability in order to accomplish a task in daily life e.g personal assistant. Further we will speculate how and when the Babbel product could be used in the life of a blind person, by imagining a day out of Kyra life and when on such a day she would use the Babbel product. After this we are able to list the use cases .

4.2.1 Assistive technology

During the user tests the following assistive technology will be used:

- Braille display
- MacBook with screen reader
- Screen reader from mobile
- Braille board attachment for iPhone

A refreshable braille display or braille terminal is an electro-mechanical device for displaying braille characters, usually by means of round-tipped pins raised through holes in a flat surface. You can connect it to a computer and can translate what is in text in refreshable braille (Erasmus+,2015). Visually impaired computer users who cannot use a computer monitor can use it to read text output. Speech synthesisers (screen readers) are also commonly used for the same task, and a blind user may switch between the two systems or use both at the same time depending on circumstances. Deaf-blind computer users may also use refreshable braille displays, see figure 8 .The Braille attachment for the iPhone looks like this, see figure 9.

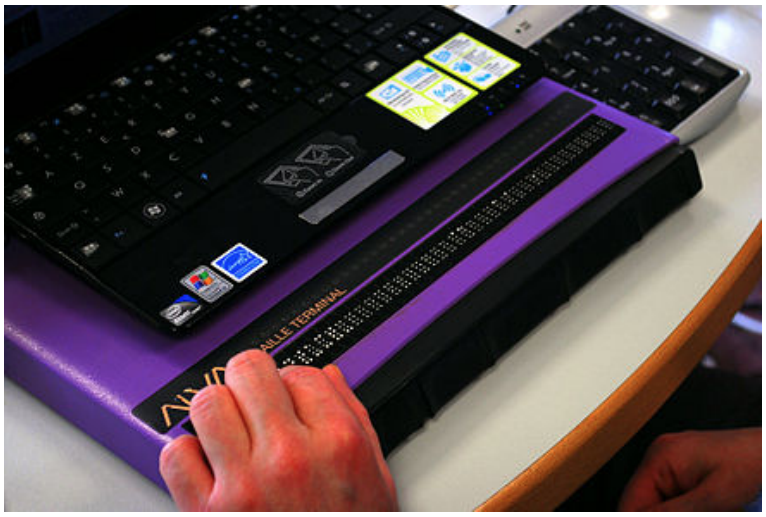

Figure 8: Braille display

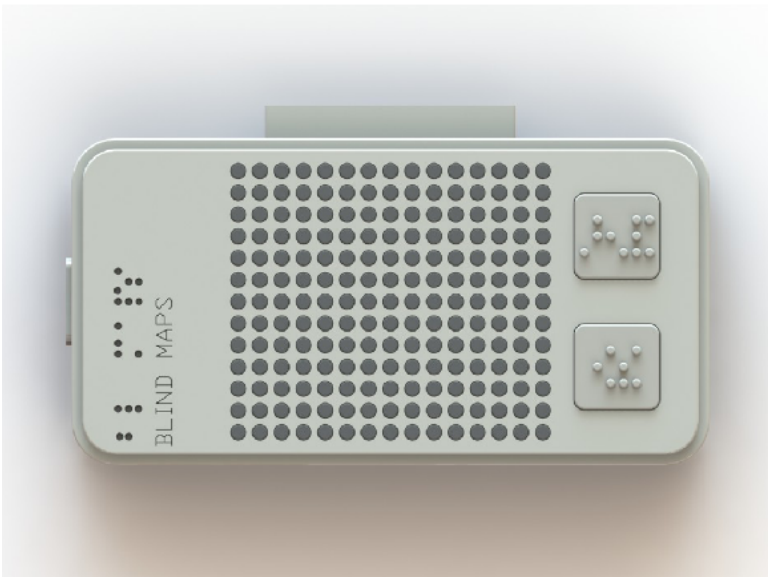

Figure 9: Braille board for mobile phones

4.2.2 Physical context of the product

There are mainly two contexts where the product product is used: in public, or at home.

When in public Kyra will never use apps while walking, because she has to completely concentrate on walking with a cain. The best opportunities for using the app are while she is in the car or while she is being driven, or when she is sitting somewhere, having nothing special to do. When using the audio function in public she will turn on the voice over very softly, or make use of her headphones. She will make sure the headphones do not cover her ears completely, so that she will still pick up sounds from the environment. When using the application, she will focus on it completely, and not use messaging apps or listen to music or podcasts at the same time, because the voice overs from other apps would disturb her concentration. In public she will only do writing exercises, because she does not want to talk out loud to her phone and disturb other people. She further values her privacy very much.

When at home, she prefers to use the computer rather than her phone, but will sometimes use the phone with the braille attachment also. Here she also feels free to use the audio functions and to speak out loud during the exercises.

4.2.3 Scenario how Babbel's application could be used

The purpose of this section is to get an understanding of how the Babbel application could be used in a number of use cases. We wrote out a scenario based on the persona Kyra in which we sketch a typical day in her life. We describe what she does and when on such a day and when she would use the Babbel product.

In the above we made a general description of the persona Kyra in the third person. In the following we consciously shift to a first person narrative in order to more thoroughly understand her situation and use of the Babbel product from her (and end users) point of view.

A day out of the life of Kyra

Kyra reports the following. On Friday I usually go to the university in the morning. I'm studying multiple foreign languages because I want to work as a translator. My native language is German. Because I've been living in the Netherlands for a few years now, I do okay in Dutch, but my pronunciation could be better. At the university I'm studying English and also Spanish, which is pretty new for me.

I have to catch up with my Spanish, so I went searching online for a new software on my MacBook. I read good reviews about the Babbel app, so I signed up for Babbel and took a 6 month subscription. Then I opened Safari, and went to the Babbel webpage. I hit the hot key combination of CMND F5 to put on my voice over. After that I navigated to Safari. I prefer to use Safari compared with other web browsers since this helps me to get a quick overview of a website. I type in the www.babbel.com. I like to get a paid account, therefore I would like to register. I navigate with my tab key to the register. Here I have to select a language (see figure 10a).

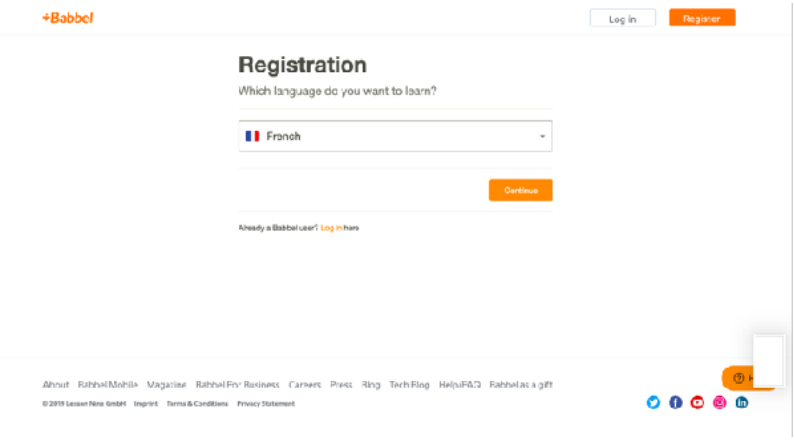

Figure 10a: Registration at the Babbel platform

I navigate with the tab button to the button and start interacting by using the VoiceOver key (VO) and press shift and the down arrow key. I fill select the language Spanish and then I hit continue, by hitting enter. On the next page I explore the next page by holding my VO key + arrow keys. On this page my screen reader tells me, that I have to fill in my email and choose a password (see figure 10b).

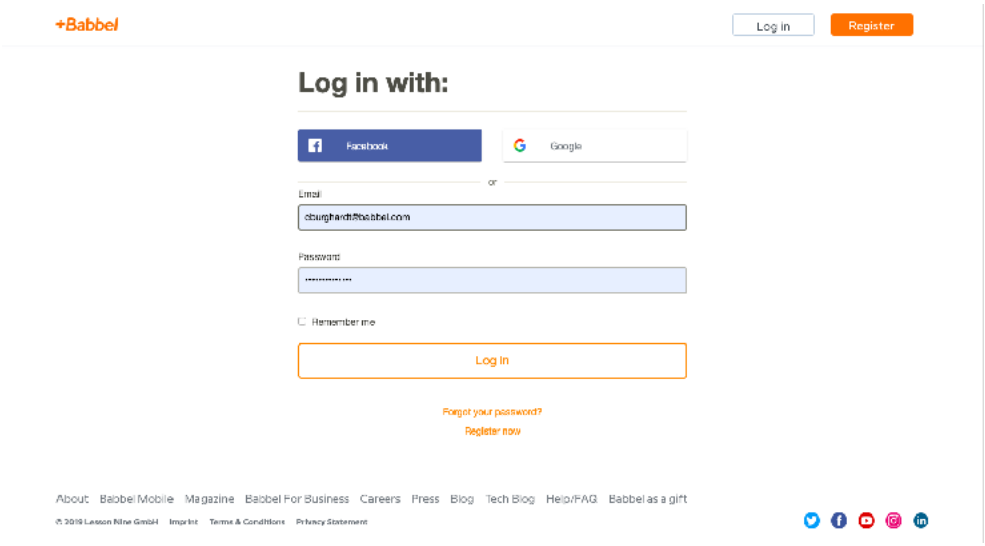

Figure 10b: Registration at the Babbel platform

I confirm my email address, I do this with my external email application Mail from apple. I switch to the other screen by using CMND Tab. After I registered and logged in I liked to buy a license, so I navigate to my profile (Tab) and press my name Kyra by hitting VO + spacebar. Using the VO + arrow keys I navigate to profile and settings, here I press VO+ spacebar again, see figure 11.

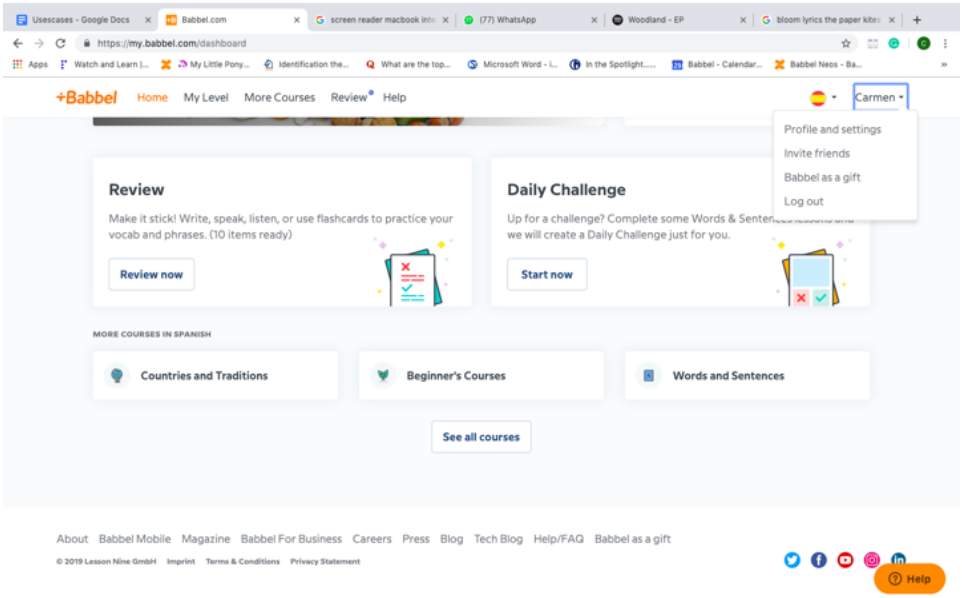

Figure 11: Screen showing the dropdown menu to go to the profile settings

I scan the webpage again (VO+ arrow keys) and I find account information (spacebar+VO) and find the following button, get full access. I take a license for 6 months.

I'm living with two other people and we usually have breakfast together. Before sitting down to eat I'll make a call to the taxi service when I'd like to be picked up. We avoid making calls during a meal, because we want to be pleasant, but also because we have to focus on what we're doing. We typically do one thing at a time and avoid trying to 'dual process'.

The taxi service is not so reliable, and I often have to wait 10 or 20 minutes, having nothing to do while waiting. That is typically a situation where I might check WhatsApp messages, but it's also an opportunity to spend some time in private to practice my foreign language pronunciation. I can do those kind of exercises best at home. I don't feel comfortable speaking out loud in public places.

The taxi drive to the university takes about half an hour. I usually sit in the back seat, and then have some time to kill. I can't use my laptop there, but can do stuff with my phone. Here I won't do exercises that require me to say or ask things out loud, but I could do short exercises that can be done in silence, and don't require too much concentration.

The taxi drops me off at the main entrance of the campus. I then have to walk for about 5 minutes or more to the right building, and then another 5 to get to class. During that period I never to listen to music or audiobooks, because I have to focus completely on walking and finding my way. I use a white cane so I don't bump into anything, and I listen attentively to everything around me to help me navigate. There are devices in development to replace the cane, but I think they're not yet reliable enough and prefer to stick to the cane.

After class I show my friend my new purchase for the Babbel app on my phone. I show them the first lesson, especially I show them the pronunciation exercises in the beginning from the lesson.

When I return home, I usually take the public transport. I then walk to the nearby train station via the shopping mall. I like to do some small groceries there. When I'm walking and shopping I have to fully concentrate on that and will not use any apps.

I do regularly take some time to have a coffee at one of the cafes. When I'm comfortably and safely seated I sometimes take 30 minutes to an hour to do some work on my laptop and can make use of earphones. It can be a bit noisy, but it's also nice to be among people, and I do find I can concentrate pretty well, once I'm working.

At the station near to the university I know my way around very well because I've been there so often and have memorized the situation. It's quite familiar. That's very different if I have to find my way around at a new location. Even then I prefer to find my way around as independently as possible, but must sometimes ask people for extra information anyway. It is then very important that I can speak the language and also pronounce things well. In Germany that's easy, but when I first went to the Netherlands that was harder. Quite a few people will respond in English, which I also didn't speak well up to a few years ago.

When I got home on Friday it was my turn to cook. As I said, I live with two other blind people, and we take turns cooking. While preparing the meal I would like to listen to an audiobook or to music, but because all the cooking activities require a lot of my attention I prefer not to try to do anything else. So, during cooking, I wouldn't use a language app for pronunciation exercises.

After dinner my friends did the cleaning up, and I had more than an hour to do something for myself, before going out. I usually go to my own room then to do some studying or some translation work. In principle then I could also work with the web version of the application on my laptop and make use of the Braille board. Right now I think the Spanish course is most interesting to me, because that language is still quite new.

I like to go to the theatre even though I can't see everything, but I can usually understand a great deal of the story. I've been going to English theater productions lately. To be honest I like musicals best, because I'm of course not there to learn things, but also to be entertained. So, last Friday we went to the English version of Cats. It was great!

And when I'm at home I've been practicing my Spanish listening skills by listening to Spanish series on Netflix. They do put in some extra information in the special audio for the blind, even though that could be improved.

So I hope that gives you some idea of what my day looks like. O yes, well, Saturday is a bit different. I usually don't do much commuting then, and spend the day on more concentrated work at home. I'll spend half the time on translation assignments, and the other half studying.

Sometimes I find something that I cannot access with my screen reader and then I like to send a message to the customer support of Babbel.

Since I am at home, I mostly use my braille display. After dinner, then, I'll typically listen to some Netflix or perhaps an audiobook, and then call it a day.

4.2.4 Use cases

Out of the story from Kyra we can extract several use cases:

- Won't use application at all during meals, walking, cooking. No 'dual processing'.
- The moment she uses the exercises for the first time
- Waiting for taxi at home, and working pronunciation exercise on phone for 10 minutes.
- Riding in Taxi, and working with silent exercise on phone for 20 minutes
- Working in Cafe with laptop on a writing/reading exercise for 20 minutes or more.
- Working at home with laptop and braille board, and all other facilities, for 30 minutes or more on any type of exercise, also those that require speaking out loud
- She demonstrates her language apps to friends at the university (in public, not at home)
- Sending feedback about accessibility issues

To summarize the details per use case check the table below (see table 3)

Context of use	Available time	Device	Assistive technology	Type of exercise/ trainer	In private	In public	At home
While making breakfast	0						
While eating	0						
While walking	0		Walking cane				
First time use of Babbel		Laptop and extra devices	Screen reader software from the laptop and braille display	Registering via Babbel website	X		X
While waiting at home for taxi	10	Phone	Screen reader software from the Iphone	Vocabulary speak trainer	X		X
While being driven in taxi	20	Phone	Screen reader software from the Iphone	Vocabulary click	X		
Showing app to friends	5	Phone	Screen reader software from the Iphone	Can be anything!			
While working in a cafe	30+	Laptop	Screen reader software from the laptop	Vocabulary click Memory			
While working at home	30 +	Laptop and extra devices	Screen reader software from the laptop and braille display	Writing,speaking and click trainer Cube choice button trainer Memory			

Table 3: overview from the use cases

4.2.5 A pilot test with the current product

The user interviews suggest that there is a need for accessible language learning materials that teach writing, speaking and grammar Before developing a new, improved, prototype it is important to assess how well the current product meets the needs of blind

people. From the various exercises that Babbel offers we have chosen to specifically test the Babbel series for teaching vocabulary. This type of exercise is one of the core types that the Babbel product offers and is also used the most. Vocabulary is one of the basic cornerstones of learning a new language.

4.2.6 Setup

For this user test we attempted to test within the natural environment of the end user as much as possible. We tested with the setup in their home. The setup of this test made use of a MacBook, using a screen reader and a Braille display. During the user test, the interaction on the screen was captured. Also an external camera was used to film the whole interaction. The screen recording was made with the computer of end user and an extra video was made with another laptop of ours. The reason to use the cameras of the laptops, is to make sure data stays secured between the end user and the company Babbel.

4.2.7 Experiment design

Although people also learn while they are moving e.g when they driven by somebody else (see chapter Context of use), we chose for the home setup. The reasons for this are that it is easier to use a braille display and check on spelling via the braille display. We wanted to test four types of exercises:

- Vocabulary through speaking
- Vocabulary through clicking
- Vocabulary through writing
- Seeing vocabulary within a sentence
- Memory

The four exercises all boil down to one basic type of lesson, namely the words and sentences type of lesson. The idea is to see what the problems are that blind users encounter while completing one lesson.

4.2.8 Retrospective out-loud- method

During the test the concurrent and retrospective out-loud method was used to get an understanding of what is going on in the head of the participant. Van den Haak, De Jong, Schellens explain this method as follows (Van den Haak, De Jong, Schellens, 2003): "The basic principle of this method is that potential users are asked to complete a set of tasks with the artefact tested, and to constantly (concurrently) verbalise their thoughts while working on the tasks. The method has high face validity, since the data obtained reflects the actual use of an artefact, and not the participants' judgements about its usability."

It is important to distinguish what the subject says out loud about what he is doing during the execution of one or more tasks (concurrent out loud) and what a users says about his experiences after the completion of the tasks (retrospective explanation and feedback). Initially we have considered having the subject say nothing at all during the tasks, and to only ask for feedback afterwards based on using the film and recordings.

According to van den Haak, De Jong, Schellens, the thinking retrospective-out-oud-method has several benefits that fit in this context. This method of postponing elaborate feedback during a task is important for multiple reasons. First of all the participants can

fully focus on their tasks and can therefore perform their task in a more natural way. Secondly, this method makes it possible to measure completion time since we are filming the process. They will not be slowed down by having to give feedback in the process. Thirdly, end users have more time to reflect on their actions and might give more high level insights. Finally if another language will be spoken, it is easier to do so you don't have to focus on several things at the same time. This will benefit the communication between researcher and the participant (van den Haak, De Jong, Schellens, 2003).

In this case, however, because the subject is blind, it was more difficult to reconstruct exactly what went well and what went wrong retrospectively, even with a recording available. After all, the subject is not able to view the recording and film. We therefore chose to allow the subject to verbalize what she is doing, but not to further discuss potential issues. We also allowed her to ask brief questions during the task on what she was trying to do, but we were also not allowed to discuss it further.

A disadvantage of verbalizing what is going on concurrently is that the quantification of the completion time of tasks will not be the same as without it. This could be a handicap when comparing the completion time of an improved prototype with the original. However, what is important is the relative length of the completion time. So, when an improved prototype becomes available the subject will also be asked to verbalize concurrently when using it. The two measurements, before and after improvement, are then comparable, and the hope is of course the execution time with the improved version will be shorter, and also that the retrospective feedback will be more positive.

In conclusion then, an adapted method of concurrent verbalization and retrospective feedback will be used, considering that the subject is blind. This will arguably provide the most valid results with a limited number of subjects. The relative completion time can still be measured, because concurrent verbalization on what is going on will be used during tests with the original and improved version of the application. We also made a time planning (see Appendix F).

4.2.9 Data processing

The test was recorded, to observe what kind of issues were encountered. The observed problems were then further considered and translated in terms of WCAG 2.1 user requirements making use of a WCAG 2.1 checklist(https://webaim.org/standards/wcag/WCAG2Checklist.pdf). Based on these requirements a proposed solution was described. When a prototype later becomes available, the completion time can be tested and compared to that of the original.

4.2.10 Results

Based on our test several areas were identified that can be improved. It provides an indication for new user stories and further design work.. Down here we will describe per trainer and screen which areas could be improved. We translated the identified problems to the WCAG 2.1 standards (see Appendix G).

Learning tips screen

The learning tips screen, is a screen that is displayed at the beginning of a lesson. Here Babbel gives tips about how to use shortcuts or how to better perform during the lesson.

The first thing that was striking is the progress bar (see figure 12). It is intended to measure progress and to switch between different exercises. However, when the screen reader read it out loud, it only says "Lesson player". This way of formulating the link does not give the blind user any information what clicking this link would mean.

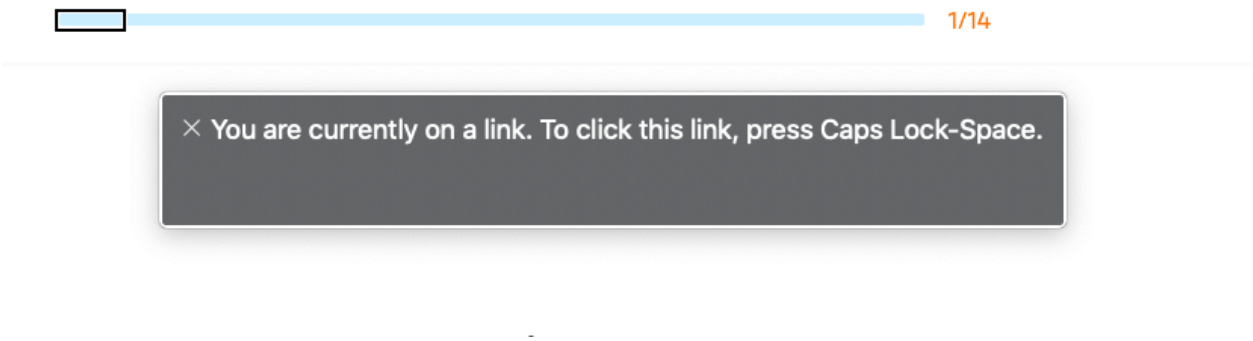

Figure 12: Progress bar within the trainers

Vocabulary show

In the vocabulary show, see figure 13) the user has to read the word and repeat after the voice telling the user how to pronounce the word. From the user test it became clear that the audio already starts before the user could navigate to the instruction. Therefore a blind user does not yet know that he has to repeat the sound. He looks confused about what to do with the information..

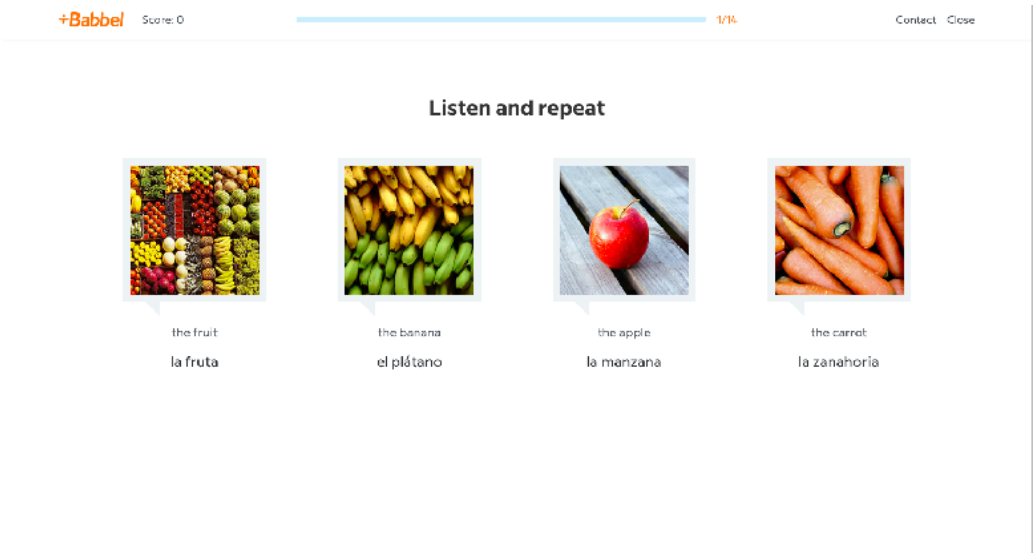

Figure 13: Show trainer

Vocabulary click

In the vocabulary click (see figure 14) there were some other issues. Within the vocabulary click trainer the user has to click the right English translation (and image) that matches the Spanish word. In this case it is la fruta, and should the word the fruit should be clicked.

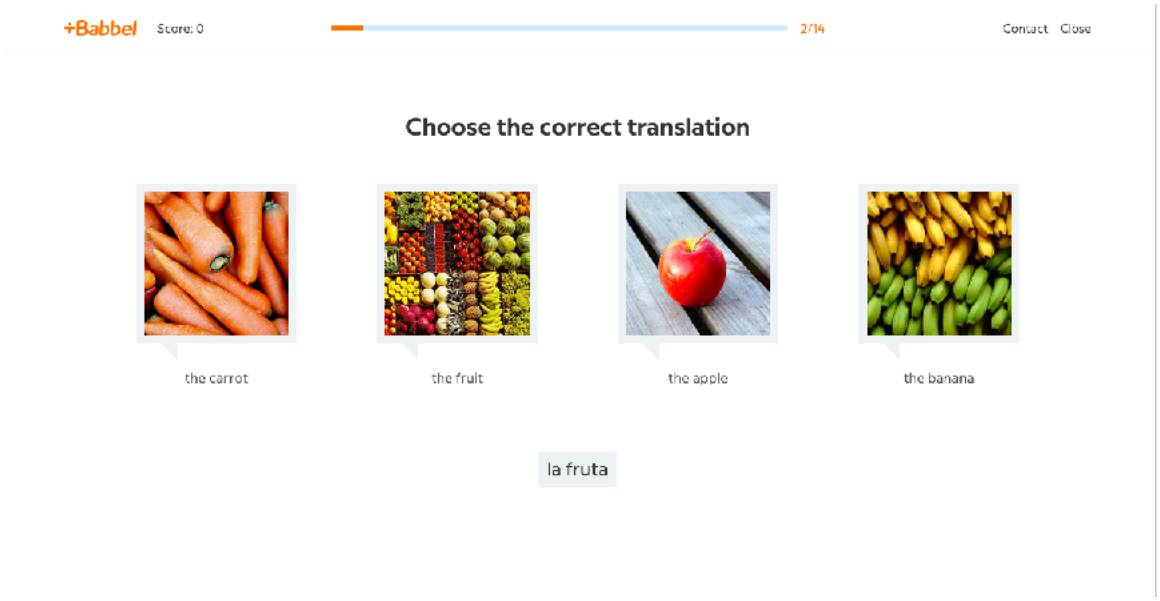

Figure 14: Vocabulary click

When the blind user navigates, there seems to be a loop, where he can not access the rest of the main screen. He keeps coming back in the same loop. We tried to reproduce this event, however it is hard to figure out how we got into this loop, and it has to be further researched. Also, the user is confused here what type of interaction is expected, e.g. should I drag and drop or should I click something. The user states the following.

"I think you have to search the words together, but you should drag the word to the right one, and that is something that does not seem to work."

However the user only has to click the right answer, instead of doing drag and dropping. Furthermore is it unclear from which language to which language he has to translate. Or which items he has to work with specifically at that moment. The order in which he hears the words, makes it confusing to know which item there is in turn. He states the following.

> Researcher: "What are you doing?"
>
> Tester:" Now I am trying to find the right word for the word banana, but I cannot find the translation."
>
> Researcher:" Aah it is the idea that you translate the Spanish word to English."
>
> Tester: " Spanish to English…But that I have no idea how to do that translation."
>
> Tester tries to spell out the words on the screen to get a better understanding.
>
> Researcher:" You are looking now how to spell the word?"
>
> Tester: "Yes"
>
> Researcher" Shall I help you ?"
>
> Tester: "This not totally accessible."

We concluded that it is the combination of the instruction, the placement of the item and type of navigation that does not intuitively work together if you do not literally see them.

Vocabulary write

In the vocabulary write trainer, see figure 15, within the vocabulary write trainer the user has to write the translation within the input field for a new word. There are letters that give a hint how to spell the translations. This letters themselves are buttons and can also be used to write the word in the input field. If the user writes the right translation he

can hit enter. If you do not know the answer, he can ask for help by pressing ‘show solution’. This trainer was the first one that required the use of a braille keyboard. That was mostly used to check out how a word was correctly written. While using this trainer the user noticed for the first time he was earning points, and remarked that he liked this feature.

In this trainer the user had a tough time with understanding the interaction between show solution, solve and hitting enter to submit the answer. This partly due to the fact that the instructions for submitting the item was a pop-up that the blind user missed during navigation/scanning of the web page. To complete the exercise he always hit ‘show solution and solve’, even when he had already entered the word correctly in the input field. He was also not aware that by hitting the button ‘show solution’, he was actually asking for help. Furthermore the jumbled letters were a bit confusing at first, it took a while before the blind user understood what he had to do with these letters.

Lastly it was a problem that the feedback was only visual: the word becomes green or red. Therefore the blind user cannot know if he wrote the word is correctly or not.

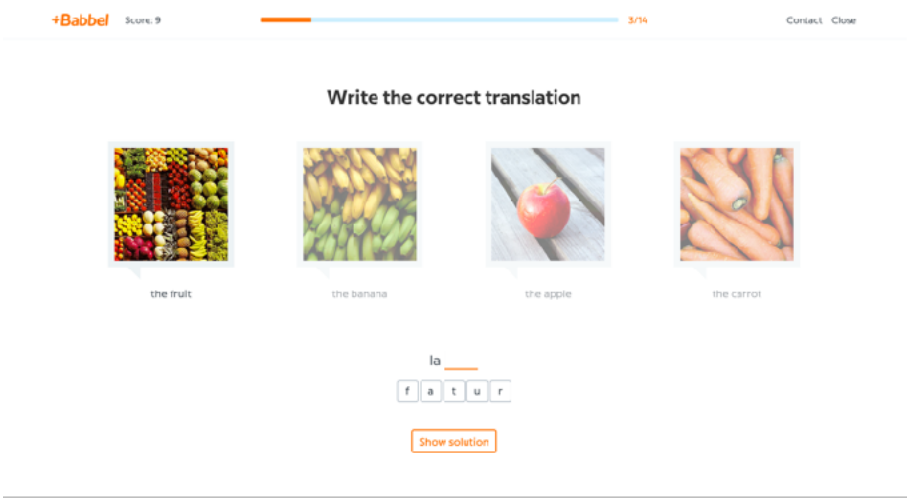

Figure 15: Vocabulary Write Trainer

Cube choice button trainer

In the cube choice button, a sentence is described in one language and the translation stands underneath it. However somewhere in the first sentence there is a gap. Here a word can be filled in and the options (as buttons) are presented for the user to choose from (see figure 16).

However the blind user could not observe that there was a gap in the sentence. The reason was, that the gap was only communicated in a visual way. Therefore the relationship with the presented option remained vague. Furthermore it was hard for him to find the English translation of the Spanish words out of the English sentence. It should be noted that he was a complete beginner. That could explain why he lacked the understanding or capability to retrace the translation from the English sentence.

What we also noticed is that there is also an image above the sentences that is described by its filename and that this is not informative (see image figure 17). The screen reader read the image as 200X200. This name of the image does not inform the tester about what the image represents. Looking further into the code, we can find that

the screen reader in fact actually read the file name and that an alternative description (alt label) was missing.

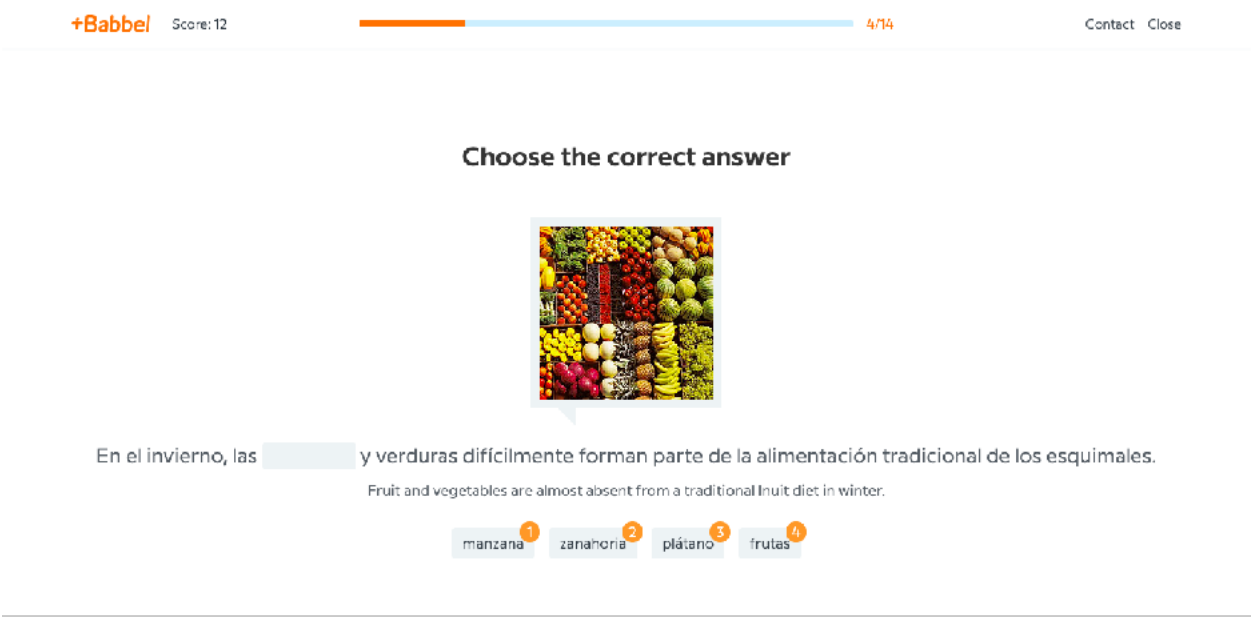

Figure 16: Cube choice trainer

Figure 17: Code from the image mentioned in figure 17

Memory trainer

The memory trainer (see figure 18) is a trainer where the user has to find the right translation by clicking a card. The card flips and shows an image of the word you are trying to learn. There was already doubt about testing this trainer, since it is very visual, however it was part of a lesson, so we chose to test it anyway. As expected the blind user found it hard to understand, because the feedback, if his response was right or wrong, was mostly only visual.

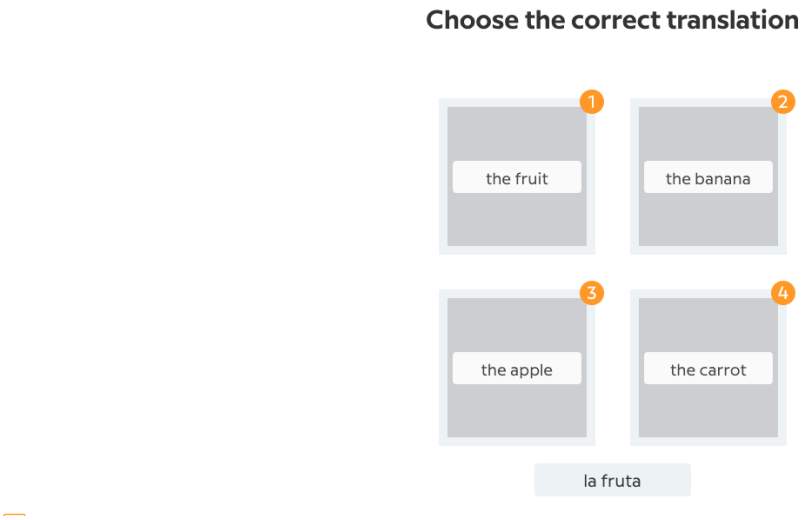

Figure 18: Memory trainer

Conclusions of test

The general conclusion that can be drawn from the analysis the customer quotes, interviews and the results of the user test is that the Babbel web trainer is usable by a blind user at this moment. However, before using it independently, somebody must assist them to that help them understand a trainer the first time it is used to explain how the interaction is intended to work, e.g. which button to click for what purpose. The participant during the user test said:

"This website lies between totally accessible and very bad, it is not the most accessible website but good enough. For me this means that I can sufficiently navigate and click the buttons"

We noticed that providing some explanation had a noticeable effect on how quickly the user could finalize an exercise correctly. Buttons and instructions were found faster by using the header option via the rotor, and answers were given more quickly once the interaction was understood.

- In general we may conclude that for all trainers the following points can be improved:
- The instruction should provide clear information about:
- What type of interaction is expected
- From which language to what language a translation is to be made
- The navigation to the main window (now the user has to navigate through the whole window to go to the next item)
- It has to be made more clear which item has to be interacted with
- The feedback may not only be visual
- Images must have a good description
- Images or visuals should not be the only way to understand the required interaction; an alternative has to be offered
- The progress bars links should get a meaningful name.

Improving on these points within the interface, should lead to a design that is usable by blind people, from the first moment. We would like to accomplish that blind people are able to use the Babbel platform without additional help from other people. therefore we

would This way of thinking should resonate with our persona. Kyra, likes to be independent and the feeling of autonomy is very important to her.

4.3 Summary of user research(3.1 until 4.2)

According to our user research the general problem blind people experience is that there are insufficient well accessible learning materials available, and that even some good applications do not stay accessible when software updates are made. In this project we tested how accessible the current version of the Babbel Product is for blind people. This target group was chosen because we expect that designing for this target group will have a spillover effect and benefit people with other disabilities as well.

Our findings suggest that the accessibility of the Babbel product can be improved by:

- providing clear preliminary instructions about the intent and use of the various types of trainers,
- upgrading navigation methods to avoid superfluous scanning of a screen and make clear to the user what word he is currently learning,
- using feedback techniques (whether an answer is right or wrong) that do not assume sight, and consider the abilities of blind people, and
- consequently giving meaningful names to visual screen elements.

Currently blind people compensate for shortcomings in the product by using assistive technology, getting additional help from others where needed, and focusing on their abilities rather than on their disabilities. For example, they learn to read braille and work with screen readers which are based on tactile and audio abilities. We would like to provide an experience where they can fulfill the exercises alone.

Blind people are often proficient users of technological devices since they are dependent on them. They frequently prefer to do a job behind the laptop where other people do not so much notice their disability. Lastly, we can imagine several scenarios(use cases) on how Kyra could use the Babbel product in combination with her assistive technology.

4.4 Literature review

This literature research aims to assess the state of the art concerning foreign language learning by the blind and related issues. It intends to show what is already available before we propose further developments at Babbel. Furthermore, the literature can also be used to find support for what we have found by means of our own user studies and tests.

Our first purpose of the literature research was to find out whether our problem statement is at all recognized by the literature. The main problem that struck us, is that there is not enough accessible learning material for blind people available via online applications. Secondly, we wanted to get a better understanding of how blind people learn in general, and more specifically how they learn a foreign language, because this could have implications for the interface design of the Babbel application (Research Question 1). Thirdly, we aimed to inventory what problems and opportunities have already been recognized, and what kinds of solutions have already been developed for blind people (RQ2).

Last but not least the review looks into how to create a good audio experience, because this is the predominant way blind people compensate for not being able to see. Interfaces can be quiet visual and it can be hard to communicate the same visual experience by means of voice. Most blind people also use assistive technology that provides another type of experience than sighted users, such as screen readers and braille displays (see context of use). A screen reader provides an auditive experience and the braille display provides a tactile one. In this section, we focus on best practices for transferring an audio-visual experience into an audio one. We pay less attention to the tactile methods, since this is well provided for by means of a braille display.

The four questions for the literature review are:
1. Does the literature recognize our problem statement?
2. How do blind people learn languages?
3. What problems/opportunities have other technologies and interfaces designed for blind people encountered?
4. What are the best practices to turn audio-visual experience in audio experience?

4.4.1 Methodology of the literature review

For this project, we agreed to make good use of 10 key scientific articles relevant to our research questions and a few practical guidelines. To find those articles we searched via several sites/databases such as Scopus, Google scholar, Google, Emerald and Researchgate. We made a first selection of articles on the basis of the relevance of the abstracts and key words to our research questions. Which articles we found is documented in our search matrix (see Appendix H).

From the relevant articles we found we made a further selection. We prioritized recent articles that were written within the past 20 years, and articles that had a Digital Object Identifier (DOI) . Even though we prioritized scientific articles, we made some exceptions for articles with a high practical relevance (such as EU guidelines) for our research questions. Based on these criteria and considerations we selected 12 articles relevant to our research questions. We documented them in a literature matrix (see appendix D) where we also indicate how the articles relate to the four basic questions for this review.

Later on we realized that the number of times that articles have been cited, referenced or downloaded, indicating their scientific significance, should also have been considered. We then added an extra column in the search matrix with this information. Later on, we made the backbone of our literature review, with a literature matrix(see Appendix I).

4.4.2 Recognition of the problem statement

All of the collected literature deals with the fact that information blind people is inaccessible in one way or the other. However, several articles deal specifically with the accessibility of learning materials. In particular the EU Erasmus+ program developed a guideline for the development of learning materials for the blind. That there is a need for this, is confirmed by Buzzi et al., who clearly states that describe specific collaboration platforms used for long-distance learning are not always designed effectively for blind people.

According to a questionnaire of Lazar et al., many webmasters recognize that accessibility is as an essential topic to be dealt with. However, they note that it is does not always receive sufficient attention for a variety of reasons such as lack of time, lack of training, lack of managerial support, lack of client support, inadequate software tools, and confusing accessibility guidelines. Some webmasters even take the position that accessibility interferes with their "web design" and that they would only be willing to take actions to make their sites more accessible if the government would require them to do so (Lazar et al., 2004).

We got confirmed our problem statement, that online learning material is not always sufficiently accessible (Liakou & Manousou,2015; Lazar et al.,2004 ; Park et al, 2018 ;Buzzi et al,2012 ;Erasmus +,2015). We found that E-learning is a potential solution to this problem (Buzzi et al, 2012; Erasmust EU +, 2015; Liakou and Manousou, 2015). According to Buzzi et al, E-learning is described as an act to achieve personal learning goals by acquiring skills and knowledge through computers or other network-enabled systems. According to them an important aspect of E-learning is the possibility of personalization of study rhythms according to the students' abilities. Furthermore, it provides educational opportunities to everyone, including those with disabilities (Liaku & Manousou, 2003).

4.4.3 Language learning while blind

In this chapter we answer the question, how blind people learn a language with particular attention for the learning cone model (Dale, 1969).

The learning cone and disabilities

According to Dale people learn a language by doing several types of activities such as reading, hearing words, seeing pictures, saying things, doing things and combinations of all these activities He categorizes the activities into passive and active ones. Passive actions are those such as hearing, seeing and the combination of hearing and seeing. What we say and do are considered to be active actions (see, figure 19) (Dale,1969).

Buzzi et al. recognize the validity of the learning cone. He argues that there is a need for change from more traditional teaching method to one that can keep up with the rapidly changing situations and that exploits the various types of activities for delivering learning materials. However, he also argues that the applicably of this model also depends

on a subjects' personal abilities. For this reason it is not a straightforward matter how to apply this cone model to everyone, because abilities and disabilities have to be considered. Clearly, not all types of activities will be available to them. For blind people seeing, and seeing and hearing in combination, are obviously not or no longer an option.

The tendency is to assume that it makes a difference at what age a person becomes blind, because memories of sight can make a difference (Buzzi et al, 2012). However, according to Chambel this might not be accurate. According to him, it depends on individual learning and life experiences(Chambel et al, 2009).

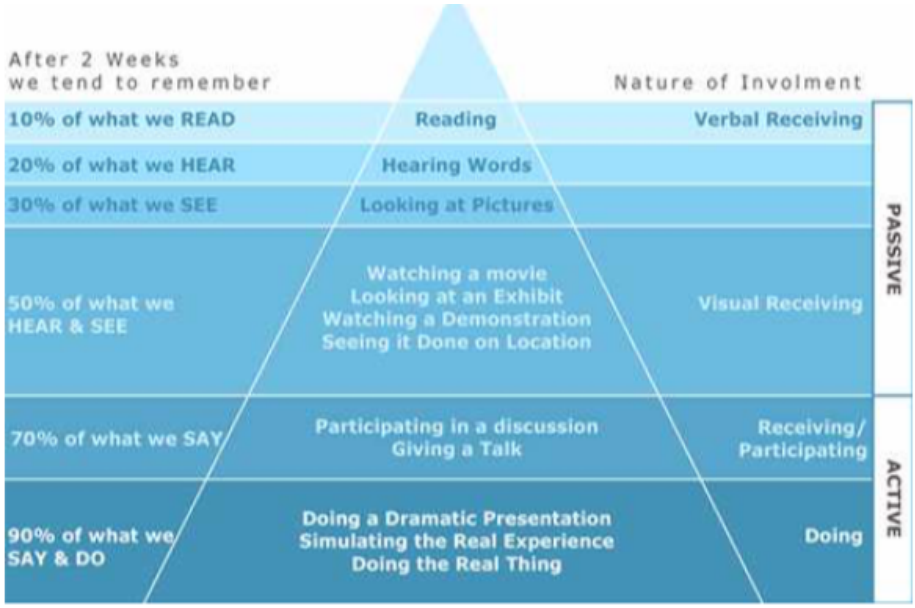

Fig. 1. Cone of learning (Dale 1969).

Figure 19: the learning cone

What conclude that a learning strategy to learn a language is very personal, it is a mix of capabilities (memories/references) and different activities (passive/ actively) to fully master a language. Because we did not find much literature specific to how blind people learn, it was essential to talk to blind people ourselves to find out.

Teaching methods

Although it was hard to find a specific learning strategy, we found several learning methods. First of all, according to Buzzy et al., blind people learn a perception of the world by using other senses (hearing, touch, sense of smell and taste). Especially hearing and touch are exploited. For example a blind person learns a perception of a word by touching a physical object.

Furthermore the EU guideline describes several learning methods that can be used in the classroom for teachers that have children who are blind. They state roughly two approaches (EU Erasmus +, 2015):

- "1.Adapting the methods already used by the teacher to meet the needs of the student who is blind in the classroom.
- 2. Implementing an entirely new teaching approach (also in the classroom). "

Method 1 adjusts existing methods in the classroom for sighted students in such a way that a blind person can keep up in the classes. For example, instead of using a blackboard

only, the teacher could read out aloud what he or she writes on the blackboard. If a word is difficult, the student can write down the new word, based on the out loud spelling from the teacher.

Method 2 proposes a whole new approach for teaching languages. A method proposed here for learning a language is called REALIA. The central concept of this teaching method for blind students is that it uses real objects while learning new vocabulary. They let the blind person, for example, feel a real object, do role plays and uses braille flashcards.

We conclude that online teaching applications should take the cone of learning into consideration when developing specific types of exercises. This is beneficial to all end users. However, when designing an exercise it should not be assumed that all end users have all the abilities to make use of all suggested passive and active activities. Preferably all exercises should be made in such a way, that when a user does not have sight or hearing, it can still be used.

4.4.4 Problems experienced in designing for blind

Besides learning styles and methods, we also interested in what should essentially be taken into account when designing for blind people when using technologies. We looked at a variety of technologies proposed by the literature that were also designed for blind people. The prototype application we developed in this project makes use of a combination of E-learning, accessibility and language learning techniques. In the literature we tried to find techniques that have relevance to, and similarities with our project.

First of all, we looked into virtual reality applications used for navigation for the blind through spatial environments(Maidenburg et al, 2014). This is interesting, because the researchers concerned with this topic were specifically developing applications for blind users. They dealt with the essential challenge of making something visual into a non-visual experience. We found that their technology can be used in a dynamical context such as our Babbel application.

Secondly, we looked into educational tools suited for blind users. Here we studied collaborative platforms accessible for blind users in long-distance education(Buzzi et al, 2012.) We thought this would be relevant because it highlights the online learning.

Lastly, we will name a set of other technological solutions used by blind people in language learning.

Virtual reality applications for blind

The virtual reality domain mostly uses their technology to analyze a new spatial environment such as a room, based on objects, and aids a user to navigate through it. (MaidenBaum et al., 2014; Guerrón, n.d.). MaidenBuam et. Al developed a prototype called EyCane to replace the cane by a mobile device that gives tactile information to a blind user. The reason they wanted to do this, is that some blind people feel embarrassed to walk with a white cane. With EyeCane the developers avoided drawbacks such as a high price, weight, and the steep learning curve. One advantage of a cane remains, that is that it also gives a signal to other people that they have to take into account that somebody cannot see.

EyeCane claims that it can make a big difference since it is practical, affordable and easy to learn. The average teaching time for learning to work with this device was within 5 minutes.

Guerron did more research and tests on how virtual reality can help to build spatial knowledge or a room. More specifically, he looked at how a cognitive map of the spatial environment can be built through the listening of audio events and the interaction with these within a virtual reality experience. This technology also can guide you through a route by talking and with the support of vibration and sound cues.

What we can learn from these two examples is that a mobile solution has to be cheap, not too heavy and easy to learn. Mostly this last point seems for us relevant. The adoption of the Babbel product by a blind user, might not be as difficult when it does not take a long time to understand the interface and the purpose of exercises e.g. Babbel trainers.

Furthermore, we learned that auditory feedback helps to create a cognitive map of a room. This may be comparable to making a mental map of a website, that helps to navigate through the application. Furthermore a type of feedback could also be given to a user of a website if he is navigating in the right direction, such as audio or vibration. The use of vibrations would require another type of technology and is out of the scope of this project.

Collaboration platforms

Another topic we looked into is collaboration learning platforms that are suited for blind people. Two examples we found in the article from Buzzi et al: Google docs and A Web tool transforming digital documents to structured audio podcasts.

According to Buzzi et al., Google docs had several problems:
“a. Many interactive elements cannot be detected by a screen reader nor be accessed via keyboard (since they are not standard (X)HTML elements and the screen reader announces their labels as simple text), making some tasks impossible to complete.
b. Blind users have difficulty orienting themselves during the interaction, listening to the interface contents sequentially, with no possibility of quickly moving from one part of the interface to another or using main editing functions (such as creating or accessing a document) or the document list.
c. Lack of a summary attribute for tables that list documents does not quickly provide useful information on its content. This then, requires an extra effort for blind users who have to read all cells sequentially to understand the content of the table (see area 5 of Fig. 2).
d. The editor is not practically accessible. The main menu (file, edit, view, insert, format, etc.) and the style formatting toolbar (font type or size, etc.) are inaccessible because they cannot be reached via keyboard, while bold, italic or underlined functions can only be used through keyboard shortcuts (CTRL+b, CTRL+i, etc).
e. Some dialogue windows are not accessible at all and messages notifying the presence of other users are not announced by the screen reader, against the awareness principle (Fig. 3)."

What we learn here, are the possible technical failures that are experienced in such interactive applications. We learned that issues we had with our interface, are pretty common defects in more interactive systems, such as Google Docs.

The second tool Buzzi et al. studied, was a web tool transforming the digital document to a structured audio podcast. The audio podcast has several advantages. First, of all, it can be used during multitasking and everywhere and anywhere. Secondly, it can be personalized and be used to one's own pace. Thirdly audio requires fewer resources than video to create and reproduce. Additionally a teacher can his own podcasts to reflect on their teaching skills.

In the application, a user must first upload a document where it got split into sections and titles. Based on this section and audio podcast was generated. They tried break down the section to small units (Buzzi et al, 2012). They refer toCebici & Tekdal and Ormond who stated that short podcasts are more effective than longer ones for learning. Ideally, a podcast should be 10-15 minutes (Cebici & Tekdal, 2006).

What is handy from this application is that the navigation is easy. For example, they converted example tables into a separate mp3, since listening to a long table seems for blind people quite frustrating. Splitting a section into small short mp3's makes it possible for the blind user to navigate quickly towards the content that interests him. First, he can listen to the title in a few seconds, and if it is not of interest he can skip to the next audio track (Buzzi et al, 2012). The navigation is rather simple, and one can navigate back and forth.

This way of going through content is extremely helpful when you listen to new audio educational material, or for the "going over phase" e.g. the time a blind user needs to navigate through all the content to get an overview of the material.

We conclude that this method is exciting because it gives a precise estimate (10-15 min) of how long an information session should be. Especially if listening is one of the main channels to convey information. Furthermore, we get an idea of how it is for a blind user to navigate through new material, namely sequentially. Also, we find it essential that the blind user is able to find the main content quickly.

Technical support

The EU Erasmus guideline describes several technical tools that can be used to learn a foreign language: the reading machine, daisy books, and players, digital recording to take notes, accessible games, and OCR software. We briefly describe what these tools are.

Reading machines: The reading machines, is a machine scans the text or is captured by a camera and then automatically recognized into a text and makes read the text out loud. Mostly this machine is used for elderly or children that have poor tactile skills, see figure 20.

Daisy books and players: Daisy books and players are e-books in mp3 format that uses navigation, bookmarking and note-taking in an audio book.

RoboBraille service: An online automated document conversion service, it converts a text to a number of alternative formats. They mostly turn inaccessible format into accessible format such as mp3 audio format, E-books,Daisy-books, Braille books.

Online dictionaries: This is mostly used in the classroom or at home instead of using a braille dictionary which are extremely big in volume.

Digital recorder to take notes: Recording class helps blind student a lot with studying, they can listen back to lessons or conversation. Now they can comprehend the material in their own pace and make notes if they like too.

Digital games to enhance vocabulary and grammar skills: Here is mostly Duolingo described, however Babbel would fit in this category. Although that Babbel is less game orientated.

Figure 20: rendering machine

Theroform: The thereform heat sheets of plastic film to a point that i will take form/ shape of any material that is laid under it. It literally creates a "picture" of the material underneath it, see figure 21.

Option character recognition: This software recognises pictures of text and translated to real text, such that the picture/ text becomes accessible to blind people.

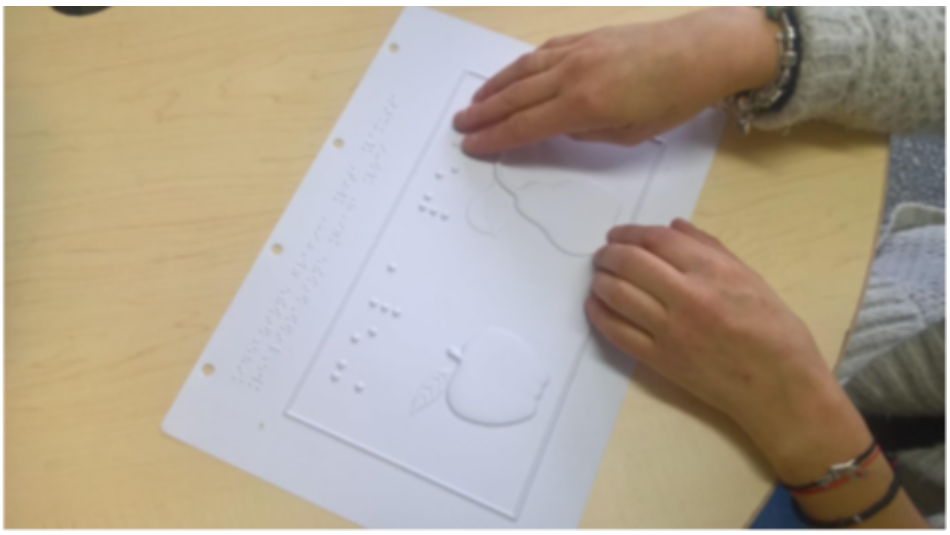

Figure 21: Theroform

All of these tools are very useful to understand the context of a blind user, more specifically what is in his language learning working environment. According to the learning cone, we never learn a language through one medium, we always learn via several types of activities, that may make use of several types of technical support.

4.4.5 Best practices for audio touch experience

We found several guidelines about the use of multimedia learning and accessibility. Also, we found some good practices with designing for educational material

Multimedia learning and accessibility

According to several authors, it is essential for people with disabilities to perceiving information through different media.. Mayer proposes the Cognitive Theory of MultiMediaLearning, and states that receiving information and processing the information via different channels, specifically audio and visual, is beneficial. Parker agrees with this, and stresses that the understanding of E-books would be better if they would multimodal support, e.g. E-books with audio that read the text. He also stresses that the combination of e-books and other media may make the implementation of accessible solutions harder. The more media that are combined, the more complex the accessibility will become.

In our prototype, we will transfer the information through audio and touch (Braille display). In some cases we would even only use audio to send information. The audio-only experience is also seen a lot in audio descriptive subtitles by movies where they translate the visual images of movies into audio descriptions (Moreno & Vermeulen, 2013; Talavan & Lentil, 2016). We therefore looked into this topic more thoroughly.

Audio descriptions

Within audio description there are several styles; the most common one is the dub over subtitles which fills in the silences of dialogues with an objective (non-emotional) description of the scenes (Talavan & Lentil, 2016). The research from Walczak et all shows that more creative audio description (also described as subjective or emotional) improves an immersive and appreciated viewing of a movie, which implies that this can be an improvement of the current 'objective/ non-creative' style. Another benefit of such creative audio descriptions in clip or movies, is that they in fact provide an extra educational activity to learn a foreign language for sighted people. This activity can especially be a useful exercise in long-distance learning and working via online platforms, because it helps to improve oral production skills (Moreno & Vermeulen, 2013; Talavan & Lentil, 2016).

For Babbel this isinteresting because it can be a new type of exercise. It helps to get a better idea of how we could translate our visual cues in a more entertaining and educational way for blind people. For our design, we are interested in how we can use this method to translate the visual aspect to an audio experience.

Best practices provided by EU

In an Erasmus plus program report (Erasmus Program of the European Union,2015) the the EU provides several best practices for teaching teaching a foreign language to the blind. First of all, they describe that the sound of audio should always be of good quality. Secondly, visual content that is important to the lesson should either be verbally described or given in a written form to the blind student beforehand. This means that the

blind user should already be enabled to understand the visual material before the lessons start.

The EU document further describes several best practices to translate the visual experiences to auditive one. They advise the following:

- Name the extension of the document, that should be preferably be a .doc, docx,.rtf or should be plain text(.txt).
- Questions should be numbered.
- A list should be clearly organized using a dash at the beginning of each item.
- Text and pictures that are irrelevant for the content should be erased, or shown differently
- Avoid spaces and blank lines
- Tables should be written in a linear manner
- A conversation that is presented as a cartoon way should also be presented in the text.

Testing and standardization of E-books

Physical books are a medium that require vision and must therefore be translated into an audio version. Usually a blind person will read a book or e-book with the aid of a braille keyboard or a screen reader. A screen reader could be used to translate an e-book (text-based) to an audio one. Before this is possible, an E-book version must of course be available, which if not always the case. And even when they are, E-books need to be tested for their accessibility. According to Park et al.,it is essential to have clear guidelines that describe what the accessibility guidelines are for E-books and how to apply them. To do this well he also proposes to make use of automatic verification tools in addition to manual verification by humans.

The first thing we can learned from this, is that it helps to test the accessibility making use of a standardized method e.g. set of guidelines. In our project we are dealing with a web application, and therefore continued to use the WCAG 2.1 and automatic testing tools that comply to this standard. Translating dynamical interfaces into another type of multimodal experience, make it more difficult test for compliance. We therefore made use of a combination of automatic testing (on WCAG 2.1 standard), expert testing (testing with screen reader and focus) and real user testing. The automated test was primarily used to check the functional requirements and the WCAG 2.1 standards. We used the expert testing to check if we missed something missing in the interface with the automatic testing. Expert testing was used as preparation for the user testing, to at least eliminate the most obvious mistakes.

4.5 User stories

We divided our user stories into four categories according to the WCAG 2.1 standard. They divided their requirements into 4 categories:

- Perceivable: Information and user interface components must be presentable to users in ways they can perceive.
- Operable: User interface components and navigation must be operable.
- Understandable: Information and the operation of user interface must be understandable.
- Robust: Content must be robust enough that it can be interpreted by a wide variety of user agents, including assistive technologies.

We added an extra category for usability requirements, such as those based on Nielsens' 10 heuristics (Nielsen, 1994). Additionally we specified some specific requirements for the application of Babbel that didn't fall into one of the first 5.

4.5.1 Perceivability

Distinguishable

- As a blind user I would like to be in control when the audio plays words, in such a way that I can control when the words are read aloud.

Adaptability

- As a blind user I would like the voice-over of the screen reader not to overlap with the voice of the exercise, so that I can listen carefully to the pronunciation.
- As a blind user, I want feedback on my answer that is not visual, so that I can understand if I made a mistake or if I was correct.
- As a blind user I want learning material that is not highly visual, so that I am able to understand the exercises without having to rely on the images within the exercise.

4.5.2 Operable

Accessible keyboard

- As a blind user I want to be able to use my braille display to read, and I want to be able to use my own keyboard when I have to write, such that I don't have to spend a lot of time to figure out how the Babbel on screen keyboard works.

Navigable

- As a blind user I would like to be able to skip to the main screen immediately, such that I do not have to navigate through the whole screen
- As a blind user I would like to know what the purpose of the button or link is, such that when click on it I understand what will happen.
- As a blind user I want to be aware of my progress in the flow of the lecture e.g you are at 3/14 of the lessons, such that I can easily go back and forth between exercises.
- As a blind user I want to understand first the explanation of the instruction, before I go to the exercise, such that I have a better understanding what is expected of me.
- As a blind user I would like to be able to get back to the explanation anytime I want so that that I don't always have to rely on memory.
- As a blind user, I would like to know first what to do before some interaction is started automatically, such that I can better understand what to do with the given information

Understandable

Readable

- As a blind user I don't want to have to switch the whole time between screen reader languages, I would prefer it if this is done automatically.

4.5.3 Robustness

Compatibility

- As a blind user, I would like to have language application that is compatible with several screen reader e.g JAWS, such that I don't have to adapt the whole time with different ones

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4.5.4 Usability (Nielsens Heuristics)

Flexibility and efficiency of use

- As a blind user I want to get an understanding of the exercise as fast as possible, so I don't have to spend so much time on learning the interface.
- As a blind user I would like to have stable software updates, such that if I still know how to deal with an interface and that I don't have to adjust the way I work with it because of an update
- As a blind user, I would like a lesson does not take longer than 10-15 minutes, such that I can stay concentrated during a lesson.

4.5.5 Specific requirements on the Babbel application

- As a blind user I would like to have lessons in which I can practice my speaking only, such that I don't have to write.
- As a blind user I would like to have an exercise in which I can also teach me how to write, such that I know also how to write words in a foreign language.
- As a blind user I would like to have an exercise that teaches me a foreign language on a higher level, such that I learn more than the basics of a language.

4.6 The user stories iteration I

According to agile working methods we prioritized the requirements and worked on them in short iterations. The general aim was to develop a minimum viable product that is ready for a feedback session from the client. In this product we prioritized the minimum wishes from client which were navigation and interaction with button (controls). This put the focus on operability requirements. We also prioritized the specific requirements for the Babbel application. We chose to go on with redesign of the Vocabulary Write Trainer because this has a lot of interaction that requires the use of the keyboard and is similar to other trainers such as the representation of the words in vocabulary speak and click, and would probably give us a good idea how to design those as well. For example the way you represent the words that have learned, the use of instructions, the use of progress-bar.

So, in iteration 1 we prioritized the above mentioned requirements for the keyboard, the navigability, and those specific to Babbel.

Accessible keyboard

As a blind user I want to be able to use my braille display to read and I want to be able to use my own keyboard when I have to write, such that I don't have to spend a lot of time to figure out the Babbel keyboard works.

Navigable

As a blind user I would like to skip immediately to the main screen, such that I do not have to navigate the whole time through the screen

As a blind user i would like to know what the purpose of the button or link, such that when click on it I understand what will happen

As a blind user I want to be aware of my progress in the flow of the lecture e.g you are at 3/14 of the lessons, such that I can easily go back and forth between exercises

As a blind user I want to understand first the explanation of the instruction, before I go to the exercise, such that I have a better understanding what is expected of me.

As a blind user I would like to be able to get back to the explanation anytime I want, such that I don't always have to rely on memory.

As a blind user, I would like to know first what to do before some interaction is started automatically, so that I can better understand what to do with the given information

Specific requirement for Babbel application

As a blind user I would like to have a lesson wherein I can practice my speaking only, so that I don't have to write.

As a blind user I would like to have an exercise wherein I can also teach me how to write, so that I know also how to write words in a foreign language.

As a blind user I would like to have an exercise that teaches me a foreign language on a higher level, such that I learn more than the basics of a language.

5. Realization I

In this section we describe the redesign of the Vocabulary Write Trainer (see image). To design this we made user stories, activity diagrams, and mockups. If we are able to redesign the vocabulary write trainer, we probably have a good idea how the other trainer also have to be redesigned also (see figure 22).

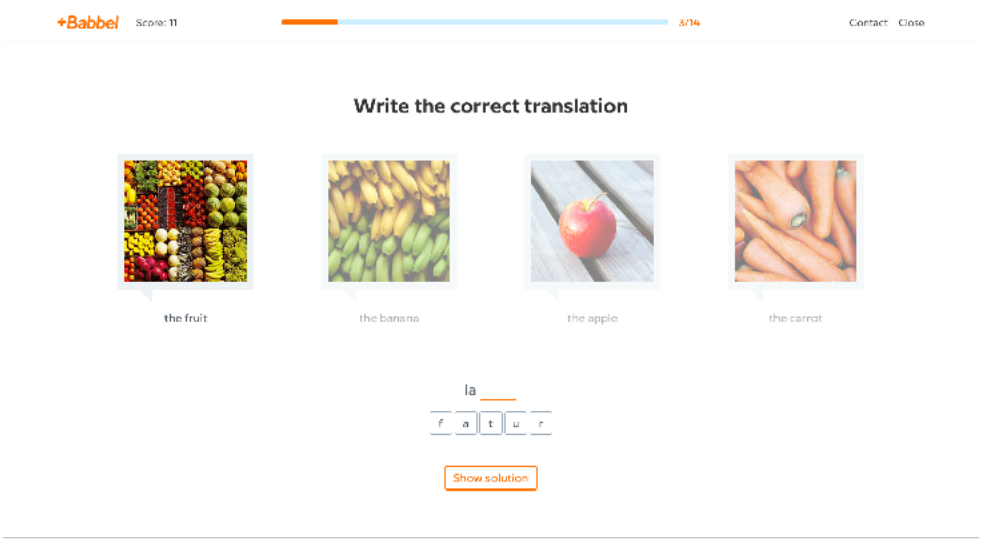

Figure 22: Vocabulary Write Trainer, the trainer that will be redesigned

Based on the user stories we made a few assumptions and design choices for this sprint. We assumed that the user wants to have the whole exercise spelled out for him in words. Therefore we tried to provide the maximum amount of information on the screen that the interface allows.

In this design we made an assumption about the preferences and the prerequisites of the user. We assumed that the user already switched on a screen reader and that he is able to recognize the display language. We also assumed that the user could make infinite attempts on the writing.

We considered to make the progress bar non selectable, so that it only serves to show the progress in text. With as a consequence the program bar, can not be used anymore for navigation between exercises. However the progress bar keeps its functionality of keeping track of how far the user is within the lesson. This way we kept the function of using the progress bar to go back and forward through lessons, and tracking progress separate. This is not a user preference, however we would like to try to make a clear cut between the functionality of tracking progress and navigation between exercises. We made this this distinction to simplify the interactive and the fixed elements on the screen.

We made a few further design decisions, to make the application as sequential as possible, while staying very close to the current structure. We developed the interface in such a way that the information for completing the exercise reads from top to bottom, thus avoiding that necessary information for the user is scattered over the screen. For example already receiving a tip before you have to fill in your own answer. That is why we decided to place the (button) letters were above the input field instead of underneath it.

There were a number of miscellaneous topics, we worked on in this iteration:

- We decided that the feedback should be presented to the user in another format, and not only visually.
- We assumed that only one item per page would be selectable
- Instead of using pop-up buttons we filled in the instruction on how to interact with the input field above andinside the label
- The images were not selectable, since they have no function to the blind people.

In this sprint we decided to postpone the. realization of the following design decisions for another iteration:

- The instruction could be implemented in a different way, for example more scattered over the page.
- Where the translated word can be place on the page, above or below
- You could have different variation in the amount of feedback for example more elaborate help versus simplistic
- How to navigate design the page such that the end user can easily jump back forth over the page, with the techniques used from the blind user e.g. using the rotor(navigation software for screen reader) to jump to heading

5.1 Flows for vocabulary write trainer

Based on this design decisions, we had to better specify 3 situations:

- The first time use of a trainer, with a first item
- The second time use of a trainer with a second item
- How to move back and forth between the two pages.

We decided to first work out the flow in a written scenario and an activity diagram (see Appendix J). In the scenario we described from the users perspective how he would go through this procedure step by step. After this we captured the logic in an activity diagram to help us check the flow of our prototype and to find out with which steps the user really needs to accomplish a certain task.

5.2 Acceptance criteria per user story

The flow and activity diagrams provided a good insight into what steps need to be taken to make use of the user stories. These steps were then translated into criteria for with acceptance criteria e.g. as the requirements that a system should meet to fulfil the needs derived from the user story. Once we had developed requirements in this way we prioritized them via the well known M(0)SC(o)W principle into ‘must-’have, ‘should-have’, and ‘could-have’ (Hatton, 2008).

Must

1.	As a blind user i would like to know what the purpose of the button or link, such that when click on it I understand what will happen
A	The user must be able to select each button with keyboard navigation.
B	The screen reader must be able to call the naming on the buttons and explain the functionality of the buttons.

C	The screen reader must be able, that if a button is selected, the naming explains what the next step is going to be.

2	As a blind user I want to be able to use my own keyboard to fill in input fields, such that I do not have to get used to a new interface
A	The screen reader must be able to navigate trough my keyboard to the input field.
B	The screen reader must be able to read out loud what data value in the input field is expected.
C	The input field must accept keyboard input for entering the answer
D	The input field must be able to accept the enter key from the keyboard to submit the answer

3	As a blind user I want to understand first the explanation of the instruction, before I go to the exercise, such that I have a better understanding what is expected of me.
A	The instruction must describe the language to what language has to be translated.
B	The instruction must describe what type of exercise can be expected.
C	The screen reader must be able to read all the instructions.
D	The screen reader must be able to pronounce the instruction in the right accent.
E	An instruction for an action, must be placed before the action in the flow of a screen reader e.g label explaining the input field.
F	An instruction must be short as possible, such that it also looks good on a mobile phone.

4	As a blind user I would like to have an exercise wherein I can also teach me how to write, so that I know also how to write words in a foreign language.
A	The system must allow the user to read the way of spelling of a word.
B	The system must allow the user to practice the writing of the new word.
C	The system must allow to compare the answers of the user with the correct answer.

Should

5	As a blind user I would like to skip immediately to the main screen, such that I can work on the exercise straight away.
A	The screen reader must be able to find a mechanism in the beginning of the flow of navigation to go directly to the main page.
B	The system must have a mechanism to skip directly to main page

6.	As a blind user I would like to be able to get back to the explanation anytime I want, such that I don't always have to rely on memory.
A	The screen reader must be able to find the main instruction via all the search techniques available by the screen reader on the apple computer.
B	The screen reader must be able to navigate back on screen, such that the user does not always has to go back to the top to go back to a former element.

Could

7	As a blind user I want to be aware of my progress in the flow of the lesson e.g you are at 3/14 of the lessons.
A	The screen reader must be able to read the progression of exercises from the user.

8	As a blind user, I would like to know first what to do before some interaction is started automatically, so that I can better understand what to do with the given information(see also requirement 5)
A	The system must not play any time of sound automatically.
B	The system must have some sort of control system if something have to played e.g. audio.

5.3 Prototyping for the first iteration

To develop the prototype we first made a mockup with the online tool Figma. It can be used to design interfaces (Bracey,2018). In this first design we tried to incorporate all the user stories. We added extra instructions. To do so we eliminated several items of the original Babbel application on the screen and changed their order (see figure 23).We also added text underneath the main title, which stated the instruction: "First, you will find the word you have to translate from English to Spanish. Second, you will find a hint, this hint exists out of the Spanish word but then mixed up. Thirdly you will find an input field where you can type in the translation. You do not have to type the article, that is already there."

We also brought the number of items back from 4 to 1 to avoid confusing the user which question he has to answer. In the former version, the blind user got confused in the flow after he had answered the first item. The answer to the first item had then still stood on the screen, while the user was already trying to answer the second item. This was partly due to the fact that it was not clear how to submit the answer. Also the screen could not well distinguish between which items were already answered, and which not. The first problem could be solved by adding an instruction above the input field such that users understand how to use it. The second problem could be solved by reducing the number of items on the screen to one. We chose for the latter.

Another choice that was made in this design was to swap the order of the input field and the hint. One could argue that giving a hint up front before trying to first answer yourself might not be didactically responsible, however functionality placing the hint underneath the input field did not make it clear to the blind user that there was a hint. For now we decided to put it above the input field. However, more research should be done how this specific hint feature can best provide both an accessible and didactic purpose.

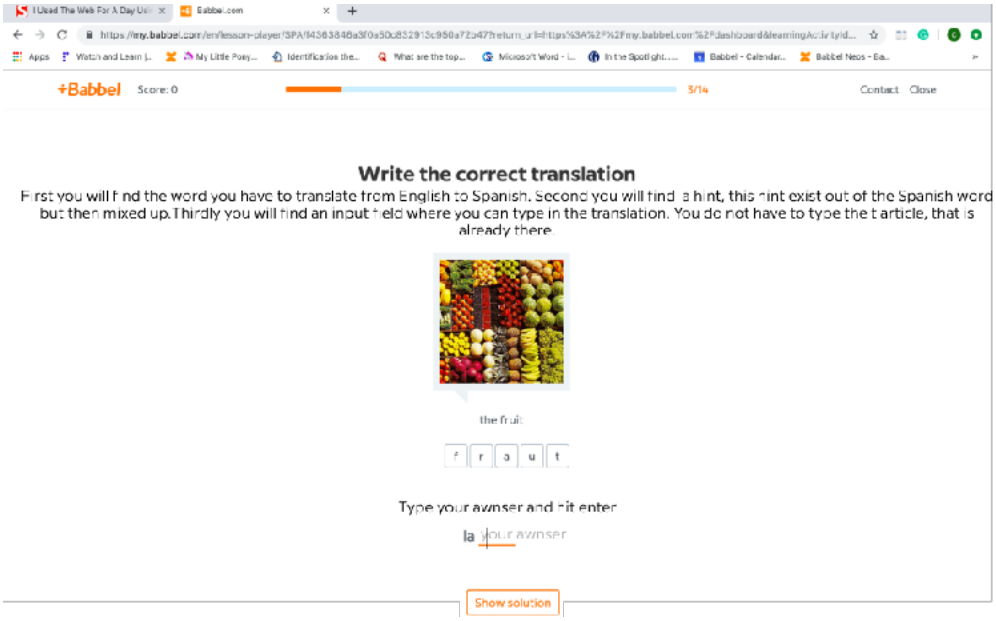

Figure 23: First design for Vocabulary Write Trainer

What was striking is the amount of text that had to be added to the screen. So we asked two feedback two designers for alternatives. One designer had a background in accessible design, and knew a lot about screen readers. She developed interfaces for Babbel every day. The second designer is specialized in UX components that are related to the text and writes up user research about this.

They commented mostly on the elaborated text underneath the main title, for aesthetic reasons. The second designer mostly helped with being more precise with the wording of the design with regard to the expected interactivity. We therefore hanged the main title to “write the letters in the correct order”. Furthermore, we changed the subtitle into "With the given English word, use the unjumbled letters to do the Spanish translation.”

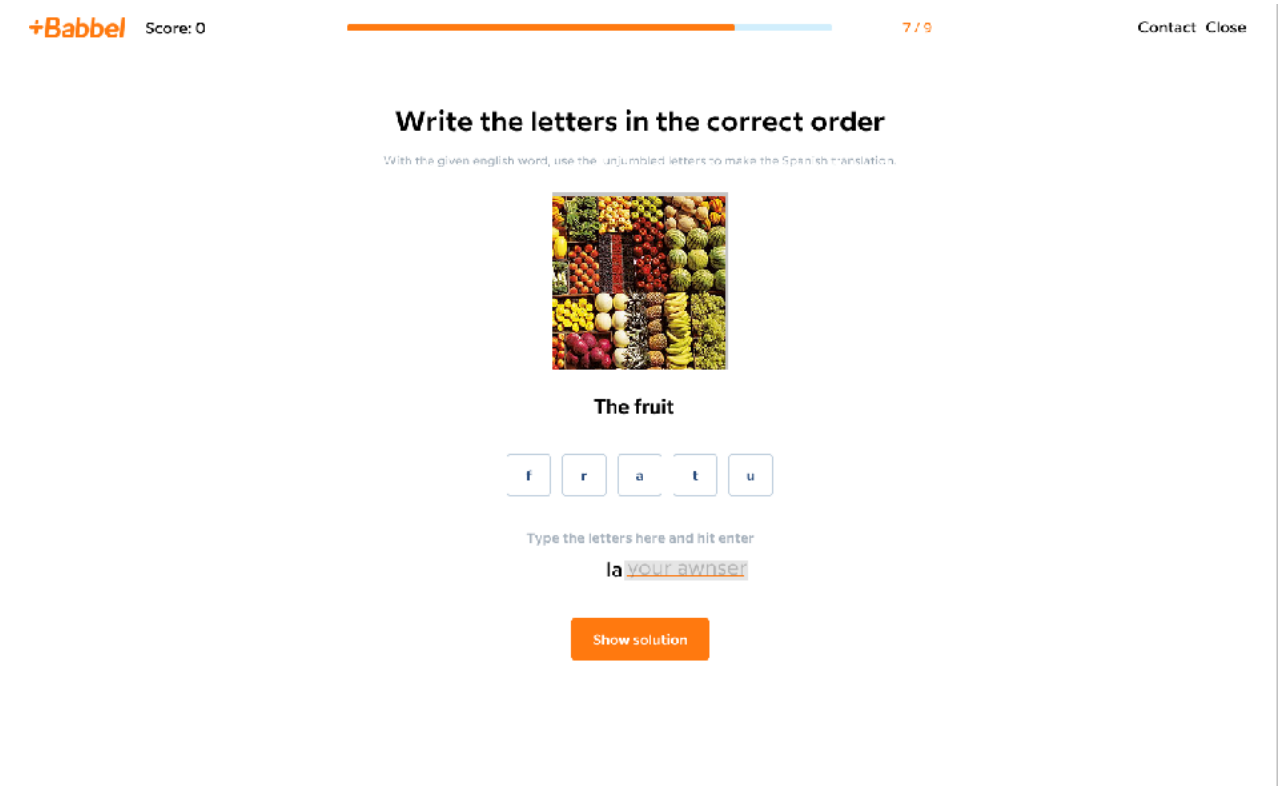

Figure 24: the redesign of the Vocabulary Write Trainer

Furthermore, we changed the wording of the instruction above the input field from "type your answers here and hit enter" into "type the letters here and hit enter." There was also some speculation about the naming of the button: "Show solution" could be changed in "Help me " or "Show me the answer". A complication here is that the the focus of the screen reader does not move back to the input field when the user asks for help. The request to “show solution” does not immediately solve the exercise. It does show the correct solution within the input field and waits for the user to type in the right answer. After that, the user can decide to type, or hit the button “solve”. The big problem here is that a blind user literally does not “see” the solution, since the screen reader focus is still focussed on the button instead of the input field. This type of interaction is very confusing for the blind user.

Lastly, we speculated about a way to give feedback to the user. One way is to provide feedback to the user if something is wrong or right via pop-ups. A message on the screen then appears with a message like: "the answer is wrong," and the focus jumps from the input field to the pop up. After hitting “ok”,the focus of the screen reader would jump back to the input field. However, this also needs further research, how accessible this principle is, and what this might look like. It is also a question if the feedback with two categories like ‘wrong / right’ is nuanced enough. In the original application, feedback is given about which part of the word is spelled wrong and which letters are still missing. However, this feedback is given visually by red and green colors. A solution to this problem is to add an extra dimension with audio as well. A real design challenge is to make clear to the blind user what part of the word is wrong and instruct him to rewrite or hit the solve button.

A lot happens within a trainer. Therefore the interface can be confusing for both a sighted and non-sighted user at first. This raises the suspicion that the interface is to

crowded and has too many functionalities, and made us wonder what the bare minimum functionality of a trainer should be.

5.3 Conclusions after this first design sprint.

This first design sprint gave us an impression of what might be a solution. It turned out that further development was needed. More complex questions came up during the design process:

- What is the real function of the hint with the jumbled letters and how can this be best communicated in an accessible and didactical way?
- What should the feedback process look like when an answer is wrong or right?
- What are the best ways to provide help to the user in its process?
- What is the bare minimums functionality for a trainer?

These questions were a good input for the next design sprint.

6. Evaluation I

In this section we describe how we tested and evaluated our first prototype.We first describe the methodology we used to test the prototype, and then present the results of the test.

6.1 Testing the first prototype

The interface was very busy. We therefore decided to remove the most complex part of the interface from the prototype, which is the mechanism to give hints.We wanted to see what help (feedback) is necessary for the exercise to succeed. Based on this test, we could decide what features that were present in our former design are redundant and what should be kept.In the new prototype we only gave an indication, if the answer was correct, not correct or almost correct. All other feedback had to be done by humans and was interesting to observe, which was exactly the purpose of this test.

We wanted to know what type of instructions can be used and what type of feedback is needed to let a blind user recover from his mistakes. To do so, we used the Wizard-Of-Oz method. This is a method that tries to simulate the behaviour of the envisioned system (Bernsen, Dybkjaer and Dybkjær, 1993). In this case we wanted to simulate the behaviour of the Vocabulary Write Trainer behaviour when it gives instructions and feedback. The prototype was built with HTML, Javascript (libraries) and css.

We wanted to answer the following questions:

- What are the appropriate instructions for the vocabulary write trainer?
- What feedback would a blind user like to have using the vocabulary write trainer?

We also wanted to test the functionality of our prototype. Our prototype was now very minimalistic, (see figure 25).

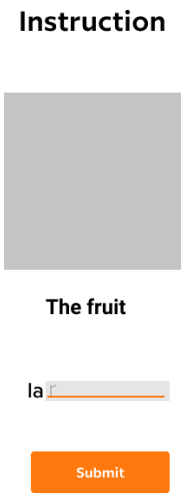

Figure 25: The prototype stripped from all instructions and feedback

6.2 Motivation for using the Wizzard-Of-Oz

According to Bernsen et all (1993), a number of points should be considered before using the Wizzard-Of-Ozz method for a design:
1. The behaviour of the interactive system that has to be simulated is something that users are good at: cognitively demanding skills.
2. If it is hard to build a system with such cognitive capabilities, it is necessary to focus on narrow and well defined application domains. This means that you need to have clear what is done by artefacts (e.g. technology) and what is done by the human.
3. Wizard-Of-Oz is not a quick and dirty method, and can be a demanding process. In that case it is worth the effort to produce a Wizard-Of-Oz prototype. It has to be taken into account that the prototype may not work, or that the intended design turns out not to work at all. Therefore it is important to have enough time to be ready for these kinds of risks.
4. Also within the system it should be taken into account that technology will have some limitations. Not all possibilities humans have can also be done by the existing technology. It is important to keep this limitations in mind.

We think this method is suited, since language communication is very fundamental to human. Secondly giving good instructions, and the right feedback at the right time, is a heavy cognitive task. Being a good teacher is an art. Also, quickly testing the principles avoids implementing features, that might be necessary, and turn out to be useless. We further tried to focus on what type of interaction of human behavior we wanted to test. In this case that it is giving instructions and giving feedback. We also took the limitations of the technology into account. In this case that means that the user can not see and that a computer will be used as a guiding tool to steer the conversation between the wizard and tester to simulate this situation as much as possible. The wizard has to teach the tester with the help of the prototype.

6.3 Timeline and roles for the test

6.3.1 Timeline

- 1.Explaining the test(5 min)
- 2.Explaining how the screen reader works (10 min)

We will first explain how the screen reader works, but as minimalistic as possible. We will teach the participants the following commands(the teacher/ as the student).

Start up screen reader: Command +F5

Navigate to right: Caps-lock+ Arrow to the right

Inside the website: Caps-lock+ arrow down

Press button: Caps-lock + spacebar

- 3.Teaching the words (10 min)

The student will be blindfolded. The teacher provides the set of words, with the translation in the language (English-Portuegese). We will use the Babbel vocabulary listening trainer to teach the words and let the teacher communicate how you spell it. At this point the teacher controls the computer.

- 4. Asking the student to write them(10 min)

The student now has to write type down the words on the screen with the prototype. The computer is handed over to the student The teacher still sees the screen and only tries to interfere when the user needs help. In the meanwhile the student talks aloud what he expects to do. The teacher will get some information about what he does, and not have to do to help the "blind user" to succeed in the exercise. During the instructions the teacher should

- Explain what the exercise is about
- What language is used
- And what interaction he/ she can expect
- Give feedback if the user clearly asks for help

The feedback can be any type, however this may only be vocal feedback, the teacher may not take over the laptop

- 5. Evaluation 5 min

Setup of the test for the second part

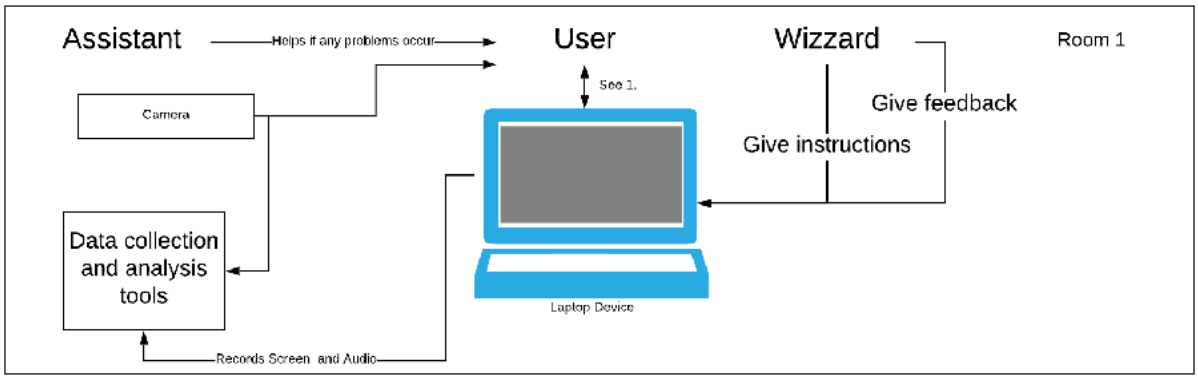

Figure 26: setup for the Wizard-of-Oz technique with the laptop

6.3.2 Roles

The user:the student

In this test the user will not see anything of the screen and only will get some few instructions about how to navigate over the screen. Further the user will only know that he is going to use the babbel product to learn a new language, namely Portuguese. Also he will know that he is experiencing the Babbel product as a blind user.

Wizard: the teacher

The wizard will give instructions and feedback. The wizard is able to see the screen of the user. The wizard will know when help is needed, by listening to what the user says and the focus on the screen. The end user will use a Screen reader to guide him over the screen.

Assistant(s)

The assistants have the role of being observer or help when the user are stuck e.g technical problems. The assistants will be instructed what they have to do in specific cases.

6.3.3 Preparations before the test

According to Bernsen et all.(1993), if a Wizard-Of-Oz prototype succeeds depends on how well the test is prepared. Therefore we first did a tryout session to make sure that the real session would run smoothly.

Activities that were done before the test were the following:

- Recruiting testers that do not know the interface by heart
- Find a wizard with a high skill in teaching, preferably with a native english speaker, to come as closest to display language that is used in this design(Vocabulary write, ENG-POR).
- Test the setup of the computers and the collection of data.
- Inform the teacher well, by telling them the possible situations he might face

6.4 Data collection and analysis

The data was collected by recording the screen of the end-user and the conversation that tester and the wizard had. Furthermore, the the end- user was filmed with an external camera. The video material was analyzed. We focussed on how the teacher gave instructions and how she taught. Based on this, we tried to formulate requirements on how the instructions should be formulated.

6.5 Limitations

There were a few limitations to this test. First of all, the number of testers, which was only 1. Because of time constraints we could not test many users, because it would take too much time to find them and analyse all the resulting data. Secondly the problem of in-house testing arose, which is the fact that many people in-house have in depth knowledge of the product which could bias their behaviour during a test. We tackled this problem, by taking people from departments that were not related to the team that is working directly on the core product e.g. marketing or legal.

6.6 Results of the wizard-of-oz test

Several usability problems came out of the test. First of all, was it unclear to the blindfolded user that a new word appeared on the screen after they submitted the answer. Secondly there were problems with the input field. The blindfolded user expected he could fill in his answer (including the article belonging to a noun) immediately after hearing the word he had to translate. However the screen reader first read the choices ‘la’ or ‘le’, and this led to confusion. To do so felt unnatural. Furthermore the focus of the screen reader stayed on the submit button, so when a new word was loaded the blind user was lost, and did not notice that a new word was on the screen. The screen reader did not recognize it either, and did not read the new word out loud. Thirdly it was hard for the blindfolded user to add special characters like those with an accent grave in the text input field.

If it came to giving instructions, we observed that the Wizard-of-Oz teacher really tried to use the knowledge that the student already had. She gave instructions by raising issues and asking participants questions. For example, “Do you recognize this word?", “How would you spell this word?". The teacher helped the blindfolded person step by step through the application and gave small additional feedback if he got stuck. When the user got stuck on how to spell a word, the teacher would explain to him what part of the word was already correct and gave him a hint where he had to adjust the word.

A limitation of this test was, that the use of the screen reader and the additional help from the teacher felt like information overload by the participants. We therefore advise to give the teacher a more elaborate training upfront.

Taking all this together the points of attention for the next iteration were:

- What the process of going from one word to the next word should look like. Where should the focus be on a new screen and how does the user know when a new item is loaded?
- Should we keep the use of the article for a noun as we do now?

7.Ideation and specification II

In this sprint we looked further into what the instructions should exactly be, what type of feedback should be given, and what type of help the user should get. We knew from our former test that asking questions can be a way of giving instructions, and that explaining what is already correct, and what should be improved, can also be a form of feedback. We investigated what the literature said about this topic, and had a brainstorm session with somebody from Instructional Design Department. The definitions of an instructional designer, is explained here down below.

7.1 Microcopy

An important concept here is microcopy. This is the area within Human Computer Interaction that focuses on the text that is communicated within a prototype. We have being doing some research about microcopy and accessibility. We found specific article from Yifrah. Yifrah came up with 7 guidelines according to microscopy and accessibility:

- Think from top-down and left to right: make sure that the microcopy comes before the action.
- Be witty, but not at the expense of the essential message: textual jokes and clear communication should be in balance.
- Make a written alternative to every icon and every image: make sure that if the image is relevant for the understanding of the page that it has a clear alternative description.
- Be more descriptive than ‘read more’ for links and buttons: make sure that the links are informative so that the user knows what they can expect by pressing the link or button.
- All microcopy should appear as live text not as an image: text in an image should be be avoided, because it is something the screen reader can not recognize. However if it is unavoidable, make sure a good alternative is offered.
- The microcopy should be readable. Permanent text should be in high contrast. All the instructions, hints and notes regarding filling a form or taking any action should always be available. For example placeholders should have a high contrast and should not disappear when the field comes into focus.
- Simple is best: try to keep the writing style simple so that everyone is able to understand it.

The use of microcopy in our design has the most affect on a few aspects:

- The instructions
- The input labels
- Buttons
- The way we offer help
- Feedback messages

We furthermore held a brainstorm session with a designer from the department Instructional Design. Instructional Design tries to not only design the textual experience, but to create an educational experience. What should the visuals look like to instruct the user in an intuitive and visual way? People working in this area should have a strong didactical background and know a lot about how people learn. They try to keep the instructions as short as possible so that the instructions also fit on a mobile screen. They gave information about what type of feedback is used within the product and what type of help can be given to the user. These were the same categories we already had within the current prototype. For feedback we only used three ways of judging an answer:

- The answer is right
- The answer is totally wrong
- The answer is almost right, but you made a typo.

Furthermore the type of help that is offered, that could be relevant for the Vocabulary Write Trainer are the following according to Instructional Design:

- If the user clicks the help button the first letter of the translation could appear;
- The user hears the sounds of how to pronounce the word again;
- The buttons that show the jumbled letters;
- The user gets multiple choice options instead of having to type the answer themselves.

7.1.1 Short Instruction before the action

For our design we will tried to put the instructions before the actions. Yifrah describes the accessible order for an input field as: <Label><instruction/hint><field> (Yifrah, 2017). In the former design we had the following setup (see figure 27).

- Label/instructions: type the letters here and hit enter
- Hint: article (before the noun),
- Field: input field with your answer

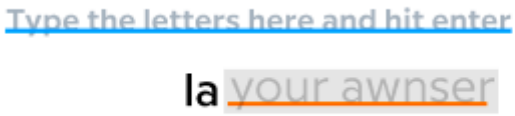

Figure 27: the input field with new instructions

Based on this article, we came to the conclusion that the main instructions should come before the exercise. Not only should instructions come before the actions, they should also be short, and should fit on a mobile device.

7.1.2 Feedback, error messages and motivation

According to Yifrah the messages should be clear and straight to the point, especially when they are confirmation and error messages (Yifrah, 2017). We decided that error messages should be especially clear. We also tried to make the messages motivating. According the instructional designer it is important to give the feedback in such a way that the user does not get discouraged. Furthermore we made use of distinct messages for the three cases mentioned by instructional design:

- A message if the user has the correct answer
- A message if the user did not have the right answer
- A message if the user almost did right but made a typo, preferably the message contains a hint on where it went wrong.

We noticed that not only the writing style has an influence on the motivation, but also the way the user has to continue after something went wrong. We had to choose between letting the user do the exercise over and over until he gets it right, or to let the user choose between improving the answer or skipping it. We decided that the user can

not continue until he gets the answer right, however when the answer is almost correct, the user can skip to the next item.

7.1.3 Description for images

Another design decision that we made is whether the image is focusable or not. If the image is focusable, then a good alt-text should be provided. According to Yifrah (Yifrah, 2017), the alt-text should not be nicely written but clear and equivocal. However since we tried to stick to a bare minimum, the question is if it is really needed. The image is another element on the screen that the user has to process. We therefore decided to make the image not navigable by the keyboard.

7.2 New user stories for iteration 2

The second iteration led to a new user stories concerned with the problem how feedback should be given to the end user. These help to specify better how instructions could be given and to improve the acceptance criteria. We added the following user stories and acceptance criteria.

10	As a blind user I want to have also non visual feedback, such that I know if I wrote the answer wrong or right
a	The system must offer the feedback on an alternative way then only visual, that is accessible for blind people
b	The system must express if the answer is wrong
c	The system must express if the answer is right
d	The system must express if the answer is almost correct
e	The messages within the feedback should be clear and equivocal
f	The messages within the feedback should not be demotivating
g	The feedback should appear on the screen in such a way that keyboard focus shifts in the correct accessible order.
h	The feedback is supported by an alternative sound to give an indication that the answer is wrong or right.

3	As a blind user I want to understand first the explanation of the instruction, before I go to the exercise, such that I have a better understanding what is expected of me.
g	The instruction can be done in questioning way
H	The instruction must describe what kind of actions the user can expect next e.g a new item is loaded

Table 4 New User Stories

8. Realization II

For the final design we made some design choices based on the previous research. First of all the article in front a noun in the input field got removed, because we felt that filling in the article and the word would be more intuitive. Secondly the action to be taken would then directly come after the instruction above the input field. This change made it necessary to add an extra notification, when the user forgets to add the article.

Secondly, we chose to add the sound of how a word gets pronounced in Spanish as additional help, because we know from former user research that blind people are auditorial very strong. The image became an audible button. Thirdly, the main instruction was formulated as a question. Fourthly, the unjumbled letters were changed into ‘help me’ button. If the ‘help me’ button is pressed a hint was shown what letters the answer contained in a jumbled order. This replaces the functionality of the former button letters (see chapter Realization I).

Furthermore we implemented a structure for giving feedback and going to the next page. First of all the almost correct case got an extra feedback option, namely what was spelled correctly. If the answer is correct the user has to actively press ‘next’ to load the new word. If the answer is wrong the user first had to click try again before he is able to improve his answer. With this design the user should be more aware of what type of action he is taking. If the feedback popped up, the input field was temporary disabled so that is was not possible to have several actions at the same time.

In this chapter the final prototype will described and how it was built.

8.1 Flow of the final design

In this section we describe how we expect the final design could be used by the persona Kyra. We elaborately describe the flow from her perspective. Please note that this section goes into great detail. The purpose of this exercise, is to develop and document detailed requirements in a user context. It is in fact a cognitive walk trough of the interface, to eliminate mistakes in the navigational structure.

8.1.1 Exploring and making my first submit

As a blind user I want to first navigate through the whole interface. To do this the action that I take is to explore the webpage. I can do this in two ways. I can use the short links above the header menu, or I can scan through the web page.

If I go through the short links, I expect three links:

- The link to score and progress panel,
- The link to navigation, and
- The link to main content.

I expect to hear the screen reader tell me that I am currently on link, and give me instructions on how to interact with this link. I also expect that these links are descriptive enough to tell me where they will take me. I also expect the screen reader to tell me I am currently on a link. Pressing one of these links will immediately bring to the specified part of the webpage.

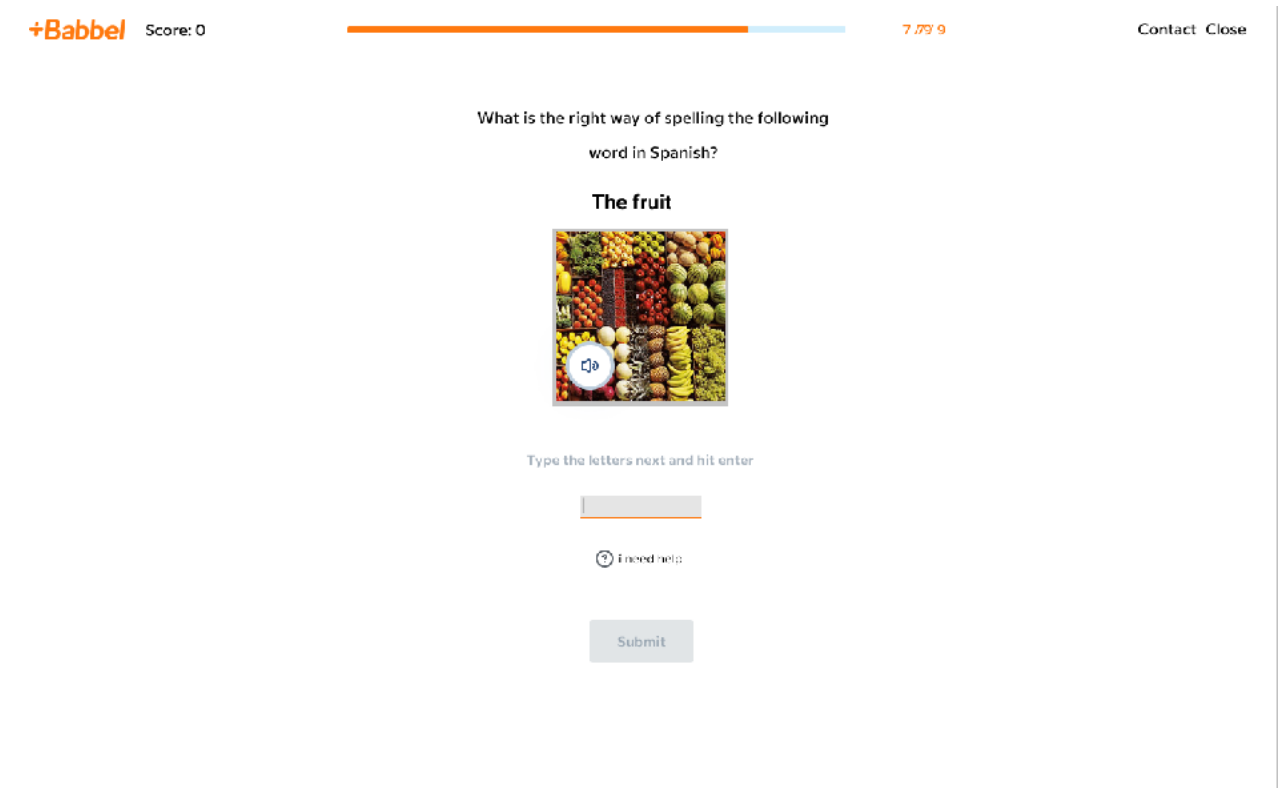

Figure 28: the final design

If I want to scan a page I do the following. I first navigate with my Voice Over (VO) arrow keys through the webpage. The first interaction I is with the banner where I expect navigational and other info. The screen reader will tell me I am currently on a banner and how to interact with this banner.

I expect to first find the home logo. There I expect that my screen reader will recognize it is an image and give me a description of it. After, I usually navigate further to a group that is described as the ‘score and progress panel’. My screen reader tells me how I can interact with this group.I can go into this group to find my score and my progress! Here I will find two items, sorted by a list. After this I navigate further’ and I find the navigation menu. The screen reader tells me that I can go within the navigation menu, and find a list of two items. Within the navigation I find two links: ‘about’ and ‘contact’. If I navigate further, my screen reader tells me, I am at the end of the navigation. After that I hear my screen reader telling me I’m at the end of the banner.

After I have checked the navigation bar I expect to find an instruction on what to do. I expect it to tel me what I have to do in which language. My screen reader will tell me when I am currently on a heading. The heading contains the following text which is also an instruction:

"What is the right way of spelling the following word in Spanish?" .

The screen reader tells me I am currently on the main menu. I enter the main menu and I find again the first header. This tells me the instructions again and the screen reader tells me I am currently on a text element.

After that I navigate further and my text reader reads out the word in English. My screen reader tells me I am currently on a text element.

After this i navigate further and I find a button. My screen reader tells me it's an audio button. I click ‘*...’ to hear the audio and put on my screen reader. I understand that I am hearing the audio as the English translation. Then I navigate further and hear the following instruction:

"Type here the word and press enter or submit”

I expect if I go further and can immediately fill in the answer including the article. Here I type the whole word, for example in the case of the fruit, I will type: ‘la fruta’. I navigate further and I hear: “your answer”. My screen reader tells me that I am currently on a text field and that if I want to interact with it and that I should start typing. I type my answer and hear from my screen reader the letters I type in. After this I expect to find the submit button. However I find a button "I need help". For now I don't need help. I find the submit button and hear what keys to use to press the submit button. After the submit button I expect that I can immediately start typing again. Therefore I want the focus of my screen reader to go back to the input field.

8.1.2 Feedback and help

I expect now to get immediate feedback if my answer is correct or not. If my answer is not correct I know exactly what I did wrong, and if I am right, I want to go to the next word. If I am wrong I want to hear that I am wrong on every attempt, by having the screen reader reading the following text:

"Not correct, but you are getting there, maybe check our help button for a hint”

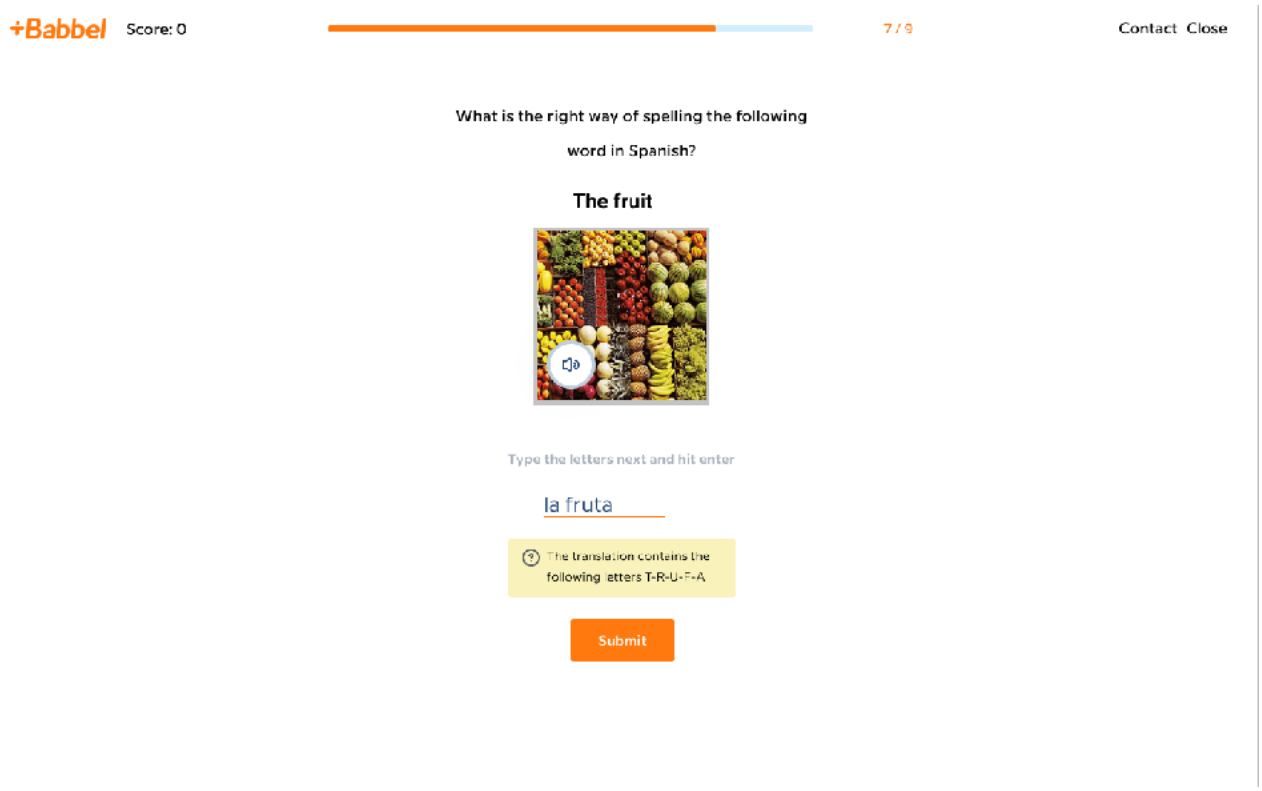

Figure 29: Kyra filling in La Fruta

I hear from the screen reader, you are currently on a button. The button is labeled ‘try again’. I expect that I can immediately try to answer the question again the moment I press this button. My focus is on the input field, I hear the voice over telling me that I am on an input field. If I am totally wrong, I want to get a tip. Because I am on the input field I navigate to the help button and I hear the following message:

"The translation contains the following letters T-R-U-F-A"(Or any word)

If I am almost correct, I will hear what part of the word I have corrected and what I have to improve. I hear the following message:

“You almost had it. Try again or skip to the next item.”

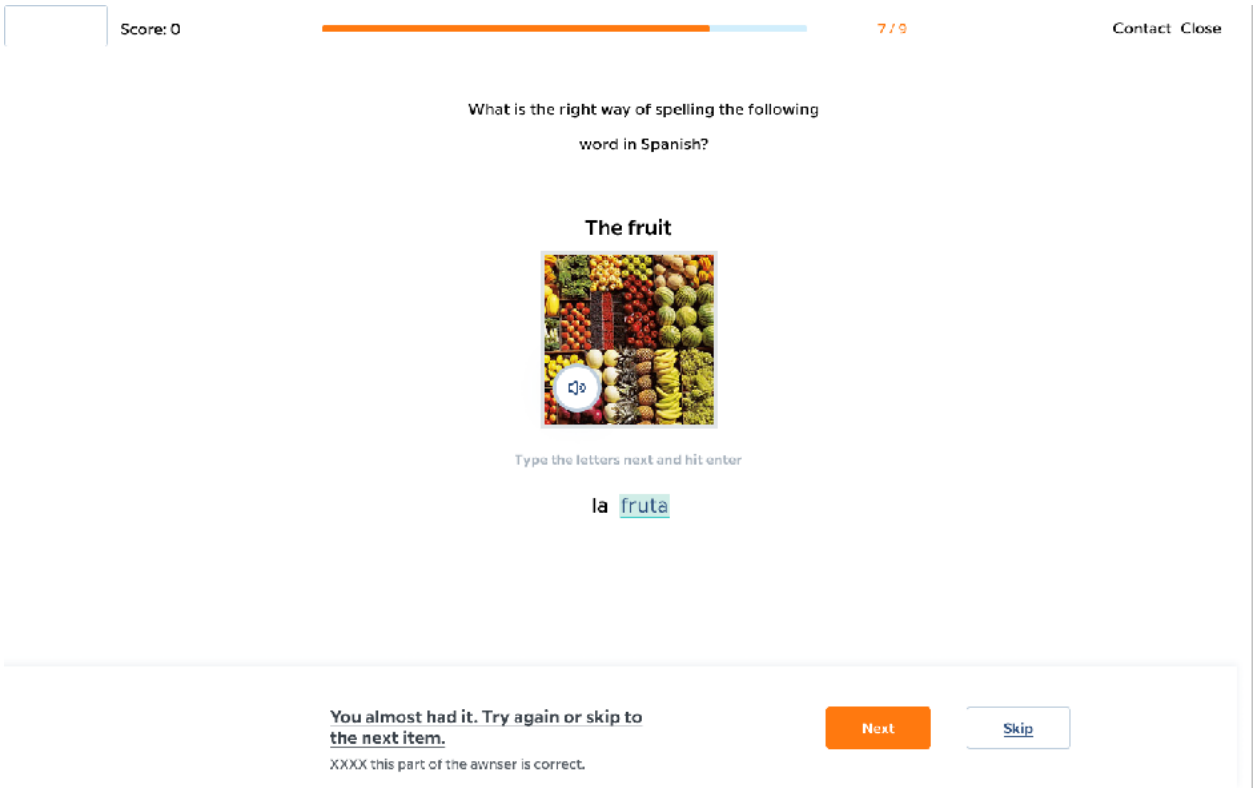

Figure 30: Kyra getting feedback on her answer

My screen reader tells me that I am now on a button called ‘try again’. If I press the button ‘try again’ I expect it will bring me back to the input field. If I tab further, my screen reader tells me that I found a button called skip. If I press the button skip, I expect it will bring me to the next item. If I go to the next item I expect that my screen reader will tell me the new word I have to translate.

If I am correct, I hear the following message: “Correct. Great work, please press next.”

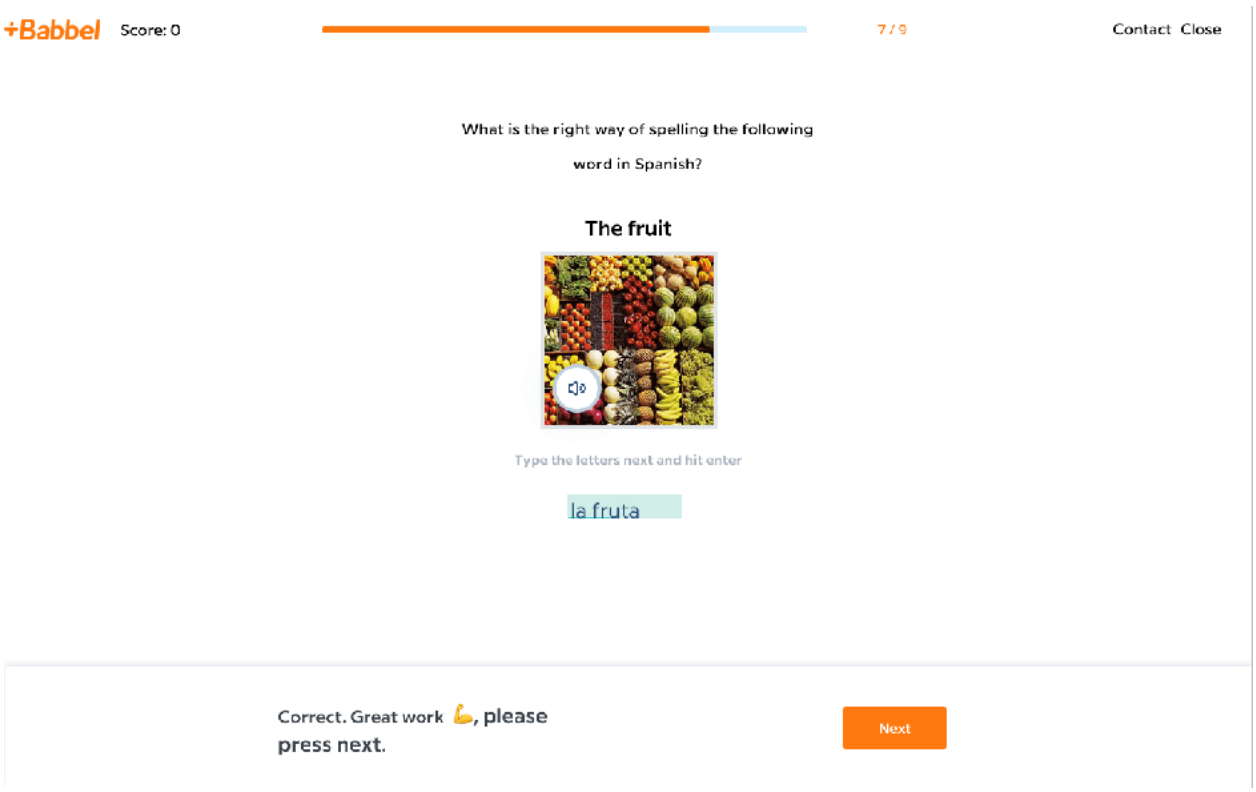

Figure 31: Kyra has the answer correct and gets feedback on that

My screen reader tells me I am currently on a button, called ‘next’. I expect that if I press the button ‘next’ it will bring me to the new English word. Every time I submit an answer I would like to get feedback. And If I am done with my set, I like to know that a new type of exercise is going to be started.

For a visual representation of the feedback see activity diagram down below:

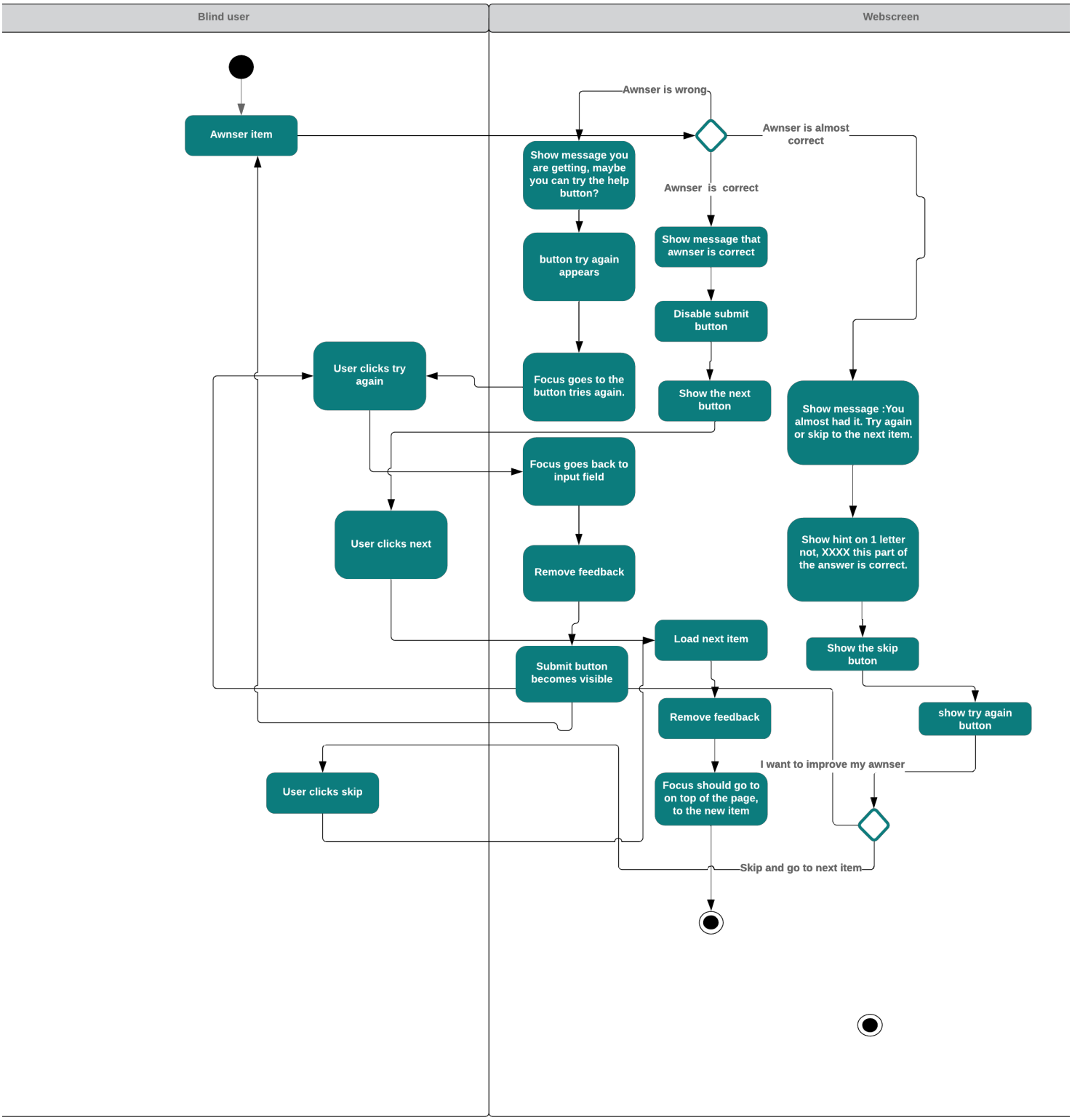

Figure 32: activity diagram for the feedback

8.2 Programming patterns

We built a high fidelity prototype corresponding to the design describe in the chapter above (7.1 & 7.2). The prototype came close in styling to the design above, however not everything was exactly the same.

8.2.1 Aesthetics

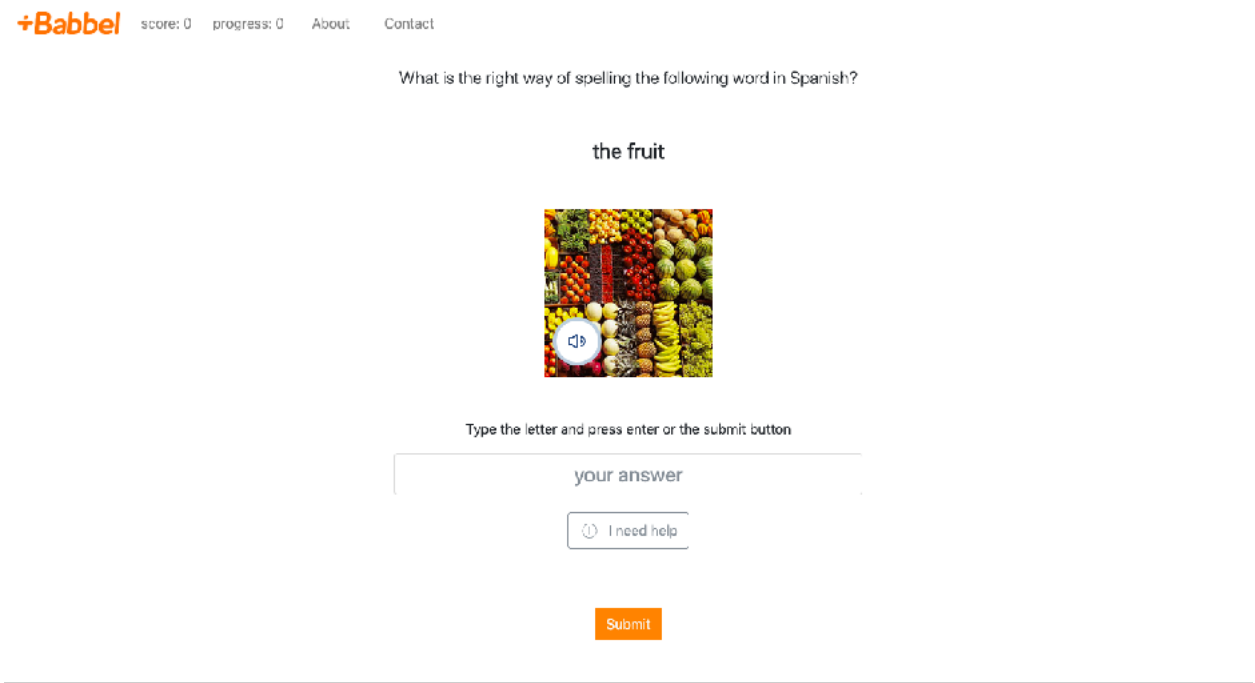

Figure 33: Aesthetics the final design

In this section we will show where the final prototype is different from the ideal design. Down below we show an image of the final prototype (see figure 33).

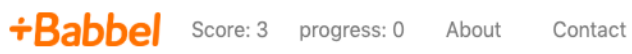

Figure 34: Score and Progress

The progress bar was not implemented, but the most important info was there. Namely the progress would be updated under the text progress (see figure 34 for the word progress). The reason for this is that the aesthetics had no priority. The functionality was the most important.

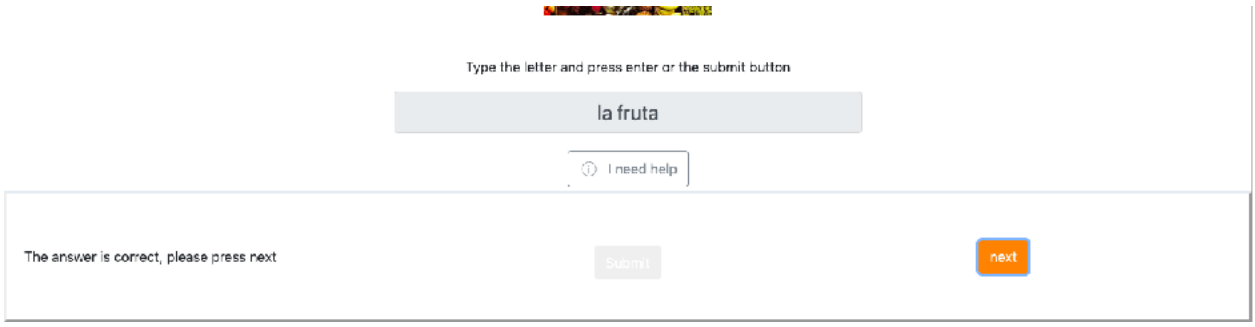

Figure 35: Correct Answer

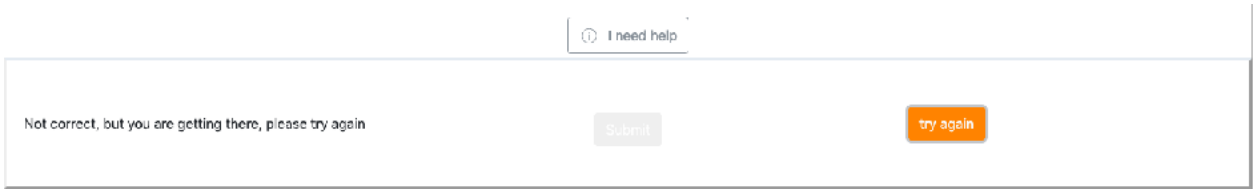

Figure 36: Not Correct

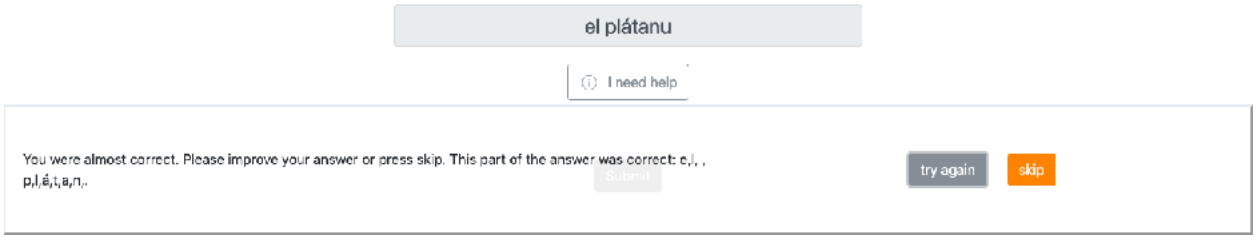

Figure 37: Almost Correct

The feedback overlay does not look exactly the same, the typography was different (see figure 35,36 and 37). Also the positioning for the help button is not exactly the same and should have been placed a bit lower. In the future the aesthetics can be improved.

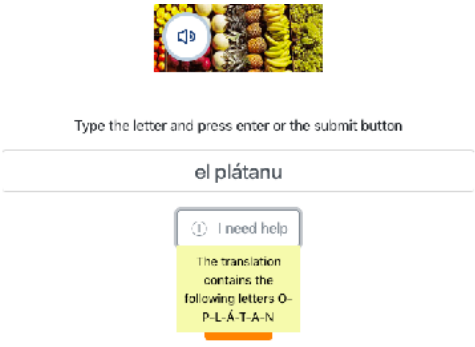

Figure 38: Translation contains PATAN

8.2.2 Coding patterns

In this section we will describe the most important patterns used. We will describe the coding languages used and what frameworks. Furthermore, to ensuring that the page was accessible we tried to use coding structures that claimed to be accessible.

Information sources

When we started with the development of this prototype, we did had not have much knowledge of Javascript and patterns that were accessible for screen readers. We user the site, www.treehouse.com, where we followed the course Front End Development. They had a whole track of how to develop, websites and explained how to build accessible ones. Furthermore we followed a youtube channel from Web Chrome Developers called A11yCast(https://www.youtube.com/results?search_query=a11ycasts). 'A11' is short for Accessibility. This youtube channel was specialized in coding for accessibility. Further we studied a book for accessible patterns called Inclusive Components and written by Heydon Pickering (Pickering, 2018).

Language and frameworks

For the development of the prototype we used HTML and Javascript. HTML is the standard markup language for websites and is mostly used by screen readers to skim the page (W3Schools, 2019). Javascript is a language to change content on web pages dynamically and we mostly used to update things on the screen (W3Schools, 2019). To further style the website we used a small amount of CSS and Bootstrap. CSS stands for Cascading Style Sheets and is used to style websites (W3Schools,2019). Bootstrap is a framework that has a lot of standard components, pre-made, that are based on CSS and Javascript (W3Schools, 2019). Furthermore we used ARIA which stands for Accessible Rich Internet Applications. We used it especially to enrich the normal HTML structure for the screen reader (Millis, 2019). The reason why we choose to use these languages is, because these are the languages that are normally used to develop the Babbel product. The combination of accessibility and javascript can be problematic. It is difficult to get a good understanding where it can go wrong and what could be potential solutions. Nevertheless, within this project we decided to go with this set of tools, especially to develop expertise in this area.

Structure of the page

For the programming of the prototype, we tried to program it as much as possible according to the order of our visual design (see figure 39). So, first the navigation, and then the main content. This is important for the focus on the screen (Yifrah, 2017 ; WCAG 2.1, n.d.). The visual order can be changed, by the use of css, however having the html programmed in the right way can may prevent quite a few unnecessary focus jumps of screen readers. Furthermore, we tried to use as much as semantic HTML as possible, which helps the screen reader to recognize the structure of the webpage.

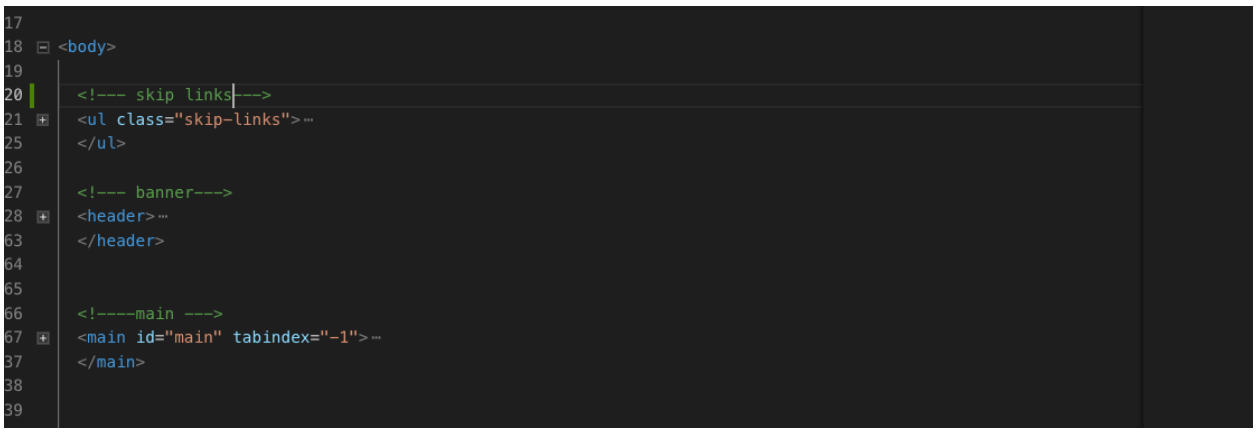

Figure 39: Code Structure of the Page

Aria label, aria-live and aria-hidden

Some constructs needed some extra ARIA. For example, the score and progress panel is within the header, but is not part of the navigation menu. Therefore we enriched this part with an aria-label, namely “score and progress panel". Furthermore we used an aria-live region to make sure that whenever the score is updated the screen reader would notify the user that the score is updated in a polite way. Now, whenever the score or progress is updated the user will be notified (see figure 40. Basically, we used aria-live for every region that had to be updated the moment the screen got refreshed.

Figure 40: Code ARIA Refresh

Another place where we inserted ARIA was the place where the word is updated (see figure 41). We also use ARIA labels used for the audio button, the input field and the toggle mechanism.

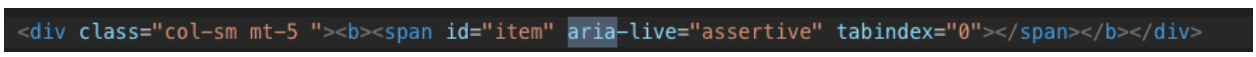

Figure 41: Aria Live

A specific technique we used from ARIA is the hidden-true label. This makes sure that the screen reader will not recognize some components. We used this technique when we wanted to make the progress bar non-selectable. In the case below, we used this technique to hide buttons. Within the feedback overlay the buttons ‘next’ and ‘try again’ were hidden if necessary (see figure 42).

```
<div id="overlay" class="feedback-sheet">
  <div class="feedback-sheet-wrapper">
    <div class="feedback-sheet-text">
      <div id="alert" role="alert"></div>
      <div id="tip" role="alert"></div>
    </div>
    <div class="feedback-sheet-buttons">
      <div id="tryAgainButton" aria-hidden="true"></div>
      <div id="skipButton" aria-hidden="true"></div>
    </div>
  </div>
</div>
```

Figure 42: Code Try Again

Image buttons

We chose to use an image button to implement the audio button. This means that we used an image as a button, by putting the image tag in between <button></button> tags in the program code. According to W3C you can use this technique, as long you add a good alt text of the image (W3C web accessibility initiative, n.d.)

```
<div class="row">
  <button id="newFocus" aria-label="audio for pronounciation in Spanish" onclick="playSound()"
    class="image-button col-sm mt-5"><img src="audio.png" alt="audio-button"></button>
</div>
```

Figure 43: Image Buttons

There was discussion with an engineer and us if it was better to use an <input> tag instead. However we were not sure if the input element would then have the same behavior as a normal button. However, the input element does not seems to have the property to include an image as we did here (Wood,2017). We assumed that, to get the same result, we should have styled the button with css, which can be time consuming. Because this was a prototype, we decided to use this quicker method. However, in the future, using an input value can be definitely be considered.

Help button

For the help button we used a technique according to the inclusive toggle tip described in the book for inclusive components written by Pickering (Pickering, 2018):

He describes the toggle tip as the follows: ”Toggle Tips are like tooltips in the sense that they can provide supplementary or clarifying information. However, they differ by making the control itself supplementary. Toggle tips exist to reveal information balloons, and serve no other purpose."

This fits our help button well, because we designed it as a balloon. The reason that this was inclusive was, because the balloon would disappear the moment the focus would go to another element. (For the implementation code please check the following link: https://codepen.io/heydon/pen/zdYdQv).

Feedback

For the feedback, we used a notification technique we learned from the YouTube channel by AllyCast. They use an HTML <template></template> tags (see figure 44). These are tags that are not rendered by the browser, unless they are included somewhere else in the program, that is visualized in the browser. They are only shown if there is new information, such as by an alert, or feedback if the answer is wrong or right. This technique is well recognized by the screen reader, when new data appears on the screen. The difference with the help button, is that this info should stay on the screen as long as necessary (Google Chrome Developers, 2016).

```
<!---- templates for notifications-->
<template id="feedback-tmpl">
  <div class="feedback">sfsgs</div>
</template>

<!---- templates for notifications-->
<template id="hint-tmpl">
  <div class="hint">sfsgs</div>
</template>
</div>
</main>
```

Figure 44: Code Feedback

Button created with Javascript

The buttons that pop up on the screen when feedback is given, such as (see figure 36,37 and 39),the ‘next’ and ‘try again’ buttons, were added in the HTML structure using Javascript. This method has one disadvantage, that it does not receive focus automatically like with HTML components. Therefore we had to do this manually with the focus() method (W3Schools, 2019).

8.2.3 Conclusions of final design sprint

We used several techniques from different sources, and learned by doing. The testing showed that these techniques work for the way we envisioned them. Sometimes we had to use complex structures e.g. with the alerts and toggle buttons, to accomplish the same result without keeping the blind user in mind, AllyCast admits that the solutions for the alerts are a “work around” (Google Chrome developer, 2016). On the end of the development, it became clear that maybe a library of standard components could have been easier than trying to implement them ourselves. However, this gave us maximum freedom, on how we wanted to create the prototype. We learned from this experience where the problems exists with dynamic web pages and accessibility. In our prototype they were the following. First of all, alerts and pop-ups are not always recognized by the screen reader. Secondly, specialized buttons added by javascript instead of HTML are also tricky. These are the challenges that designers and developers have to deal with on a daily basis.

Now that we have collected a good list of resources and have a better understanding what it means to “program” accessible code, we can provide to the point information to

Babbel. For example, we can create a confluence, where we collect all these websites and things to keep in mind while programming.

9. Evaluation II

For this final test we would like to see if this design is more accessible, according to the old design. According to our literature research we found that using automatic testing tools can be good to use additional to manually testing, see chapter testing and standardization of accessible E-books. According to the google developers web page about checking website on accessibility, it would be good to first let your website check with application like Axe and Wave before manual testing. Therefore we first tested our most recent application via Axe and Wave (Dodson, 2019). However we found another accessibility feature within the google Chrome Development Kit.

9.1 Google chrome development kit

We found a tool within the google chrome developer kit another automatic test, that tested within the browser on accessibility. This can be found in the inspect menu under the audits menu in the google chrome developers kit. We ran the test and we found out that we our code passed with 94% of accessibility (see figure 45).

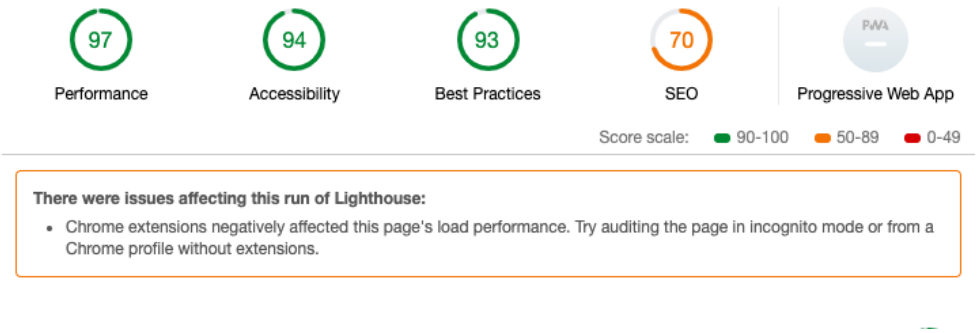

Figure 45: Choose Dev Kit

However this test point out the following point to check manually:

The page has a logical tab order

Interactive controls are keyboard focusable

Interactive elements indicate their purpose and state

The user's focus is directed to new content added to the page

User-focus is not accidentally trapped in a region

Custom controls have associated labels

Custom controls have aria roles

Visual orders on the page follows the Dom order

Offscreen content is hidden from assistive technology

Headings do not skip levels

HTML 5 landmarks are used to improved navigation

9.2 Axe

Axe is described as accessibility checker for WCAG 2 and the section 508 accessibility. It finds accessibility defect via the google chrome extension (Axe, 2019) . According to Axe there are two severe issues, concerning to color contrast(see figure 46), especially for the buttons like Submit and I need help.

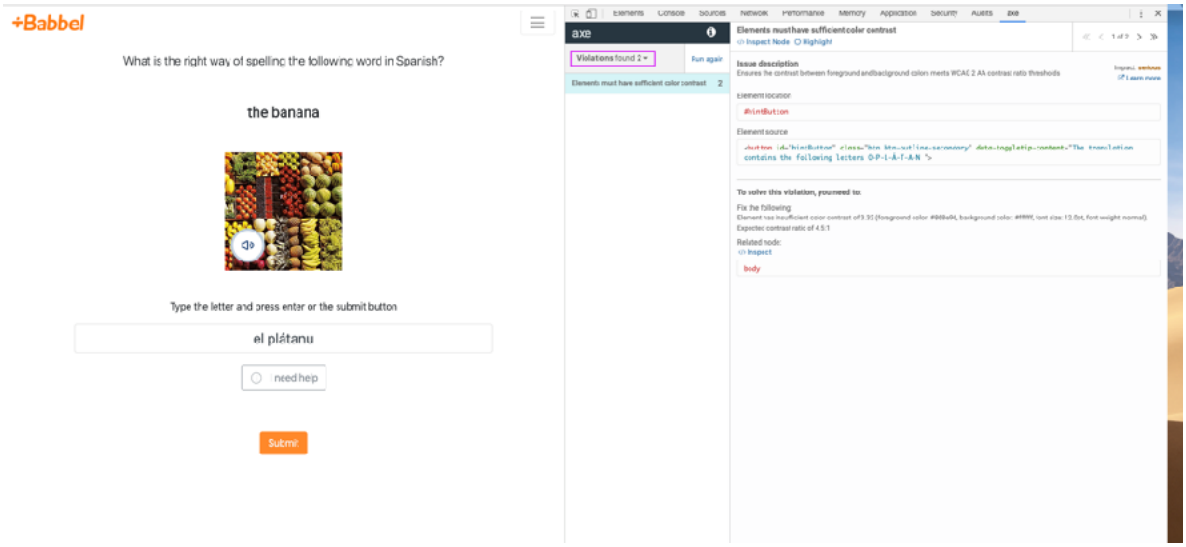

Figure 46: AXE

9.3 WAVE

WAVE is a web accessibility evaluation tool, developed by WebAim.org. It gives visual feedback about the accessibility of web content. However they claim that automated tests can not replace manual testing, but can be a support (WAVE, 2019). According to wave there are specifically two issues, which are called empty button, which were the next and try again buttons. However we expected that these buttons will updated the moment that the page was loaded, since this HTML would be generated with Javascript and therefore probably the issue will be resolved. It looked like WAVE only analysed the page statical and not the moment the exercise was used. Important to note here is that this is related to our user story 1, in chapter 4.6.

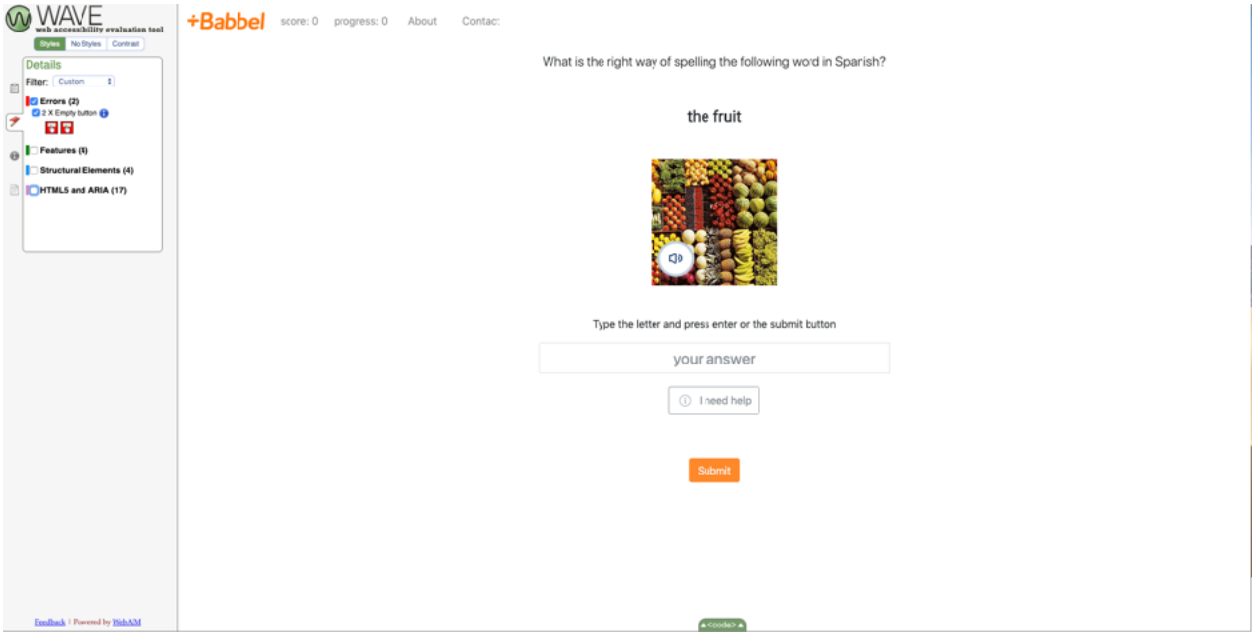

Figure 47: WAVE

9.4 Manual testing

The manual test will be comparable with the pilot test (see chapter 4.2.5 until 4.2.9). However the vocabulary write trainer will be replaced by our trainer and after this trainer we will stop. The order on how we tested the trainers:

Vocabulary show (same version as before)

Vocabulary click (same version as before)

Vocabulary write (new prototype)

We tested on the same user as we tested with during our pilot test, so that we clearly could see the differences between the design before the redesign and the design after. Out of our former testing came that we check some points manually(9.1).

9.4.1. (Skip) links

The links and skip link within the application were experienced as well done. They were clear, and the blind user used them to navigate to the main content. In combination with the instruction, we also noticed that the blind user knew better now what type of button to expect. These are referred to in WCAG 2.1, as 2.4.1 Bypass blocks. Within this thesis this is related to the user story 5, in chapter 4.6

9.4.2 Instructions

The instructions were well received by the test subject and seen as an improvement. It was very clear what had to be done and from which language to which language there had to be translated from English to Spanish. The instructions around the input field were understood by the end user as well and the interaction of the input field gave no problems. These instructions can be referred to in the WCAG 2.1 standards as 2.4.2 Page Titled. The instruction now better identified what the webpage was about and what to be expected. We implemented user story 3 successful (see chapter 5.2).

9.4.3 Buttons

The end user found the *submit button*, *help button* and *audio* very quickly via the tab order. Also described in the WCAG 2.1 as 2.4.3 focus order. We were especially surprised that the *audio button*, that if triggered play two seconds of audio of how the word should be pronounced in Spanish, did not interfere with screen readers voice. The interaction between the two audio seemed natural. We expected the screen reader would talk through the sound of the Spanish word. We think the reason why during our testing internally this caused problems and that it now was not the case, is that the speed of the screen reader here was way higher than we had. Blind users are exceptionally trained in listening to the screen reader and work way faster than we do, as just starting screen reader users. Therefore no problems were experienced; the screen reader did not interfere with the audio of the button. Also, the technique used here for making these buttons was a success. The blind user knew what he had to do with the button and what it had to be used for. However, the *button next* and *try again* within the feedback overlay name, see figure(include a picture where you see the overlay), were hard to be found by the screen reader.Being able to recognise the purpose of the button is described by the WCAG 2.1 as guideline 4.1.2 role, name and value. In some cases, this requirements met(*submit button*) and in some cases not (next and try again).

The focus shifted to the newly added button; however, the screen reader did not read the naming of the button out loud. The response of the end user was to start tabbing through the menu structure and mostly ended behind the feedback overlay, on the *submit button* (which was that point disabled). This created a some sort of trap. This issue is described by WCAG 2.1 as 2.1.2 No Keyboard Trap. Therefore user story 1 has failed (see chapter 5.2). This issue was already predicted by WAVE, which was indicating the button without purpose. Changing this buttons, should be next point of attention.

We think that the submit, help, and the *audio button* was recognized by the screen reader and not the next and try again, is because we implemented the first set of buttons with plain HTML. The buttons *next* and *try again* were added via Javascript. Another solution of how to add them on and off the screen dynamical and be recognized by the screen reader we have to further research.

9.4.4 Special characters

The end user had problems with entering special signs on the keyboard and needed help with entering those. With a special sign, we mean e.g., accent grave. This problem came up mostly by the word el plátano. A potential solution for this could be an additional tooltip at the beginning of the lesson that explains how to enter special signs with the keyboard. Further specific feedback that a special sign is forgotten could be given. At this moment we only give feedback if you forget the article and give a tip when you had it almost correct. Further this really depends on the skills of the user and type of device the user uses.

9.4.5 Submitting process

The instruction above the label seemed to help to make clear how to enter and how to submit the answer. The *submit button* was mostly used by the end user instead of hitting enter. After making a mistake, the end users' first reaction was to go back to the input

field and not use the *try again button*. In the current design, the input field was disabled, until he clicked the *try again button* and then the input field could be edited again. However, this was experienced as annoying by the end user. We might consider not to disable the input field, and remove the try again mechanism. This issue is a usability problem and we found it hard to relate this issue to the WCAG 2.1 standard.

9.4.6 Focus order

Adding elements within the tabbing structure that are not interactive is seen as bad practice (Google Chrome Developers, 2016), but we felt that in this case, it might be beneficial. The end user does not have to navigate from the navigation menu to go the next word now. It seemed that the automated focus on the new word did not cause any problems. Furthermore, the end user remarked that the navigation structure was also experienced as well done. This is related to user story 6 (see chapter 5.2). With implementing the focus order as we did and adjusting the structure of the page, navigating over the screen including the instruction became easier.

9.4.7 Feedback

The programming technique we used for the feedback was always recognized by the screen reader. This technique is described by the WCAG 2.1 standard as 4.1.2 status message. However, the tips that were integrated within the feedback were not clear at all. For example, if you almost spelled el plátano correct for example the end user answered plátuno. The following hint would appear: "You were almost correct. Please improve your answer or press skip. This part of the answer was correct: e,l, p,l,á,t. " By implementing this feature, we also implemented user story 11 (chapter 7.2) almost correct. We had no time anymore to add sounds to the feedback.

The commas were added to separate the letters clearly and make the screen reader spell it out. However this was experienced by the end user as confusing, and there was advised to give a complete overview of the word, and replace the letter that was wrongly typed by a dot. In the example, as mentioned above, that would mean the feedback would become the following:

"You were almost correct. Please improve your answer or press skip. This part of the answer was correct: el plát.no "

Furthermore, he would have liked to have always feedback, instead of only when you have it almost correct. However, he also doubted if this was the ideal way of learning. Also, as earlier mentioned, he would like to have feedback if he forgot special signs.

9.4.8 Help me button text field

The text that was triggered by the toggle button was sometimes spoken by the screen reader and sometimes not. This issue is described by the WCAG 2.1 standard as 4.1.2 status message. We noticed that the braille display was not able to recognize the text anymore after 15 seconds or so. The hint was gone, and the end user was not done with reading the tip. Maybe because the focus would shift from the button, the moment another element got selected. Another technique must be used here, to make sure that the braille keyboard is still able to access it. Intuitively this issue is also related to WCAG 2.1 standard, however the specific guideline we had trouble to determine.

Furthermore, the end user noted that the hint became a bit hard to understand at the moment the word became way longer e.g., the word la zanahoria. Maybe with the adjustment of the what is not correctly spelled, described before, this problem might be resolved.

9.5 Conclusion of evaluation

All in all, we did not do a bad job, but there is definitely room for improvement. The color contrast can be improved, the recognition of the *try again* and *next button*, and the interaction with input field after making a mistake. Some of the guidelines we failed e.g 4.1.2 and 2.1.2, we do not meet the A or the AA levels. These are the levels of accessibility within the WCAG 2.1 standards. Normally AA levels is desired by companies (Gumienny,2018). Based on our current prototype, we would not make this level, however only small changes are needed to achieve full compliance.

10. Conclusions

This thesis project was conducted in cooperation with Lesson Nine (Babbel), the Universidad Politécnica Madrid (Spain) and the University of Twente (Netherlands). Babbel is a company that currently offers online language courses in 14 different languages. The courses develop the reading, writing, listening, and speaking skills. Professional linguists, educators, and authors produce high-quality content for the courses (Support Babbel, n.d.).

In general we conclude that the project has provided initial evidence that accessibility is a driver for usability that can benefit both blind and sighted users. Making Babbels' products more accessible will help reduce the shortage of accessible language learning materials for people who are blind. Our literature review confirmed this shortage and that it made sense to work on accessibility at Babbel.

The goal of this project was to help Babbel make their products available to a broader audience, including the blind, through the use of accessible design methods. We asked ourselves two research questions:

1) What does an exercise for learning a new language within the Babbel platform look like for somebody that is blind?

2) What are the technical implications and opportunities for developing an interface for a language exercise with the Babbel platform for somebody that is blind?

To answer the questions we needed a good process. A design process may be considered to support accessibility well, when it keeps a broader audience in mind and makes use good use of the Web Content Accessibility Guidelines 2.1 (WCAG 2.1).To design and structure this thesis, we used two main frameworks, the Creative Technology Framework (CTF) and the the Microsoft Inclusive Design Framework (MIDF). We were familiar with CTF and knew that its in a creative and technical project like this, and we conclude that its phased structure did serve us well.

MIDF was a valuable addition because it focuses specifically on designing for people with a disability and is up to date on this. Making use of its Persona Network and Persona Spectrum techniques proved to be very useful in the development of specific requirements on the product for blind people. Moreover, if we meet these special needs, we may also meet those of people with other disabilities, such as the visually impaired.

During our research we also tried to involve blind participants as much as possible to understand their needs well. We spent much time to build trust, and asked for their permission to use their data, and feedback on the results, during all stages of the project. Working with them was of value to fine-tune our requirements and the prototype.

10.1 User stories and requirements

The first research question was all about envisioning what what a potential exercise for a blind user might look like. Developing for a persona, that we named Kyra, greatly helped us to develop our ideas. Kyra is blind, and is very interested in learning languages. She is even studying to become a profession translator.

In our user stories Kyra is very dependent on the use of language since speech is her primary way to connect to other people and the world. Although she thinks that learning to speak is very important, she also needs to be able to write. Therefore she makes use of the Vocabulary Write exercise of Babbel to practice her writing skills. Preferably she

would like to be able to do this Vocabulary Write exercise independently, without the help of others. With her disability she has become very good in using technology. She makes elaborate use of assistive technologies to be able to read, write, and browse on her phone and computer. The assistive products she uses most is a braille display and the screen reader. She uses these tools to translate the visual experience into an audio and tactile one. For example, the screen reader translates text into audio, and the braille display translates text into a pattern she can feel.

The first requirement that became clear to us is any Babbel exercise that can only be used well by a blind person independently, if it provides a clear preliminary instruction about its intent and use. This goes for all types of exercises. The instruction must describe what type of exercise it is, from what language to what language a translation has to be made and how exactly to interact with the interface.

A second main requirement we found out is that all the exercises should upgrade their navigation with methods such that superfluous scanning on a screen is avoided, and so that it becomes clear to the user exactly what word he is currently learning. Here it is important to consider (according to the literature also) that a blind user will usually go through a website sequentially, certainly the the first time a blind user sees a website in the “going over phase” After that, a blind user wants to be able to jump quickly from one part of the page to another. Considering this we found out that the order of the webpage in HTML has to be the same as that of the visual order. Additionally, the structure of the page should precisely communicate the current word the user is translating. In particular the focus of the screen-reader must be accurate. It is also essential that interactive elements on which it focuses, have a clear purpose and value that are informative for the blind user. For instance a button must have a meaningful name and communicate to the blind user that the element is a button.

More in general the navigability of the screen can sometimes be improved by not making images selectable at all when it does not contribute in the understanding of the webpage. Partly this also goes for links. When links are selectable the names should of course be meaningful. For example the screen reader named every link in he progress-bar, “lesson player”, which was not informative. The naming should be meaningful such as “Vocabulary Write Exercise”. Interestingly, when later improving the structure of the interface in the prototype, adding bypass blocks, offering alternative texts and paying attention to how text is used in the interface, such as text, made a significant impact on the accessibility already. The blind person we tested with at the end of this project, thought the navigation structure had improved greatly.It turns out that these changes were not hard to implement, even though there are some specific challenges. Starting here can help a great deal to make exercises way more accessible.

A third important requirement we found while working on R1 is concerned with how exercises provide feedback (whether an answer is right or wrong) when the user does not have sight, and must make use of the abilities blind people do have. Obviously visual feed back such as changing colors of words does not work. In general adding auditory feedback is the preferred option. The feedback should further be meaningful and motiving, which is important for sighted users as well.

Our fourth finding is that images, buttons, and links should all have meaningful names. Lastly, all the functionality within an interface must be accessible by a keyboard shortcut because blind people use them a lot.

While developing user stories and requirements in relation to R1 we also investigated in which practical situations a person such as Kyra could use the Babbel product. Based on her user stories we developed specific use cases in different various circumstances. We decided to focus on the specific use case where Kyra would use the Babbel application in combination with a laptop, a screen reader, and a braille display at home. The latter can be connected to a computer and translate what is available as text into refreshable braille that can be read by touch (Erasmus+,2015).. Speech synthesizers (screen readers) are also commonly used for the same task, and a blind user may switch between the two systems or use both at the same time depending on the circumstances.

10.2 Technical implications

According to a census taken by the World Health Organisation, 2.6 % of the world consists of people with visual disabilities (about 0.6% are blind). In the U.S. alone about 1.8 million people cannot easily see printed words. Unfortunately, only about 10% of people who are blind can read and write braille. Therefore we chose to focus our work with regard to the technical implications on the interaction between blind people and screen readers. We believe that secondary target groups, such as the visually impaired, will also benefit from the above mentioned improvements that we tried to demonstrate with a prototype that focuses entirely on the Vocabulary Write Trainer (see figure 1) and implemented the suggestions that were made earlier (see figure 2) We believe that success here, within a limited scope, could create spillover effect to other Target groups.

First of all, we improved the instructions in the prototype, by reformulating them as questions. This made it clear to blind users what type of exercise they could expect, and from which language to what language a translation was to be made. In was important to place the instruction before a desired action in an exercise. For example, before the input field, we added the label: “Type the letters here and hit enter”. We kept the instructions short, such that they also also fit and look well on a mobile screen.

The second improvement we worked on is reducing the number of items on an exercise screen from four items to just one. By doing so there was no longer confusion about what word the user was working on. We added bypass blocks (links) on top of the page so that a blind user can quickly navigate to the part he is looking for. Additionally, we changed the order of the main exercise structure: instruction, word to translate, *audio button,* instruction how to use the input field, input field, *help button*, *submit button.*

The third thing we did, was to improve feedback by adding additional text. We defined three options: correct, almost correct, and not correct. Every message was positively formulated and to the point. For example,”Your answer is not correct, but you are getting there, please try again”. Here we also tried to formulate the instructions in such a way that the end user knew what to expect next. We implemented the feedback with a technique that made sure that if the feedback changed, for example into: “The answer is correct, please press next”, the blind user would be notified by the screen reader.

A more technical challenge was dealing with dynamic content e.g. layouts that change during the use of a webpage. Dynamic components are usually added with Javascript. These components do not contain the standard features, such as focus, of standard HTML elements. Therefore it is a practice to use semantic HTML as much as possible. However, this is not always feasible. Therefore workarounds are needed to make content dynamic and accessible at the same time.

Often such dynamic content is a problem for the screen reader. It notices and reads static elements, and easily misses dynamic content that change during the use of a webpage. We paid a great deal of attention to inform the screen reader (and the user) if any changes happened on the screen. We did this by the use of ARIA, and techniques found on AllyCast YouTube Channel and in the book Accessible Components written by Pickering.

Our redesign is not totally accessible yet but has already made useful improvements. We found some issues after both automated and manual testing. Some buttons ('try again' and 'next') were not working as well as we hoped, and the screen reader did not notice them. This was probably because we usedJavascript instead of HTML. Because of this issue we did not reach the A-level of the WCAG 2.1 standard. However, we passed a lot of the WCAG 2.1 standards and were able to implement most of our user stories successfully. The user tests greatly helped to improve many specific issues. The first thing we learned is that understandable instructions about how an exercise works are essential. Second, our structure had to be made clear and consistent enough for the blind user to navigate to the next item and main content quickly. And, third that the naming of buttons and links must be intuitive. For the limitation, during this thesis, please see the chapter 12.

We conclude that our prototype is close to becoming totally accessible, however there is still room for improvement.

11. Limitations

Within this chapter, we will describe the limitations of our study. The biggest limitation we experienced was the sample size, the effects of using simulations instead of testing with the real user group and the variation within the sample.

11.1 Sample size

We did a lot of tests within this study, mostly we checked with 1 or 2 participants. Unfortunately, we were not able to test with bigger sample size. The reason for this is that testing with the blind user can take a lot of time. First of all, we did the testing mostly done in person. Secondly, the acquisition of participants took quite some time. Blind people are quite a specific target group. Therefore this study would become more significant if we did more test with blind users.

11.2 Simulations as a test method

As a potential solution for the limited amount of blind users we could test with, we tried to substitute blind users by blindfolding sighted people. However, these methods only work for a small part of the experience. Sighted users are missing the advanced skill set with the screen reader that a blind user has.

During these simulations, we used people from within the company. We tried to ask people that were not immediately related to the product. However, the possibility remained they were familiar with the product's interface. This pre-knowledge would influence the test.

11.3 Variation in participants

Lastly, we were not sure if testing at the beginning (pilot) and in the end (final test) with the same person, would be a disadvantage or a benefit. On the one hand, it was easier, since we could make a clear comparison if the interface improved. On the other hand, you can never be sure that the pre-knowledge of the product could influence the final test.

All in all, to improve our research, this project could be repeated with a bigger and more diverse sample group.

12.Future work

Within this chapter, we will describe topics we were not able to research within this thesis. The main topics to further investigate would be the new potential target group that would benefit from this study and the business case of this thesis. Finally, we will present some potential innovative ideas that came across while we were doing our literature review.

12.1 Potential target groups

We were not able to further research the persona of the visually impaired user. Visually impaired people are not entirely blind but have a limited sight for varying types of reasons. Researching this new target group would be the first logical step to continue after this project. We concluded, based on Annex B of standard 508 (see chapter 4.1.9), that they would benefit the most from the implications of this study. Furthermore, it would be good to keep on researching how designing from the accessibility angle influences other target groups too, and to build a good business case.

12.2 Innovative ideas

During our literature research we came across several articles that proposed a new teaching method for language learning. They claimed that making audio descriptions for movies for people who are blind, is a didactical activity in itself. The students have to describe images, make a script, and practice their writing (Walczack & Fryer, 2016; Talavan & Lertola, 2016; Moreno & Vermeulen, 2013). This didactical approach could be a new exciting idea for a new trainer or exercise.

Another finding out of the literature research was the use of vibrations as a type of feedback. This type of feedback we saw within another project and application, namely a VR navigating system for the blind. They used vibrations to give feedback (Interview with Expert). Another point of attention to improve the audio experience would be to see if the quality of speech of the screen reader could be improved. Currently the screen reader sounds very robotic, inhuman at this point.

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Appendix

Appendix A: Consent-form

Updated: March 2019

DECLARATION OF CONSENT

Title: Research Session Interview

Recipient: Lesson Nine GmbH (“Babbel”), Max-Beer- Str. 2, 10119 Berlin, Germany

Background: Our portal www.babbel.com offers 14 languages and serves users from all over the world. To continuously improve our online and mobile services, Babbel is interviewing customers for their insights into the language learning process and will be recording their voice and image in a video of the interview. We will create audio and video recording of your interview/user session with the researcher and we might take notes of it (“Records”).

The purpose of these interviews is to collect insights about the Babbel product along with the learning behaviors of users and language learners, to research and develop a better product and user experience (“Purpose”).

Participation in this research session and interview is completely voluntary. At any time, a participant may refuse to participate, take a break, or ask questions.

Consent: Babbel would like your consent to record your image and voice as well as take notes and use this information for the Purpose.

By agreeing, you understand, consent to and agree that Babbel may record your image and voice as well as take notes of the interview session, create the Records, and use this information for the Purpose. Also, you understand, consent to and agree that:

- You have read and understand this consent form completely and voluntarily agree to participate in the interview and research session.
- The information you share as a part of the research session will be kept by Babbel and used to help develop its products, and the data related to this information will be processed for this purpose.
- Your personal data provided to Babbel will be processed (saved and used), as described.
- Your personal data will be kept confidential, used internally, and not shared with anyone not associated with Babbel. It will also be deleted when the Purpose has been realized.
- You may withdraw your consent at any time.
- Babbel may use the information you share for analysis of Babbel’s products and develop a better product and user experience.
- You will keep in strict confidence and shall not disclose to any third party information which you have received in connection with the Records and/or performance of this Declaration of Consent

Appendix B: Interview questions

1)Agreement

Inform user about the interview and ask for permission to record

2) Back ground

What is your relationship towards blind people, can you tell me something about that?

How much have you worked with blind people in real life?

In case of blind users:

- Can you telll me a bit about yourself?
- What do yo do?

3) General interaction

How was the interaction between you and the blind person?

What type of assistive tools did you use to communicate ?

What were the biggest problems in general that you experienced in daily interaction?

4) Learning languages

How did people who are blind learn languages?

Mostly until what proficiency did they came, A1,A2, B1. B2 etc?

What do you think is the main motivations for blind users to learn a new language?

What keeps

And if you learn a new language, what is the most important skill in your daily life?

Spelling, or speaking?

How do blind people read and write?

5) Technology

If they learn a language what are the assistive tools they use?

Which tool do blind users use the most when it comes to language learning?

What was the blinds users technological background?

What kind of media do blind users mostly use in learning languages? Netflix? Podcasts

And what do you like about them and what not?

Are there any type of barriers you encounter using the apps?

Appendix C: Notes from observers

Observator 1 about interview 1:

The observations and discussion with observer raised a few question:

1. Is he born blind?
2. Can we test competitors on Accessibility ?

He mostly found the most interesting and what learn about it was:

1. What being blind entails
2. What a brail display is
3. How it work to read from the screen with a screen reader
4. He is wondering how to test code well on this and how exactly it works to work with such a screen.

He concluded a few things:

1. The combination of keys are important to understand, since they form a key in inclusive design
2. The navigation in a website should work well, since this is something that can be a barrier
3. Macbook clearly has a god accessibility screen reader
4. Testing the end prototype, without hosting is to share it via drive or dropbox and just download the files on his computer(testing ideas)
5. Use in iPhone is clearly very easy
6. The design of the system must work well, otherwise voice over does not work
7. The end user uses its own keyboard instead of those of the trainers, therefor not all trainers are usable
8. The way he been teached in class are also his wishes,
9. Preferably he types in public, since he does not like to talk to his phone(privacy)
10. He likes to learn English to speak to others
11. He does not do a lot of multitasking
12. No difference in motivation, compared with the other users
13. After shock ears could be a cool project to work on with the company

Obeservator 2 about interview 1

likes to listen to books and music and cabaret

only works a few hours a day

(also) reads Braille on laptop

uses regular keyboard

works in the administration of a university?

apparently can't use a mouse, so take the 'fast keys'

the phone talks to ie, it reads aloud

learn languages: listen a lot,audio books, sentence structure, audiobooks, sometimes Braille books

what's with the spelling? -> braille (less important for him?)

uses twitter, facebook, listens to the radio

Apple's voice over is automatically included in all Apple productions, but you have to build your apps so that voice over can use them as well. this is not necessarily automatically good.

ideal app?

translate words

listen exercises

Laptop would definitely be preferable to the mobile phone

Observer 2 about interview 2 2

The user studies languages

So it would rather fall under "made power users

what does not matter to you as blind?

trainers that can only be solved by looking at and / or moving pictures

but: if the pictures have a description, that works again

good exercises:

Pronunciation exercises (probably especially important for blind people)

writing exercises
grammar
not so good exercises:
not only "how do I order a drink in the bar

As a general rule

Apple uses voice over, she also knows talkback from android
Braille reading is a bit unwieldy. she likes to be read by the computer
likes to learn through audiobooks and podcasts, and even 'watches' series

the ideal app to learn languages
teaches the language completely, not just for special situations, see above
Focus on pronunciation grammar, spelling

Appendix D: Transcripts

In this appendix all the transcripts for all the user interview can be found. However the customer support quotes had to be left out, since they would be asked permission on 140 people to publish their data. Probably this would be able to do this within the time standing for the thesis. The published data is anonymized and published with the permission of the user. The interviews contain the interview from the teacher, the interviewee 1, interviewee 2, and the expert.

Interview expert

Background

Javier works mostly with blind people by doing research with them about the use of VR for developing new aids to help them when navigating indoors. The type of people he works with are older blind people. Since mostly young students get already good guidance from a school. His research is mostly focussed on teaching movement and help them navigate through new spaces.

Working method

Mostly he first do a training session with them for about 30 minutes and then try to let it do it themselves. Mostly this elderly have some cognitive impairments as well. He tries to measure for example how fast they navigate through the room, but also how confident they feel to go from the first stage to the second stage.

Assistive technology

The type of assistive technology they use in this project are headphones, that don't cover their ears totally such that they still perceive natural/ contextual information. We give feedback in the system through sounds and soundscapes, but also they use stimuli such vibration. There are many ways of giving feedback.The biggest feedback stimuli they like most is sounds. Furthermore having a headphones gives a sense of privacy. For example I am blind and I receive an email in the metro, the email would be read out loud. So your sense of privacy is gone. Therefore we would like to use the headphones to improve this privacy and not take away the contextual information. Losing more senses e.g hearing when you are blind is uncomfortable. Most people have a high technical skill, since they are depending on technology a lot.

Motivation

The reason why most blind people like to use this concept is because it makes them feel empowered. I helps them reassured to walk through a strange room and push their boundaries. The system he is designing gives them a sense of reassurance as it would be if another person would help them, it basically guides them through a strange environment.

Mostly blind people are very motivated to learn new things, since they have a lot of time since they don't go to the cinema, or do other stuff normal people do. Mostly blind people have several degrees also for that reason. Blind people have the ability to focus and concentrate very well, maybe different than normal people.

The biggest wish blind people have is to be normal as possible. They want to be autonomous and be able to go out the door themselves. They also like to learn new

languages for that reason. The type of skill they probably use most is speaking, since this the main way they communicate with the world. They rely on their speaking abilities and therefor their might be quite a big interest in learning to speak mostly. They have a lot of apps already that make them help to read.

Learning

Learning from older people who are blind is different than those of younger, since mental map is different if you saw in the beginning and get blind at a later age. People that get blind at a younger age, have a very good orientation/ coordination instinct while older people are a bit more scared to move. Therefore having a system that motivates them and reansures them is important. Using soundscapes help to create this mental maps, but is therefore also pretty personal. Every person became blind differently and therefore it is a challenge to make the system fitting to different people.

The system/technology

The most uncomfortable situation is mostly when blind users come into a new environment. They rely a lot on their memory, which is pretty intense process. Therefore our system helps them. The feedback and the use should be easy and not cognitive heavy

They use a setup of mobile phone and headphones. Mostly the app is steered by patterns e.g. 2 fingers, swiping etc. The most preferred type of interaction is actually depending from person to person. Also they prefer that feedback in sounds is very fast and simple to comprehend. For example I use the system in navigating it is important that I can have a conversation at the same time while I navigate. Using the hands with the mobile phone is hard, because sometimes they also use a cain at the same time. At the moment we are also working that the application can be steered by voice control, because they should have their hands free (Walking cain).

Working with blind people

One the biggest advises he gives in working with blind people, is to act natural as possible e.g. dont try to avoid words about "lets see..." or "bye bye". Also one of the biggest trends coming up is image recognition. For example he explains that when a blind persons stand at the bus stop and I want to know which bus is coming it would be really like to know which bus is coming, having an application for that is for that reason really interesting. We actually design therefore more for inside than outside, since there are already quite some apps that do that. Furthermore they are very practical people, which means that it app should makes sense and to the point.

Interview met een docent

Ik heb twee blinde kinderen in de klas gehad. De computer deed nog maar net zijn intrede in het onderwijs en er was weinig materiaal ontwikkeld voor slechtziende kinderen.

De peuterspeelzaal had hulp aangevraagd voor ambulante begeleiding van een school die specialist zijn is mbt blinde kinderen . De dame met die functie kwam heel regelmatig op school. Ze ging apart zitten met de kinderen, keek steeds of er voldoende groei was en gaf mij tips.

Ik vond het best verwarrend dat ze ontzettend goed konden bouwen, tussen de boom en het hek konden sturen met een grote stuurkar (en dat paste maar net...)

Ze zaten naast me wanneer ze een vouwopdracht kregen, ze voelden ook aan mijn papier met de scherpe vouwlijn.

Alles wat ik deed ondersteunde ik auditief. Ik verwoordde wat ik anderen zag doen. Ook met mimiek en lichaamshouding. Als ik het gevoel hadden dat ze het niet begrepen, pakten we het anders aan. We gebruikten schuurpapieren letters, koppelde daar een beweging en een klank aan. Voorbereiding als woordjes hakken op een kaart deed ik individueel. Ook schuurpapieren cijfers.

Van de begeleidster leerde ik om mooie dingen uit de natuur voor een zwart papier te houden. Een spinnenweb werd zo zichtbaar. Boomschors voelen, kevertjes over hun hand laten lopen, veel kliederen met zand en water.

Knippen leerden ze met een duo schaar, lijntjes maakte ik zwart met een stift. Ze waren beiden dol op filmpjes, het was een kunst om de tv zo neer te zetten dat ze het goed konden zien (licht inval). Bij het lezen van een prentenboek had ik al vaak pre teaching toegepast (vooraf aan hen voorgelezen) en later zaten ze naast me in de kring om het nogmaals te zien. Met ouders werd vaak gesproken over woordenschat uitbreiding dmv spelletjes, boekjes e.d. Deze taak lieten ze graag aan school over..... Een luisterboek hebben we wel eens ingezet maar eigenlijk wilden ze liever iets doen.

Het licht in de klas werd aangepast, later in alle lokalen kwam ook een bordlamp.

Op de computer werd een programma met een grote muis geïnstalleerd. Bij de overgang werd 1 van hun een half uur buiten de groep begeleid. Dan werd lezen (boekjes werden vergroot), spelling en begrijpend lezen geoefend. Ook had het kind extra groot lijntjes papier zodat hij/zij zijn eigen schrijfwerk terug kon lezen.

Het gezichtsvermogen werd langzaam minder. Op den duur werd het kind vaak moe, alles kostte meer moeite en inspanning.

Vanaf dat ze net op school waren wilden ze eigenlijk geen uitzondering zijn, ze wilden zo graag net als anderen meedoen. Ze werden altijd gebracht met de auto.

Interviewee 1

00:00-19:03

Wat zou je eigenlijk willen weten, wie ben je, wat doe tijden dagelijkse leven?,

Ik ben 26 jaar. Ik ben volledig blind. Mijn hobbies zijn muziek luisteren, ik luister graag naar cabaret. Ik houd van lezen, of in dit geval het luisteren van boeken .

Mag ik vragen welke app je gebruik?

De daisy lezen, het is van passend lezen. Dat is een bibliotheek voor blinden en slechtzienden.

Welke cabaret vind je leuk ?

Ik houd van Najib Amhali, Jochem Myjer, Dolf Jansen, Herman Vinkers.

Hoe kijk je een video van cabaret, zet je gewoon het filmpje aan en luister je gewoon naar de audio ?

Nou ja, meestal zet ik gewoon het geluid aan. Het meeste is wel op gehoor te volgen. Als er iets is, wat echt niet op gehoor te volgen is, bijvoorbeeld in het theater, dan vaak de persoon die met meegaat verteld die wat er gebeurd. Maar vaak is het niet echt nodig.

Bijvoorbeeld met films, ik weet dat je vaak naar de radio luistert, bijvoorbeeld met films die beschrijvingen geven gebruik je dat ook wel eens?

Ja dat is inderdaad wel in opkomst. Maar ik moet eerlijk zeggen, dat ik nog weinig films kijk. Dat komt omdat ik dat eigenlijk nooit deed.

Zou dat nog wel iets cools vinden om uit te proberen?

Ja misschien wel ja.

Ik had eigenlijk nog een andere vraag, je gaat dus naar je werk toe, zou je mij een beetje kunnen vinden hoe zo'n dag gaat?

Op maandag, dinsdag en donderdag werk tussen 10:00-13:30. Elke dag word ik opgepikt met de taxi, dan word ik hier rond 08:45 opgehaald en gaan we naar het werk. En dan loop ik naar mijn kantoor.

En gebruik je dan z'n stok?

Ja!

Jij bent wel compleet onafhankelijk? Hoeveel hulp heb jij nodig? Of kan je alles onafhankelijk doen ?

Meestal loopt een taxichauffeur loopt mee naar de lift. Hij wil even zeker weten dat het allemaal lukt. En dan maakt hij een praatje met de receptionist. En dan loop ik zelf naar mijn kantoor en dan haal ik laptop op het kastje en dan sluit ik mijn laptop aan, mijn brailleleesregel. Meestal ga ik nog een bakkie doen, voor dat die laptop is opgestart, dat duurt wel even. Haha windows 7. Voor die laptop is opgestart heb ik me negende kopje koffie al op. Nee dat valt nog wel mee en dan kijk even of er nog mail voor mij is. En dan gaan we aan het werk.

Wat is het type werk dat mensen vaak doen als ze blind zijn?

Sommige zijn zelfstandige en krijgen hiervoor subsidie voor.

Wat doe jij ?

De brieven maak ik. Ok de brieven maak jij.

En dan gebruik jij het normale toetsenbord of het braille toetsenbord?

Ik heb een brailleleesregel en die zet alles wat op het scherm te zien is dat wordt omgezet naar Braille. Jullie zien een heel scherm en ik moet echt alles regel voor regel interpreteren.

Ja, maar dat is de output, je krijgt een mailtje binnen en dan wordt dan vertaald naar Braille I guess. Hoe doe je dan bijvoorbeeld typen?

Ja daar gebruik ik gewoon het toetsenbord voor, een qwerty toetsenbord.

Vaak zit er ook een screen reader bij. WAt vind je dan fijner alleen de braille of beide ?

Nou ja eigenlijk gebruik ik spraak en Braille. Spraak gaat toch sneller, en braille gebruik om mijn braille vaardigheid op peil te houden.

Het is eigenlijk als een soort nieuwe taal.

Ik vergelijk altijd met pianospelen. Nou ja, als je dat niet bijhoud ga je ook verleren.

Heb je het idee, dat brail uitraakt?

Nou ja uit aan het raken, ja misschien wel hoor. Maar daar heb ik eigenlijk niet echt zicht op.

Ja omdat je zegt dat je het op peil moet houden, dat klinkt alsof niet zou moeten doen.

Ik ben eigenlijk gewoon lui heel plat gezegt

Dus als het kan gebruik je audio.

Ja het is eigenlijk ook gewoon goed om je spelling bij te houden. Als ik bijvoorbeeld had ik Carmen met een K gespeld.

Maar z'n braille toetsenbord word alleen voor ouput gebruikt, of zou je het ook voor input kunnen gebruiken ?

Je kan het voor input gebruiken, niet in alle Brailleleesregels, daar zit z'n braille toetsenbord bij.

Als jij komt op een nieuwe website komt, hoe gaat dat dan een beetje?

Nou ja dan, dan start ik eerst de browser op internet explorer, safari als ik op mijn mac zit. En dan, ga ik eerst naar de adresbalk, met sneltoetsen. Want ik kan de muis niet gebruiken.

Sneltoetsen, zijn een combinatie van toetsen?

Voor internet explorer is dat Control O en voor sommige browser is dat ctrl L.

Aah, kan ik die sneltoetsen ook gebruiken?

Ja Ja, eigenlijk kan je alles met snel toetsen doen.

Je bedoel om te navigeren door de pagina?

Ja

Moet de pagina er speciaal voor aangepast zijn, of werkt dat altijd?

Als een site, html gebruikt, dan is dat altijd leesbaar. Maar als bijvoorbeeld als een site heel grafisch is dan is het wel moeilijker. Het hangt weer af van of je de mac gebruikt dan is dat ook wel anders dan als je een windows zou gebruiken. Dat verschilt.

En waar zit dat verschil hem dan in?

Ja, wat ik persoonlijk van de Mac beter vind, is dat je meer overzicht hebt hoe de website is opgemaakt.

Was dat meer bij de Mac of inter explorer?

Allebei, de mac helpt daar ook wel bij.

En waar zit hem dan in? Kun je daar iets over zeggen?

Ja, dat is een beetje moeilijk uit te leggen.

Mag ik daaruit opmaken, dat je het ook prefereert om een macbook te gebruiken?

Ja voor internetten wel.

En hoe zit dan met je telefoon? Ik begreep dat jij een Iphone hebt, is een iphone dan ook makkelijker te gebruiken voor blinden?

Iphone is heel makkelijk te gebruiken.

Hoe gebruik je een iphone als blinde?

Elke telefoon daar zit een voice over op en als je wilt scrollen over het scherm. Dan veeg je met je vinger over het scherm.

Van boven naar beneden?

Ja kan het niet laten zien. Mijn camera staat niet aan.

Camera ging niet aan, was moeilijker.

Jij veegt dus in principe van boven naar beneden en dat is in principe for scrollen bijvoorbeeld. En hoe loop je dan door een app, als je Iphone gebruikt?

Ook gewoon scrollen, bijvoorbeeld ik raak nu icoontje aan. Dus 1 keer aanklikken is horen,en dan scroll ik naar recht dan hoor ik wat er recht is. Als je een incoontje will openen moet je het eerst aan raken of scrollen en dan kan je op elke willekeurige plek op het scherm dubbel tappen.

Aanraken is navigeren en dubbel tappen is selecteren.

Bijvoorbeeld jij wilt je mail open dan zoek icoontje en tik je dubbel.

Zijn er nog meer interacties die je veel gebruikt?

Je kunt een waarde aanpassen. Dan kan je van boven naar beneden vegen voor z'n invul menu.

Wat betreft het invullen in forum? Doe je dat alleen op je computer of ook op je mobiel?

Liefste op me laptop maar op me telefoon doe ik het ook wel.

Hoe werkt het dan op z'n toetsenbord op je telefoon?

Dat kan je op verschillende manieren doen. Je sleept als het ware door alle letters tot je de juiste letters hebt.

Aha je rolt als het ware door z;n menu heen

Ja!

Dus eigenlijk gaat het op je laptop dus eigenlijk sneller.

Ik begreep dat talen niet helemaal je ding. Hoe leerde dat dan op de middelbare school. Hoe ging het dan z'n taal les?

We hadden luister en na spreek oefeningen. Dan hadden we een cassette bandje, dan hadden we een zin en dan moesten we dat dan nazeggen. Soms ging dat te snel maar dan zette de docent op pauze.

Later kreeg ik echt engels van een Engelse docent, en toen kregen we ook digitale boeken in word. En dan konden we ook echt oefeningen maken. In het begin vond ik vreselijk, maar hij deed zo veel mogelijk in het begin in het Engels. Hij sprak heel veel engels in de les.

Moest je wel is dictees maken?

We moesten wel brieven schrijven, dictees weet ik niet meer.

Hoe kon je zien hoe er een woord eruit ziet dan?

Stond in het boek uitgelegd, een de docent legde het dan uit. Die kon je dan ook helpen met de uitspraak van bepaalde woorden.

Hoe je het spelt wordt gecommuniceerd door Braile.

Ja, maar je kan ook voice over op Engels zetten en dan spreek hij het hopelijk goed uit.

Ja dat schijnt tegenwoordig wel een probleem te zijn. Later heb je geleerd dat letter die voelt correspondeert met de letter op je toetsenbord.

Dus als je een J typte op je toetsenbord voelde je ook J op je braille bord

Dus een hand typte je en een hand voelde je om te interpreteren. Ja. En het word ook voorgelezen.

Dus je schrijft nooit wat met de hand?

Nee want ik kan geen gewone letters lezen.

Als jij leest, of je hoort iets, dus het wordt voorgelezen. Maar wat als je weten of iets gespeld wordt.Ooh ja dat kan je natuurlijk gewoon volgen met je Braile toetsenbord.

Ok wij moeten natuurlijk helemaal in de mindset komen, het is vrij logisch als je er over nadenkt.

Jouw niveau engels is op middelbare school niveau?

Ja, het is niet heel slecht.

Vind je het ook leuk om een nieuwe taal te leren?

Vind het sowieso leuk en belangrijk, zou ook graag Engels wat meer bij willen houden, want dat is wel een wereld taal. En duits heb ik 1 jaar gehad op de middelbare school.

Talen is voor jou leer je gewoon omdat je het leuk vind, of heb je het echt meer nodig?

Meer omdat ik leuk vind en het waarschijnlijk ook mee nodig zou hebben.

In wat voor situaties heb je het meer nodig, op je werk bijvoorbeeld?

Niet echt op het werk, maar bijvoorbeeld als ik een keer naar het buitenland gaat. Of als ik een keer iemand ontmoet die geen Nederlands bent geweest.

Je bent laatst op vakantie geweest, mag ik vragen hoe dat ging?

Het was een groepsreis, en gingen ook begeleiders mee. Dus als er echt een heel verhaal in het Engels gehouden moet worden helpt mijn begeleider. Of als een vriendin van mij was mee die vertaalster was, maar die heeft ook engels taal.

Voor jou zijn alle skills eigenlijk wel belangrijk? Als je z'n taal zou willen leren, wat zou je het liefste willen leren?

Het spreken en de zinsopbouw. Maar ook dat ik bang ben omdat ik dan iets heel fouts of dubbelzinnigs zeg,

Je gebruikt ook veel podcast, wat voor media gebruik je verder?

Stereotoren, een radio, Ik ben ook een beetje met podcast begonnen. Via de podcast apps en online luister ik

Je gebruikt allemaal Facebook, gebruik je ook instagram?

Ja ik heb Facebook, maar nee gebruik geen instagram. Dat zijn allemaal fotos daar heb ik niet zoveel aan. Daarnaast heb ik al Twitter. En dan moet ik dat allemaal gaan bijhouden.

Ik heb wel een tijdje facebook aan twitter gekoppeld

Gebruik jij wel is een google translate of een talen app?

Laatste tijd niet, google translate, die gebruik ik niet. Vroeger gebruik ik het woordenboek van dale. Dat was een programma in windows .

Gaat dat dan ook samen met z'n daisy speler?

Nee dat niet

Momenteel gebruik je geen app die je helpt met vertalen?

Nee niet dat ik weet. Ze zullen er vast zijn.

Hebben al die verschillende apps, hebben je universeel 1 app die blinden ondersteunen, of heeft elke app zijn eigen ondersteuning?

Ja je hebt die voice over, dat zit in principe in elk Apple product. Als een app zo is gebouwd dat de voice over ermee overweg kan, dan dat kan ik hem gebruiken.

Als je z'n podcast gebruikt en soms navigeer je dan. Want sommige mensen multitasken. Maar dan hoor je dus aan de ene kant die podcast en aan de andere kant die voice over.

Dat doe ik eigenlijk zelf niet, meestal wil ik gewoon die podcast luisteren. Je wilt geen ander dingen doen.

Want dat vind je storend?

Ja het is ook storend en z'n podcast is bedoeld om naar te luisteren. Gewoon alles mee te krijgen.

Stel jij zou een app mogen designen voor jezelf zou mogen designen hoe zou dat er uit zien, Wat zou je willen?

Waar oefeningen in zitten, na spreekoefeningen, woorden vertalen.

Hoe zou je dat vertalen het liefste doen?

Ik denk dat allebei wel, maar ik denk typen. Met name voor mijn privacy, want als ik dan in het openbaar iets moet opzoeken en ik moet dicteren. Ja dat gaan niemand wat aan wat ik op mijn telefoon aan het doen ben.

Hoe gaat je daar mee om in public, dat kan een schending zijn van privacy bijvoorbeeld met een email?

Meestal staat mijn voice over heel zachtjes dus.

Dus je gebruikt geen headphones?

JA maar die moet ik dan wel met net bij mijn bezig hebben.Bedoel je van die Aftershock oortjes?

Ooh ja, ja dat zijn van die aftershock oortjes die trillingen door je bot sturen en je dus een helder geluid hoort.

Ja je hebt ook die in-ear oortjes, maar dan ben je dus helemaal buitengesloten van de wereld.

https://www.youtube.com/watch?v=JKm_pzy-iUM

Je zou dus liever dit soort taal oefeningen, liever op je telefoon of op je laptop?

Op me laptop.

Interview user 2

Zou jij je iets over jezelf kunnen vertellen?

Ik ben bij blind, ik kan nog een beetje licht en donker zien. En soms wat kleuren als ze heel sterk zijn, maar niet genoeg om mee te werken. Dat is al heel me leven zo, ik ben 25 jaar. Ik studeer engel en nederlands om als vertaalster te werken. Ik spreek dus Duits, dat is mijn moedertaal. Engels, Nederlands en theoretisch Frans, maar ben al heel veel vergeten.

Je spreek dus heel veel talen begrijp ik.

Ja ik dus heb veel plezier in talen, leer ze graag. Ik leer dus een beetje Spaans met apps, maar ben nog niet zo succesvol geweest.Ik zou dus niet echt zeggen dat ik Spaans spreek.

Mag ik vragen welke apps jij gebruikt?

Ja ik heb het met Duolingo geprobeerd.

Hoe ging dat?

Ja dat ging eigenlijk best wel goed, zij hebben mooie oefeningen, waar jij je uitspraak kan laten oefenen. Ook voorbeelden kunt luisteren en er waren niet zo voorbeelden die je moest zien om het te kunnen gebruiken. In mijn geval dus Spaans. Ik heb andere talen geprobeerd, die minder goed gemaakt, omdat minder mensen die willen leren. Daar waren de lessen wat minder professioneel opgemaakt. Maar Spaans ging eigenlijk best goed.

Vooral visuele dingen gaan niet zo goed, maar daar kom je wel doorheen?

Dat hangt af hoe de app gemaakts is, als je het visuele moet bewerken om door te gaan. Dan werkt het eigenlijk niet. Ik heb jaren geleden gewerkt om Nederland te leren. En daar had ik echt oefening die je moest doen om verder te kunnen, dingen als zoek het passende beeld. Dat werkt dus helemaal niet. Bij Duolingo zijn er beelden om het duidelijk te maken over wat ze je willen leren, maar zijn niet noodzakelijk om het te begrijpen.

Maar ik begrijp wel, dat je de descriptie van zo'n beeld,omschrijving. Gebruik je dat dan nog wil is, om het te verleuken ofzo?

Praten we nu over talen of over het algemeen gesproken?

Beide,het is een app. Wat wij proberen te leren, Van oké hoe moet het er dan echt uitzien , ja het is beide zeg maar.

Zeg maar als een opdracht in een talen app is, een woord bij de juiste beelden moet voegen. Dan zou daar wel bij helpen als daar er een beschrijving bij een beeld is. Als mijn Spaans app mij wil leren, weet ik veel, ehm een perro een hond is, dan zou dat natuurlijk helpen als daar in het Spaans of in het Duits, dan zou het helpen een beschrijving erbij stond, er is een zwarte hond in die foto of zoiets. Ja dan kan ik de beschrijving erbij voegen. Als het beeld nou niet echt nodig is te begrijpen, omdat het ook uit de tekst duidelijk wordt. Heb ik de scriptie niet echt nodig,some mooi om hem te hebben, maar ik ben niet heel geïrriteerd als ik hem niet heb.

Wat voor oefeningen vind je het leukst?

Hangt er een beetje vanaf, ik vind het leuk om je uitspraak een beetje kunt testen. Omdat jezelf dan een beetje anders hoor dan het programma. Het programma hoort het dan toch beter dan jij Schrijfopdrachten zijn ook leuk om te doen. Vind het ook belangrijk om het niet alleen te spreken maar ook kunt spellen. Ehm, dat zijn eigenlijk zo de dingen die ik zo het belangrijkste vindt voor een talen app. En ik vind ook belangrijk dat het een app is, die je taal echt leert, en niet alleen de talen leert die je voor een maand nodig hebt zegmaar. Bijvoorbeeld voor een vakantie, als ik een app hebt die mij leert om een drank te bestellen in een restaurant, dan vind ik dat niet zo heel spannend.Dus ik als een taal leer wil ik die ook echt leren. Dan wil ik ook een beetje grammatica leren, hoe saai dan ook. Ik wil echt een taal leren spreken, als ik al tijd investeer, dan wil niet alleen kunnen spreken.

Mag ik ook vragen van voor soort opstelling je gebruikt voor je computer?

Je gebruikt een macbook van Apple.

Gebruik je ook een braille toetsenbord of alleen de computer?

Ik heb wel ook een braille toetsenbord, maar gebruik momenteel alleen de computer. De braille toetsenbord gebruik ik meestal alleen als ik ook echt de spelling moet checken. In mijn vrije tijd gebruik ik gewoon een screen reader.

En je typt iets, dan neem ik aan dat je feedback krijgt via de screen reader, hoe doe je dan bijvoorbeeld met die apps? Hoe doe je dat dan bijvoorbeeld via Duolingo?

Ja op me telefoon, ook meestal zonder braile leesregel.

Hoe typ je, hoe interacteer ?

Ook mijn telefoon is van Apple, ik gebruik een Iphone. Apple in hun toestel een screen reader inbegrepen. dat heet een voice over. Als je een Iphone gebruikt en daar de voice over aanzet, dan verandert de bediening. Dan kunnen dingen op een

schermpje doen, maar moet twee keer typen ofzo en dan kun je horen waar je vinger op zit ofzo. Enne daar verandert dus een beetje de bediening. Ja ik heb vriendin, die een keer voice over aangezet. Toen belde ze me heel gefrustreerd, mijn telefoon werkt niet meer, hoe zet ik dat weer uit?! Ja voice over werkt gewoon anders. Het probleem is, dat niet alle apps toegankelijk zijn met voice over. Ik weet niet precies, wat het bedrijf moet veranderen om het toegankelijk te maken voor voice over. Maar vele apps werken met voice over en dan werkt dat heel makkelijk.

Met scrollen ga je naar boven en naar beneden met je vingers?

Ja of dat, of als ik met vinger horizontaal over het scherm veeg, dan van 1 icon naar het volgende springen, of naar een volgende regel. Dat is ook mogelijk.

Dan heb je zelf ingesteld of dat is altijd zo?

Dat is altijd zo, dat is altijd bij Iphone dat die voice over is geïnstalleerd. Dat hoef je alleen maar zelf aan te zetten. Dan ga je naar instellingen, dan naar accessibility en daar kun je dan voice over aan zetten. Daar verandert de bediening een beetje, en die bediening is altijd hetzelfde als je voice over aanzet. Volgens mij heb je het ook bij Android, dat heet het Talkback, maar naar mijn ervaringen werkt dat minder goed. Dus ben ik altijd, ben een Iphone blijven gebruiken.

Hoe leer jij het liefste een taal, doe je dat liever op je laptop of een iphone?

Mijn telefoon, dan kan ik altijd even leren, wanneer ik een minuutje tijd hebt. En niet eerst mijn computer moet opzetten, dus eigenlijk leer ik liever met mijn telefoon.

En dat vind je niet lastig, met intoetsen en met de interacties enzo?

Nee dat is gewoonte, iphone heeft ook de optie dan je Braille kan intypen. Dan moet je telefoon gewoon horizontaal houden, dan kan je met je vingers braille intypen. Dat is IOS 10 ofzo is nou inbegrepen, wat handig is als ik langere teksten moet schrijven. Of ik gebruik bluetooth keyboard, gewoon met een normaal toetsenbord te schrijven.

Je vind als je dingen moet inspreken vind je niet vervelend bijvoorbeeld in het openbaar?

Ja, wat betekent openbaar. Nou ja las ik in een ruimte zit met mensen, begin ik niet tegen mijn telefoon te praten.Meestal gebruik ik mijn koptelefoon en schrijf ik op het scherm. Ik maak heel weinig gebruik van optie om te dicteren. Dan moet je toch nog een keer corrigeren, omdat hij toch niet alles goed begrijpt en dan maakt hij gewoon fouten. En dat vind ik dan toch lastiger, dan het gewoon zelf in te typen.

Met dicteren bedoel je spreken ?

Ja met dicteren, dat de meeste smart phones dat je de tekst niet zelf moet schrijven, maar dat de smartphone het voor je schrijft als je de tekst inspreekt.

Jij vind het dus prettiger om te typen dan te dicteren?

Om te typen, want dicteren maakt dus heel veel fouten bij de herkenning. Dan moet je toch nog een keer verbeteren. Maar ik weet dat vele blinde mensen zijn die liever willen dicteren. Die dan ook niet de moeite nemen om het te verbeteren en dat is dan vervelend als je het moet lezen.

Als jij een taal leert, hoe doe je dat dan?Je begint met een app?

Ik ga dus nu Nederlands als voorbeeld nemen, omdat dat een taal is die ik zelf heb geleerd. En Engels en Nederlands op school heb gehad, dus dat telt niet echt. Ik ben met Nederlands begonnen met leren toen ik nog geen Iphone had. Ik heb eerst geprobeerd eerst online les te vinden die toegankelijk waren en dat was niet te vinden. Rosetta stones gemald om te vragen of die toegankelijk was. Ik heb toen een boek gekocht om de taal te leren.

Want voor soort boek was dat dan? Een e-learning boek?

Nee, dat was een print uitgave die ik dan zelf had ingescand. Wat een beetje onhandig was om de taal te leren, omdat de scanner altijd fouten maakt. Als je OCR scanner gebruikt. Dat is niet zo erg als het je eigen taal is, maar als je het een taal is die je niet kent is dat een beetje irritant. Dat was dus niet echt effectief. Toen heb ik heel veel geleerd met muziek, ik houd van muziek en musicals. Ik heb Nederlandse zangeres, die hier eerst speelde in Wicked hier en toen in Nederland.

Dus zij speelde dan dus ook in Nederland en toen zij daar speelde ken ik het al heel goed. Toen kende ik de duitse tekst mee spreken en als je het zo uit je hoofd kent, dan kun je ook zo in de andere taal schrijven, dan leer je automatisch een beetje de taal. Toen kon ik al min of meer een conversatie in het Nederland leiden. Toen ben ik 4 en half jaar geleden Nederlands gaan studeren aan de universiteit in Duitsland, sindsdien heb ik ook echt lessen gekregen met fonetica en grammatica lessen.

Waarom vind je talen nou zo leuk, wat motiveert jou?

Nou ten eerste vind ik het super irritant, als ik in een land ben met vakantie en daar niet met de mensen kan praten. Dat vind ik irritant. Ik vind dat gewoon beleefd als ik met die mensen in hun eigen taal kan praten en zeker als ik degene ben die te gast ben . En dat is ook gewoon iets waar ik talent voor hebt, als je niet kunt zien, moet je een beetje overleggen wat kan ik doen, wat is een optie voor mij om te leren kan ik doen om mijn geld te verdienen. Dan is vertaalster een optie is die werkt, die schrijven is en waar er heel veel mogelijk is met de computer.

Ja,dus heb ik gewoon nagedacht wat kan ik doen wat kan ik doen dus ben ik begonnen met talen te studeren.

Wat ik met name af vroeg,want je hebt als eerste taal Duits geleerd. Hoe zagen jouw dagelijkse lessen eruit om een taal te leren. Hoe leerde je letters ?

Nou het probleem voor mij is een beetje, dat ik niet goed kan spellen als ik de woorden niet voor me zie. Ik moet echt de letters echt actief zelf lezen, om de spelling te leren. Ik heb heel lang problemen gehad, om te begrijpen wanneer ik een klinker moet verdubbelen of twee keer moet schrijven en daarmee had ik hele grote problemen. Pas toen ik zelf ben begonnen met actief te lezen met Braille, werd dat dan ook beter. Het is dus heel belangrijk voor mij om zelf te lezen , ja op school was ik daar dan een beetje ongemotiveerd voor. Wat audiobooks zijn zoveel gemakkelijker als je alleen maar hoeft te luisteren in plaats van zelf lezen. Je weet ook dat braille heel wat meer, ruimte nodig heeft dan gewoon prints. Een boek in braille is heel veel papier en heel groot. Dus dat is onhandig.

Ik moet erbij zeggen, dat ik mijn eerste 5 jaar van school heb ik op een school van blinde mensen gezeten. Dus ik heb eerst geleerd Braille te lezen. En toen was ik op een normale school met ziende medestudenten. Ik heb dus de eerste 5 jaar alleen maar Braille gelezen en daarna ben ik begonnen met computer te werken. Wat ik toen wel heel wat makkelijker voor en heel wat minder werk, omdat je dan met de screen lezer kan lezen en jezelf niet per se zelf hoeft te lezen. Ik weet niet zo heel goed,hoe wij de eerste 5 jaar meer hoe we de taal in het begin hebben geleerd. Ik weet dat het probleem in het begin was voor mij, dat ik in het eerste jaar het braille systeem met S punten hebben geleerd, het klassiek braille systeem. En toen ik het tweede jaar was, dat we beter het braille systeem met 8 punten kunnen leren, want zo wordt het ook op de brailleleesregels wordt geschreven. Moet weer over nieuwe beginnen om te leren, super irritant. We hebben heel veel dictees geschreven, van die dictees, waar je naar toe moet lopen om een zin te lezen en dan terug te gaan naar je plaats om het op te schrijven.

Je gebruikt wel is je app, om talen te leren. Gebruik je dat ook als je loopt of moet je echt gaan zitten?

Als ik lopen, concentreer ik liever op het lopen . En als ik even ga zitten en even tijd heb, kan ik even leren.

Je doet het echt als je in een ruimte zit of thuis?

Thuis of als ik in de auto zit of even niets te doen hebt dan kan ik leren.

Jij rijd auto of rij je met iemand mee?

Nee ik rij met iemand mee. En dan heb ik niet te doen en dan kan ik leren

Je gebruikt laptop, je gebruikt een smartphone, gebruik je nog andere technologische dingen om verder te helpen?

Leesregel, of een zonder laptop of telefoon,dan moet ik Braille lezen. Ik heb een account bij american Booksell waar je boeken dan downloaden om in Braille te lezen. Ja dat doe ik soms, dat ik brailleleesregel gebruik om iets te lezen. Ik heb nog een

ipod touch, voor als ik bijvoorbeeld een woordenboek nodig heb maar geen internet mag maken, tijdens examen ofzo. Ik studeer vertalen en daar moet ik dus de examen vertaling schrijven, daar mogen we woordenboek gebruiken maar natuurlijk zien we natuurlijk dan we geen online woordenboek gebruik. Omdat ze zeker willen zijn dat ik niet meer hulp krijg mag krijgen. En daarvoor heb ik een ipod aangeschaft, waar ik geen wifi connectie op maak en waar ik me woordenboek opgezet waar ik tijdens een examen die woorden kan opzoeken.

Dus als ik een website die ik bezoekt dan word die tekst, die online staat die wordt niet automatisch omgezet naar Braille.

Als ik zonder braille leesregel werkt dan hoor ik hem alleen maar via mijn screen reader.

Maar als je wel met je brailleleesregel werkt en je gaat op internet word dan die tekst wel automatisch omgezet?

Ja er zijn wel teksten, maar als teksten alleen in een foto staat, als er een foto van de tekst op de website staat, dan is het voor mijn brailleleesregel niet mogelijk om te laten zien. Maar als het echt alleen maar tekst op de internet staat dan werkt het automatisch.

Jij gebruikt wel online vertaal apps, dus ook van vertaal apps, welke gebruik je dan?

Voor Nederlands, gebruik ik de apps van van Dale. Omdat die wordt aangeraden. En voor Engels gebruik verschillende woordenboeken, omdat ik nog geen woordenboek heb gevonden waar ik tevreden over ben. Dus daar ben ik nog een beetje op zoek naar de juiste oplossing.

Dat snap ik google translate heeft het niet altijd goed.

Ja nee als vertaalster, kun je dat niet echt serieus nemen. Daar horen we teveel over de fouten die het maakt, om er op te vertrouwen, dan doen we eigenlijk niet.

Oefen je ook wel is je taal door naar Podcast te luister, je luistervaardigheid hoe oefen je dat het meest?

Ik luister podcast soms, ik ben nu aantal weken geleden begonnen the iterest, dat is een brit-engels podcast een verhaal over dorpje. Ik luister ook heel veel naar Audio books die ik in het verleden in Duits heb gelezen en die ik nu opnieuw in het Engels luister. Er bestaat ook een Nederlands bibliotheek voor blinden en slechtzienden Passen lezend en daar heb je ook de mogelijkheid om audio boek te downloaden en te lenen en daar in het Nederlands te luisteren.

Dus die app gebruik om podcast te luisteren, of gebruik je nog andere apps?

Nou voor de podcast gebruik ik gewoon de podcast die op mijn Iphone zit, ehm voor mijn normale audio books gebruik ik de app van Amazone en die mensen van passend lezen hebben een eigen app Daisycom.

Deze apps zijn ook wel accessible, bijvoorbeeld Amazone?

Ze zijn alle drie accessible.

Gebruik je ook netflix?

Ik gebruik Netflix, vooral de Engelse series hebben audio description. Ik kijk wel is series zonder audio descriptions en dat is soms heel irritant maar vooral bij Game of Thrones of outlander ofzo. En soms is het een beetje irritant vooral bij Games of Thrones bij the generics die in het ander land leeft en heel veel andere talen spreekt. En voor ziende mensen zijn er gewoon er dus ondertitelingen en die kan ik dus gewoon niet lezen. Dat betekent dat ik hele scènes heb waar staat te spreken en dat ik dus me afvraag wat verteld ze me nou eigenlijk. Dat kan dus een beetje irritant zijn, maar opzich werkt het wel. In het verleden had Apple het zo gemaakt dat die subtitles wordt voorgelezen, op de een of andere moment doet dat het niet meer. En dat vind ik heel jammer.

Als jij de ideale talen apps jouw zelf zou mogen ontwerpen hoe zou die er dan uit zien?

Die zou zeker de taal echt leren, onderwijzende taal leren niet alleen gebiedende woordenschatten. En een beetje over de grammatica leren, echt van echt van het begin af aan de taal leren. Vind het ook leuk als de kans bestaat om me uitspraak te corrigeren, niet echt te corrigeren. Bij duolingo werkt het zo, dat je een zin of een woord te herhalen en dat je het haalt als je het goed uitspreekt. Als je het niet goed uitspreekt moet je het nog een keer doen.

Dat vind ik handig, ook schrijven vind ik handig. Zo zijn de belangrijkste dingen om talen te leren.

Dan denk ik duidelijk beeld hebt wat jij cool zou vinden.

Appendix E: Theme analysis

In this appendix all the analysis of the transcripts can be found. Besides the agreement of another user researcher on the themes and categorization. Down below here is a table of content for the themes.

1.Who exactly is going to use the design?

The handicap: this category states all the types of blindness that has been used within the interviews.

Interview

1.*Handicap: is completely blind

2."Handicap: Is blind but sees light and dark and

some strong colors"

3.*Every person becomes blind in a different way (disease, age, etc)

4.People at younger age is easier to adapt to their

handicap

Customer support

HAD TO BE REMOVED, NO CONSENT WAS GIVEN BY THE PEOPLE THAT GAVE A REACTION ON THE BABBEL PRODUCT VIA ONLINE COMMUNICATION TOOL OFFERED FROM BABBEL. THEREFORE THIS DATA WILL NOT BE PART OF THIS THESIS.

Work:This category describes which future work blind people can do.

Interviews:

1.Blind people mostly start working later in life as self employed/ freelancer

2.*Working as a translator works well if you are blind,

since a lot is possible to do via the computer

Customer service

X

Hobbies: This category describes the hobby that blind have in their daily life.

Interview

1.Hobby: music, cabaret, listening to books

2.She loves a lot musical an theater

3.The blind children could build and navigate a car truck well trough a portal, which was really impresive, this confused me

4.We tried to work with audiobooks, but mostly they liked

to do something

Customer support:

X

2.Why exactly is he going to use the design? (Persona)

Problems experienced by blind users: This category describes the daily life the products that blind people make use of in daily life and how they experience them.

Interview

1. Navigation with screen reader on phones doesn't work when the app is not accessible

2. When I searched for apps/ online learning material I could not find accessible material that I could learn from

3. In the end she bought a book and actually scanned it in herself

4. She also uses netflix with audio description. in the past it was possible to let non existing language(for example in a fantasy serie like games of thrones), to let the screen reader let the subtitles read out loud, unfortunately that functionality is not available anymore

5. *Blind people feel uncertain if they lose feel of contextual information

6. The biggest wish blind people have is to be autonomous and normal

7. New situations / locations are very uncomfortable for the blind people,

8. because they do not yet have a memory of it

9.They rely on their memory in a location, and that is a pretty intense process

10.*20 years ago there was not much learning material for blind children

11.From the moment they came on school they did not want to be an exception

Customer service:

HAD TO BE REMOVED, NO CONSENT WAS GIVEN BY THE PEOPLE THAT GAVE A REACTION ON THE BABBEL PRODUCT VIA ONLINE COMMUNICATION TOOL OFFERED FROM BABBEL. THEREFORE THIS DATA WILL NOT BE PART OF THIS THESIS.

Attitude of blind people towards technology: This category describes how willing blind people are to accept new technology, and t also how skilled they technically are.

Interview:

1.Blind people are very technical since they depend on technology

Customer support:

X

Coping mechanisms for new situations:this category explains how blind people

Interview : X

Customer service:

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3.When and where would he use such an application?(Context of use)

Logistics/ transport: This describes the way blind people move themselves around from place to place.

Interview

1.She mostly studies when she has nothing to do, like within the car. She is always driven by somebody else

2.Mostly does not walk and uses application at the same time, she prefers to focus on the walking when walking

2.*uses a walking cain to find his way around

*Be brought to work by taxi

3.*They were always brought by car home

Customer service

X

When and where they use applications(privacy):This category describes how the application would be used.

Interviews:

1.*"He does not use multitasking, when he listens

to podcast" * also he pu the podcast very soft, because it is nobody's business what he does on his phone.

2.*She mostly studies when she has nothing to do, like within the car. She is always driven by somebody else .

3.Mostly does not walk and uses application at the same time, she prefers to focus on the walking when is walking

4.Normally she does not talk to her phone in public, then she prefers to type on her phone.

This also a sense of privacy

5.Headphones that do not cover your ears, such that blind people still perceive contextual information

6.Headphones also give a sense of privacy

Customer support:

X

4.What is the exercise he is going to use? (User stories and requirements)

Type of exercises: This category describes which types of exercises, are the most preferred or which they would use the most in language learning.

Interviews

1.*"The perfect application contains repeating an audio exercise"

2.They are very practical people which means the app should make sense and be to the point

3.*Preferably in the application there would pronunciation exercises and it would not be necessary to have images to complete the exercise, duolingo did this well

4.I like pronunciation exercises

5.But writing exercise are also very important to learn a language

6.The application really must teach me a language and not only the basic for going on a holiday for example how to order a drink in a restaurant.

7.*the type of skill they use most is speaking since it is their main way of communicating

Customer support

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Efficiency: This category explains something over the efficiency of the use of the product, so how efficient can they get through the lessons.

Interviews

X

Customer support

1.Being visually impaired, I use a huge amount of energy to navigate and use the Babbel app, which I appreciate very much nonetheless.But since you can not enlarge the

character format, it's still difficult for me to work more than 30 minutes on the application.

Visuals: This category describes how and when images can be used

Customer support

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The way of getting feedback from a system: this gives feedback on how a system could give feedback to blind users.

Interview:

1.The system give feedback trough soundscapes

2.This system empowered and reansures them

3.They prefer feedback through sound that is fast and do not distract them (relation to being able to keep on focus on their surroundings).

Customer support:

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Text size: This category says something about the text size of the Babbel product.

Interview:

X

Customer support:

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Contrast: This category describes how contrast is used by blind people, and if the Babbel product has sufficient contrast

Interview:

1.They learn to cute with a duo scissor and we falding lines in white on black paper.

2.We putted black paper behind spider web, such that it became visible

Customer support:

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5.How is he going to use the application?

Usage of Braille: This explains the usage of braille in learning a language and interacting with the web

Interview.

1.Brail is mostly used to get and understanding of the spelling of the language"

2."He is reading through brail and types in the letters thought he keyboard"

3.Audio books are so much easier then if you have to read it yourself by braille

4.*S point system is the classic braille system and the 8 point system is the one used on brail reading ruler

5.*She read books via online american company where you can download braille books online

6.She learns languages preferably through apps on her phone.If you keep your phone horizontal you can

also type in Braille (IOS 10)

7Mostly I can type in Braille with my phone but otherwise I connect a bluetooth typing board

8."He is reading through brail and typs in the letters thought he keyboard"

Customer support

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Navigation through websites: this explains how the assistive technology is used to navigate the web

Interview

1.*"Has a preference for Mac , because safari/mac gives more overview of a webpage. He has a windows computer for work who is slow, however voor using the internet

he prefers a macbook"

2.He is reading trough brail and types in the letters thought he keyboard"

3.He prefers to work on his laptop

4.*"Has a preference for Mac , because safari/mac gives more overview of a webpage. He has a windows computer for work who is slow, however voor using the internet he prefers a macbook"

5.He is reading through braille and types in the letters thought he keyboard"

6.He prefers to work on his laptop

Navigation through the Babbel App

Customer support

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How to use screenreader with the mobile application

Interviews

App

1.Uses his voice over on a very soft volume in public

2."The navigation on Iphone becomes very different, when you put on the voiceover."

3.Navigation with screen reader on phones don't work when the app is not accessible

4.Navigation horizontal you can do by swiping the left to right you can jump to the next app or the next line in a text

5.Navigation horizontal you can do by swiping the left to right you can jump to the next app or the next line in a text

5.Audio books/screen readers are so much easier then if you have to read it yourself by braille

Customer support

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How to use the screen reader with the web

Web

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How they learned language: This category describes how blind users have learned in the past a foreign language

Interview

1.*"Brail is mostly used to get an understanding of the spelling of the language"

2.He learned in high school mostly through listening exercises, when he started with languages and later on he got digital books. Here he was also able to make the exercises

3.*I learned a lot of language through music and musicals

4.She only learned a language well, when she started reading the language actively

5.They rely on their memory in a location and that is a pretty intense process

6.The blind children could build and navigate a car truckwell through a portal, which was really impressive, this confused me

7.I supported everything by vocal/ auditief and described everything that I saw others do.

8.We used building block/ letters and coupled words to movement and sound.

9.They did a lot by feeling, outside inside (nature)

10.They learn to cute with a duo scissor and we falding lines in white on black paper.

11.We putted black paper behind spider web, such that it became visible

12.The light in the class became adjusted such they could see better the blackboard(light setting/ special lamps)

13. We literal cut the word on paper

Customer support:

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Navigation on application:This category describes how blind users navigate through a mobile phone

Interview

1."Brail is mostly used to get and understanding of the spelling of the language"

2."Mobile interaction: there are many different interaction on the screen, swiping from top to bottom for scrolling and you can roll basically through a keyboard. He has an

iphone"

3.Users Iphone since the navigation is very easy

4."The navigation on Iphone becomes very different, when you put on the voiceover."

5.Navigation with screen reader on phones don't work When the app is not accessible

6.Navigation horizontal you can do by swiping the left to right you can jump to the next app or the next line in a text

7.Navigation horizontal you can do by swiping the left to right you can jump to the next app or the next line in a text

8.She learns languages preferably trough apps on her

phone.If you keep your phone horizontal you can

also type in Braille (IOS 10)

9.Mostly I can typ in Braille with my phone but otherwise I connect a bluetooth typing board

10. Audio books are so much easier then if you have to read it yourself by braille

Customer support:

X

Setup computer:

Interview

1.Has a preference for Mac , because safari/mac gives more overview of a webpage. He has a windows computer for work who is slow, however voor using the internet he prefers a macbook"

2.He is reading through braille and types in the letterstrought he keyboard"

3.He prefers to work on his laptop

4.Macbook from Apple is the nicest to work with

5.*On the computer a program was installed with big mouse, this was in the time that the computer was just introduced in the educational system

Customer support

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Use of keyboard

Interview:

X

Customer support:

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Extra help:This category explains what type of external help blind people need, if they can not solve the problem on their screen with their assistive technology

Customer support

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Other

Apps they currently use

Interview:

1.Application: Passend lezen

2.Used Duolingo before

3.I never dictate to my phone, since there are so many mistakes I have to correct afterwards

4.She owns an Ipod with dictionaries without any internet connections such that she can use it during exams.

5.She uses the podcast app from apple/ Iphone

6.She read books via online american company where you can download braille books online

Customer support:

X

Attitude towards Babbel

Interview:

X

Customer support:

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Usage of films:

Interview:

1.She also uses netflix with audio description. in the past it was possible to let non existing language(for example in a fantasy serie like games of thrones), to let the screen reader let the subtitles read outloud, unfortunately that functionality is not available anymore

Customer support

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Appendix F: Time planning of pilot test

Minutes	Task	Notes
10	Setup computer with Babbel account and cameras	The cameras should be a screen recording and an external recording with laptop
5	Read and sign declaration of agreement	Give declaration of agreement
60	Going through the lesson with concurrent verbalization but without retrospective feedback	In this part the talking speaking-out-loud method is used
15	Interview, asking about his experience	To allow for more elaborate reflection and feedback
15	Looking at other websites that he experiences as good accessible websites	To get ideas for possible improvements of the Babbel application
10	Discussing further steps	

Checklist

- Macbook computer from research
- Subscription Babbel
- Setup of assistive technology of end user

Appendix G: WCAG 2.1 analysis

In this appendix the state user problem can be found and the translation to wcag 2.1 standards can be found.

Screen/ trainer	User problem observer1	User problem observer 2	Time code	Wcag 2.1 guideline	Success criteria
Learning screen	The user needs help to know where to navigate towards to find the next button and learning tips	navigation on learning tip screen seems impossible for speech assisted browser	19:02	Operable :Navigable	2.4.1 Bypass Block
	The progress bar is described with "lessonplayer"		19:01	Operable: Navigable	Link purpose 2.4.9

Vocabulary speak	The audio start playing before he understands the instruction, therefore he does not understand what to do with the words	it doesn't read at all what the user is supposed to be doing, it doesn't say at what point the lesson should transition also there was no sound recording	21:00	PerceivablE: Adaptable	1.3.1Info and relationship 1.3.2 Meaningful sequence
	He seems to not get a screen where he can select the microphone	Noted here as well	19:00		
Vocabulary Click	There might be a loop in the interface where the user gets stuck	Noted as well	25:01	Operable:Keyboard accessible	2.1.2 no keyboard trap

	The instruction that explains the type of interaction should be included, since from the content it is not clear what to do.		25:16	Perceivable:Text alternatives	Non-Text content
Writing vocabulary	Here the braille display has to be used	vorab write. how is he supposed to know the correct spelling (in case braille reader is not attached)	29:57		
	He likes the point he got	seems happy with his progress, after all. he smiles	43:00		

	Did not understand the principle for asking for help	the buttons are not clear, what does help/ solve mean	29:57	Robust:compatible	4.1.2 name, role value
	Does not understand that he made a mistake(mis sed the feedback)	it is not clear to the user if the word is currently correct or not show solution works (surprisingly enough)	39:07	Perceivable:Text alternatives	1.1.1 Non text content
	He does not see the pop up buttons		41:03	Perceivable: Distinguishable	1.4.13 Content on Hover on Focus
	He does not seem to at first instance the function of the letter underneath fill in screen.	the buttons are not clear, what does help/ solve mean	29:57	Robust:compatible	4.1.2 name, role value

		it seems to be clicking continue before he voluntarily tries to click continue	44:00		

Cube choice button trainer	Another way of communicating a word is missing should be implemented, based on the screen reader it does not become clear enough —> maybe some words in it	it's not clear where the gap is, i think. the sentence is super long and in spanish, and he's a total beginner. no help there. the translation is there, but comes after this super long text and he can't know that in advance. no explanation given in advance about how it works.	45:...	Perceivable adaptable	1.3.3 Sensory characteristics
		he finds the words buttons but has no idea what to do with them	47:19		

		second item goes a lot better	51:01		
		the image seems to be described as 200 by 200 somethings	44:55	Perceivable:Text alternatives	1.1.1Non-text alternative
Memory trainer	Has problems with understanding what exactly is happening	to click the wrong answer has only visual feedback	55:30	Perceivable:Text alternatives Perceivable adaptable	1.3.3 Sensory characteristics 1.1.1 text alternative
	He thinks he is stupid, because I feels he does not enough effort to try to understand it		58:29		

Appendix H: Search Matrix

In this appendix, we describe how we found our literature for our literature review.

	Keywords	source	Type	DOI	How many times cited	Link	Topic	available
		Gotten from a specialist of Universidad Politecnica					Sensitive intrfaces n applications for blind	Yes
	Google scholar	Found in former research	article	yes	140 times cited	https://www.sciencedirect.com/science/article/pii/S0747563203000906	Improving web accessibility: a study of webmaster perceptions	yes

		Former research	article	yes	Not cited	https://www.sciencedirect.com/science/article/abs/pii/S092054891830146 6	Development of an electronic book accessibility standard for physically challenged individuals and deduction of a production guideline	yes

		Google(used because the topic was very relevant)	Conference paper/ informatic paper	no	no	Teaching the blind language learning	https://robobraille.org/sites/default/files/resourcefiles/teaching_foreign_language_-_blind.pdf	yes

22 of Mach	Online learning tools for people with a impairment	Google	website			https://www.special-education-degree.net/top-12-websites-children-learning-disabilities/	Top 12 Websites For Children With Learning Disabilities	
		google	Website			https://www.accreditedschoolsonline.org/resources/helping-blind-low-vision-students/	Helping Students With Visual Disabilities Resources, Tools And Technology To Foster School Success	
16 of April								

	Eric Vellemann	Google scholar	Article	Yes	3	**https://link.springer.com/chapter/10.1007/978-3-540-27817-7_39**	3D Shooting Games, Multimodal Games, Sound Games and More Working Examples of the Future of Games for the Blind	No
	blind people and online language learnin	Google scholar	article	Yes	6	https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.0268-2141.2005.00379.x	Supporting foreign language learning for a blind student: a case study from Coventry University	No

	g	Google scholar	Article	No	N.A	https://www.researchgate.net/profile/Marco_Arrigo/publication/228613727_E-learning_accessibility_for_blind_students/links/0c96051c9a5404e6d9000000/E-learning-accessibility-for-blind-students.pdf	E-learning accessiblity for blind students	

		Google Scholar	Article	NO	N.A	https://www.researchgate.net/profile/Sheryl_Burgstahler/publication/248226093_Universal_design_of_distance_learning/links/5453a5970cf2cf51647c1eb2/Universal-design-of-distance-learning.pdf	Universal design of distance learning	Yes

	Blind People and long distance learning	Google Scholar	article	Yes	45 citations according to (https://www.researchgate.net/publication/265474644_The_'Eye Cane'_a_new_electronic_travel_aid_for_the_blind_Technology_behavior_swift_learning)	https://content.iospress.com/articles/restorative-neurology-and-neuroscience/rnn130351	The "EyeCane", a new electronic travel aid for the blind: Technology, behavior & swift learning	
		Google Scholar				https://www.taylorfrancis.com/books/e/9780203053492/chapters/10.4324/9780203053492-8	Constructionism in Practice	No

	Online learning for blind	Emerald	NOACCESS					
		Google scholar	Article	Yes	According to research 12 citation and 7 references https://www.researchgate.net/publication/313861613_Active_audiodescription_to_promote_speaking_skills_in_online_environments	https://repositori.udl.cat/handle/10459.1/58785	Active audiodescription to promote speaking skills in online environments	Yes

17 april	Blind People and long distance learning	Google	Website	No	No	https://thejournal.com/articles/2012/08/15/school-for-blind-leads-the-way-in-distance-learning.aspx	School for Blind Leads the Way in Distance Learning	
			Website			http://www.ra.ethz.ch/cdstore/www6/access/ACC226.html	Thessaloniki School for the Blind: A Distance Education Program for Blind Children Based on the WEB	
	blind and learning on a distance	Google	Article	No	No	https://www.citejournal.org/volume-1/issue-1-00/current-practice/distance-learning-and-the-visually-impaireda-success-story/	Distance Learning and the Visually Impaired: A Success Story	NO

		Google	Article	Yes	n.a	https://content.sciendo.com/view/journals/eurodl/18/1/article-p72.xml	Distance Education For People With Visual Impairments	Yes
		Google	Article	No	n.a	http://www.eurodl.org/?p=archives&year=2015&halfyear=1&article=671	Distance Education for People with Visual Impairments	Yes
		Google	Article	Yes	4(downloaded: 4717 4)		Designing E-Learning Collaborative Tools for Blind People	Yes
	blind and learning on a distance doi	Google				https://www.igi-global.com/article/wrestling-online-learning-technologies/42094	Wrestling With Online Learning Technologies: Blind Students' Struggle to Achieve Academic Success	No

						The Status of Web Accessibility of Canadian Universities and Colleges: A Charter of Rights and Freedoms Issue	https://www.learntechlib.org/primary/p/4693/	NO

	Audio and language learning	Chapter from a book	Yes	Yes(ISBN)	published	Ibáñez Moreno, A., and Vermeulen, A. (2013). Audiodescription as a tool to improve lexical and phraseological competence in foreign language learning. In D. Tsagari and G. Floros (eds.), Translation in language teaching and assessment (p. 41-64). Newcastle upon Tyne: Cambridge Scholars Publishing.	https://biblio.ugent.be/publication/4211313	Yes

						https://www.researchgate.net/publication/269096749_Interlingual_Subtitling_for_Intercultural_Language_Education_A_Case_Study	Interlingual Subtitling for Intercultural Language Education: A Case Study	Yes, but no incopo rating accessi bility
						https://www.peterlang.com/view/title/34898	Audiovisual Translation – Subtitles and Subtitling	No

	(produced much over the job so search authors) Talaván, N., and Rodríguez-Arancón, P. (2014a). The use of reverse subtitling as an online collaborati					https://www.tandfonline.com/doi/abs/10.1080/1750399X.2014.908559	The use of reverse subtitling as an online collaborative language learning tool	No

		Website				https://beyondlanguagelearning.com/2018/02/15/audio-description-of-tv-and-movies-a-great-source-of-comprehensible-input-for-language-learners/	Audio description of TV and movies: a great source of comprehensible input for language learners	
		Research gate, via google	article	yes	24 references and 6 citations	https://www.researchgate.net/publication/301723454_Using_audio_description_to_improve_FLL_students_oral_competence_in_MALL_methodological_preliminaries	Using audio description to improve FLL students' oral competence in MALL: methodological preliminaries	Yes

				No	No	https://dcmp.org/learn/279-listening-is-learning-audio-description-aids-literacy	Listening is Learning: Audio Description Aids Literacy	Yes

	audio description language learning visual impaired	Research gate and google	Article	yes	yes(according to research gate) 12 citations https://www.researchgate.net/publication/312659141_Creative_description_The_impact_of_audio_description_style_on_presence_in_visually_impaired_audiences	https://journals.sagepub.com/doi/abs/10.1177/0264619616661603?journalCode=jvib	Creative description: The impact of audio description style on presence in visually impaired audiences	Yes
	Further same articles							

	Scopus					https://www-scopus-com.ezproxy2.utwente.nl/record/display.uri?eid=2-s2.0-84991010616&origin=resultslist&sort=plf-f&src=s&st1=visual+impaired++online+learning&nlo=&nlr=&nls=&sid=dac5764ec24f6e97f934068dcab7bc34&sot=b&sdt=sisr&sl=47&s=TITLE-ABS-KEY%28visual+impaired++online+learning%29&ref=%28visual+impaired+and+learning%29	How useful are closed captions for learning mathematics via online video? (Article)	No

Appendix I: Literature Matrix

Authors	Title	Q1: availability	Q2: How learn?	Q3: Tech pro/opp	Q4: Best practices
Liakou, M., & Manousou, E.	Distance Education For People With Visual Impairments	Aims for decreasing social exclusion for lower impaired user, by researching how to make a long distance education for visual impaired			
Lazar, J., Dudley-Sponaugle, A., & Greenidge, K.	Improving web accessibility: a webmaster study of webmaster perceptions	Inaccessibility is recognized by web programmers, but not always a priority			
Park, J. H., Kim, H., & Lim, S.	Development of an electronic book accessibility standard for physically challenged individuals and deduction of a production guideline	E-boooks are not always accessible since they are lower distrubuted than websites, low standarization and testing.	We have to learn trough different media	High automated compliance checking to standards	It is important to learn through several media, however verifying accessibility will become more complicated.

Claudia, M., Buzzi, M., & Mori, B. L.	Designing E-Learning Collaborative Tools for Blind People	Not all long distance collaborative platforms are accessible for people with a disability	Learning cone enabling collaborative learning	Google docs and webtoll transforming digital document to a structured audio podcast	
Walczak, A., & Fryer, L.	Creative description: The impact of audio description style on presence in visually impaired audiences.		High use of subjective description of movies as opposed to objective		
M. I., Vermeulen, A., & Jordano, M.	Using audio description to improve FFL students oral competence in MALL: Methodological preliminaries.				Medium Prototype VISP
Guerrón, N. E., Cobo, A., Martín, C., & Serrano, J. J.	Sensitive interfaces in application for blind people.			High Hearing or feeling shapes augmented reality	

Talavan, D., & Lertola, D	Active audio description to promote speaking skills in online environments. Sintagma:		AD can also be a good way to learn a foreign language	Addressed AD for blind	High making use of Clipflair Studio to collaborative make AD AD can also be a good way to learn a foreign language
Moreno, A. I., & Vermeulen, A.	Audio Description as a tool to improve lexical and phraseological competence in Foreign Language Learning. Researchgate			Medium: using Audio descriptor to learn higher level communication / translation for non blind	No prototype mentioned
Maidenbaum, S., Hanassya, S., Abboud, S., Buch, G., Chebat, D., Levy-Tzedek, S., & Amedi, A.	The “EyeCane”, a new electronic travel aid for the blind: Technology, behavior & swift learning.		Blind also want easy to learn apps/ devices	MEdium device for moblitiy	A prototype seems to have been used

Erasmus t Programma of the European Union	Teaching the Blind Foreign Language: A series of special education teaching guide	VERY clear: lack of material for blind		VERYclear : most materials are Audio and visual Specialize d teachers: -reading machines -Daisy books and players RoboBraill e service -Online dictionaries -Digital recorder to take notes -Digital games to enhance vocabulary - Thereform -Option Character recognition	Practica l illustration s
Chambel , T., Antunes, P., Duarte, C., Carriço, L. & Guimarães, N. (2009).	Proceedin gs of Creativity and HCI: From Experience to Design in Education	States that it learning depends on the individual experiences			

Mayer, R. E.	Multimedia learning.		States that learning trough several media is important to all people in general		
Dale	Audovisual methods in teaching		Designed the learning cone		

Appendix J: Flow of Sprint and Activity diagrams

We will write this design again from the point of view of Kyra and would describe therefor from I perspective.

Scenario

I am completely blind, so I do not see anything on the screen. I use my screen reader to navigate trough webpages.

The moment I used the Babbel Writer Trainer, I mostly first scan the page to form a mental image of the page. I will first enter the page, by pressing shift my voice over key and down arrow. Then I First I will navigate with my Voice Over key(VO)-arrow keys through the webpage. First I will check the navigation bar and check out which topics there are.

After I checked the navigation bar I expect instruction on what to do.

I expect from this instruction that it tells me what I have to do in which and what language, but also what I can expect in the sense of the type of exercise (reading, writing, etc) and how the interaction might look like.

I read that I have to translate from English to Spanish and that I will first hear the word, that I then will see the mixed up version of the Spanish translation and after that, I have to fill in the item through my keyboard. I hit my arrow key to the right(still my VO pressed) and expect now to find the item I have to translate.

I hear the audio from the word. If I am not sure anymore what to do I can navigate back with my arrow and VO keys back to the instructions in the beginning. When I go back to the instruction I hear the total instruction again.

I decide to continue to navigate further and I hear a letter combination of-U- F-R -T-A spelled out through my screen readers voice (Here she again can go back to the instruction). I navigate further and I hear through her screen reader "La" and then she finds elements she can interact with. She presses the VO and the arrow keys. I see that it is something I have to fill in, and read in the label: FILL IN HERE THE ANSWER AND HIT ENTER TO SUBMIT.

WAIT! What do I have to do again? I would like to hear again the way you pronounce it and how did you spell it again? I navigate to the left again and hear the mixed letters. I navigate back to the right and try to type in F-R-U-T and hit enter. I hear a negative sound(This is something a design choice should be made), where I kind of assume that I miss typed it.

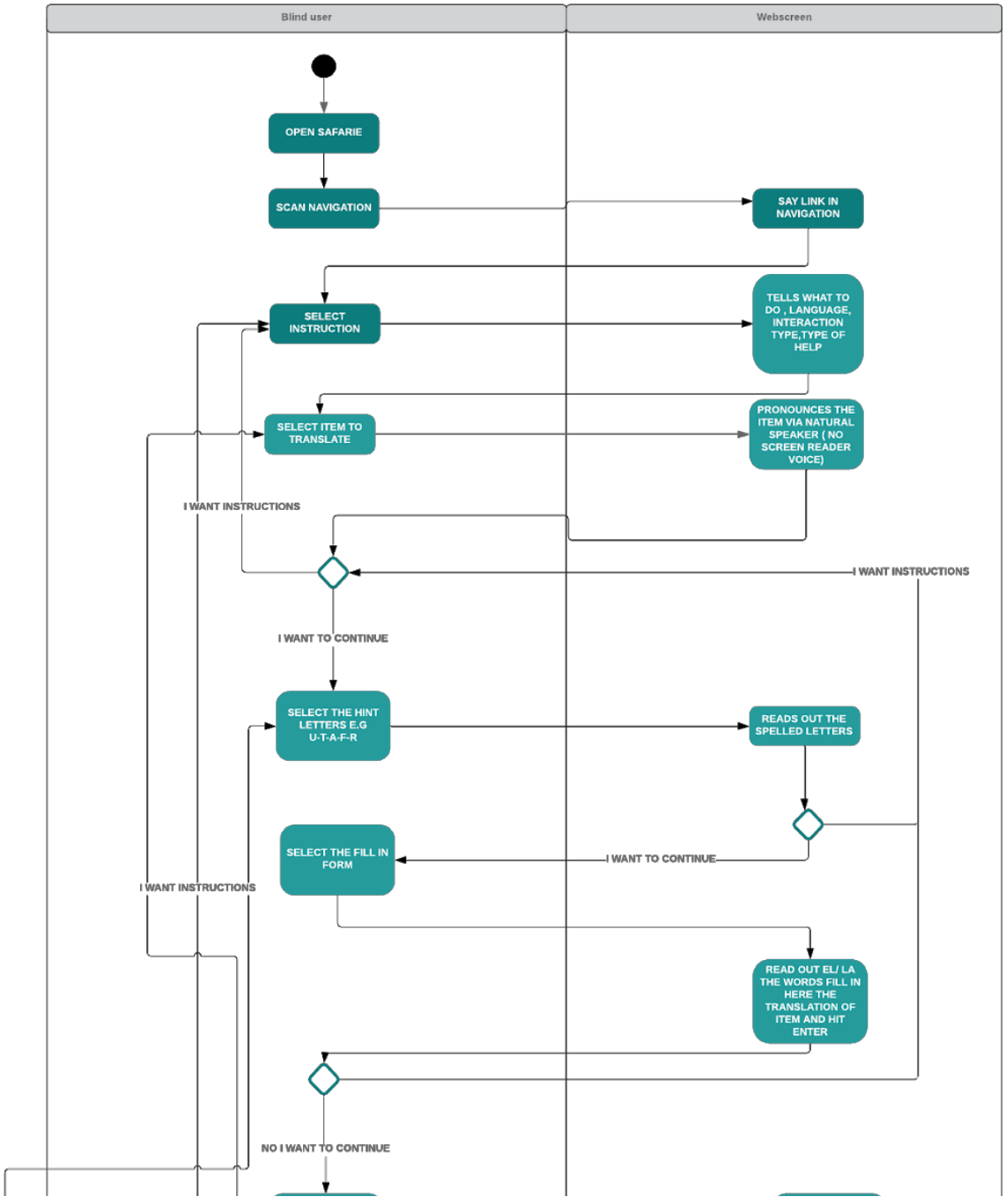
I miss typed it but don't know what to do, so I just navigate to the right. I find a button SHOW SOLUTION. Yes great I want to know the solution. I click the button SHOW SOLUTION. I hit to the next again and find a link: go back to answer(QUICK LINKS!), this navigates me back to the gap where I can fill my answer. Now I see the words in the label, F-R-U-T-A: fill in the word now yourself is filled in the label or hit press the button solve. I type the word and hit enter.

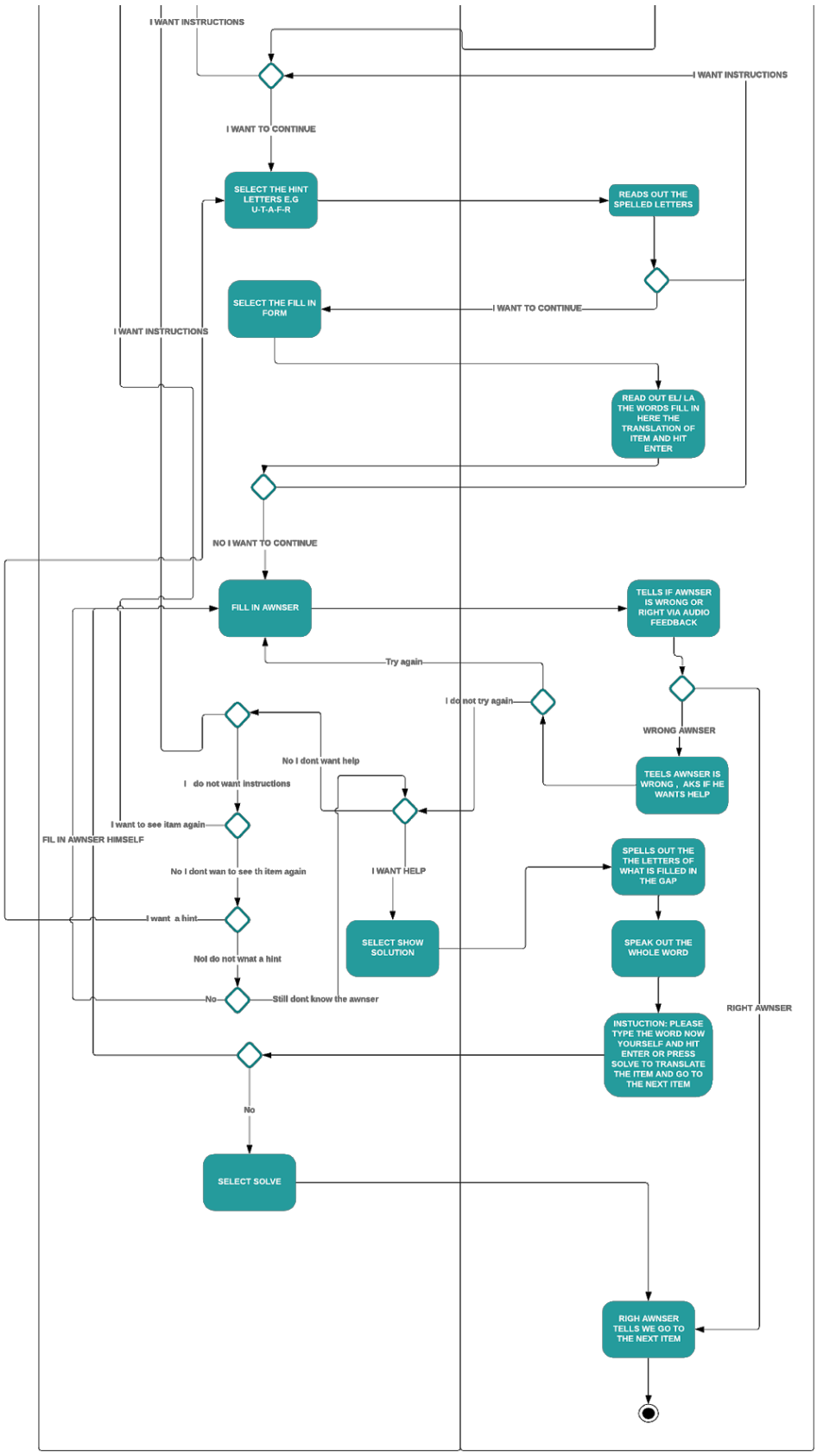
For a more visual representation see the activity diagram here down below.

FIRST TIME USE OF VOCABULARY WRITE TRAINERWITH THE FIRST WORD :FRUTA

Carmen | May 19, 2019

*ASSUMES THAT DISPLAY LANGUAGE IS SELECTED IN SCREEN READER
*INFINITE AMOUNT ATTEMPS ARE ALLOUWED
*WE STICK WITH THE CURRENT FLOW

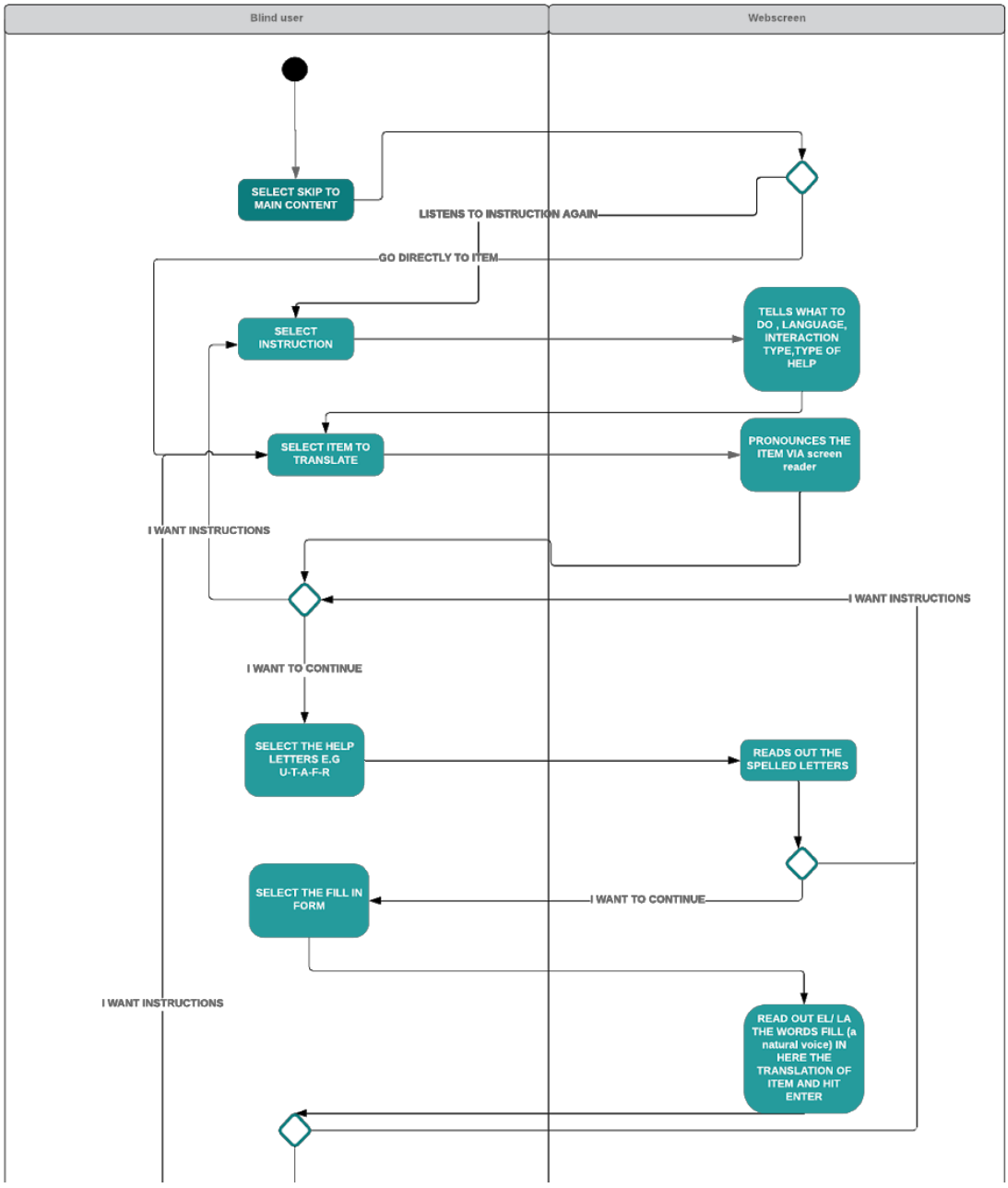


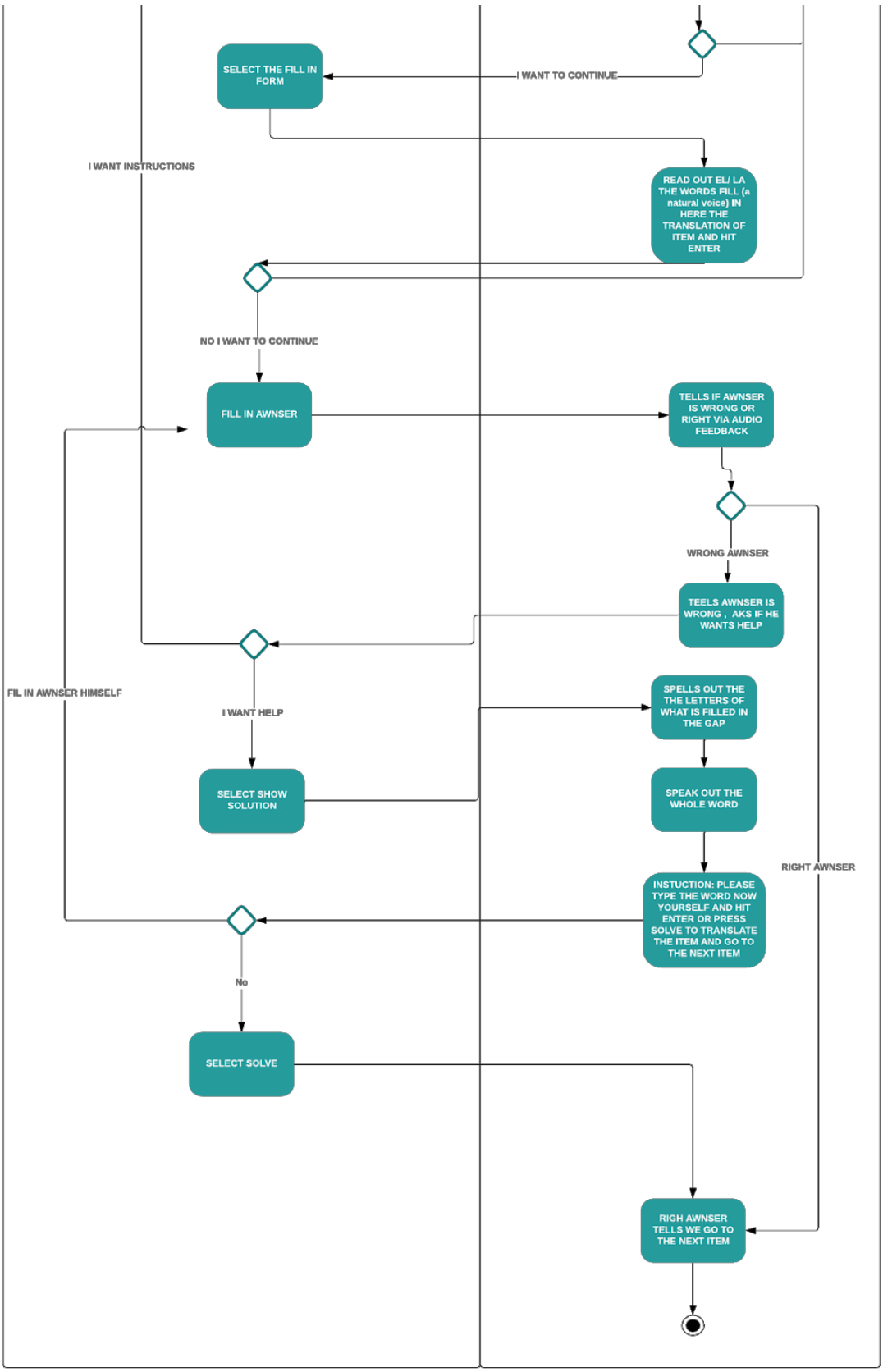

I WANT INSTRUCTIONS
I WANT INSTRUCTIONS
I WANT TO CONTINUE
SELECT THE HINT LETTERS E.G U-T-A-F-R
READS OUT THE SPELLED LETTERS
SELECT THE FILL IN FORM
I WANT TO CONTINUE
I WANT INSTRUCTIONS
READ OUT EL/ LA THE WORDS FILL IN HERE THE TRANSLATION OF ITEM AND HIT ENTER
NO I WANT TO CONTINUE
FILL IN AWNSER
TELLS IF AWNSER IS WRONG OR RIGHT VIA AUDIO FEEDBACK
Try again
I do not try again
WRONG AWNSER
No I dont want help
I do not want instructions
TEELS AWNSER IS WRONG , AKS IF HE WANTS HELP
I want to see itam again
FIL IN AWNSER HIMSELF
SPELLS OUT THE THE LETTERS OF WHAT IS FILLED IN THE GAP
No I dont wan to see th item again
I WANT HELP
I want a hint
SELECT SHOW SOLUTION
SPEAK OUT THE WHOLE WORD
Noi do not wnat a hint
No
Still dont know the awnser
RIGHT AWNSER
INSTUCTION: PLEASE TYPE THE WORD NOW YOURSELF AND HIT ENTER OR PRESS SOLVE TO TRANSLATE THE ITEM AND GO TO THE NEXT ITEM
No
SELECT SOLVE
RIGH AWNSER TELLS WE GO TO THE NEXT ITEM

SECOND TIME USE OF VOCABULARY WRITE TRAINERWITH THE SECOND WORDL PLATANO

Carmen | May 19, 2019

*ASSUMES THAT DISPLAY LANGUAGE IS SELECTED IN SCREEN READER
*INFINITE AMOUNT ATTEMPS ARE ALLOUWED
*WE STICK WITH THE CURRENT FLOW




SELECT THE FILL IN FORM
I WANT TO CONTINUE
I WANT INSTRUCTIONS
READ OUT EL/ LA THE WORDS FILL (a natural voice) IN HERE THE TRANSLATION OF ITEM AND HIT ENTER
NO I WANT TO CONTINUE
FILL IN AWNSER
TELLS IF AWNSER IS WRONG OR RIGHT VIA AUDIO FEEDBACK
WRONG AWNSER
TEELS AWNSER IS WRONG , AKS IF HE WANTS HELP
FIL IN AWNSER HIMSELF
I WANT HELP
SPELLS OUT THE THE LETTERS OF WHAT IS FILLED IN THE GAP
SELECT SHOW SOLUTION
SPEAK OUT THE WHOLE WORD
RIGHT AWNSER
INSTUCTION: PLEASE TYPE THE WORD NOW YOURSELF AND HIT ENTER OR PRESS SOLVE TO TRANSLATE THE ITEM AND GO TO THE NEXT ITEM
No
SELECT SOLVE
RIGH AWNSER TELLS WE GO TO THE NEXT ITEM