UNIVERSITY OF GOTHENBURG

DEPARTMENT OF EDUCATION, COMMUNICATION & LEARNING

Digital Accessibility for Swedish Second Language Learners

A development project for an online museum resource

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Thesis:	30 higher education credits
Program and/or course:	International Master's Programme in IT & Learning
Level:	Second Cycle
Semester/year:	Spring term 2021
Supervisor:	Géraldine Fauville
Examiner:	Linda Bradley
Report no:	VT21-2920-006-PDA699

Abstract

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Keywords:	Design Thinking, Universal Design for Learning, digital accessibility, second language acquisition, second language learners, digital learning resources

Purpose: The overall purpose of this development project is to explore the struggles that Swedish second language learners (SSLL) encounter while using digital learning resources and to suggest digital accessibility improvements on the Human Nature Skola, which is a museum digital learning resource.

Theory: This thesis is a development project which is based on Design Thinking theory and the framework of Universal Design for Learning (UDL).

Method: The methodology used in this project is based on the five-stage Design Thinking model proposed by Hasso Plattner at Institute of Design at Stanford, which is commonly known as d.school (Plattner, 2010). The five stages followed are: Empathise, Define, Ideate, Prototype and Test.

Results: The results indicated that SSLL encountered several struggles in addition to learning the new language. Such struggles are: difficulties to comprehend written texts, self-consciousness and difficulties to adapt in the new culture. Furthermore, the findings of this development project provide recommendations for re-designing the Human Nature Skola in order to be more accessible for SSLL. More specifically, it is suggested to apply methods and theories of the Multimodal framework as well as the UDL framework, with focusing on the principle of multiple means of representation of the information. Finally, the results showed the need for making learning experiences customized and personal considering the individuals' needs.

Foreword

I would like to thank my supervisor Géraldine Fauville at the University of Gothenburg for supervising and dedicating her time to help me throughout this project. I would also like to thank the Museum of World Culture in Gothenburg, Sweden for the collaboration and the support. Finally, I would like to express my gratitude to all the participants who devoted their time and shared their experiences.

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DT - Design Thinking

EU - European Union

SLL - Second-language learners

SSLL - Swedish second language learners

UD - Universal Design

UDL - Universal Design for Learning

Chapter 1: Introduction

The growth of digital technologies has provided access to numerous digital learning resources and has affected how people learn. Digital technologies have spread in every aspect of society, including museums which used to be only physical but now they offer a variety of digital learning resources, creating new experiences and enhancing accessibility for a wider range of people (Lisney et al., 2013). While digital technologies can enhance accessibility and reduce inequities, it can also create challenges for second language learners who are facing difficulties due to language barriers. This paper is concerned with exploring the struggles that Swedish second language learners encounter while using digital learning resources and suggests design strategies for improving digital accessibility incorporated into an existing museum digital learning resource.

In a world of increasing human mobility, globalization and migration, Swedish schools are more diverse than ever with 25 % of children (under 18 years old) with a foreign background (SCB, 2020). This increased diversity in the population has impacts on schools with classrooms hosting a wide range of students either fluent in Swedish or learning Swedish as their second language. According to Skolverket (2020), the number of students that enrolled in Swedish as a Second Language course has increased dramatically in the last eight years. In the academic year 2019-2020, around 137 000 students attended the Swedish as Second Language course, corresponding to about 13 % of all the students' population who attend in the compulsory school system. Second language learners encounter various challenges in the new country such as anxiety, frustration, cognitive and culture (over)load (Meyer, 2000; Miller & Endo, 2004; Woodrow, 2006).

With the growing linguistic and cultural diversity in today's classrooms, and the demand to meet a wider range of students' requirements, arises a greater need for Universal Design for Learning (UDL) and digital accessibility (Doran, 2015). UDL is a framework based on the importance of providing multiple ways of representing knowledge in order to improve learning and teaching for everyone (CAST, 2018). UDL also makes instructions more accessible and appropriate for learners with diverse backgrounds and learning styles, by providing teachers with strategies on how to meet the needs of the diverse spectrum of learners. Similarly to the UDL framework, the multimodality approach can support a variety of learners' needs, as it allows the presentation of artefacts with multimodal options (Jewitt et al., 2016).

Recently, the European Union (EU) has made great progress in establishing laws about accessibility for a wider range of people. In 2016, the EU enforced the Web Accessibility Directive 2016/2102 (EU commission, 2016) that requires websites and applications of public sector in the EU to implement and maintain a uniform set of accessibility standards (EU commission, 2016). In 2019, the EU also adopted the European Accessibility Act (Directive 2019/882) (EU commission, 2019) that ensures access to products and services for a broader spectrum of people. The European Accessibility Act also encourages companies to integrate accessibility into their development process by following common accessibility rules across the EU (EU commission, 2019).

Human Nature Skola (http://humannatureskola.se/) is a digital learning resource for schools and is part of the Human Nature project by the government-owned National Museums of World Culture (Swedish: Världskulturmuseet). The Human Nature Skola aims to create

awareness about sustainable development and responsible consumption for students. Their website is currently only available in Swedish, which creates barriers for students who are Swedish second language learners (SSLL).

This design project is a preface of a research project proposal about digital accessibility for Human Nature Skola created by the Museum of World Culture in Gothenburg and Funka which is a digital accessibility organization. The problem I will try to address stem from two components: the collaboration with the National Museum of World Culture and their project about digital accessibility for Human Nature Skola as well as my personal experience moving to Sweden and being a SSLL. In this project, I will focus on the difficulties SSLL are facing while using digital learning resources in the classroom and I will suggest design strategies that can be implemented to Human Nature Skola for enhancing accessibility for Swedish second language learners. For the purpose of this development project, the Design Thinking approach was adopted as it is an approach that focuses on what people need and how technology can satisfy their needs while promoting an innovative way for problem solving. During the Design Thinking process, UDL principles will be considered as a tool to strive for meeting a wide range of student needs and for improving the accessibility of learning resources. I will follow the five-stage Design Thinking model proposed by Plattner at Institute of Design at Stanford (Plattner, 2010) to get a better understanding from the target users and propose design strategies for improving accessibility for SSLL of the Human Nature Skola website.

Purpose and Research Questions

The aim of this project is to explore the challenges that SSLL face while using digital learning resources. Furthermore, based on the five-stage Design Thinking model (Plattner, 2010), this thesis suggests design strategies to improve digital accessibility for the Human Nature Skola for SSLL.

To do so, this thesis addresses the following research questions:

1. What challenges do Swedish second language learners encounter in the classroom when using digital learning resources as part of the formal education?

2. What design strategies can the Human Nature Skola implement to make it more accessible for Swedish second language learners?

Chapter 2: Literature Review

2.1 Museums as learning environments

Museums constitute a cultural public institution where people can take part in various experiences that promote education, learning, dialogue and debate (Falk & Dierking, 2018; Hein, 2002). According to the International Council of Museums (ICOM) Statutes (2007), Article 3, Section 1, a museum is:

> A non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment. (p.3).

Based on this definition, it is apparent that museums must provide access to education for all members of society, including people who are second language learners and might face difficulties accessing the museum content. The use of digital technologies in museums enables visitors to get a better understanding of the exhibitions by offering the option for complementary information, but also enhances accessibility for a broad range of people (Vaz et al., 2018).

Since the 19th century, museums have been considered nurturing learning environments (Crowley et al., 2014). Museums provide a wide range of informal learning experiences that enhance learner engagement and differ from the planned and guided formal school classroom experiences (Crowley et al., 2014). Hein (2002) described how people learn in museums by constructing knowledge and making connections with the exhibition's objects and their own experiences. Hein (2002) supported that visitors learn "by constructing their own understandings" (p.179).

2.2 Second language acquisition

Second language acquisition (SLA) constitutes a research field seeking to understand how people learn a second language and the process involved (Gass, 2013). More precisely, SLA is a term that describes learning a second language after the first one is established, although sometimes learning a second language can happen while the person has not yet acquired their mother tongue (Ortega, 2014). Second language learners in addition to the language itself, need to face the requirements of the people that they communicate with (Brown, 2000).

In today's multilingual society, the number of second language learners is growing. Second language learners face various challenges as they establish themselves in a new country, in addition to trying to learn the new language which mainly derives from linguistic and cultural differences (Miller & Endo, 2004). While some students progress fast with the acquisition of new language, others struggle (Marshall & DeCapua, 2013). Many researchers have investigated the challenges second language learners face in the classroom. According to Krashen (1982) most of the studies related to successful SLA focus on the importance of motivation, self-confidence and anxiety. Miller and Endo (2004) described the first experience with the new language as a "language shock" (p.787) for learners which can be a source of anxiety and frustration. They highlighted that learners' anxiety due to the struggle with the language might also negatively affect their academic performance and decrease their

motivation and self-esteem. Similarly, Woodrow (2006) mentioned that the anxiety and the fear of failure are caused by the worry of making mistakes while speaking the second language. Another barrier is the cultural differences between the learner and the practices of the classroom, coined by Meyer (2000) as culture load. Likewise, Miller and Endo (2004), argued that students coming from another culture with different educational curriculum have to adapt to the new information and consequently can experience increased cognitive load.

Today, 25 % of school students in Sweden, or around 500 000 children under the age of 18, are either born abroad or born in Sweden to foreign parents (SCB, 2020). Therefore, it is important to consider the variety of specific and unique needs of the students due to the increasing linguistic and cultural diversity in Swedish classrooms. According to the curriculum for primary and lower secondary schools in Sweden, students have the right to develop their native languages in order to develop confidence in their language ability. Students have the right to get instruction in their mother tongue or Swedish as a second language (Skolverket, 2018). The importance of embracing the students' mother tongue in order to learn the second language has been highlighted by many researchers (Cummins, 2001; Cummins et al., 2015; Yazici et al., 2010). However, it is important to focus also on teacher preparation and on positive learning environments for all students and specially for those who are coming from another country and face several challenges besides the language barrier (Miller and Endo, 2004).

This project will investigate the challenges that second language learners experience while using digital learning resources. In this project, second language learners will refer to students who have moved to Sweden and have a foreign background.

2.3 Multimodality

Multimodality is an interdisciplinary approach that understands that meaning-making is possible in different modes and media, apart from text (Jewitt et al., 2016). According to Bezemer and Kress (2008) a mode is "a socially and culturally shaped resource for making meaning" (p. 171). They highlighted that information in learning resources is a combination of different modes such as, static or dynamic illustrations, written text, layout and speech. Using multimodal texts, contributes to a more comprehensive content which might address the needs of more people in the society (Bezemer & Kress, 2008). Due to the increased use of digital technologies, creating multimodal texts has become an everyday practice. Digital technologies enable the combination of different modalities and media which facilitate meaning-making (Kress & Selander, 2012; Serafini, 2014).

There is a great body of research on the benefits of multimodal composition, especially for culturally and linguistically diverse students (Ajayi, 2009; Cook & Durpas, 2004; Jewitt 2008; Mayer, 2002; Picciano, 2009; Sankey et al., 2010). Combining multiple modes for meaning-making, benefits a wider range of learners by allowing them to "experience learning in ways in which they are most comfortable while also challenging them to experience and learn in other ways" (Picciano, 2009, p.16). Using multimodal texts in multicultural and multilingual classrooms provides students with "a more representative platform for meaning-making" promoting varied ways of entry into texts (Ajayi, 2009, p.586). These results are similar to those reported by Jewitt (2008) and Sankey et al., (2010) who argued that providing multiple modes of representations can contribute to include needs of a diverse range of students by generating multiple access points of the content. Furthermore, the

combination of words and graphics (such as pictures or videos) provides the opportunity for the learners to construct verbal and pictorial representations and connections between them (Mayer, 2002). However, some researchers have found that multimodal learning environments do not necessarily contribute to deeper learning although they improve satisfaction for the learning experience (Sankey et al., 2010).

This development project will be focused on theories and methods of the multimodal learning approach in order to address the needs of SSLL for comprehending the content of Human Nature Skola.

2.4 Digital Learning Resources

The term digital learning refers to learning supported by digital technologies. More specifically, ESSA (2015) defines digital learning as "any instructional practice that effectively uses technology to strengthen a student's learning experience and encompasses a wide spectrum of tools and practices" (p.1969). ESSA (2015, p.1969) states that digital learning includes:

1. Interactive learning resources, digital learning content, software or simulations with academic content.
2. Access to online databases and primary sources of information.
3. The use of data and information to personalize learning and provide targeted supplementary instruction.
4. Online and computer-based assessments.
5. Learning environments that allow for rich collaboration and communication, which may include student collaboration with content experts and peers.
6. Hybrid or blended learning, under direct instructor supervision
7. Access to online course opportunities for students in rural or remote areas.

Digital learning resources refer to a variety of "digital resources such as applications (apps), software, programs, or websites that engage students in learning activities and support students' learning goals" (Zehler et al., 2019, p.155) and are divided into three categories:

- digital academic content tools
- digital productivity tools, and
- digital communication tools

For the purpose of this development project, digital learning resources refer to digital material that is organized in educational platforms and can be used as learning material in the classroom which describes the Human Nature Skola website.

Various studies have explored the experiences of SLL while using digital learning resources and have highlighted the advantages of digital learning resources for the SLL. Hafner (2014) suggested that integrating digital videos into a learning activity has a positive impact on SLL who engage actively in language learning. Similarly, López (2010) indicates that using digital learning tools can improve the performance of SLL in the classroom. SLL can also encounter challenges while using digital learning resources which can affect the learning experience. Regarding SSLL and struggles they face while using digital learning resources, not much research is done, therefore it needs to be examined further.

2.5 Digital accessibility

Digital accessibility has increased with the growth of information and interactive services available through the web and mobile devices. Web accessibility is included in digital accessibility and it specifically refers to the ability of websites, tools and technologies to be accessible to a wide range of people. Everyone should be able to use the Web and to perceive, understand, navigate and interact with the Web (World Wide Web Consortium, 2019). An accessible environment can satisfy the needs of a broader range of people. For example, information in clear and simple language can benefit speakers of a second language (World Health Organization, 2011). To help improve Internet accessibility, the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C) introduced the Web Content Accessibility Guidelines with the latest version WCAG 2.1 being published in 2018 (World Wide Web Consortium, 2018). These guidelines aim to make web content more accessible and more usable for users by recommending alternative text for images, transcripts for audio and speech keyboard input (World Wide Web Consortium, 2019). Second language learners can also benefit from these guidelines as they are enhancing content's accessibility.

2.6 Universal Design and Universal Design for Learning

The concept of Universal Design (UD) or as it is also called Inclusive Design comes from the field of architecture and started as a revolutionary proposal for planning and designing physical spaces that are usable for a wide range of people (Mcquire et al., 2006). UD increases the quality of life for many individuals and reduces stigma for people with functional limitations (Steinfeld & Maisel, 2012). The most widely known definition of UD by Mace is "the design of products and environments to be usable by all people to the greatest extent possible without the need for adaptation or specialized design" (Connell, 1997, para.1). With the recent emphasis on social inclusion, a new definition by Steinfeld and Maisel (2012) described the concept of UD with a focus on people with disabilities, but also recognizing that the concept of UD can also be used in a virtual world or in delivery for services. According to this definition, UD is a "process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation" (Steinfeld & Maisel, 2012, p.29).

Universal Design for Learning (UDL) was developed by CAST, a non-profit organization dedicated to enhancing teaching and learning experiences for all the students. Similarly to the idea of UD in architecture, UDL is a design framework for instructors to design learning experiences that accommodate a wide range of skills and abilities among students as well to develop inclusive learning environments (CAST, 2018). UDL has a great potential to contribute in making learning environments more accessible for all the students (Dalton, 2017). The aim of UDL is to reduce barriers that learners are facing in the classroom and increase access to learning opportunities (CAST, 2018; Rose & Meyer, 2006). Davies and colleagues (2013), in their effort to measure the effectiveness of UDL, found that student learning can be more effective if the instructors incorporate effective UDL strategies in teaching and learning experiences. Furthermore, Chita-Tegmark and colleagues (2012) suggested that learning for culturally diverse learners can be enhanced by the implementation of UDL principles.

CAST (2018) developed the UDL guidelines (Figure 1), a tool to use in the implementation of UDL. These guidelines are based on three main principles (engagement, representation, action and expression) that are further subdivided into multiple checkpoints. They provide

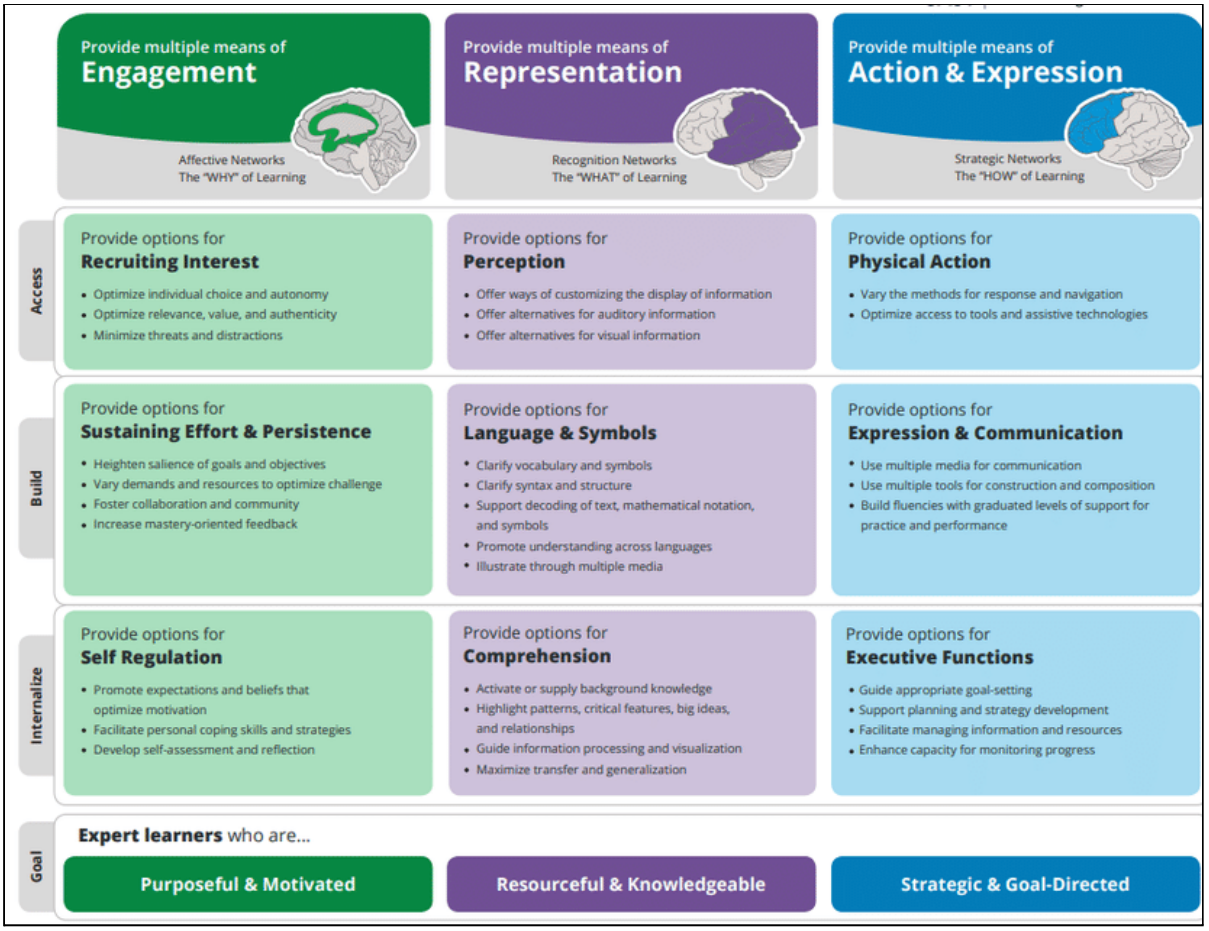
recommendations that can ensure access and meaningful learning opportunities to a wider range of learners. The concrete suggestions are based on the principles referred above and give guidance on how instructors can provide multiple means of engagement, means of representation of information and finally means of action and expression as learners seek to demonstrate their knowledge (CAST, 2018).

The first principle of UDL, *Provide multiple means of Engagement*, is referring to the "why" of learning (Rose & Meyer, 2006). This principle encourages instructors to use various ways to motivate learners. It considers the variety of individuals' needs and understands that learners differ in the way they learn. The second principle of UDL, *Provide multiple means of Representation*, refers to the "what" of learning. It encourages instructors to provide various ways of representation in order to support the acquisition of knowledge and comprehension for all learners. Many studies have shown that instructors have used various ways for providing multiple means of representation to their students to make the learning experience more meaningful for them. More specifically they have tried including options for language and symbols, perception and comprehension (Scott et al., 2015), using accessible technology (Tobin, 2014) and providing content in multiple formats (Davies et al., 2013; Tobin, 2014). Finally, the third principle, *Provide multiple means of action and expression,* is referring to the "how" of learning. It supports instructors to provide learners with different ways to demonstrate their knowledge. Every learner differs in the way they learn and show what they have learned. Some learners prefer to indicate their knowledge through written texts while others prefer visual or oral presentation of the knowledge. Additionally, some students work better individually and others prefer group projects. Therefore, it is important that learners are provided with various ways for demonstrating their knowledge based on their individual needs and interests (Rose & Meyer, 2006).

Technology-based learning environments and digital tools provide many solutions which facilitate the integration of UDL guidelines into the learning experience (Rose & Meyer, 2006). Many studies have shown the benefits that accessibility provides for the students. Rice (2018) argues that improving accessibility on online courses can have benefits for a wide variety of learners. She highlights that digital accessibility encourages students' persistence, increases students' participation, promotes good results and literacy development. Sapp (2009) argued that digital accessibility would also benefit students with learning disabilities, students with cognitive impairments and second language learners. Greer and his colleagues (2014) suggested that there are better opportunities for including disabled students with the provided flexibility and individualization through online learning platforms and tools. One of the most important benefits of online learning environments is the ability they have for presenting content in multiple formats which aligns with one of the three principles of Universal Design for Learning, Multiple means of Representation (Rose & Meyer, 2006).

Figure 1

The UDL guidelines by CAST (2018).



Chapter 3: Research Context

This section represents the context in which this design project has operated. This development project is a preface of a research project of the National Museums of World Culture with the accessibility organization Funka (https://www.funka.com/). The aim of their research project is to develop and implement a model for digital accessibility. This model will enhance possibilities for the National Museums of World Culture to put forward research-based information and exhibition materials that will be digitally accessible for students, especially those with disabilities or those who are second language learners. In this project my sole focus will be on second language learners who encounter challenges due to the language barrier and therefore need digital accessibility.

3.1 The National Museums of World Culture

The National Museums of World Culture or Världskulturmuseerna in Swedish, consist of four museums located in Sweden: The Museum of Ethnography, The Museum of Mediterranean and Near Eastern Antiquities, and The Museum of Far Eastern Antiquities are located in Stockholm while The Museum of World Culture is located in Gothenburg. The four museums together cover a collection that spreads over all continents and over thousands of years of human culture. One of their main tasks is to illustrate various cultures around the globe. These museums belong to the Swedish Ministry of Culture and their mission is to promote a more humane and inclusive world. Additionally, these museums engage in research both nationally and internationally. The National Museums of World Culture use digital technologies in order to cross geographical and cultural borders and make museums' artefacts accessible. Furthermore, digital technologies enable people with language difficulties or disabilities to be able to participate and interact within the provided experiences. Finally, digital technologies can prepare, deepen and extend the experience for the visitor (Världskulturmuseerna, 2020).

3.2 Human Nature Skola, a digital learning resource for schools

The Human Nature Skola (http://humannatureskola.se/) is a digital learning resource for schools (Figure 2) created by The National Museums of World Culture. It is a part of the project Human Nature which consists of a museum exhibition, a pop-up mobile application that is a mini-version of the physical exhibition and finally the Human Nature Skola which is a digital learning resource aimed mainly for schools. The content of the project is based on objects from the museums' collections and based on results of research projects that they collaborate with.

Figure 2

Human Nature Skola website's home page.

The main goal of the Human Nature Skola project is to contribute to a more sustainable future by focusing on the impact of mass consumption on our planet and raising issues of change and attitudes for a more sustainable world. Although it is a learning platform specially created for schools it is accessible to the general public. The first page that someone sees when visiting Human Nature Skola is illustrated on Figure 2. The user can explore further and choose on of the six themes that Human Nature Skola is based on (Figure 3):

1. **Mass consumption:** How people's consumption without thought causes climate change.
2. **What can our earth tolerate?:** Mass consumption, fossil combustion, change of lands, illegal hunting and deforestation are all causing climate change.
3. **Resistance:** Those who are hit the hardest by climate change are those whose lives and consumption have the least impact on the climate which causes many to resist and protest.
4. **Our things:** We humans surround ourselves with things and our constant hunger for new things negatively affects our earth.
5. **Nature's rights:** The idea of nature's rights means that nature has an intrinsic value instead of being a resource used for human needs.
6. **Thinking again:** The global economic system that binds us together in the world has led to a huge environmental impact.

Every theme includes films, exercises, discussion questions and in-depth texts that can be used for a better comprehension (Figure 4, 5 and 6). The material is in Swedish and it is

designed both as preparation for a visit to the exhibition or as support for education in schools throughout Sweden. Figure 4 illustrates the different subjects that Human Nature Skola is providing for students to explore. Students can choose a subject and discover material both in text and in videos. In every subject it is provided suggested activities that students can do both individually and in groups (Figure 5, 6). As the Figure 5 and 6 shows, the content is represented either with long text or videos with talks.

Figure 3

Human Nature Skola website. List of themes.

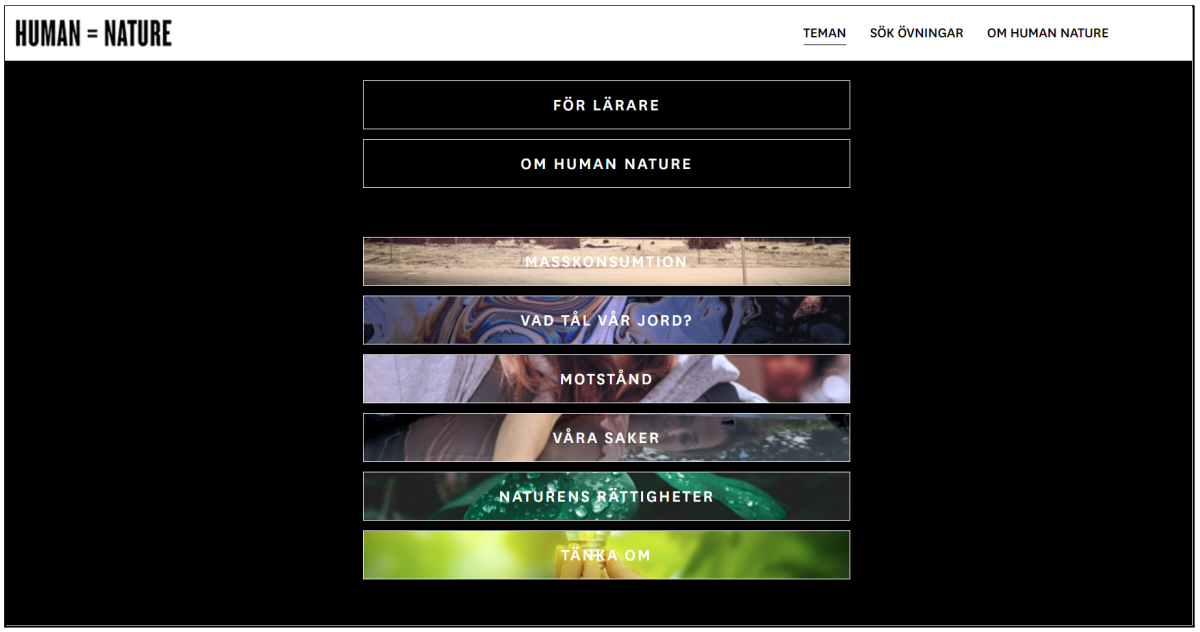


Figure 4

Human Nature Skola website. List of subjects and material.

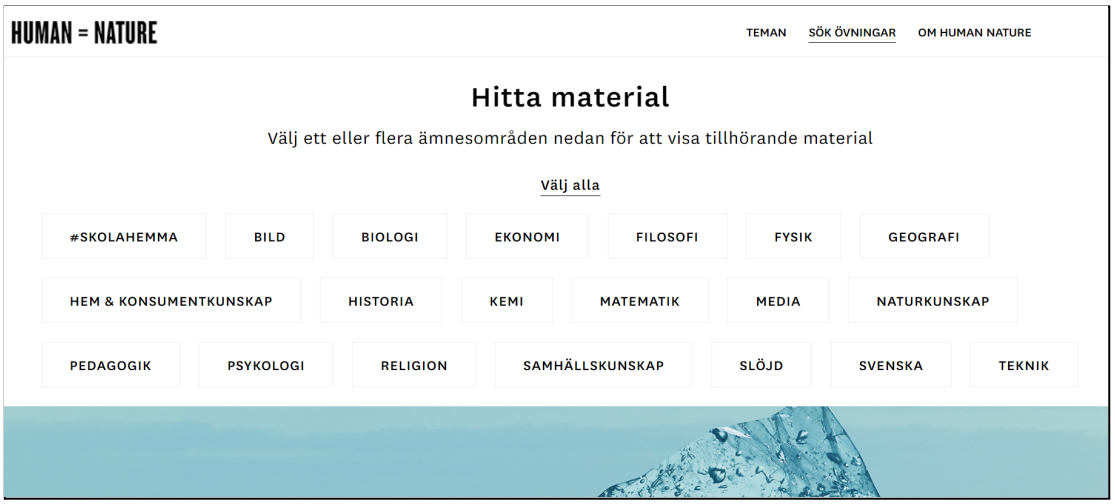


Figure 5

Human Nature Skola website. Material in subject "Our things".

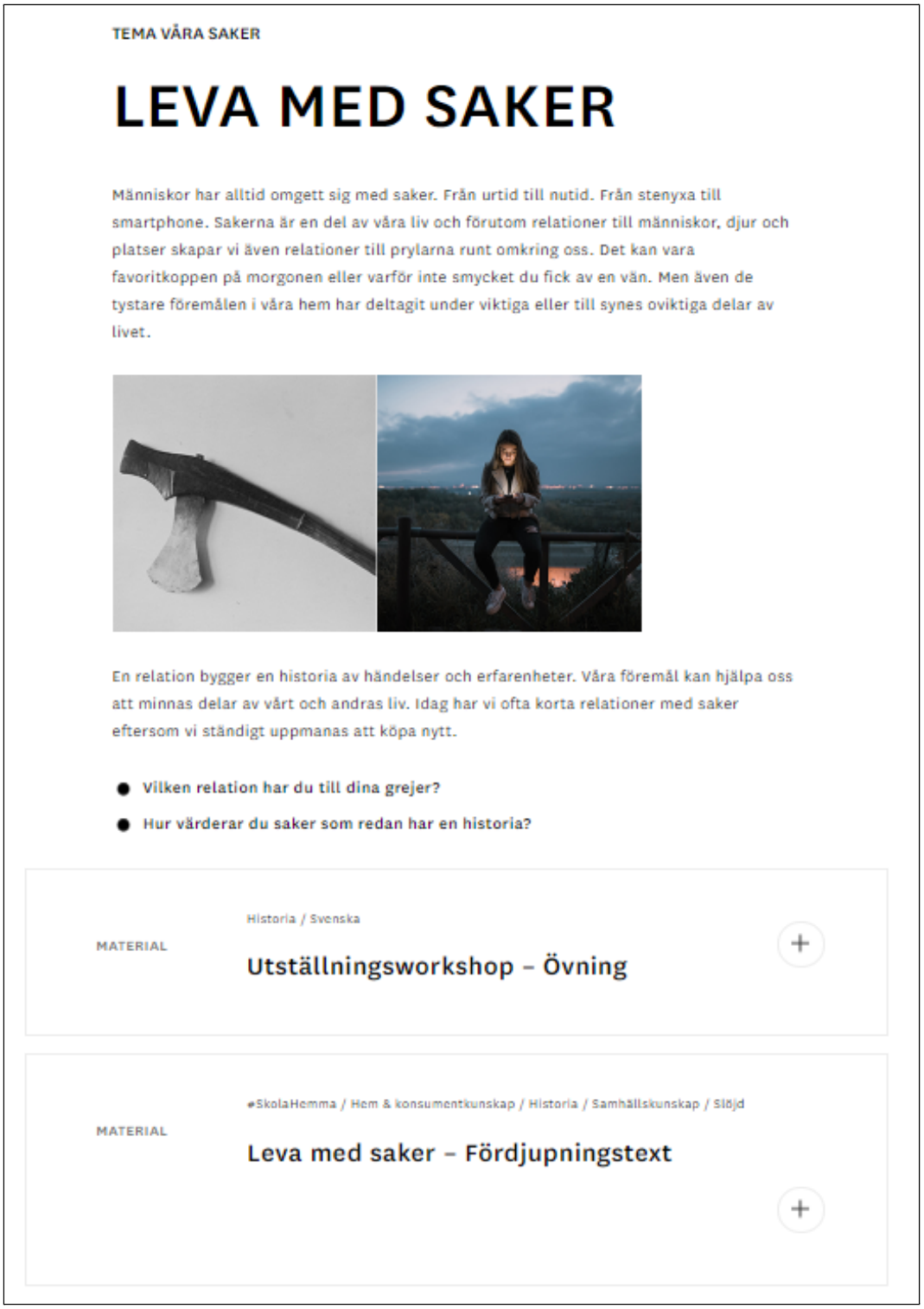
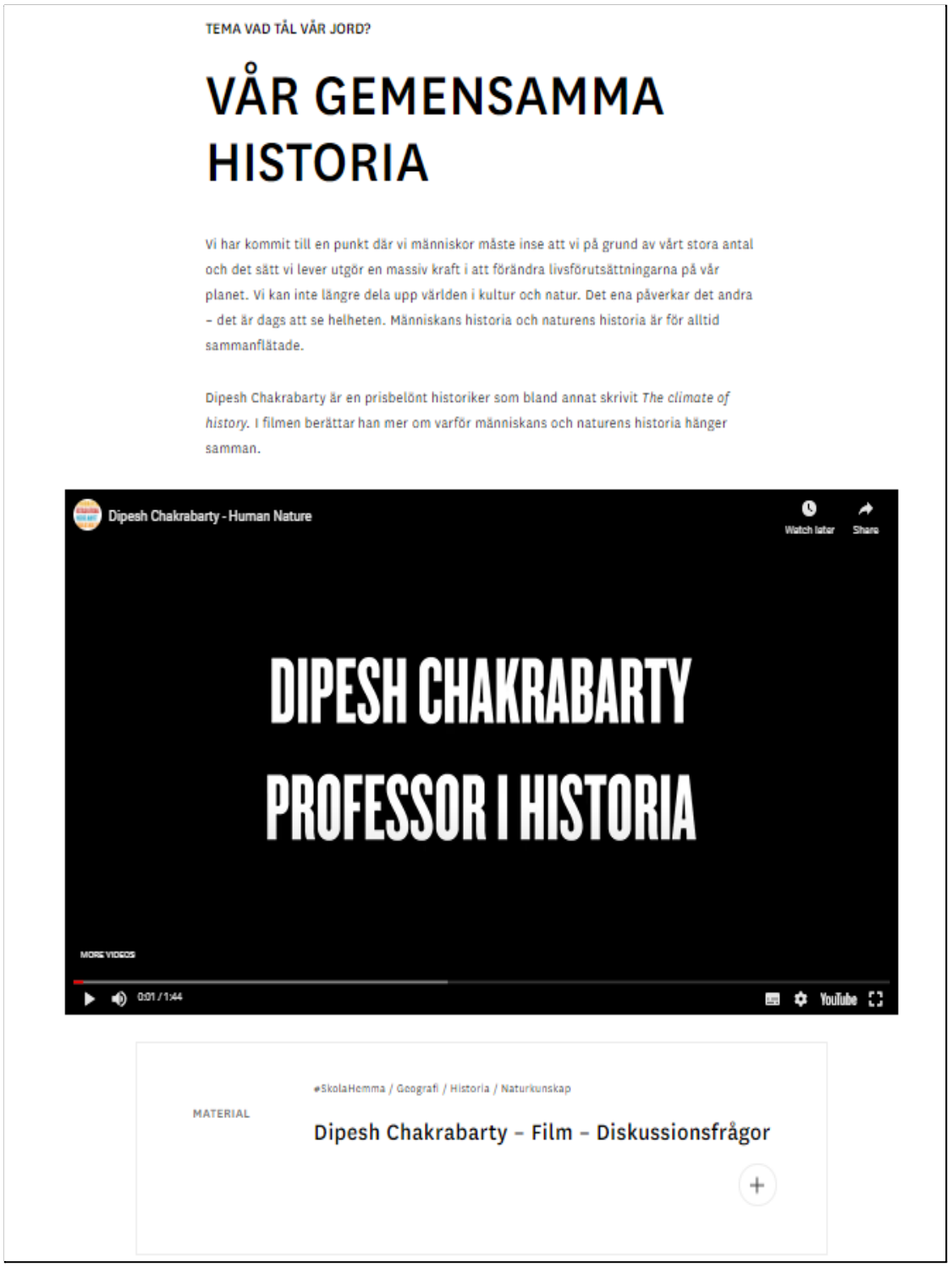


Figure 6

Human Nature Skola website. Material in subject "What can our earth tolerate?".



Chapter 4: Research Methodology

4.1 Research approach

The Design Thinking (DT) approach was adopted to develop improvements to make the Human Nature Skola website more accessible for SSLL. This development project initially started as a preface of a National's Museum of World Culture project for digital accessibility of Human Nature Skola. However, this thesis project was carried out independently. The methodology used in this project is based on the five-stage Design Thinking (DT) model proposed by Plattner at Institute of Design at Stanford, that is also commonly known as d.school (Plattner, 2010). The five stages of the DT model are: Empathise (data collection), Define (data analysis and synthesis to understand the problem), Ideate (suggest possible solutions), Prototype (develop tangible representations of the ideas) and Test (with the potential users for getting feedback) (Plattner, 2010). I chose DT as the methodology of this project since it is an approach that focuses on problem-solving and innovative design trying to understand what people need and how technology can cater these needs (Sharp et al., 2019). Using this design methodology allowed me to understand the SSLL's needs regarding digital learning resources, reframe the problem in human-centric ways, create ideas, and implement a practical approach in prototyping and testing.

DT can be described as a multi-disciplinary approach that focuses on human-centered design ethos problem solving, creativity and innovation (Brown, 2008; Carlgren et al., 2016; Johansson-Sköldberg et al., 2013; Sharp et al., 2019). DT focuses on what designers can do to solve people's problems by understanding their needs (Sharp et al., 2019). DT approach can be applied and transferred into different disciplines apart from the design (Brown, 2008). According to Dörner (1999), the designing process can take various forms based on environmental conditions, individual circumstances and the problem to solve. Dörner (1999) claimed that design starts as a cloudy idea that will be more concrete with time. The various methods available to the designers will help them go from a vague idea to a final solution. Such methods are: Sketches and models, which involves visualising the ideas in two or three dimensions, the picture-word cycle, which is about verbalizing the ideas and elaboration, which refers to a dialectical process regarding the design (Dörner, 1999).

4.2 Participants

A total of eight participants contributed to this project: one of the creators of Human Nature Skola (n=1), who provided insight concerning rationale behind it and about the target users, a digital accessibility expert (n=1) who provided information about digital accessibility, teachers (n=4) who have in their classrooms SSLL students and described their experiences with them and SSLL students (n=2) between 11-16 years old.

Three of the teachers who participated in this project are teaching in Swedish primary schools while the fourth one is teaching in a Swedish upper secondary school. All had experience working with SSLL students in their classrooms. Teachers' average age was 31 years old and all of them were females. The SSLL students were females and were 11 and 16 years old. One student was born in Sweden with parents having a foreign background. She could speak three languages (mother tongue, English and Swedish) and the level of her Swedish was advanced. The other student moved to Sweden at the age of 7 from another country with parents having

a foreign background. She could speak two languages (mother tongue and Swedish) and the level of her Swedish was upper-intermediate.

As mentioned above, this design project is a preface of a research project proposal created by the Museum of World Culture in Gothenburg in collaboration with Funka. Therefore, the creator of Human Nature Skola and the digital accessibility expert, recruited through the collaboration with the Museum of World Culture. I recruited the teachers and SSLL students through personal connections and word of mouth.

4.3 Data collection

Data were collected during the Empathise stage and the Testing stage of the DT process. I collected data through semi-structured interviews, informal discussions and the think aloud method used while testing the prototype.

4.3.1 Interviews

Thomas (2017) describes an interview as "a discussion with someone in which you try to get information from them" (p. 106). Interviews is a data gathering technique that aims to explore issues, behaviors, experiences and opinions (Sharp et al., 2019). The main types of interviews are: open-ended or unstructured, structured, semi-structured interviews. More specifically, in structured interviews a list of predetermined questions is asked to the informant, while in open-ended or unstructured interviews are exploratory and a kind of regular conversation Finally, semi-structured interviews combine predefined questions along with follow-up questions emerging based on the reply from the interviewees (Sharp et al., 2019; Thomas, 2017). Regarding Design for Learning, interviews can provide feedback to the designer regarding the designed learning experiences, specifying what is working or not (Dirksen, 2015). For the purpose of this development project I conducted two types of semi-structured interviews: expert and empathy interviews.

Expert interviews is a method for qualitative empirical research. According to IDEO (2015), expert's interviews can provide valuable information about the project-area by giving a system-level view, talking about failures, successes and innovations. Expert interviews method is a quick way to access specific information in a new or unknown field for the designers. Experts have specific knowledge and high insight for their field.

Empathy interview is the foundation of the DT process. This type of interview helps understand peoples' thoughts, desires, motivations and needs through active listening. For designers to provide solutions relevant to the people's needs, it is crucial to talk directly with the people they are designing for. Empathy interviews allow users to contribute to the design project by expressing their thoughts and feelings. During this process, the designer can get a better understanding on how users behave in specific situations and possible solutions for the design problem might be revealed through the empathy interview (IDEO, 2015).

4.3.2 Think- aloud method

The think-aloud method asks participants to share out loud their thoughts and explain them, while they are performing a task. This technique aims to reveal what they are thinking while they are interacting with the design (Sharp et al., 2019). Nielsen (2012) highlighted that this

method has a lot of benefits for the design process. Using this method, the designer can explore what the users really think about the design and can see what they like or struggle with. Users' misconceptions and difficulties can provide recommendations for redesigning the final product which are relevant to the end users. However, it is important to be considered that users who participate in this data collection method might feel uncomfortable as it is unnatural to go through this process of thinking out loud while performing a task (Nielsen, 2012).

4.4 Data analysis

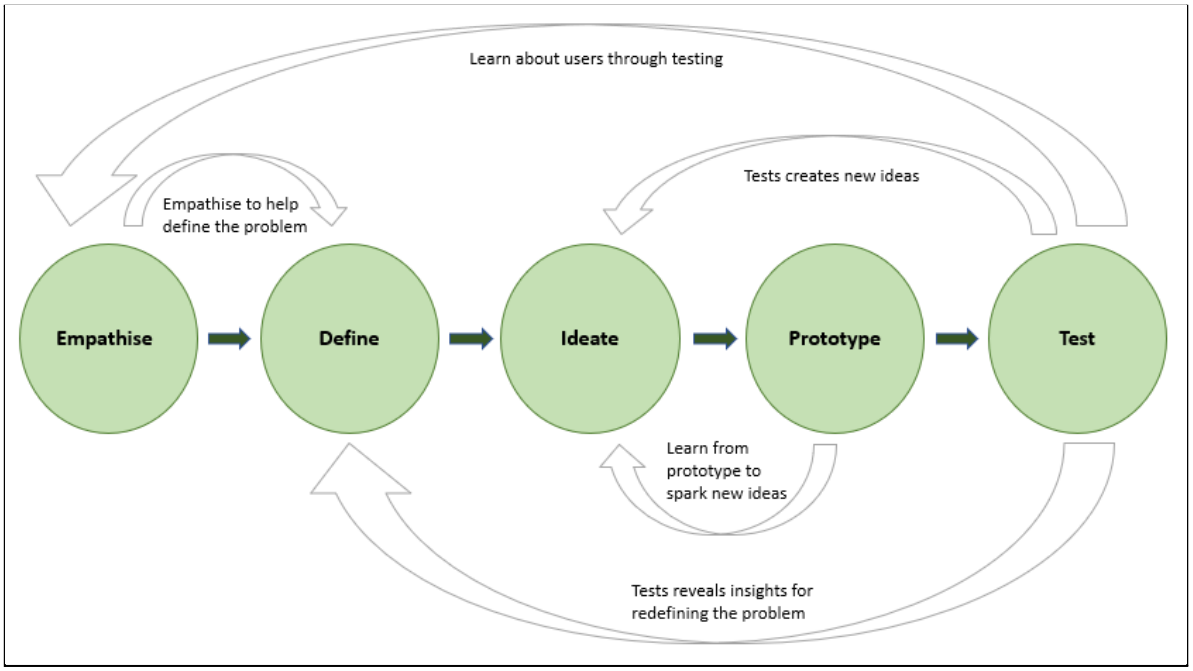
To analyse the data collected, I used the constant comparison method and the empathy maps tool. Constant comparison method is a process for analyzing qualitative data in which researchers mark data up with codes with the purpose to derive thematic categories which summarise the collected data (Thomas, 2017). This method involves going through the data many times comparing the answers of the participants to find patterns. Empathy maps is a tool used in the DT process for analysing and synthesizing data collected during the Empathise stage. Empathy maps organize and visualize the finding into four main categories which guide the designer during the DT process (Plattner, 2010).

4.5 Research Design

DT has a human-centered foundation and empathy is the core element of the human-centered design approach (Brown, 2008; Carlgren et al., 2016). DT starts with gaining empathetic understanding for the users and ends with bringing a design solution that fulfils their needs and brings them into life (IDEO, 2015). During the design process, the focus should be on the users' in order to reduce the possible assumptions, bias and judgements about their needs and desires. DT is a non-linear process (Figure 7), as the five stages of the design process do not follow a linear sequence and can occur in parallel (Dam & Siang, 2020). DT is an iterative process that has many benefits such as rapid resolutions of misunderstandings, user in the center by considering users feedback and cost-effectiveness (Dam & Siang, 2020).

Figure 7

Recreation of the Design Thinking process by Teo Yu Siang and the Interaction Design Foundation.



The following section will present the design procedure based on the five stages of the DT process in a chronological way: Empathise, Define, Ideate, Prototype and Test. The Gantt chart (Table 1) illustrates the timeline of the project and shows the start and the finish dates of the different stages of DT. However, it is important to mention that the process of DT is iterative and requires several back-and-forth steps between the different stages. The table (2) below presents the stages that I followed, the participants on each stage and the methods used during the DT process.

Table 1

Gantt chart of the project.

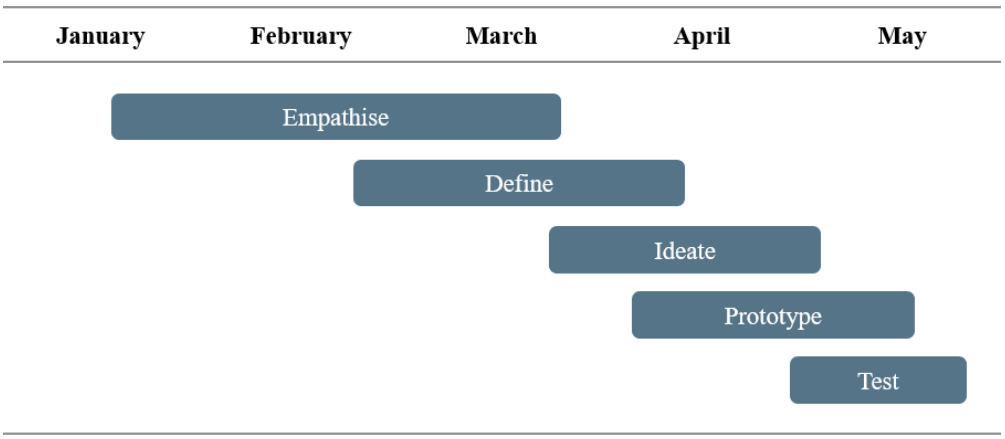


Table 2

Overview of the five stages of the DT process.

	Empathise	Define	Ideate	Prototype	Test
Participants	• Teachers (n=4) • SSLL students (n=2) • Digital accessibility expert (n=1)				• Teachers (n=3) • SSLL students (n=2)
Methods and tools	• Empathy interviews • Expert interview	• Personas • Empathy maps	• Brainstorm • Mind maps • Sketches • Storyboard	• Figma prototype	• Think aloud • Unstructured interviews (informal discussions)

4.5.1 Empathise- Who are the users

A DT project starts with considering and understanding the users and their needs. This stage intends to create empathy for the problem to be solved (Dam & Siang, 2020; Plattner, 2010). Gaining empathy for the users is critical in the design process, as it enables to understand their needs and uncover their desires (Brown, 2008; Carlgren et al., 2016). Empathising with the users is the foundation of human-centered design (Brown, 2008; Carlgren et al., 2016). Empathy allows designers to overcome their own beliefs about the users and to get an understanding of the actual needs of the users (Dam & Siang, 2020; Dirksen, 2015). Plattner (2010) highlighted the importance of spending time with the potential users by using the following three techniques: engagement, observation and immersion. More specifically, there are several ways to use these techniques, such as interviews, conversations, surveys, observations in the users' natural environment, users' journals and research on what has been done before (Plattner, 2010).

Concerning design for learning, Dirksen (2015) argued that designers usually focus on talking with project stakeholders, managers and experts instead of focusing on the actual learners. Furthermore, she maintained that talking with the learners is important as it provides insights on what happens in the real world and not what should theoretically happen. In addition, learners can provide information about what has confused them or made them struggle regarding similar designs. They can also give specific examples, ideas and suggestions helpful for the designer (Dirksen, 2015).

Interviews

In order to gain a holistic understanding of the problem at stake and to develop empathy for the users, semi-structured interviews have been conducted with different actors (Table 3). As a first step, I interviewed one of the creators of Human Nature Skola to acknowledge the aims and objectives of this specific digital learning resource. Following this, I conducted empathy interviews with SSLL students (n=2) and teachers (n=4) who have SSLL students in their classrooms. The aim was to gain an empathetic understanding of the challenges that SSLL might face while they are using Swedish digital learning resources at school. Finally, I interviewed an expert to get insights into the context of digital accessibility and to obtain exclusive information about strategies and procedures for implementing digital accessibility. The interviews were recorded, transcribed and analysed to find patterns. Due to the

COVID-19 pandemic and the social distancing restrictions, the interviews were conducted on the video conference platform Zoom.

Table 3

Topics discussed during interviews.

Interviewees	Topics discussed
Creator of Human Nature Skola (n=1)	▪ Intentions behind Human Nature Skola. ▪ Users ▪ Requirements ▪ Feedback from the users. ▪ Procedures
Teachers (n=4)	▪ Challenges faced while using digital learning resources. ▪ Processes of choosing suitable digital learning resources for using in the classroom. ▪ Examples of good designs. ▪ What is missing from the digital learning resources?
SSLL students (n=2)	▪ Difficulties and usage of digital learning resources. ▪ Digital accessibility for non-native Swedish speakers. ▪ Examples of digital learning resources that they like.
Digital accessibility expert (n=1)	▪ Digital accessibility and Human Nature Skola. ▪ Design process for evaluation and design accessible websites. ▪ Digital accessibility and SLL students. ▪ Challenges and needs for digital accessibility.

4.5.2 Define- What do the users need

The next stage of the DT process focuses on unpacking users' insights and needs, in order to refine a Point of View (POV) which is an actionable statement that describes the design problem that the designers try to solve. The main goal of the Define stage is to redefine a meaningful problem statement in a human-centered manner which the designer will try to solve through the design process (Dam & Siang, 2020; Plattner, 2010).

Personas

Matthews and colleagues (2012) highlighted that the concept of personas has been first introduced by Cooper (1999) as a way to gain empathy for the users and put them in the center of the design. Sharp and colleagues (2019) support that personas are the representation of the real users that have been involved in data collection during the empathy stage. Personas include information related to the design such as their goals, behavior descriptions, needs and frustrations. Creating personas in the DT process is a useful method for supporting human-centered design by engaging the design team in thinking about the end user during the design process in order to make the right design decisions (Matthews et al., 2012; Sharp et al., 2019).

Empathy maps

As described by Plattner (2010), empathy maps constitute a tool to visualize the collected data. The aim of the empathy map is to systematically specify the needs of the users. These maps are used by the designer to synthesize and find patterns emerging from the data collected. More specifically, empathy maps break down the collected data into four key groupings while having the user persona in the center (Plattner, 2010):

-What the user **says**: Which includes their quotes.

-What the user **thinks**: Which includes the users' thoughts and beliefs.

-What the user **does**: Which includes their actions and behaviors.

-What the user **feels**: Which includes their feelings and emotions.

Problem statement

Problem statement or Point of View (POV) helps guide the design projects. It focuses on the needs and the insights of the users, describes the problem and defines the right challenges for the designers to address (Dam & Siang, 2020; Plattner, 2010). A well-defined problem statement is a requirement for doing a good brainstorming (Kelley, 2016).

4.5.3 Ideate- What solutions are there

After the design requirements decisions, follows the ideate process, also called Idea Generation or Ideation (Norman, 2013). During the Ideate stage, the designers generate ideas in order to solve the defined problem. The designer can use ideation techniques for expanding the problem area and for thinking broadly (Dam & Siang, 2020; Plattner, 2010). This stage

aims to develop solutions in an innovative and creative way (Plattner, 2010). Dam and Siang (2020) highlighted the importance of generating many ideas and thinking outside the box. Norman (2013) argued that the designers apart from focusing on generating ideas and being creative without regard for constraints, challenge any assumptions. He supported that "the obvious often is not obvious at all" (Norman, 2013, p.226) and questions that might considered stupid or obvious could reveal the solution to the problem.

Brainstorming

Brainstorming is one of the most common ideation techniques for groups which facilitates the generation of ideas, constructing shared knowledge and promoting the collective thinking of the group. Using this technique, the group members engage with each other, by listening, commenting and suggesting ideas which lead to generation of more creative and innovative ideas (Dam &Siang, 2020; Plattner, 2010). The aim of brainstorming is for the designers to build good ideas based on each other's various ideas (Dam & Siang, 2020). Plattner (2010) described that brainstorm sessions will be easier and more effective with following the brainstorming rules that will lead to many, wide-ranging ideas that will consequently facilitate the design process. More specifically, these brainstorming rules are about setting a specific period of time that the team will be in "brainstorm mode" and focus on generating as many ideas as possible within this period of time. Furthermore, it is important to have a clear statement or question which will facilitate the brainstorming session by providing a focus for the designers while generating ideas. Finally, it is crucial for the designers to be open minded and accept all the ideas without judging or discouraging.

Mind maps

Mind mapping is a graphical technique for representing ideas and concepts. The mapping process allows a better understanding of the collected information and gives new insights on solving the existing problem. This technique starts with a clear written problem statement and then adding ideas and solutions that might be related to the problem. Finally, after discussing the different ideas the participants connect the different points with lines in their effort to find connection between the presented ideas and solutions (Dam & Siang, 2020).

Sketches

By visualizing these ideas, the designers will probably generate more creative ideas and get a broader perspective of the design problem frame. Sketches contribute to clarify the characteristics of the design and develop the primary idea into a more concrete and complete task. Sketches do not require excellent drawing skills to contribute to the idea generation. They can be very simple for representing ideas and concepts which will create dialogue between the designers (Dam & Siang, 2020; Dörner, 1999).

Storyboard

A storyboard consists of a series of images (sketches, illustrations or photographs) which visualise how the user might act through a task while using the developing design product. Storyboard technique aims to visualise thinking and to promote dialogue and ideas generation through the designers' team. Storyboards can represent an initial stage of the prototype

(Plattner, 2010; Sharp et al., 2019).

4.5.4 Prototype- What does the solution look like

At this stage, the aim is to find the most suitable solution for the problem at stake. The Prototype stage enables the different design ideas to come into the world (Plattner, 2010) as the only way to evaluate if an idea is rational is to test it (Norman, 2013). According to Sharp et al., (2019, p. 422) "a prototype is one manifestation of a design that allows stakeholders to interact with it and to explore its suitability". This is an experimental phase for the design as the solutions being implemented within the prototype, might be re-examined, rejected or accepted based on the users' feedback and experience (Dam & Siang, 2020).

Prototypes facilitate the process of reaching the final desirable product by visualising the ideas. Although, prototypes include two aspects of design: the conceptual part, which represents the general idea of a product, the concrete aspect, which visualises in detail how the final product will be and behave (Sharp et al., 2019). Prototypes represent the final design and in the early stages of the DT process can be pencil sketches, simple drawn images, spreadsheets or PowerPoint slides, but also a complex piece of software (Norman, 2013; Sharp et al., 2019). Designers prototype their ideas with the aim to get an effective and constructive evaluation of their design (Sharp et al., 2019). Prototypes let the users participate in the design process and contribute by sharing their ideas and comments for the potential solutions. Different types of prototypes can have higher or lower fidelity that varies on the areas of: visual design, interactivity and content. Low-fidelity prototypes are simple and usually do not look like the final product. Although they are easier and useful as they can still facilitate the design process while they are cheap and quick to create and allow modifications without big costs. Examples of low-fidelity prototypes are storyboard, sketches, Index cards (cards that represent elements of interaction) and Wizard of Oz (testing simulation of the actual functionality). On the other hand, high-fidelity prototypes have a more realistic look of the final design and provide higher functionality and interactivity (Sharp et al., 2019).

4.5.5 Test- How well does the solution work

Testing can be initiated throughout the whole process of DT facilitating users' feedback, although it is usually undertaken at the same time with the Prototype stage. However, it is common that there are several back-and-forths where the designers need to redesign and test the prototype multiple times until it caters the users' needs. Testing the prototype is an important stage which enables the designer to ensure that the design is going in the right direction by generating feedback from the users. At this stage, users are asked to contribute and share their thoughts by navigating and exploring the prototype or performing a specific task. Furthermore, users are encouraged to express what they like in the design but also their concerns about it. By sharing what they find problematic, they can help the designer to redesign and improve the final product to cater the users' needs. Some methods for testing the prototype include think-aloud method, observations and interviews with the users (Dam & Siang, 2020; Sharp et al., 2019)

4.6 Ethical considerations

Research involving human subjects needs to be ethically sound (Thomas, 2017). Participants need to be informed about what they will be asked to do, their rights while participating in the research as well the use of the collected data and consent to participate (Sharp et al., 2019). The aim of an informed consent process is to protect the participants by ensuring that they fully understand what is expected for them to do and aware of any potential consequences from their participation (Thomas, 2017). In this research project, participants were informed about the implications of the study and then they consent to participate. More specifically, they were informed about the voluntary and anonymous participation as well the possibility to withdraw their participation any time during the process.

Chapter 5: Findings

This chapter will describe the key findings of the five stages of the DT process that were adapted in the research project. The findings are represented in the following order: Empathise, Ideate, Define, Prototype, Test. However, it is important to highlight that the DT process is a non-linear, iterative process which means that the results of each stage were used for reviewing and questioning the initial findings that ultimately tailored the final results.

5.1 Empathise stage

This section summarizes the key findings from the Empathise stage. The data collected showed that the SSLL students encountered a number of challenges in the classroom while using digital learning resources. Their struggles can be categorised as: (a) Difficulties with text comprehension, (b) embarrassment and fear of failure and (c) difficulties adapting in the new culture. The findings also highlighted some potential strategies to mitigate these challenges.

5.1.1 Difficulties with text comprehension

Results revealed that SSLL struggle with long texts in digital learning resources. Both teachers and SSLL students reported that one of the biggest challenges for SSLL students is to read long texts in Swedish, especially when there are no illustrations to support the content of the text. One teacher argued that, because of the language barrier, SSLL students avoid participating in activities where they have to read a text and discuss it in the classroom. A teacher said that “SSLL students struggle with reading comprehension of long texts in Swedish and they need a lot of support for understanding the content”. Another teacher reported that “SSLL students struggle with vocabulary comprehension while reading texts in Swedish, however it is easier for them when the text includes illustrations that visualize the content”. A third teacher said that “It is very difficult for the SSLL students and especially when the language used is not simple or when slangs and expressions are part of the texts”. One SSLL student said that “I have to use Google Translate to be able to understand the content of the texts in Swedish and to understand what is asked to do in the activities related to the text”. Another student commented that “It has happened to me in the past that I did not understand a text that our teacher asked us to read so I stayed quiet during the followed activities”. The teachers and SSLL students agreed that long texts which don’t include illustrations are not very attractive for the SSLL. Furthermore, SSLL who are in a more advanced level of the second language seem to struggle with how difficult a text is. For example, one student who is in a more advanced level commented that “I wish there were different levels of difficulties in the text so I could choose which one is more suitable for me” which indicates that SSLL students prefer customized learning experiences in order to be aligned with their personal needs and their level. Customized learning experiences based on the personal needs of the SSLL students can contribute to helping the SSLL to understand the content of the texts.

5.1.2 Self-consciousness

Findings show that SSLL also struggle with embarrassment and fear of failure due to the lack of accessibility of digital learning resources that are not aligned with their needs. For example, one SSLL student commented that “Sometimes there are specific phrases or slangs that I don’t understand in the texts and I don’t ask as I feel embarrassed that my classmates understand it, while I don’t”. Another student said that “I try to understand everything in Swedish and I ask when I don’t understand, however sometimes I feel that my questions are stupid or not very important so I prefer to skip it and go further without really having understood the content”. Teachers indicated that SSLL students have to deal with a lot of new information and they experience that some students lack motivation to participate when they are unable to understand the content. Teachers supported that SSLL students can be shy and very quiet, especially in the beginning. Also, unfamiliar vocabulary is a problem for SSLL students that makes them feel unsure and uncomfortable to participate in activities. This finding indicates that language barrier affects how SSLL students feel in the classroom. In all cases, results showed that dealing with a second language can be challenging and SSLL can feel lonely or not able to express themselves due to the language barrier.

5.1.3 Difficulties adapting to the new culture

Another reported struggle that SSLL students encountered was the difficulties of adapting to the new culture while simultaneously trying to learn the language. In this project, the term SSLL refers to students who have immigrated to Sweden or whose parents were born in another country. In this way, teachers consider that these students struggle not only with the language but also with a new culture. A teacher said “It is very difficult for some students. They feel sad and sometimes even lonely, being away from their friends and their relatives. Coming to Sweden they have to find new friends and due to the language barrier, this can take some time”. Another teacher commented that “Older students who come to Sweden after being in another school in their home country have difficulties adapting to the new school culture. They are used to something different and they have to face new rules and routines while they also try to learn the language”. Students, as newcomers in Sweden, also expressed that it can be challenging in the beginning to adapt and understand how everything works. One student commented that “It is very different from my school here with my school in my home country, for example here I don’t have to do homework, but in my home country I had homework every day. So, in the beginning I wasn’t sure if I missed some information or what I was supposed to do”.

5.1.4 Strategies for supporting SSLL

Teachers were also asked regarding the strategies they use for supporting their SSLL students. All the teachers reported that they adapt to the SSLL students' needs and they provide support by using images, icons, simple language and explanations when needed. One teacher explained “I use pictures to support the content of what I ask from the students to do or I find pictures online to show when they ask me about specific words that they do not understand”. The teacher continued “It is very interesting that not only SSLL students benefit from the pictures but also native speakers who might have difficulties understanding specific difficult words”. That was an interesting finding which was also indicated by the digital accessibility expert who suggested that accessibility can benefit a wider range of students. Furthermore,

teachers argued that using digital tools facilitates their communication with SSLL students by allowing them to translate, show pictures, videos and apps that provide material in their mother tongue. For instance, one teacher said "Digital technologies and digital tools are my extra hand in the classroom. I use them every day to explain concepts, difficult words, introduce new subjects and to enhance communication with my SSLL students". SSLL students also expressed that they individually use digital technologies in the classroom which supports their understanding of difficult words and the communication in the classroom. One student said "I use translation apps for understanding difficult words". These findings show that digital technologies can significantly support the SSLL to understand the second language and participate in the classroom activities. Another strategy for supporting SSLL students reported by the teachers is to allow students who share the same first language to work together and then present in Swedish. One teacher explained "I have students that have the same first language and this really benefits them as they support and help each other in their first language feeling more comfortable expressing themselves". SSLL who have classmates that speak the same first language, might feel more comfortable and less afraid to express themselves using the second language.

In summary, these result show that SSLL struggle with the following while using digital learning resources in the classroom:

- Hard to understand due to the excessive amount of text and the use of difficult expressions or slang.
- Usually not a possibility to choose different languages to support diverse students' needs which also contributes to feeling of exclusion.
- Hard to navigate due to lack of understanding, leads to either frustration or lack of interest to participate.
- Embarrassment and fear of failure lead to lack of interest to participate in the activities.
- Lack of images and videos which can support the meaning of the content.

This first stage of the design process aimed to gain an empathetic understanding of the SSLL, their needs and motivations regarding using digital learning resources in their second language. In the next section it is described the process that I followed in order to define a clear problem statement.

5.2 Define

In this stage of the DT process, I tried to make sense of the collected data in order to identify the Point of View (POV) which involves defining a meaningful and actionable problem statement. In order to narrow down the problem area, I tried to find patterns on the collected data from the interviews. I created two personas and I used the tool of empathy maps to synthesize and visualize the insights gathered from the participants in order to explore common patterns and connections. Using empathy maps facilitated the process of narrowing down the problem area and articulating a clear design problem that I tried to solve during the whole DT process.

Personas

In order to better understand the user's needs and frustrations regarding Human Nature Skola, I developed two personas (Figure 8, 9) based on the findings of the interviews and the empathy maps. These personas accompanied me during the whole development project as a way for me to remind myself of the needs of SSLL.

Figure 8

Persona 1.

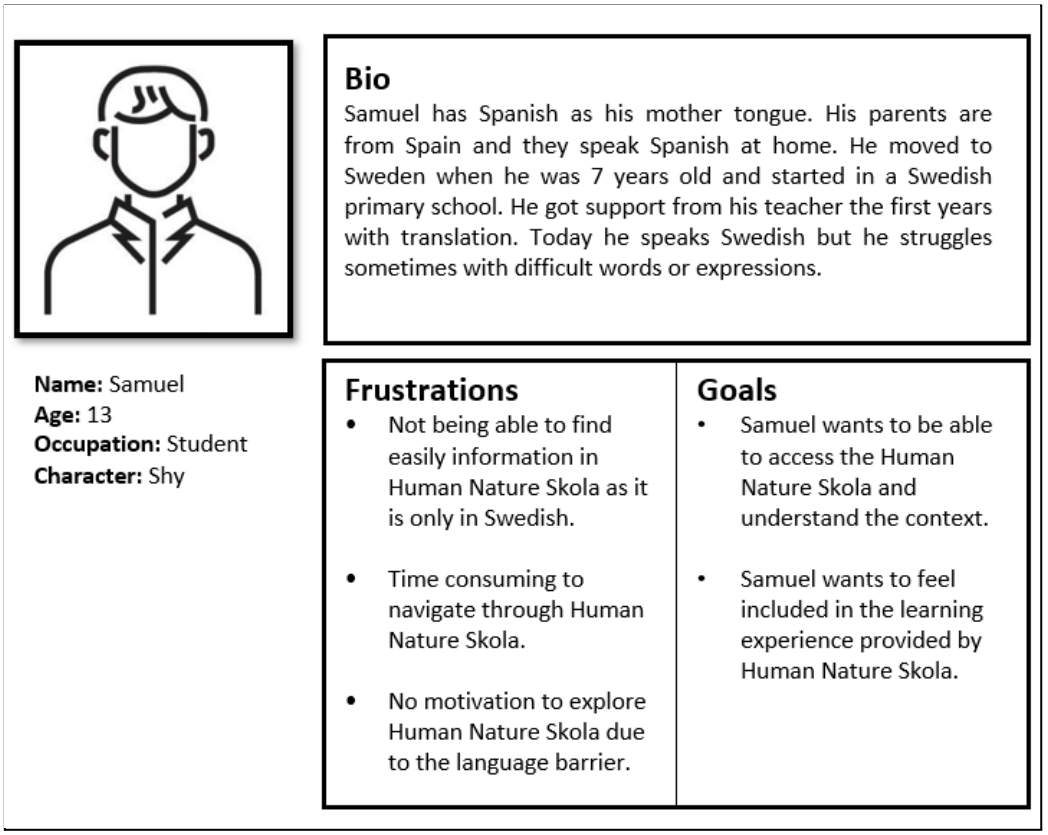
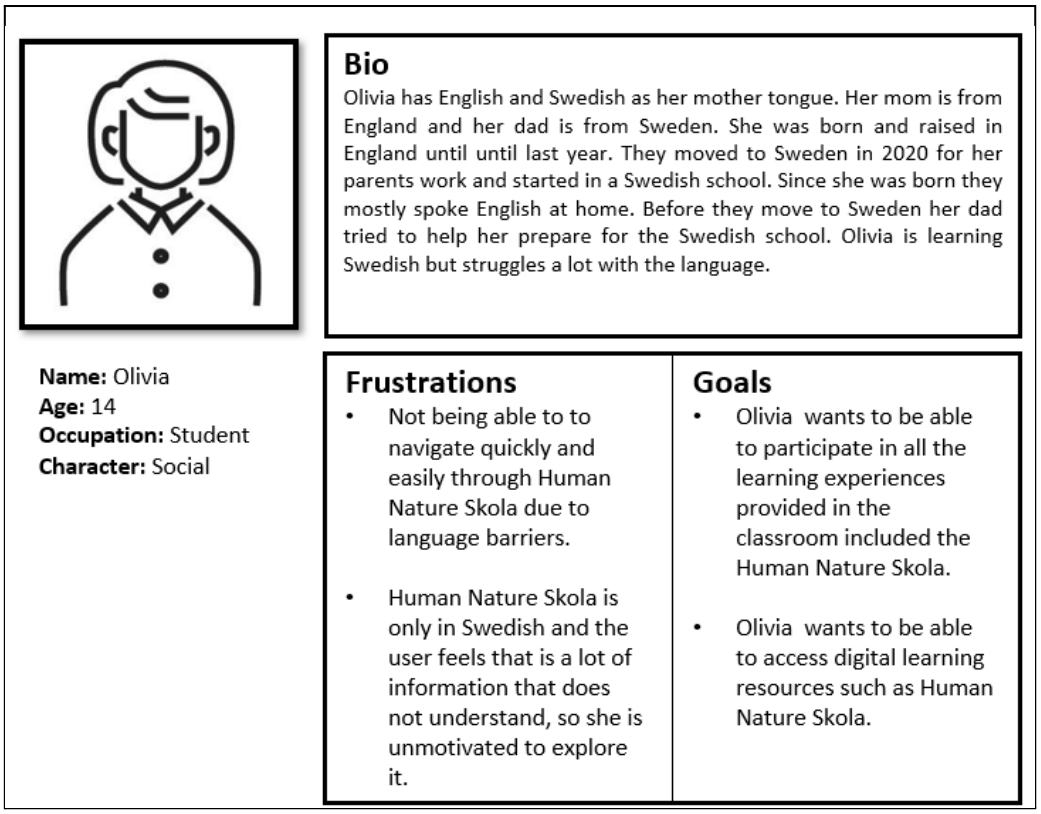


Figure 9

Persona 2.



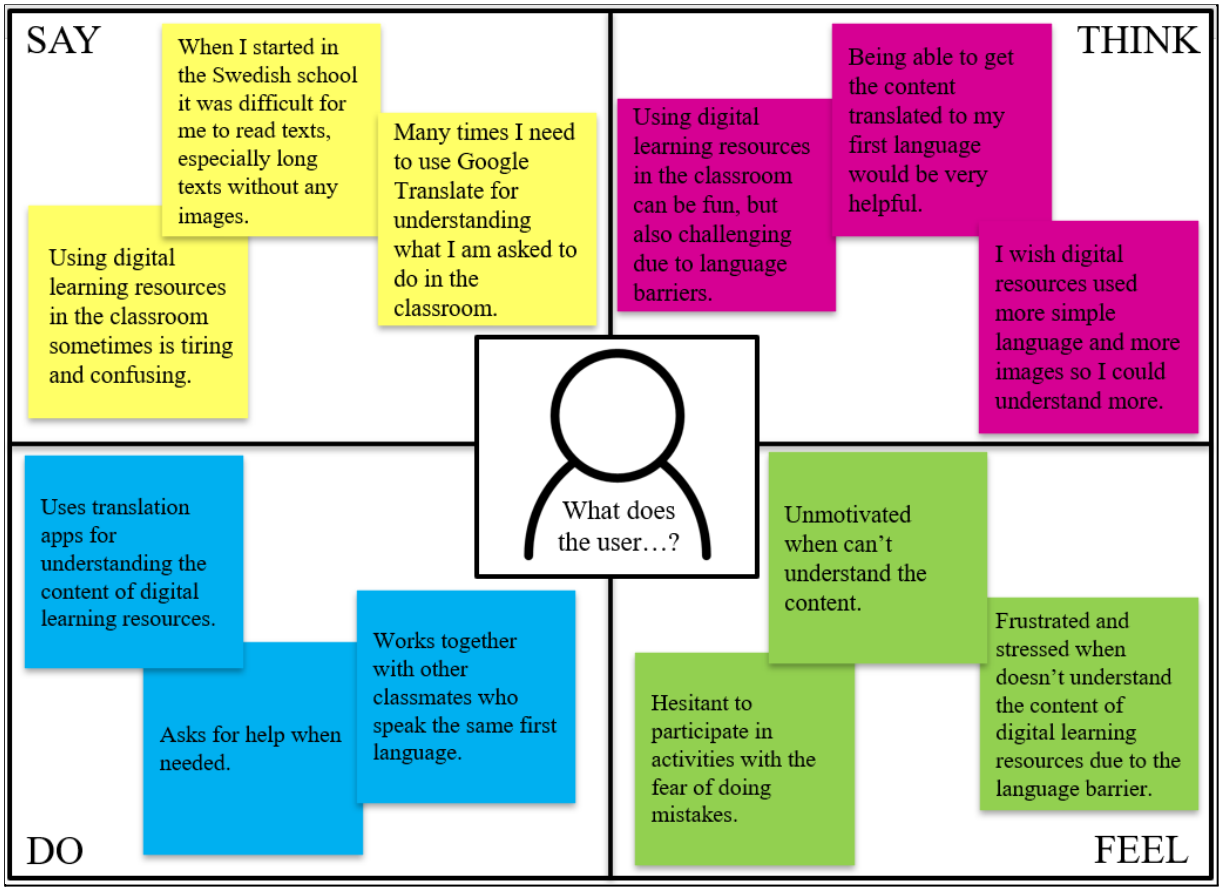
Empathy maps

After completing the empathy interviews and creating personas, I used empathy maps to look for patterns and synthesize the collected data. Empathy maps allow visualization of the collected data and helps the process of identifying thoughts and feelings of the users. The four categories of empathy maps are referring to what the user: says, thinks, does and feels. Figure 10 illustrates what the user says (in yellow), thinks (in pink), does (in blue) and feels (in green) based on the data being collected from the teachers and the students during the Empathise stage. Using Swedish digital learning resources can be challenging for a SSLL. More precisely, the user says "I have to put more effort and use Google translate in order to understand difficult words in the content of Swedish digital learning resources". This illustrates an increased effort for understanding all the provided information in digital learning resources due to language barriers. Furthermore, long texts can be difficult to comprehend and the user loses motivation for exploring the content. The user says that "Long texts especially when they do not include any pictures are difficult to understand in the second language". Users believe that images and icons could facilitate the comprehension of long texts and enhance the learning experience. The user says "It can be annoying and tiring to use digital technologies in the classroom when there are technical difficulties" and that is another reason why the user might feel unmotivated to continue using a digital learning resource. It seems that users need to be able to choose and customize the digital learning resources based on their needs. One of the students said that "it is important to be able to choose the level of how

difficult a text is" and that indicates that accessibility does not mean that one size fits all, as also highlighted by the digital accessibility expert who highlighted that digital accessibility depends on the needs and desires of the individual. Users feel comfortable using digital technologies and digital learning resources that are in their language. However, users feel frustrated and stressed when they are not able to participate in the learning process while using Swedish digital learning resources due to the language barrier. Teachers highlighted that SSLL feel bad and insecure and except for the support they need for the language, they also need psychological support for continuing their effort to participate. Teachers also mentioned that these feelings can lead students to lose their motivation and have worse academic performance.

Figure 10

Empathy map.



After synthesizing the data and having a clear understanding of what the SSLL needs I decided to follow the methods and the theories from the UDL approach and the multimodality framework to solve the design problem. More specifically, users expressed their need for alternative options for representation of the content on the Swedish digital learning resources. The UDL principle, provide multiple means of representation, as well the multimodality framework, the interplay of representational modes for meaning-making, were my guides

during the whole process. Based on the specified context and narrowed down problem area, a meaningful and actionable problem statement was defined which guided me through the design process.

5.3 Ideate

With the understanding of users' needs, I used different ideate techniques to generate ideas and possible solutions for the problem in an innovative and creative way. I used the following ideate techniques: brainstorm, mind mapping, sketches and storyboard.

In order to start generating ideas I used the technique of How Might We (HMW) questions (Plattner, 2010) in order to open up the brainstorm session by focusing on these specific questions and exploring ideas guided by them. The HMW is a tool for reframing the defined problem statement and to turn the challenges into opportunities by developing creative solutions to the design problem (Diam & Siang, 2020; Plattner, 2010). The HMW questions I developed based on the problem statement are the following:

- How Might We support a student who is a second language learner to feel included while using a digital learning resource?
- How Might We support a SSLL while using Swedish digital learning resources?
- How Might We support a SSLL student to understand the content of Human Nature Skola?
- How Might We support SSLL to not feel excluded from Human Nature Skola experience?
- How Might We cater the needs of SSLL that might have difficulties to understand long texts?

Using the above HMW questions I tried to reframe the problem by brainstorming and generating ideas that could work as solutions for my design problem. These questions facilitated the brainstorming session and provided opportunities for creativity and innovation. The brainstorming was carried out in the form of a mind map form which is an effective way for visual representation of the generated ideas (Figure 11). During brainstorming, I also experimented with setting a specific goal for the users and tried to find possible solutions that would be suitable for this particular situation (Figure 12).

Figure 11

HMW questions in Mind map form.

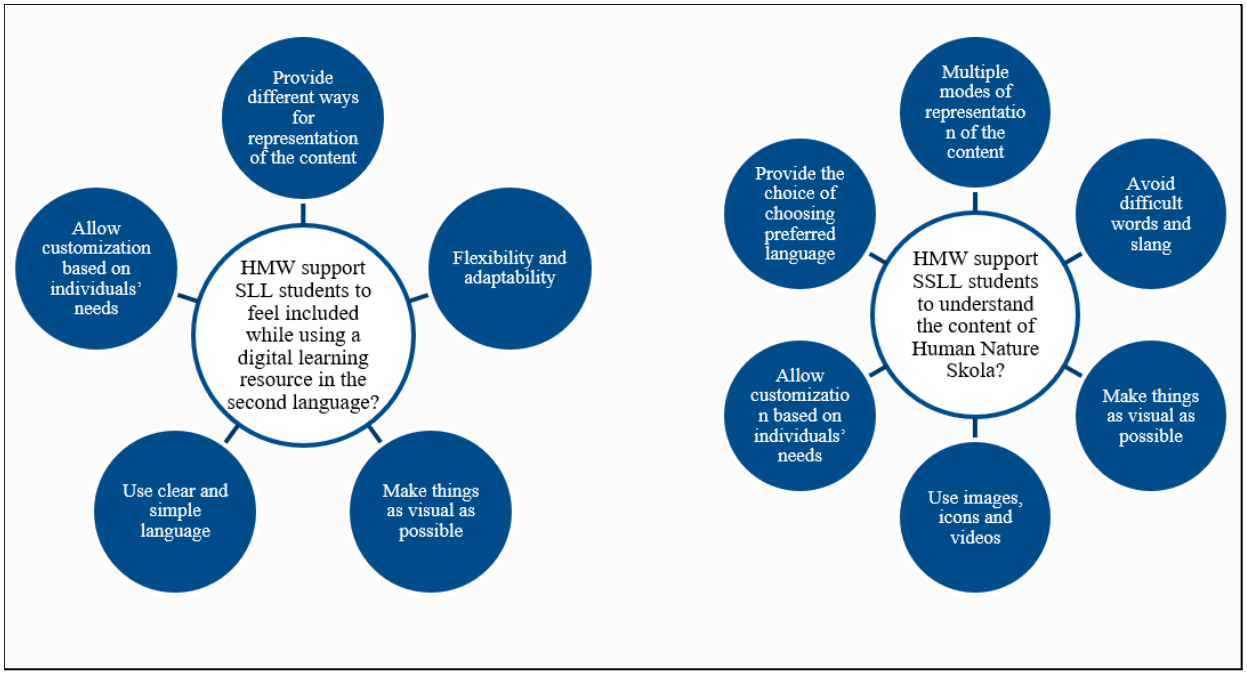
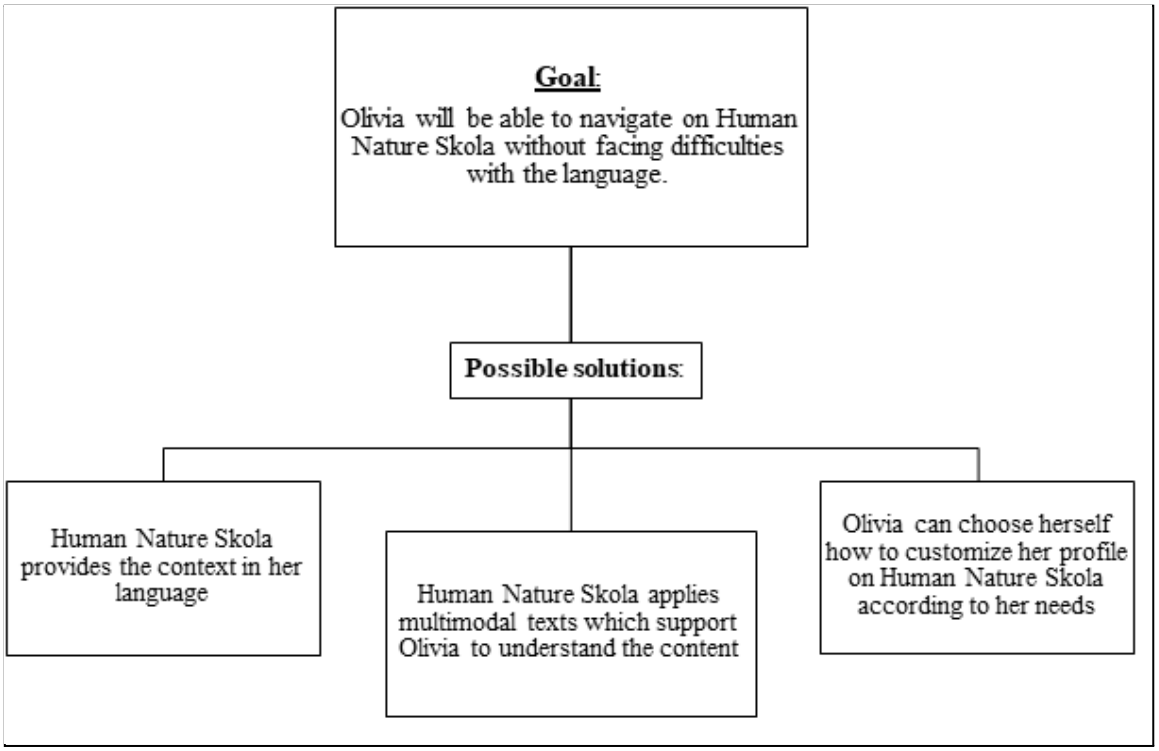


Figure 12

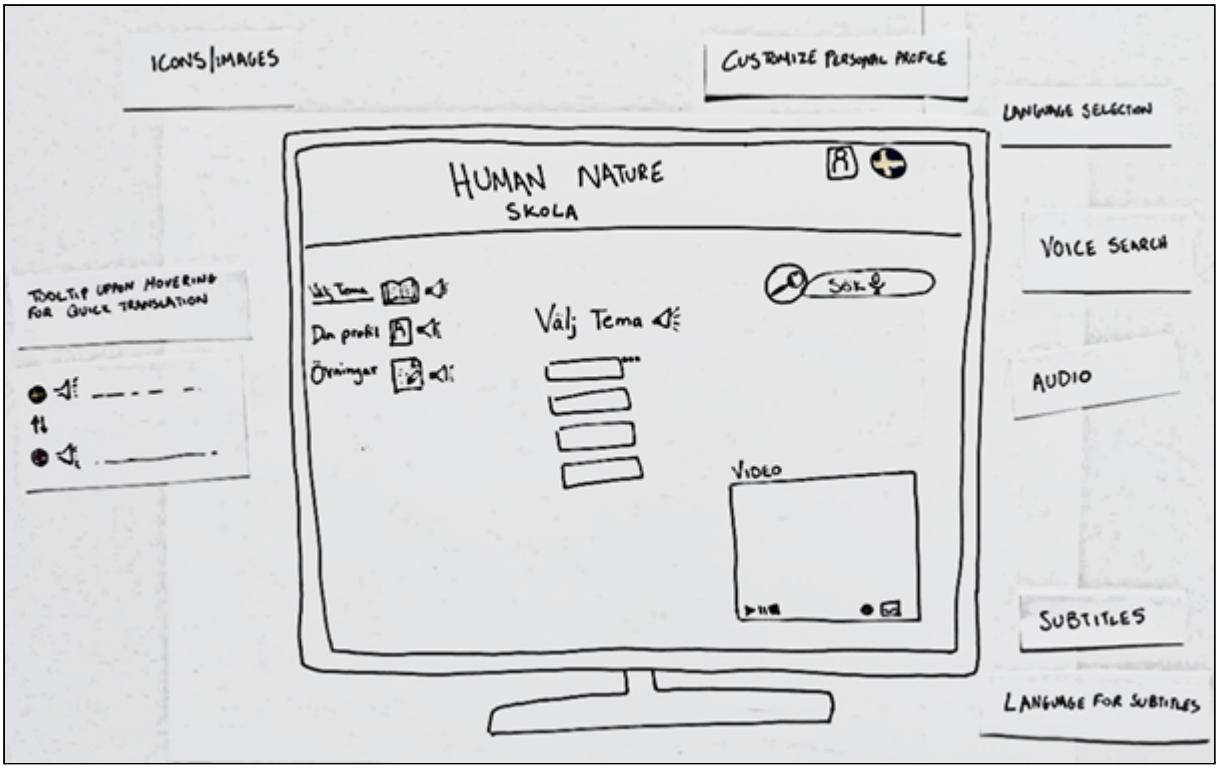
Goal and possible solutions.



Following the brainstorming session, I created sketches to visualise the different ideas and features that came up with possible solutions (Figure 13). I tried to not put the focus on the aesthetics but instead on the functionality of the different features. Sketches facilitate the design process by allowing documentation and reflection of the various ideas.

Figure 13

Sketch of digital accessibility improvements Human Nature Skola.

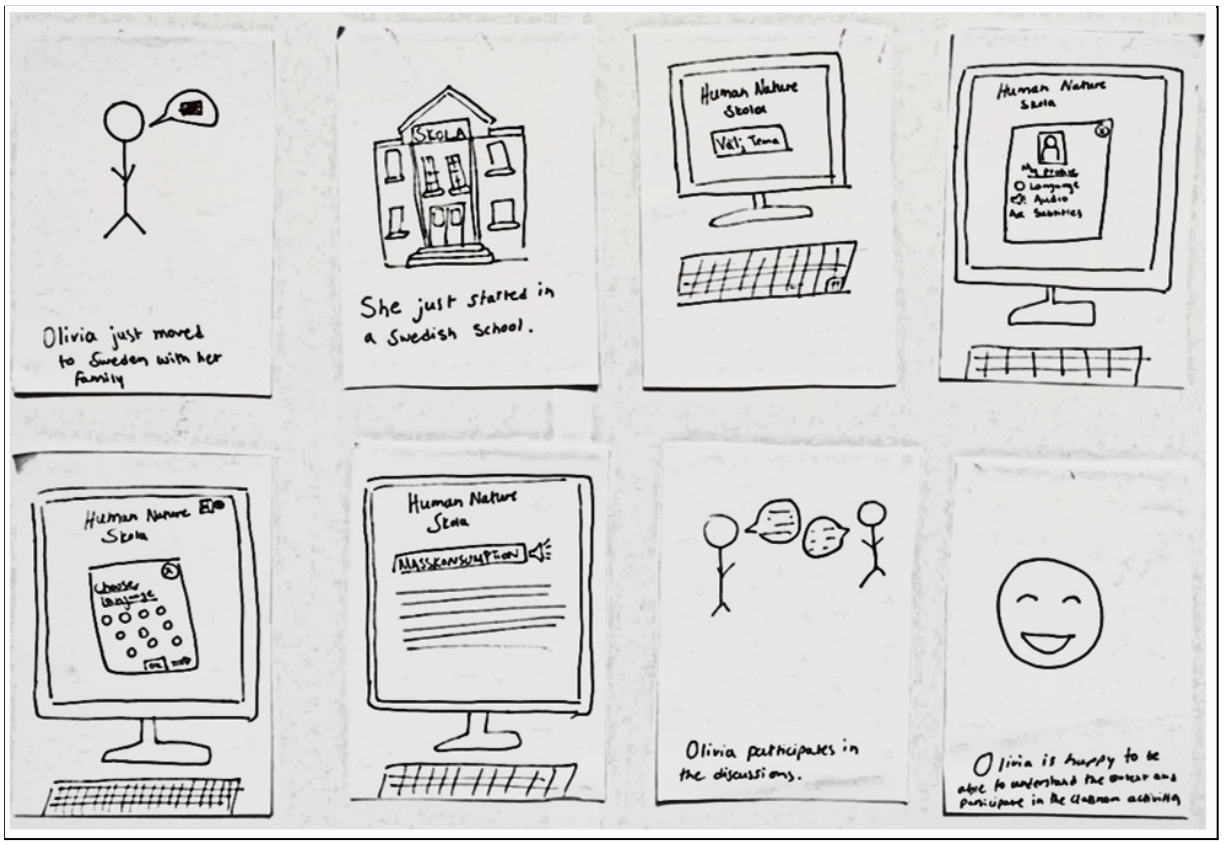


In order to refine and visualise the different ideas that came up from the brainstorming session and the sketches, I created a storyboard to visually represent the user's reaction. In Figure 14, we follow the story of Olivia who attends a Swedish school. Olivia is half Swedish and half English and spent most of her life in England. Olivia struggles a lot with learning Swedish and it is very hard for her to understand difficult words or long texts. She prefers to listen to content rather than to read. In the classroom, the teacher prepares the students for a visit in the Museum of World Culture by opening a dialogue with them about issues for the future of sustainability. The teacher suggests everyone to visit Human Nature Skola for reading the provided information in the website about Mass Consumption. The teachers ask them to read and then suggest doing one of the exercises all together and discuss the topic. Olivia follows the instructions and visits the website. She explores the website in Swedish and feels stressed as the information is in her second language and consists of a lot of text. She realizes that her classmates have already found the topic and started reading the information. Then she feels even more stressed and fears falling behind the other students. Then, she sees that there is an option for changing the language and the option for listening to the text while she is reading

it. She wants to try to read the text in Swedish in order to be able to participate in the discussion later using words and phrases as they are written on the text. Although, she wants to be sure that she understands the content. So, she decides to choose to listen to the audio of the text in English and keep the written text in Swedish. At the end, she feels happy that she could adjust Human Nature Skola based on her needs and finally she could easily participate in the discussion with her classmates.

Figure 14

Storyboard.



The Ideate phase started with Brainstorming in a mind map form which was guided by the HMW questions and generating ideas for identified goals, followed by sketches and a storyboard. During the idea generation, I had as a reference the personas that were developed on the Empathise stage to keep focus on what the users need.

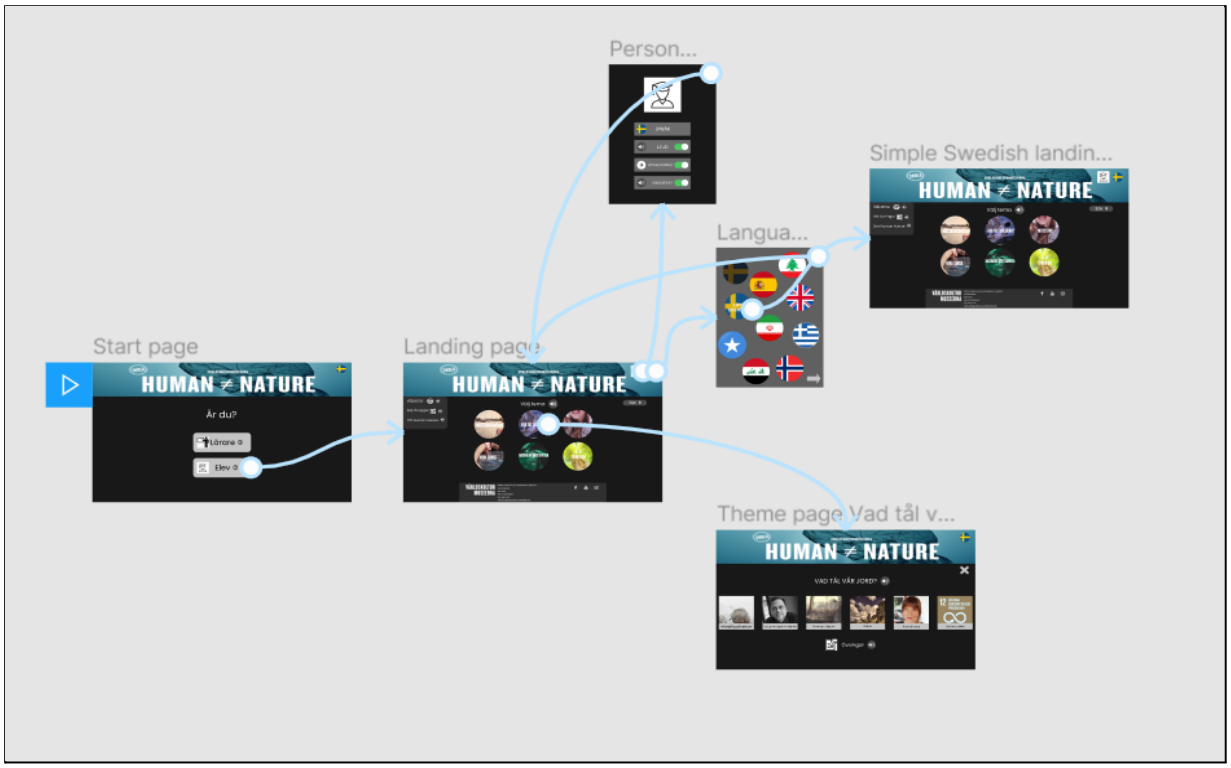
5.4 Prototype

In this stage the aim was to further develop the generated ideas and create a prototype which facilitates the process of communicating and testing my ideas with the end users. The

prototype was my tool to communicate and visualise the generated ideas and examine their functionality. The storyboard created on the previous stage worked as an initial version of the higher fidelity prototype I developed in Figma. Figure 15 presents the overall structure of the suggested design of Human Nature Skola showing a possible navigation experience for the user.

Figure 15

Information architecture of Human Nature Skola.



Having the UDL principle, multiple means of representation and the multimodality framework as guides, I included different representational modes on Human Nature Skola which enhance the understanding process for SSLL students. Human Nature Skola landing page does not distinguish between students and teachers. I thought that it would be beneficial for both to have two different versions of the website, one for teachers and one for students in order to support their needs. Figure 16 presents the first page that users will see, where they have to choose their role, leading them to a different interface of the content. The Human Nature Skola is currently available only in Swedish. Another improvement I designed for supporting SSLL students was the possibility of choosing language. On the upper right corner, the user can choose the preferred language by clicking on the flag (Figure 17). The user can choose the preferred language and can even choose “Lätt svenska” which means “Easy Swedish” and can cater students who wish to explore the website in Swedish, but they prefer a lower level of language difficulty.

Figure 16

Welcome page of HNS.

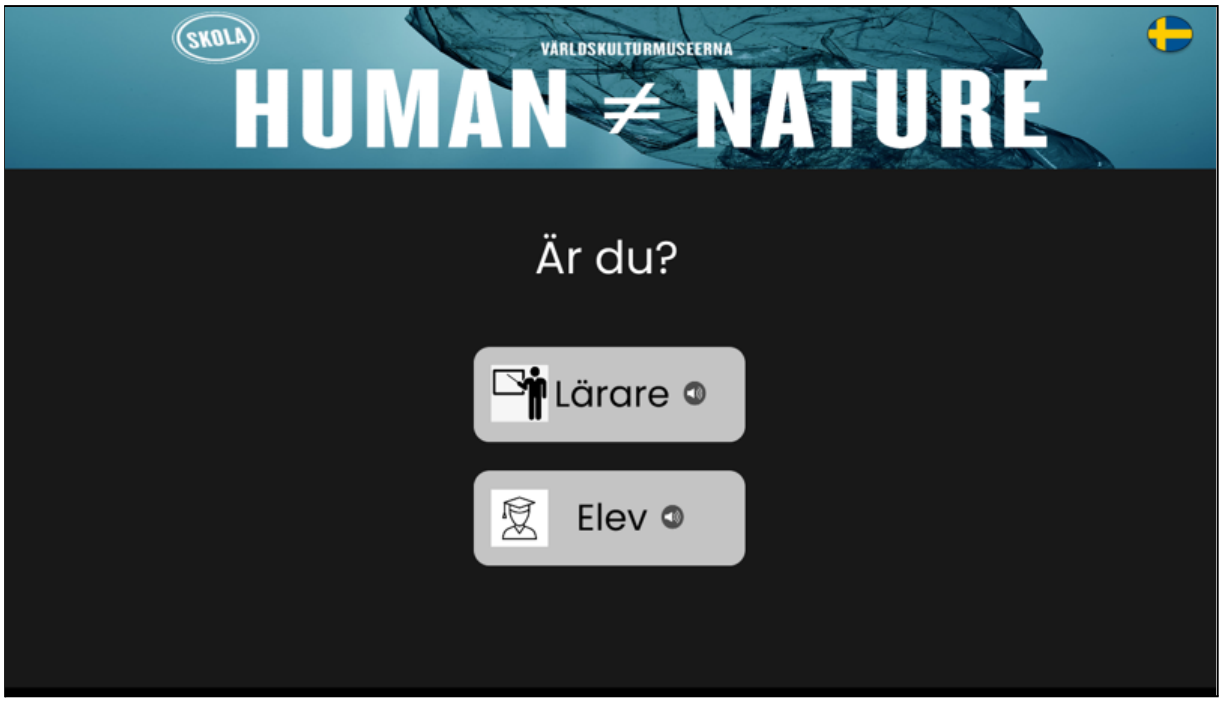
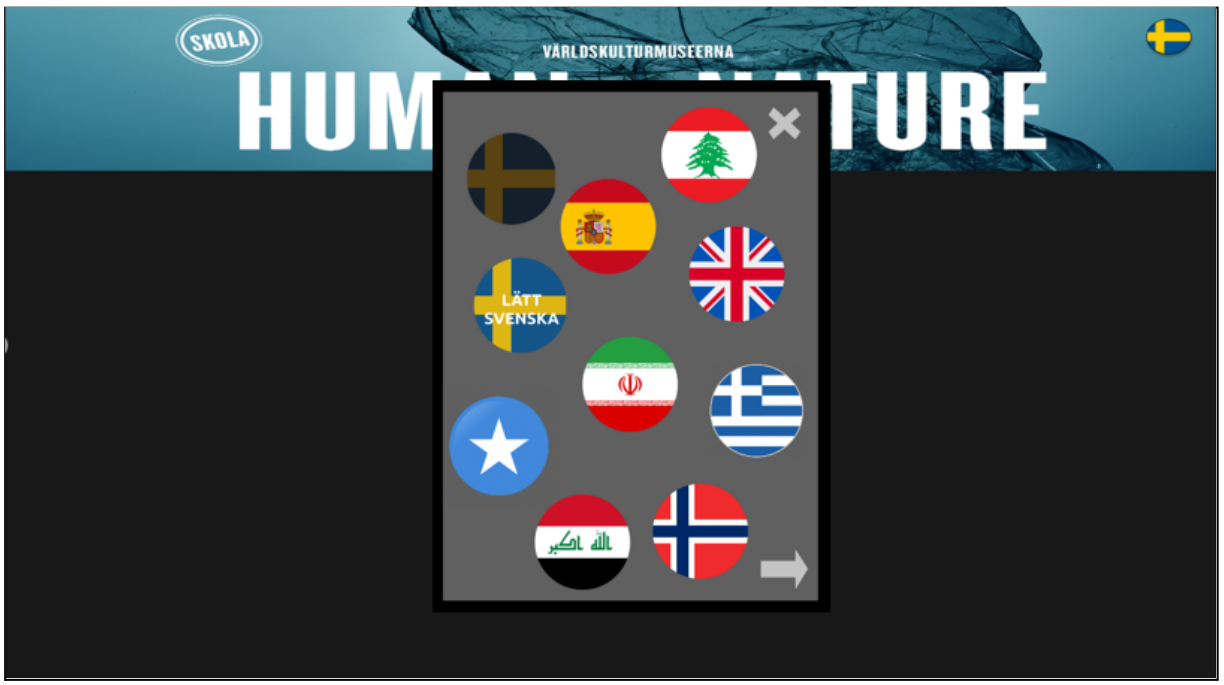


Figure 17

Language choice.



After selecting the preferred language and the profession, the user can navigate further to the content of Human Nature Skola. The existing website does not provide multimodal alternatives of the content, e.g. audio transcript, descriptive figures, text-to-speech, additional language version. Following the theories and methods of UDL principle, provide multiple means of representation and the multimodality framework, I decided to include the above features on the prototype in order to support SSLL to have different means of understanding the content (Figure 18).

Figure 18

Subjects page.

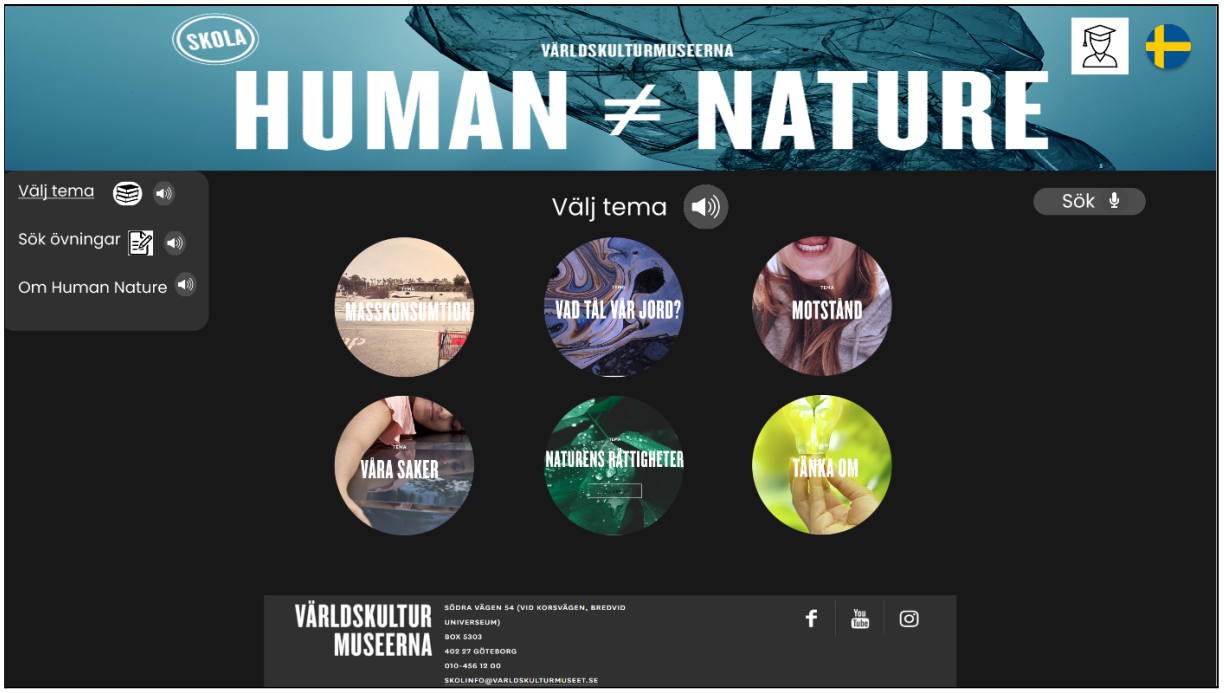
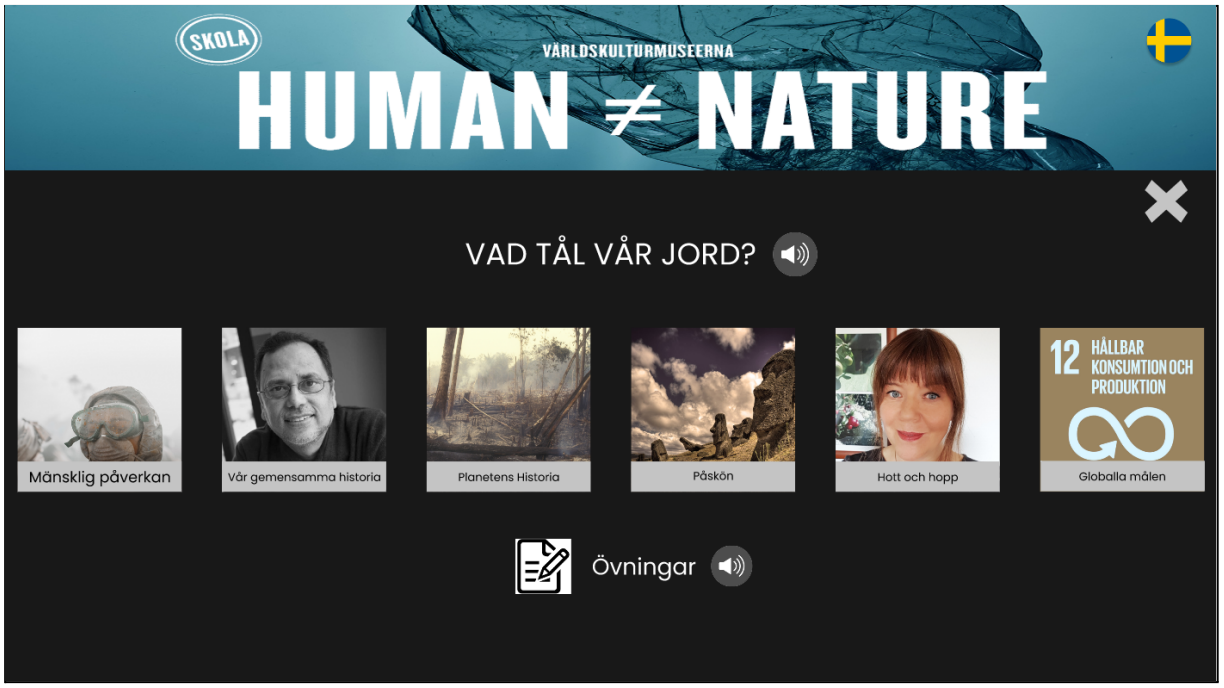


Figure 19

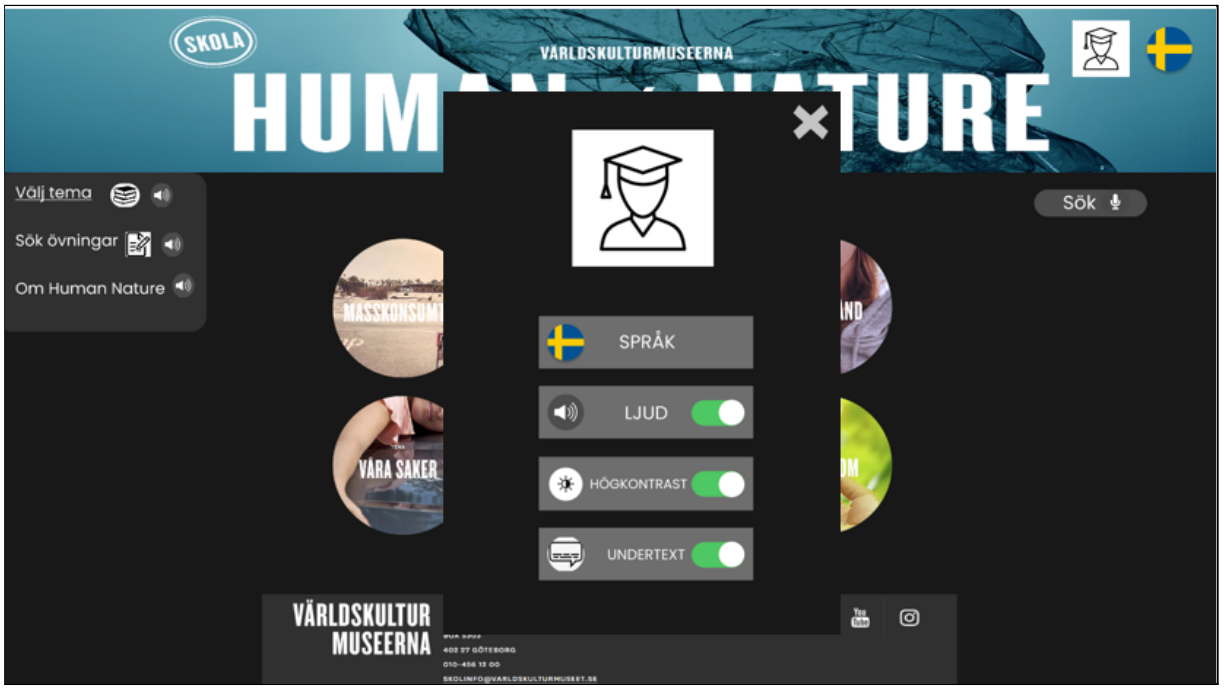
Example of specific subject page.



Finally, considering that "one size does not fit all", as also highlighted by the digital accessibility expert, I decided to include the choice for the user to customize its own profile and choose features that are suitable for the particular user. The user can customize the personal profile by clicking on the icon with the student on the top right corner (Figure 20).

Figure 20

Profile customization.



5.5 Test

In this stage, three of the teachers and the two SSLL students tested the prototype in order to provide feedback. Considering that the DT process is an iterative process with back-and-forth steps, I started by testing the prototype in a very early stage in order to get feedback from the users. The first phase of testing included an informal discussion about the ideas included in the prototype. Interviewees were asked about specific features implemented in the design, such as the audio transcript and subtitles in different languages and if that could be a suitable solution for the design problem. As DT is a human-centered design process, it was important for me to include the users and let them contribute by sharing their opinions and expressing their thoughts about the design. Taking this feedback, I further developed a higher-fidelity prototype using Figma. Later, a usability test was carried out using the method of think-aloud in which users described what they were doing and thinking while they were performing the task. The session started with participants being asked to explore the Human Nature Skola prototype on Figma with the suggested improvements for digital accessibility for SSLL. They were prompted to think out loud about what they saw and would do to interact with the content. Furthermore, they were encouraged to share what they like on the design and what features facilitate their navigation. After exploring the improved Human Nature Skola, the users were asked to carry out two different tasks. The first task was to customize the settings for their profile based on their preferences on the types of the content of Human Nature Skola. The second task was to find information about a specific subject and find the suggested activities of this topic. During these sessions, I was observing and taking notes of the users' comments and how they were interacting with the prototype. After the think-aloud sessions, users were asked to provide general feedback, to share their thoughts and what they liked and

did not like about the prototype. This final session was an informal discussion where I had an idea of the topics I wanted to discuss with them, but there was no strict order in which the topics would be discussed.

The testing with the participants generated mainly positive feedback, but also some critical feedback and suggestions for improvement.

Positive feedback:

- Users liked the possibility of customizing their profile and making adjustments based on the different needs and levels.
- All the users agreed that having the option of audio transcript can support both the process of understanding the content but also support learning Swedish.
- Users liked the text-to-speech feature. Most of the users highlighted that it is easier to say a word than writing it, especially for SSLL.
- Users thought that it is beneficial to include descriptive figures which support the easier understanding of the content of Human Nature Skola.
- Users liked the option for choosing different languages and especially the possibility of choosing “Easy Swedish”.

Critical feedback:

- Users expressed their need for having mixed languages on the representation of the content. More particularly, they wished to have subtitles in Swedish while the audio is in their first language.
- Users also wished to have the possibility of direct translation of difficult words when they have chosen the Swedish language which is their second language.
- The users suggested that except for the choice for the language, they would like to be able to switch the content between different modes. More specifically, they thought that being able to get the information which is in a text on Human Nature Skola also on a video or an illustration would make it more accessible for them.
- The users expressed that being able to create an account and be able to communicate, through Human Nature Skola with other students that share the same first language would facilitate the process of understanding the content.

Based on the feedback from the users, I suggest a design improvement to cater the need for direct translation of words that can be more difficult to understand and in parallel to provide different modes of representation of the content. My suggestion is to get a description on the preferred language supported with images that will be displayed when the user hovers the cursor over the difficult word. Figure 20 illustrates an example of this feature while the user hovers the cursor over the subject “Vad tål vår jord”. A tooltip appears providing translation, audio transcript and pictures that are related to the content of this subject. In that way, the user can benefit from both the multiple representational modes but also from the direct translation in the chosen language. This design suggestion for improving accessibility on Human Nature Skola got positive feedback from the users, who thought that this feature can facilitate the navigation and the understanding process. However, two teachers recommended that a tooltip feature should be an optional choice. They explained that native speakers or SSLL who are on a more advanced level in Swedish and use the Human Nature Skola, might find it unnecessary to get a tooltip feature that explains all the different words. Although, they agreed that this feature will benefit new SSLL or SSLL that are not very confident with the second language

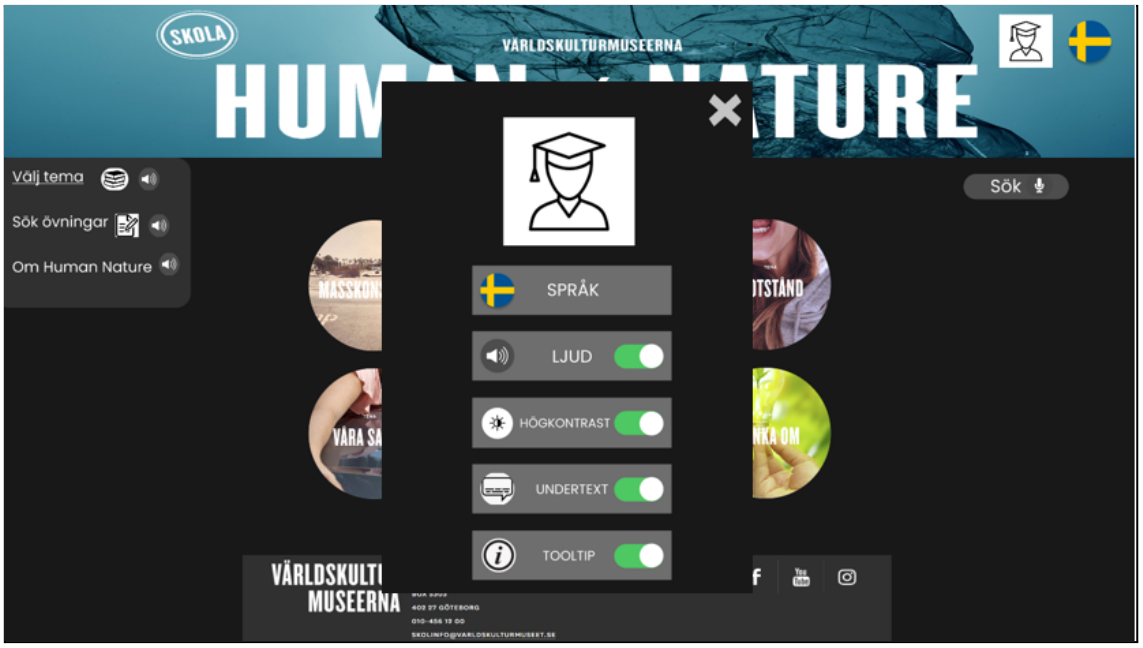
yet. Therefore, my suggestion to that comment is to add the tooltip feature as an option on the settings for profile customization so students can choose it based on their needs (Figure 21).

Figure 21

Tooltip while hovering.

Figure 22

Profile customization with added tooltip feature choice.



Chapter 6: Discussion

The aim of this development project was to explore the struggles that SSLL students encounter while they are using Swedish digital learning resources. Additionally, it aims to suggest digital accessibility improvements for Human Nature Skola, which is an existing digital learning resource for schools created by the National Museums of World Culture. For the purposes of this project, I followed the five-stage Design Thinking (DT) model proposed by Plattner (2010) to gain an empathetic understanding with the target users and suggest digital accessibility improvements for the Human Nature Skola.

The iterative DT process started out by gaining insights regarding the Human Nature Skola and its purpose. To achieve this, one of the creators interviewed and provided information about the purpose, how it started and the users of Human Nature Skola. For gaining a better understanding for digital accessibility and its importance, information gathered by interviewing a digital accessibility expert who is a specialist on the subject and provided insights and knowledge. Following this, empathy interviews with both teachers who work with SSLL students and SSLL students participated in order to provide information about the needs, desires, concerns and thoughts of SSLL.

The first research question in this study sought to determine the struggles that SSLL encounter while using digital learning resources in the classroom. The findings of the empathy interviews showed that SSLL students encounter several struggles while they are trying to learn the new language such as difficulties with text comprehension, self-consciousness and difficulties adapting to the new culture.

SSLL students experience difficulties comprehending long written texts that lack illustrations or translation. This finding was also reported by Miller and Endo (2004) who indicated that SSLL students experience cognitive overload in their effort to understand the information in the second language. A possible explanation for this result might be that the information provided on digital learning resources exceed the capacity of SSLL's working memory. Learning a new language requires time and effort both from the students and teachers who coordinate the learning experiences in the classroom. Additionally, SSLL needs more time and effort (due to the need for translation) in a fast-moving learning process that can affect their motivation and even their academic performance. SSLL students need scaffolding and learning experiences that are adapted to their needs in order to participate and get involved. This phenomenon is also highlighted by the digital accessibility expert who mentioned that cognitive overload is a result of the excessive amount of information which lacks accessibility.

Another important finding is that SSLL experience self-consciousness while using Swedish digital learning resources in the classroom. SSLL students are feeling embarrassed to express themselves, especially when they are beginners in the second language. This feeling is accompanied by the feeling of being afraid to fail that can lead to self-consciousness. The findings showed that SSLL students stay quiet or avoid participating in activities which require them to speak in Swedish. This outcome reflects those of Woodrow (2006) who also found that second language learners experience the fear of failure caused by the concern of making mistakes while speaking the second language. However, Woodrow (2006) and Miller and Endo (2004) mentioned that second language learners experience anxiety and frustration which was not shown in this study. Although, this could be explained due to their young age.

Finally, the findings indicate that SSLL experience difficulties with adapting to the new culture. This finding is consistent with that of Meyer (2000) who referred to culture load and Miller an Endo (2004) who argued about the process of adapting in the new culture as a second language learner. This result may be explained by the fact that culture is an important part of society. SSLL coming from another culture face difficulties adapting with the new reality. It is required for them to understand the cultural background that gives meaning to the different words in addition to learning the language.

Overall, these results are in line with previous studies, however it is important to highlight that findings from previous studies focused on second language learners in general while this study focus only on Swedish second language learners. These results were the ground for the design part of the project which strived to suggest digital accessibility of Human Nature Skola for SSLL.

The second research question aimed to explore the design strategies that Human Nature Skola can implement to provide accessibility to SSLL. The frame used for addressing this question was based on Plattner's five-stage DT process (Plattner, 2010) which provided a human-centered approach to problem solving. DT is an iterative process which indicates that there were many back-and-forth steps and repetitions of different processes. As DT has a human-centered design approach, it enabled me to suggest design strategies that are based on the actual peoples' needs and desires. Teachers and SSLL students who participated in the Empathise stage and shared their needs and motivations, took part on the Prototype and Testing stages where they were prompted to provide feedback. Based on their feedback and concerns, I recommended improvements and suggestions for further development of the project. Furthermore, the different tools and methods used in the DT process facilitated the whole procedure, worked as guidance and helped me reflect on my own thoughts and suggestions. Finally, interviewing a digital accessibility expert provided a deeper understanding of how experts address the issue of accessibility. "One size does not fit all" has been highlighted by the digital accessibility expert and it is a phrase that I took under consideration during the whole process of DT. This was also indicated by the participants of the empathy interviews who all agreed that people's needs differ even if they share common characteristics.

Considering all the above, my recommendation for making Human Nature Skola more accessible for SSLL, is to apply the theories and methods of multimodal framework and Universal Design for Learning (UDL). This development project showed that information represented using different and multiple modes can enhance the learning experience for SSLL. Additionally, my recommendation is to provide the ability for the SSLL users to customize their profiles based on their personal needs and desires. This can benefit the learning process for SSLL by including them, making them "feel heard" and respecting their individual needs.

These results therefore need to be interpreted with caution and the limitations of this development project should be noted. The first limitation of this project was the number of the participants which was small and does not allow generalizations. The SSLL students who participated had different ages and different backgrounds which do not allow making general statements for all the SSLL students. Although, the struggles that SSLL encounter while using digital learning resources in the classrooms has been investigated regardless of their age. Furthermore, this development project had a limited time to occur which did not allow to

deepen and repeat the different processes. In addition, DT is a process that commonly occurs in teams of designers promoting collaborative design. This did not happen on the current project as it was an individual thesis project. Finally, due to the limited amount of time for this project, the DT process completed without a final fully functional design. Although, it provided suggestions for further development of the project based on the findings. The feedback from the participants indicated the need for further development and improvement of how Human Nature Skola can enhance accessibility for SSLL students. Finally, further research could also examine whether providing accessibility on the digital learning resources would reduce the challenges that were indicated during this study.

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Appendix

Appendix 1. Consent form for interviews

Dear participant,

I invite you to participate in a research study about digital accessibility on Human Nature Skola, which is a digital learning resource for schools created by the Museum of World Culture. I am currently studying in the Master Programme of IT and Learning at the University of Gothenburg and I am in the process of writing my Master's Thesis. The purpose of the research is to examine how the Human Nature Skola platform can be more accessible to students with swedish as their second language promoting an inclusive education model.

Important information to consider:

- The first interview will take 30 minutes and the second interview will take 30 minutes.
- Your participation in this research is completely voluntary, anonymous and you may decline your participation anytime during the research project.
- The interview will be recorded and a transcript will be produced.
- The transcript of the interview will be analysed by me and the actual recording will be destroyed after I finish my thesis.

Thank you for agreeing to be interviewed as part of the above project.

Kind regards,
Vasiliki Ziourka

Appendix 2. Students interview guide

- How old are you? In which grade are you?
- Which languages do you speak?
    - What language do you speak at home?
- Have you experienced difficulties understanding the material handed from your teacher due to the language?
    - What do you do when this happens?
- When you don't understand a word in Swedish what do you usually do? (Using a dictionary on your smartphone, ask for help from the teacher or your friends, you ignore it)
- Do you use technology in class?
- As a student, what is your experience with technology in the classroom? Do you prefer them over traditional instruction? If yes, why?
- Have you ever experienced any problems with using technology and digital resources in the classroom?
    - What was the problem?
    - What could be improved?
    - What do you wish it had?
- Have you ever used a digital learning resource that you felt was very good?
    - What was good with this resource?

Appendix 3. Teachers interview guide

Personal context

- What is your educational background?
- How long have you been teaching?
- Which grade are you teaching?

About their students

- Do you have students in your classroom for whom Swedish is not their native language?
    - What is your experience with students that are not Swedish native speakers?
- What languages do they speak at home?
- What challenges are these students encountering at school in regards to understanding Swedish?
    - How do you address these challenges? (Are there any strategies, resources, tools you are using for enhancing communication and understanding?)

Views on Digital Learning Resources

- Which digital learning resources do you use in your teaching?
    - How do you use them?
    - What is your experience with them?
        - Benefits
        - Challenges
- What is your students' experience of these resources?
    - Benefits
    - Challenges
    - Learning Outcomes
- How do you choose which digital learning resources you will implement in your teaching practice?
- Can you think of any way these resources could be made better for your students that are second language learners?
- How can digital technologies help students who are second language learners?
    - What did you encounter as a good function on websites/digital learning resources you have used for students as a second language learners?
- What do you think is missing when you are using websites with your students who are second language learners?
    - What do your students struggle with?
    - What do you wish that was on the website to help the students?
- Have you seen any good designs that you thought were very good and suitable for your students?

Appendix 4. Creators of Human Nature Skola interview guide

- When did the project of Human Nature Skola start?
- What were the intentions behind human nature skola?
- What is the platform supposed to teach?
- Who are the users of the platform?
- Have you gotten any feedback since you created this platform?
- Is it necessary for someone to have visited the exhibition to be able to use the platform?

Appendix 5. Digital accessibility expert interview guide

- Can you tell me about the collaboration with The National Museums of World Culture and the proposal you wrote together for making Human Nature Skola more accessible for students?
- Why is web accessibility so important according to you?
- What is the process you follow when you evaluate and design a website?
    - Are there any specific guidelines that you are following? (i.e. Web Content Accessibility Guidelines (WCAG) version 2.1)
- What do you think about assistive technology?
    - Do you think it helps with digital accessibility?
- What is your experience of designing digital accessibility of content for students who have Swedish as their second language?
- What is, in your opinion, a good way to enhance digital accessibility for students who are second language Swedish learners?