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Usability of mobile solution designed for school children: case School Helper

Metropolia University of Applied Sciences

Bachelor of Engineering

Information and Communications Technology

Bachelor's Thesis

28 May 2021

Abstract

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Title:	Usability of mobile solution designed for school children: case School Helper
Number of Pages:	50 pages + 1 appendices
Date:	28 May 2021
Degree:	Bachelor of Engineering
Degree Programme:	Information and Communications Technology
Professional Major:	Mobile Solutions
Instructors:	Ulla Sederlöf, Senior Lecturer

The purpose of the thesis was to find out what needs to be taken into consideration when designing a mobile solution for children. The thesis aims to create an initial mobile prototype of a School Helper -tool, offer suggestions on what needs to be considered in the remote user testing of the mobile prototype with children and present ideas for the future development of the mobile solution.

The theoretical framework of this thesis is based on the demands that child users pose on mobile application design, the Cognitive Load theory, usability of mobile applications, and was formed through desktop research. After comparison of prototyping tools Figma was selected for the prototype and user testing.

The paper prototype could be translated successfully into digital format, though the new format did require creation of additional features. To keep children interested and occupied with the mobile solution, features such as child-friendly use of color, images and other functionalities were added. To conclude, the mobile format allows the benefit of added interaction and guidance when compared to the paper prototype. The mobile prototype can be used later to evaluate the potential of the solution and justify, whether it would be beneficial to invest more research to further develop the School Helper application.

Keywords: mobile solution, prototype, usability, user design, Figma, remote user testing with children, cognitive load theory

Tiivistelmä

Tekijä:	Emma-Riitta Honkala
Otsikko:	Koululaisille suunnitellun mobiilisovelluksen käytettävyys: case Kouluapuri
Sivumäärä:	50 sivua + 1 liite
Aika:	28.5.2021
Tutkinto:	Insinööri (AMK)
Tutkinto-ohjelma:	Tieto- ja viestintätekniikan tutkinto-ohjelma
Ammatillinen pääaine:	Ammatillisena pääaineena mobiilisovellukset
Ohjaajat:	Lehtori Ulla Sederlöf

Insinöörityön tarkoituksena oli selvittää mitä tekijöitä tulee ottaa huomioon lapsille suunniteltavan mobiilisovelluksen suunnittelussa. Insinöörityö pyrki suunnittelemaan ja toteuttamaan ensimmäisen version Kouluapuri -työkalun mobiiliprototyypistä, tuottaa ehdotus asioista, jotka tulisi huomioida, kun tehdään mobiiliprototyypin etäkäyttäjätutkimuksia lapsien kanssa ja esittää jatkokehitysideoita mobiilisovelluksen kehittämiseksi.

Opinnäytetyön teoreettinen viitekehys on muodostettu tutkimalla lapsikäyttäjien mobiilisovellusten suunnittelulle asettamia vaatimuksia, kognitiivisen kuormituksen teoriaa ja mobiilisovellusten käytettävyyttä lapsien näkökulmasta. Prototyyppaustyökalu Figma valikoitui prototyypin luontiin ja käyttäjätutkimukseen tarjolla olevien työkalujen vertailun pohjalta.

Paperinen prototyyppi voitiin onnistuneesti muuttaa digitaaliseen muotoon, mutta sen toteutus vaati joidenkin lisäominaisuuksien luomisen. Jotta lapset pysyvät kiinnostuneina ja keskittyneinä käyttäessään mobiilisovellusta, lisättiin ominaisuuksia, kuten lapsiystävällinen värien käyttö ja kuvitus. Johtopäätöksenä voidaan sanoa, että mobiilisovelluksessa on mahdollista tarjota enemmän interaktiivisuutta ja ohjausta paperityökaluun verrattuna. Mobiiliprototyyppiä voidaan myöhemmin käyttää mobiilisovelluksen potentiaalin arvioimiseen ja sen päättämiseen kannattaako Kouluapurin jatkaa työkalun kehittämistä sovellukseksi.

Avainsanat: mobiilisovellus, prototyyppi, käytettävyys, käyttäjäsuunnittelu, Figma, etäkäyttäjätestaus lasten kanssa, kognitiivisen kuormituksen teoria

Contents

List of Abbreviations and terms

HCI: Human-Computer-Interaction: the interactions between human and a computer.

ICL: Intrinsic Cognitive Load: the inherent level of difficulty associated with a specific instructional topic.

ECL: Extraneous Cognitive Load: generated from the way information is presented to learners and is under the control of instructional designers.

GCL: Germane Cognitive Load: the processing, construction, and automation of schemas.

1 Introduction

COVID-19 pandemic has forced basic school children to remote school in Finland. Indeed, remote schooling has drastically changed the children's study environment and the way in which teaching, and learning is being conducted. Remote schooling has also brought forth new obstacles that are diverse; some of these difficulties relate to a student's individual capabilities, such as to their level of independence or self-motivation. In brief, together with individual students' study skills, family resources as well as the way in which schools are organizing studies all influence the results of remote schooling. As we well know, not all students' have the same background or the resources available to them. Remote schooling has led to the need of new ways to help students, their families, and schools to manage studying and to ensure that every student has the necessary tools to help them meet the study targets. (Saramo 2021; Leinonen 2021; OAJ 2020)

The new learning environment has brought big changes on how school tasks are organized, as well as to the scale of entities to be managed. Thus, demand for students' cognitive control skills is higher. This has led school children to feelings of stress, melancholy and in inert to advance in school tasks (Kivimäki, 2021; OAJ, 2020). For teenagers, the main challenge is inefficiency and tiredness caused by larger than average workload and changes (Demi & al., 2020). Subsequently, it also requires the students and their families to take more responsibility at progressing according to the study schedule. Suomen lukiolaisten liitto (2020) found out that 60% of college students experienced emotional stress due to remote studying. In that same study one college student stated that the teachers give a lot of exercises to be done independently on top of the ones given during class, which results that there is no more time for anything else during the day (Suomen lukiolaisten liitto, 2020). Survey of Lasten ja Nuorten säätiö (2020) supports this: schoolwork took more time than before, work, and free time get blended, the amount of schoolwork causes anxiety, and the assignments seem to pile up. From 1068 lower secondary school children

24% said they experience some difficulties and 7% said they experience a lot of difficulties with remote schooling (Lasten ja Nuorten säätiö 2020). Some children also only receive task lists through Wilma online platform and feel that the situation is chaotic (Ervasti 2020).

The students' families are also getting their fair share of new demands, one of which could be seen affording new technical tools for their children. Families are facing the need to support their children's studies more than ever in a situation where because of COVID-19, many parents are much like their children either studying or working remotely from home as well. (OAJ, 2020.).

This thesis is based on a social innovation project conducted by two students doing their Master's degree in Laurea University of Applied Sciences. During their project they created paper prototype of the service called School Helper (in Finnish Kouluapuri). The idea behind it is to fulfil school children's need to organize their school task better and help them understand adequate input for each task and assignment. The creators of School Helper envision that by creating this tool, we can help students to understand what is required from them and what is realistically achievable for each assignment given by the school. The thesis will provide more information on the usability and user experience requirements of children and a prototype matching these with the already existing functionalities of paper prototype.

2 Research background

The research or this thesis focuses on the development of a user tested paper prototype showcased in Figure 2 to a mobile prototype that can later be user tested and implemented to create the final interface for mobile application. The case is based on a pre-start-up considering the viability of a mobile solution version of an existing idea for a service. The main target group of the prototype is Finnish school children between the ages of 10-15, but it could also be used by children aged 7-9. Children with recognized special needs are left out of the main scope for the mobile solution.

2.1 Research questions

The purpose of the research is to find out what needs to be taken into consideration when designing a mobile solution for children. The thesis aims to create an initial prototype, consider how the mobile prototype could be remote tested with children and present ideas for the future development of the mobile solution. The first version of interactive mobile prototype created as part of this thesis aims to prove how the paper prototype could work in digital format and be used to evaluate if there is any real potential to invest in further development of the application.

To evaluate the potential of the mobile application, Hyypiä and Honkala plan to user test the mobile prototype in the next phases of the development process, which is out the scope of this thesis. The future remote user test is planned to help validate the design choices made in this first mobile prototype and if School Helper could realistically help empower schools and students to develop even further their organization and self-management skills. This should result in more clear structure to (remote) school days.

Before creating the mobile prototype and later develop it into viable mobile application, several aspects needed to be addressed related to the special requirements school children have for the usability and user experience of a mobile solution. Due to COVID-19 situation, also the remote user testing practices that can be used with children need to be investigated.

Research questions this thesis answers are:

- Research question 1: What special needs do children have for usability in mobile solutions?
- Research question 2: How do the cognitive models affect the usability of a mobile solution?
- Research question 3: How the user experience theory (usability etc.) can be applied to the design of a mobile solution?
- Research question 4: What should be considered when conducting remote user testing of a mobile application prototype with children?

2.2 Research method, approach, and development task

This thesis is a qualitative case study that uses prototyping as a method. The method was chosen because it is suitable for this type of project where the aim is to produce a prototype in the context of single service. Case study is appropriate approach in situations where the purpose is to produce useful ideas and proposals for development of a service. This thesis focuses on contemporary phenomenon of usability of a mobile prototype with children; the environment for the future user testing is conducted possibly during COVID19 at children's homes which makes the environment out of control of the researcher. For a case study it is common that it produces information about a very current or on-going phenomenon without trying to simplify it too much. This aspect further supports the method chosen for this project. (Ojasalo & al. 2015, 52; Yin 2018, 5; 13).

Process of the qualitative case study usually has some main principals that are characteristic to it that are described in Figure 1. Commonly the process starts from getting familiar with the chosen case or subject. Defining the aim, methods, and questions for the research further exploration around the subject is usually needed and it is common to redefine it during the process. (Ojasalo & al. 2015, 54) During this project, the scope of the thesis also changed, and it was needed to redefine the aim for the case study. Initially, the idea was to focus mostly on the remote user testing of the prototype with children, but as the work progressed it was evident that within the boundaries of time and school year, the focus would be adjusted to deliver the initial prototype fitting the usability and user experience requirements of children to the creators of School helper, and only give some ideas for the user-testing.

Figure 1 Different steps of a case study.

Prior to starting the thesis some time was taken to orientation to the subject. Digitalization is spreading, and with it more and more publications and research papers have switched to digital format. There are some great sources from which to gather reliable and peer-reviewed information such as Google Scholar and some other academic electronic resources and databases that university students can get access relatively easy. As for this project literature information was gathered mostly from the Google scholar, MetCat Finna and few other e-resources that were part of Metropolia UAS library. Google Scholar offers variety of books, abstracts, articles and such from multiple sources and it can be argued that as a source of information it can be held plausible. Some digital publications that were not peer-reviewed were used when they provided interesting insight about the subject and were published by acknowledged facet.

2.3 Case School Helper

This thesis is based on a social innovation project conducted by two students doing their master's degree in Laurea University of Applied Sciences. The social innovation project was done within the context of COVID-19 and the aim of the project was to innovate a planning tool for school children.

While conducting their project Hyypiä and Honkala came across problems related to a student's individual abilities in the context of independence and self-motivation as well as division in abilities in study skills. They also found that there were differences in the way remote schooling was organized in different schools as well as differences in resources between families. It came apparent

to Hyypiä and Honkala, that the current situation with remote schooling required the students to take on more responsibility on organizing larger entities than before which ultimately results in higher demands on cognitive skills of the students. To both Hyypiä and Honkala it came clear early on, that organization of students' task could be improved by delivering a tool for them to manage and plan school in a way that is simple as well as empowering. (Hyypiä & Honkala, 2020.)

The tool was named School Helper during the project and the final paper version of the tool is presented in Figure 2. School Helper thrives to create at tool for school children battling with difficulties that have risen during the remote schooling periods resulting COVID19.

The original School Helper project got good reviews and raised interest among the participants such as a teacher, school psychologist, and school children taking part in user testing paper tool. Therefore, the persons behind the project, Marja Hyypiä and Eeva Honkala decided to look further into developing the idea of School Helper to a mobile solution.

Next, the final paper prototype of the tool will be introduced together with the user flow of children using School helper to organize their tasks with the help of a teacher or another adult. This paper prototype will be the base from which the mobile protype will be designed. The paper prototype will not work as it is in the form of mobile solution, which is why in the chapter 4, the adaption of the paper prototype to different format is explained.

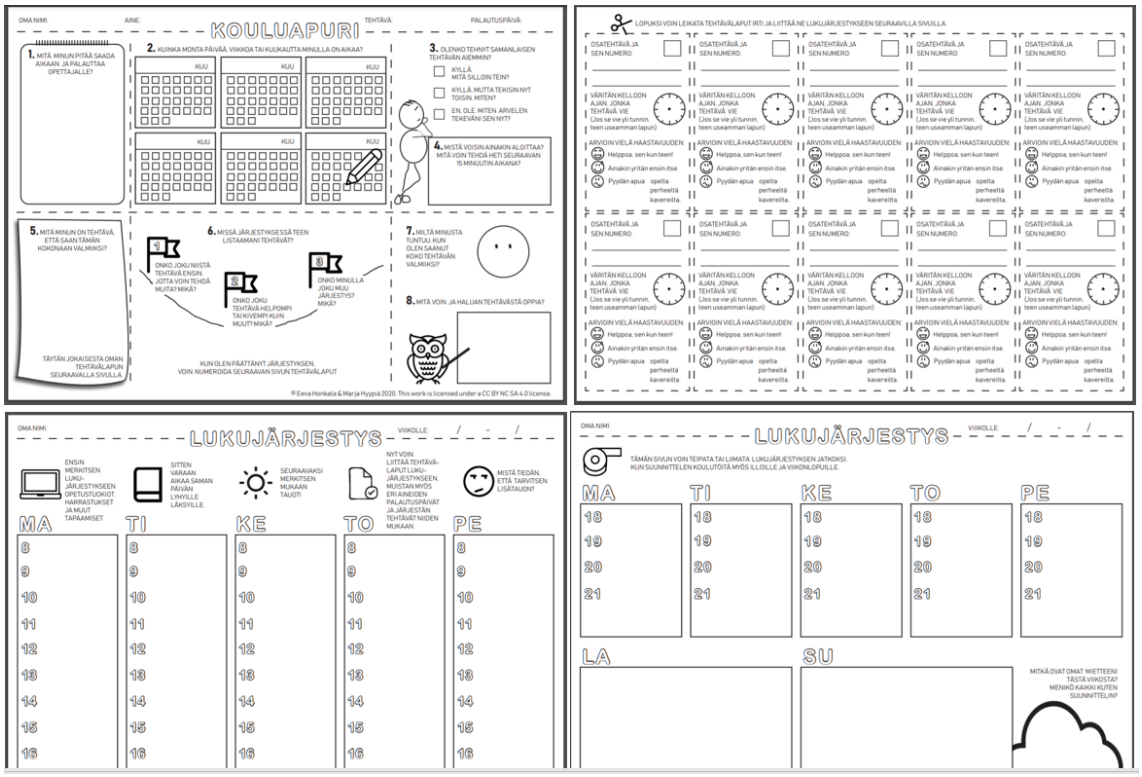

Figure 2 The final version of the original School Helper template in paper format (Hyypiä & al,2020).

The paper tool (see Figure 2 above) is recommended to be first introduced to children with the guidance of a teacher or other adult. The process is sectioned into 8 steps and each step will be described next in further detail.

Step 1. The process of using the tool for the first time starts with guidance from the teacher or another adult. The child is prompted to think aloud what assignment s/he have been given from the school and think through what exactly they are expected to do with each assignment or possible subtask. This will help the child to create more coherent idea of what s/he will be doing in the assignment and help get started. The teacher will offer help in division of larger tasks to smaller ones.

Step 2. Next step is for the child together with guidance from the teacher and with the help of calendar provided by the tool, to evaluate how much time s/he has got to do the assignment defined during the previous step. To help visualise

the timeline for the assignment the child can colour from the calendar all the days s/he has left to accomplish it.

Step 3. When the timeline is clear in the child's mind the next step is to consider if s/he has in the past done similar assignment. To do this the child is given a card with detailed helper questions to further consider how they could proceed with the assignment.

Step 4. Questions such as where it would be the easiest to start or what could be done for the assignment in next 15 minutes aim to give incentive to get the process started, and later to accomplish the assignment.

Step 5. Now the child should have even clearer idea of what to do next about the assignment and is guided to consider what s/he should do to finish the whole task. To help the child to divide the assignment into smaller subtasks, the tool provides a template of cards. Idea is that the child fills information about each subtask one card at a time, evaluating time that it takes to do the subtask and how demanding it is to accomplish for them. If the child feels that the subtask is too demanding, the card guides to ask help from the teacher, family, or friends.

Step 6. When all subtasks are made into cards, child is prompted to consider the order in which they should be carried out. To help consider the right order the template offers questions to evaluate if one subtask is easier or more fun to do than another, or if there is already a rule which determines the order used. Finally, all that is left is to just number each card and place them on the two schedule templates provided by the School Helper tool. The template promotes 4 steps to help organize the schedule; 1. Fill first lectures, hobbies, and other appointments, 2. Allocate time for short day tasks, 3. Remember to mark down breaks, and 4. Place all the subtask in the order that was decided earlier. After each school week it is suggested to reflect how the week was and whether the plans were realized.

Step 7. Now that one assignment has been scheduled and divided into subtask, the child is guided to reflect how it makes them feel now that they have more realistic idea what they need to accomplish.

Step 8. The final task is to help reflect what they can and want to learn from the assignment.

After the first round, the child can start using School Helper independently with support from the teacher or other adults: the age and personal qualities of the child affect the level of support they need in adopting the tool and process.

2.4 Process

The development process of turning School Helper tool from paper format to digital started from gathering background information about the development of the original project and preliminary researching about the subjects concerning mobile development for children. In Figure 3, the process of the empirical part of thesis is described highlighting the parts affecting this thesis.

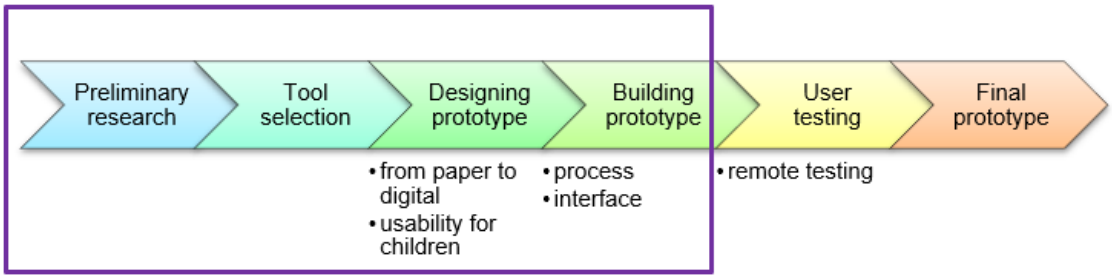

Figure 3 Process of designing and prototyping digital version of School Helper visualized.

The process flowed from preliminary research to tool selection into designing the prototype leading to the building of the digital prototype. As visualized in the Figure 4, user testing and final prototype are out of the scope of the thesis, meaning that these steps will be conducted and created in the later stages of the School Helper development by the School Helper owners. Usually

prototyping process is iterative, meaning that the different elements of sketching, prototyping, evaluation, and testing are repeated and flow many times in a cycle which is described in Figure 4 . School Helper was originally designed as paper template, which makes sense as the target audience for it are children. Paper affords children to write their thoughts and ideas easily and quickly on the paper as well as affording them to make changes to it relatively easy. It also does not require a lot of investment for children or their families to use it.

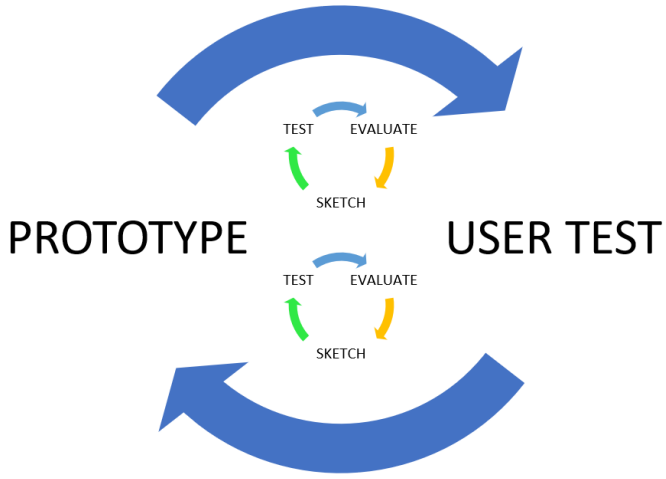

Figure 4 Diagram visualizing the iterative design process of prototyping.

The original paper format also meant that the viability of the original idea was easy and cheap to be evaluated when user tested as paper prototype. Prototyping is not simply a tool to be used as part of design and development process, but it can also be seen as design philosophy. Using prototyping as a mean to test your design, idea, product, or a service in the intended form, allows it to find out in practice how it potentially could be used and whether it is viable or not. Prototyping makes it faster to test and make changes to your design by allowing one to experiment with the design before it is built to perfection. By testing and seeing the idea in its intended form one learns more about the design choices than by just simply imagining how it would look and work. Mistakes in the design can be tested and validated by simply prototyping and user testing. (Warfel 2009, xii; Baird 2020, xxiv-xxx.)

Prototyping starts commonly from selecting the right tool to be used and ends to the final user tested prototype which is then implemented the final interface for the actual product or service.

The thesis project, as stated above, focused on designing preliminary prototype that could later be tested to evaluate how users experience the walkthrough and UI of the potential application, and a suggestion for remote user testing. The final guidelines for UI in future development of the School Helper mobile solution were left out of the scope of this thesis, as they would be affected by the later findings from the user testing.

In the following chapters I will go through each step of the process described in more detail and discuss the theory background affecting the prototyping process and design choices made in the creation of the School Helper mobile prototype.

3 Usability and UI of a service from the children's perspective

During COVID-19 the need for educational mobile tools has exploded. As businesses and industries around the world have been forced to remote work and conduct daily activities from distance, also students have faced new demands. The growing need for new applications and tools to help manage the everyday school life is speeding up the development of innovation in the industry.

COVID-19 has affected how teaching is organized in Finland. The Trade Union of Education in Finland (OAJ) reports that 75% of the teachers who participated in their survey seem to share mutual opinion about how remote schooling has probably been both negative and positive impact on an individual students' learning. As many as every sixth teacher thought that remote schooling has had positive impact on most of the students. In their survey summary OAJ also point out how schools have been forced to a large digital leap in remote schooling and how there are areas where the digital tools to ensure the quality of remote teaching is sometimes lacking. As many of 40% of the teachers participating in

the survey told that the tools used for remote teaching were new to them. (OAJ, 2020.)

The OAJ's survey verify that there are still a lot of room to improve in the teacher's knowledge of different tools available for them to be used to improve the quality and reach of remote teaching. In this situation, it seems that there is great opportunity and the need for tools such as School Helper that can help both students as well as their teachers to improve the quality of learning in remote environment.

Changing environment is bringing up new usability challenges as well as highlighting some areas that are lacking richer insight about the demands for the development in the current remote centred environment. It is important to gather more information about how the current situation is affecting the use of devices with children and if the changes in the school life are affecting the cognitive models of growing children, since resulting new demands for the usability of applications and the context in which these applications are used. For this purpose, it is important to know about usability and development of mobile solutions to children.

As is generally known, children pose different social, physical, and cognitive abilities depending on their age compared to adults and so, many designer's advice segmentation to distinct age groups when targeting child users. Common practice is to segment according to different school stages; ages 2-5 (Preschool), ages 6-10 (Elementary) and ages 11-14 (Middle school). Since we want School Helper tool to succeed in what it is designed for, which is to help children manage their school tasks in a way that will empower them, we need to make sure, that our application meets the usability demands children have for it and therefore works as is intended. Children especially need to be able to follow the relationships of cause and effect to build a mental model.

As our users for the mobile prototype will be mostly children born in the 2010s, we need to make sure in our design that the users are aware what they are

expected to do: for example, that the navigation and purpose is clear and easy to comprehend. To make this possible, a consistent user experience from start to finish is important. User testing in later stages of development is important to assure the mobile application will have simple, graphical, and intuitive UI: after first round of user tests, it is likely that the initial prototype designed in this thesis will have to be refined, as the likelihood for achieving all the usability requirements on first round is unlikely, and user tested again.

3.1 Usability of a mobile application with children

Paper publications of the development of mobile solutions to children were slim. In order, to get valuable insight about the subject some digital publications were chosen as part of the theoretical background. The research conducted for this thesis revealed that there is one cognitive load theory that is repeated in many articles concerning designing for children: theory of cognitive development created by Jean Piaget. Piaget studied the development of children's' logical thinking in different age groups. According to Paige's theory there is a stage in the Cognitive Development stages of children which is relevant for the scope of this thesis. The concrete operational stage (Age 7-11) where kids are just learning how to use logic to make assumptions and reason about the world, they live in. During these ages children's other cognitive capacities are still developing. Because of the developing skills of for example: processing conflicting information and switching perspectives or planning and monitoring their own behaviours it is important to pay attention to this fact in the design of School Helper prototype. One of the aims of School Helper is to help develop children's cognitive thought process by promoting child to reflect how they feel in different stages of using the application about the assignments and task, and therefore understanding the demand child's age puts to the usage and understanding of operations in the application is important part of the final design of the prototype and final product as well. (Feifei 2018.)

When companies developing mobile applications and software want to gain valuable insight about customer needs or about the viability of their intended

new products, they often create a prototype to conduct a user testing and/or user research. It is commonly known that instead of assuming what customers want or need, it is more important to do thorough research about targeted users. It is better to ask from the customers what they want or need than just assume that you know the right answer. Sometimes even customers themselves do not know what they need and therefore it takes a bit of research work to find the underlying or hidden problems that are waiting to be solved, and with it finding that niche for a new product, service or even a business. Designing services and products that can compete with other similar products on the market dictate that companies need to be truly aware of what their target groups need, want, and expect from their products or services. According to Laura Klein the author of UX for LEAN startups (2013), the best way to validate if an idea of a service is solving the problem it is designed, is not to ask if it solves the problem, but to test it with the real users and observe what reactions using the service brings in them. Klein suggests using a prototype that feels and looks as much as the final product or service, but with minimal effort used in the development. (Klein 2013: 14; 27-29.) This approach is also strongly endorsed by Todd Walfre the author of Prototyping: A practitioner's guide 2009 who claims that without prototyping and testing before building a product or a service is a recipe for failure, going as far as claiming it to be insane (Walfre 2009: xii.).

One of the main reasons for using prototyping and user testing besides validating an existing or potential idea, is to gain valuable information about the usability of the product or a service. Usability is one of the hot key words now in software industry. After all, the usability mobile application the prototype of this thesis is designed for will be used by children, and children born in this decade have grown natively to use mobile devices and services. ISO 9241-11-standard (1998:6) defines usability as follows:

> The "extent to which a product can be used by specified users to achieve specified goals effectively, efficiently and with satisfaction in a specified context of use".

This is where interaction design comes to the picture. Interaction design is a design method which focuses on the usability of the structures and the design

of different interactions between user and the product, system. Interaction design combines different theory and practices from Human-computer-interaction (HCI), product and graphic design as well as considers cognitive psychology. In this thesis interaction design approach was taken in the designing of the mobile prototype as a lot of focus was the user interface design (UI) to make the School Helper tool easy to use and useful to students using it. Cognitive load models also affect how the usability is being perceived by users and with young users this is something that should be considered in the design. (Steane & al 2018: 6, 214; Feifei.2018.) Cognitive load theory will be discussed in more detail in the next chapter 3.2. It could be argued that these so called "Digital Natives", which are the target group of School Helper, also have different expectations and needs to the usability of product than those born before mobile gadgets and internet was the norm. As a result, it is necessary to user test with Digital Native children to ensure our application suits their specific needs. (Gasser & Palfrey 2010: iii – xvii; Gallavin 2015; Feifei 2018; Nielsen 2019.)

The term usability is often linked with ease of use or context of use. One of the popular terms connected to usability is affordance or in some cases perceived affordance. The term affordance is used in many contexts and with many meanings. There are two main definitions that are usually used when talking about affordance, the perceptual psychologist James J. Gibson's definition and Donald Norman's definition. It is said that James J. Gibson introduced the term first to public in his seminal book The Ecological Approach to Visual Perception in 1979: he implies that object exists even if it cannot be perceived by anyone else then the observer. The term perceived affordance was originally introduced to the Human Computer Interaction (HCI) community by Donald Norman, the author of The Psychology of Everyday Things, 1988. Both definitions of affordances by Norman and Gibson focuses on the physical constraints, but Norman's definition has become widely used in the design context. In this study, the term affordance is used in the broader sense where the definition of Norman is combined with the more physical definition by Gibson. (Still & al. 2013: 285-289, 291.)

> "...the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.” (Norman 2002, 9)

3.2 Cognitive Load theory

In the resent years, a lot of emphasise has been given to the understanding of User Theory, or Cognitive load theory as it is sometime referred to. The Cognitive load theory gives insight on how software and applications could and should be designed. The Cognitive Load Theory is an important part of understanding usability and user interface design. As it is, it could be argued that human cognitive architecture is the key to provide mobile developers the knowledge, justification, and insight to help designers generate instructional hypotheses and data. It is critical to know how humans learn, think, and solve problems to design more usable software and applications. It could be said that by deeper understanding why and how humans think and as a result act or react to things can explain why some interface designs work while others fail or why some designs come across as seemingly effortless. Designs, where the beauty of the user interface lies in the art of the designer having been able to create the instructional procedure so easy to conceive that we do not even realise it is there. (Sweller, Ayres & Kalyluga 2011: v; Hollender &al. 2010: 1282-1286)

In their book about the Cognitive Load Theory, Sweller, Ayres and Kalyluga (2011) state that when learning secondary knowledge, it is not desirable to use procedures such as simply leaving students to learn by themselves immersed in appropriate environment even if this type of procedures can be pleasing or even unavoidable when acquiring primary knowledge, as this is something that we have evolved to accumulate whereas secondary knowledge is something culturally invented by us humans. Therefore, this type of knowledge requires different and, in some senses, “artificial” techniques for assisting learners. As of this, it could be argued that by forcing students to remote school, we have created suitable but not in every situation desirable environment for students to learn secondary knowledge, and as Sweller, Ayres and Kalyluga point out in

their book, as a result we need to provide students more explicit guidance to require the needed techniques and knowledge. (Sweller & al. 2011: 24)

In a review conducted by Hollender & al. (2010: 1279-1286) the three different types of Cognitive Load are presented: Intrinsic Cognitive Load (ICL), Extraneous Cognitive Load (ECL) and Germane Cognitive Load (GCL). According to the review these three different types of cognitive load affect our ability to learn. The term Cognitive load refers to the working memory of humans, more specifically to the used amount of working memory resources. In Cognitive Load Theory (CLT) according to Hollender & al. (2010: 1279-1286) the ICL refers to the cognitive demands involved in using for example interface, ECL refers to the demands involving attention, memory etc. in manipulating for example when user must figure out how the interface works and lastly GCL refers to demands involving attention, memory etc. in learning and enjoying. (Hollender & al. 2010: 1282-1286)

Understanding how Cognitive Load Theory affects users and the way they use software and interfaces; it is easier for the designer to design applications for novice users, and it also helps to plan how to increase different possible functions to different level users. This could also help evaluate and consider how to design good educational applications especially for children. The working memory capacity of a child is smaller than adults and thus children’s usually have shorter attention span, are easily frustrated, and get confused if the interface of an application or software does not work as they expect it work compared to that of an adult. (Feifei 2018.)

In the coming chapter the development process of the first version of the mobile prototype of the School Helper is discussed in more detail. The Cognitive Load theory and the implications that it has to the designing of user-centred usable mobile application are addressed by trying to design the functions and interactions to be as intuitive and as simple as possible. In addition, it is suggested that more consideration should be used regarding the implications of

GCL to the children's learning and attention keeping aspects in the further development of School Helper.

3.3 Designing mobile apps for young audience

Many studies concerning the use of educational mobile application in teaching and designing educational applications to improve students learning support the impression that schools and educational faculties around the globe are embracing digitalization in teaching children to learn. (Chou, C., Block, L., & Jesness, R. 2012; Shafiq, S.& Khan, T. 2018; Tahir & al. 2015; OAJ 2020.)

A study conducted by Shafiq and Khan, in which the usability of mobile educational learning applications was studied and compared to prove their hypothetical statement that usability has a strong impact on learning. In their study, a sample 30 children of ages 4-8 participated. The learning outcome was evaluated by using questionnaire designed to evaluate the learning outcomes of selected educational apps for learning either math or English. The results of the study supported the hypothesis but considering the scale of the study conducted it has limitations. Still, the study gives interesting insight to the possible correlation between the usability of children's educational mobile applications to children's learning. (Shafiq & al. 2018: 70-76.) According to article from Nielsen Norman Group from the author Liu Feifei (2018) children usually expect some type of instruction for how to use an application, as they can easily get confused, which is why clear and specific instructions are advisable. As mentioned in two previous chapters the provided instructions and messages should be tailored according to the targeted audience age and level on cognitive understanding. There is no point of for example ask a question if the user is not able to understand what you are asking from them. Good idea is to copy existing mental models that the children already know and mimic it in the application or feature. Children presented with a drawing game mimicking colouring book showed that no instructions were needed as the cognitive mental model was already learned previously and familiar. (Feifei 2018.)

More insight to the importance of assuring the usability and consideration for the cognitive skills of children when designing mobile application targeted to children can be found in paper written by Tahir and Arif in which they aimed to provide measurement model for evaluating the interface of mobile educational applications targeted to children. They provide in their paper some guidelines for designing mobile applications to children. In their study conducted for the paper, Tahir & al. found that the applications tested all seemed to lack usability in some functionalities. The paper would indicate that when designing mobile applications for children some additional focus concerning for example help, tutorials and voice instructions could be a factor to improve usability. Not so surprisingly poorly designed navigation as well as error messages were features that seemed to cause poor usability. (Tahir & al. 2015: 16-21, 28.)

To keep the attention of the children using School Helper, I chose to follow the insight I got from various sources and have gained from personal experience. I ended up using more pictures. This led to introduction of additional features such as a Study buddy to adventure with the user. The hypothesis is that this would effectively hold the attention of the children and help them navigate in the tool. In addition to this, all the pictures used were deliberately chosen to be as simple and informative as possible, because the children interpret the images literally as opposed to adults who can detect underlying meanings. Example of the choices can be seen in the visualization in Figure 5. (Nielsen 2010(2019); Gallavin 2015.)

Figure 5 Picture of study buddy and some icons used.

In the next chapter I will go through the prototyping process of School Helper in more detail and explain how the original paper template affected the whole design process.

4 Prototyping of School Helper 2.0

Prototyping is an experimental process where design teams create an early sample, model or release of product or service into tangible form from paper to digital to test a concept or process. The good thing about prototyping is that it helps to gather valuable information early on the designing process and testing of different concepts is usually cheaper and faster than with a real product or service. Simply put, prototyping makes the ideas more tangible. (Walfre 2009: xii-9)

Teams build prototypes of varying degrees of fidelity to capture design concepts and to test on users. With prototypes, one can refine and validate one's designs so one's brand can release the right products (Walfre 2009: 2-9.). As mentioned in the beginning of this thesis, a paper prototype was produced during a social innovation project conducted by Hyypiä and Honkala while doing their master's degree in Laurea University of Applied Sciences. The focus of this development work is to design a mobile prototype which is based on the original paper prototype done by Hyypiä and Honkala. The final paper prototype which is

presented in the Figure 2 in chapter 2.3 was designed to be used as it is in paper format for organizing and planning of school tasks.

The aim is to produce a mobile prototype that follows the original idea, but considers the changes needed to make it work in mobile format for the end user. This is essential so it can be later implemented to create the final interface. Consequently, to implement the created prototype into final interface, user testing with children is needed to validate the chosen design choices and further develop the service. Because the current situation with COVID19 seems to continue and there is no proof that the user testing can be conducted on site even in the later stages, remote testing was taken into consideration when choosing the tool be used in prototyping. Turning the paper format into digital meant that the original flow of the tool was to be followed to ensure that the main idea of the tool was not lost. The final layout of the paper format is showcased below in Figure 6 by using different colour blocks to emphasise the matching components in the paper and mobile prototype.

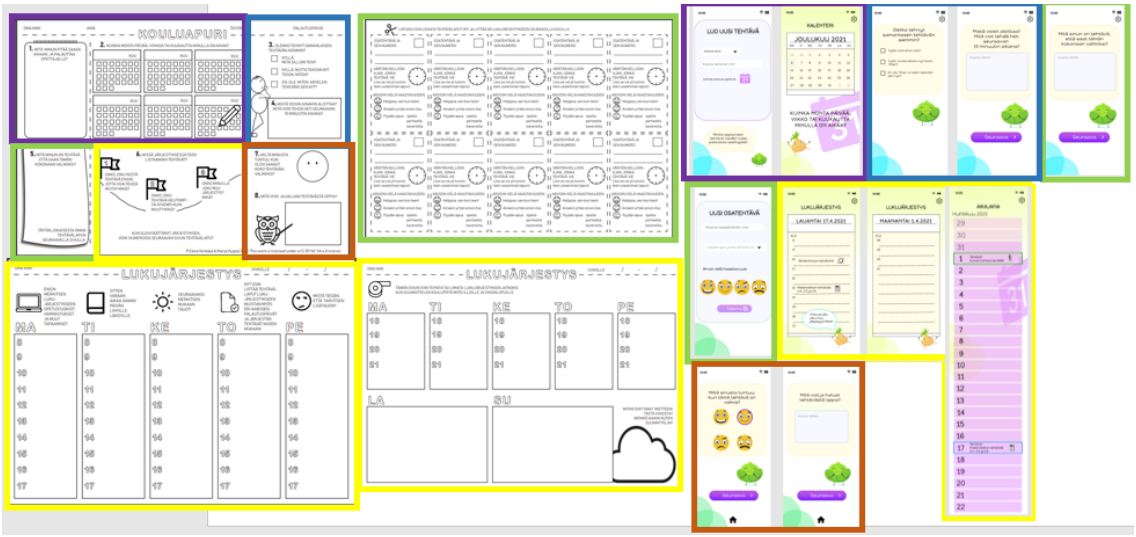

Figure 6 Showcasing the steps with of the original paper format and the main components of the same functions turned into digital illustration.

As explained in chapter 2.3, the application flow of the mobile prototype strongly follows the flow of the School Helper paper template, with few differences. First of the dissimilarity is that before the user can access the application s/he is shown landing page, followed by a request to either register or sign in. After that

the user is moved to the profile page where the user can see previous assignments, upcoming subtasks, and incomplete assignments with time left for returning. In addition, user can change their password, add assignments, look assignments according to school subject, add more school subjects, browse assignments and subtask in calendar view, change their Study buddy and mark assignments and subtask completed.

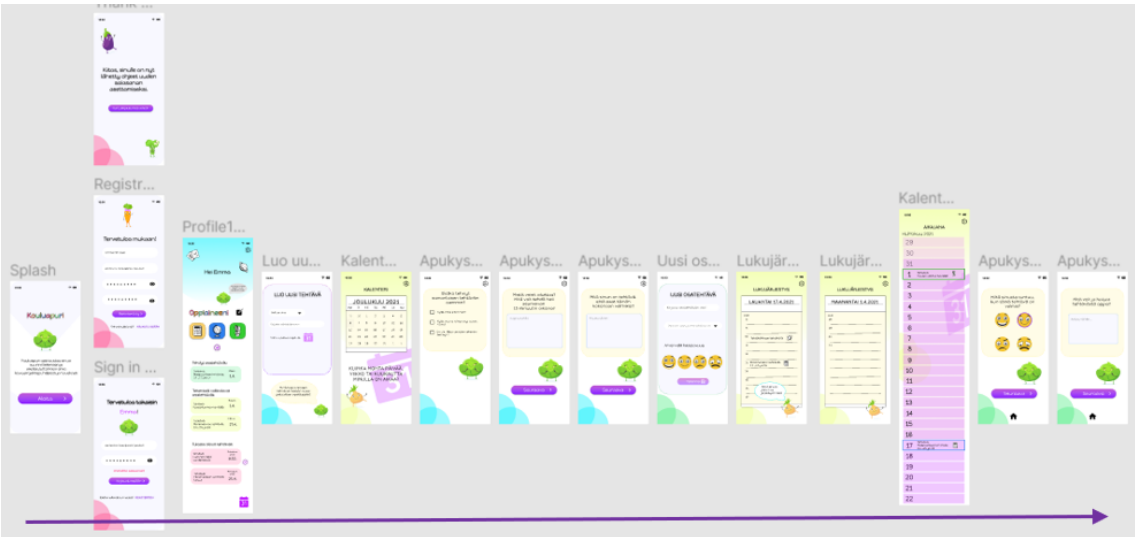

Figure 7 Process flow visualized from starting the application, through the saving of the assignments and subtasks (see full sized version in Appendix 1).

The cognitive walkthrough of using the mobile prototype which is visualized in Figure 7:

Step 1. The process of using the tool for the first time starts with guidance from the Study buddy. The child is prompted to write what assignment s/he have been given from the school and think through what exactly they are expected to do with each assignment or possible subtask. This will help the child to create more coherent idea of what s/he will be doing in the assignment and help get started.

Step 2. Next step takes the child together with the Study buddy to evaluate how much time s/he has got to do the assignment defined during the previous step.

To help visualise the timeline for the assignment the child can tap on the calendar the day s/he has to accomplish it.

Step 3. When the return date is clear in the child's mind the next step is to consider if s/he has in the past done similar assignment. To do this the Study buddy asks helper questions to further consider how they could proceed with the assignment.

Step 4. Questions such as where it would be the easiest to start or what could be done for the assignment in next 15 minutes aim to give incentive to get the thought process started, and later to accomplish the assignment.

Step 5. Now the child should have even clearer idea of what to do next about the assignment and is guided to consider and write down what s/he should do to finish the whole task. To help the child to divide the assignment into smaller subtasks, the application forwards the user to fill in subtasks after steps 1. to 4. Idea is that the child fills information about each subtask one card at a time, evaluating time that it takes to do the subtask and how demanding it is to accomplish for them by choosing appropriate emoji. If the child feels that the subtask is too demanding, the card guides to ask help from the teacher, family, or friends.

Step 6. When all subtasks are submitted, child is prompted to consider the order in which they should be carried out. To help consider the right order the Study buddy offers questions to evaluate if one subtask is easier or more fun to do than another, or if there is already a rule which determines the order used. The user is then able to move subtasks and assignments one task at a time to different days and months in the calendar depending on the type of the assignment. After each school week it is suggested to reflect how the week was and whether the plans were realized.

Step 8. The final task is to help reflect what they can and want to learn from the assignment.

There are several prototyping tools on the market some require some fees, and some can be used for free. As in many cases, choosing the best tool to be used depends on individuals' preferences as well as the type of project or service being prototyped. Some of the most popular prototyping tools are Invision, Sketch, Zeplin, Framer X (only for Mac users), Mockplus iDoc, Balsamiq, Webflow, Flinto, Axure RP and ProtoPie to name a few. Some of these are only for Mac users and some for Windows and Linux users. When choosing the prototyping tool, it is commonly advised to use a tool one is comfortable with, but in some cases, one is left using the tools available or chosen by someone else making the decisions. It is also advisable to consider if the tool chosen is effective in communicating what is needed to the user. Prototyping is a good way to simulate the different interactions of a mobile application and is one aspect to keep in mind when selecting the tool. (Walfer 2009: 23.)

In the coming chapters I will go through in more detail to prototype in Figma and the designing process of the actual prototype.

4.1 Prototyping in Figma

As mentioned previously, there are several prototyping tools on the market. For this thesis and for the prototyping of School Helper Figma was chosen. Figma was selected from the available tools, as it is cloud-based design tool, and works on any operating system that uses a web browser. It can also be used as a desktop version. In addition to this, it is free to use to some extent. For students there is also educational subscriptions available, and student license was used in this project. Figma can be compared to Sketch, although it has some features that make it better for collaboration. Some of these features are integration to Slack and Zeplin, platform independency, file collaboration that happens in real-time with different operating systems as it is cloud-based and permission-based sharing as well as in-app commenting.

As a prototyping tool Figma was new to me and choosing it as a tool to be used in prototyping of School Helper presented an opportunity to expand my personal

skill set. Using Figma also had the advantage that it provides transitions which can be seen in between frames in Figure 8, which eliminates the need for another tool to showcase slideshow style presentation. The transitions can be seen as the blue arrows zigzagging across different frames.

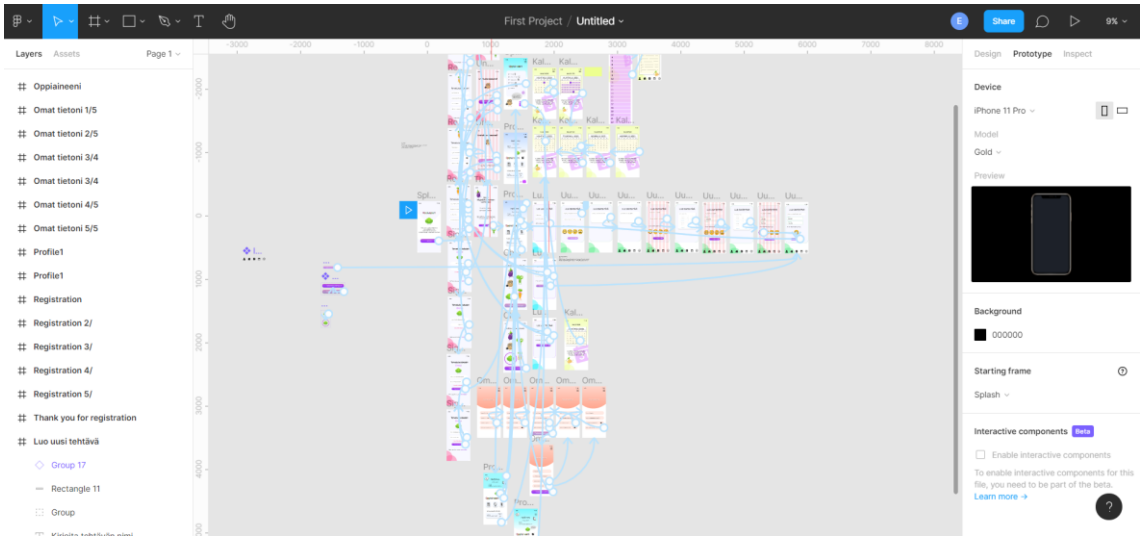

Figure 8 Different transitions used in Figma from layer to layer.

Another good feature is the possibility to use plug-ins, and create library out of components and different variants, which makes the prototyping process a lot faster than without it. For a person just starting to learn how to use Figma, this is one of the things I recommended to get to know right in the beginning. The use of component library enables one to drag elements to the template and use variants to quickly change the component to another in the Design view. This can be seen in Figure 9, and it makes it much easier to manage different elements like buttons, layouts, icons etc. Using this feature of Figma, the elements one uses a lot and might want to modify fast, can be changed by just adjusting one parent component.

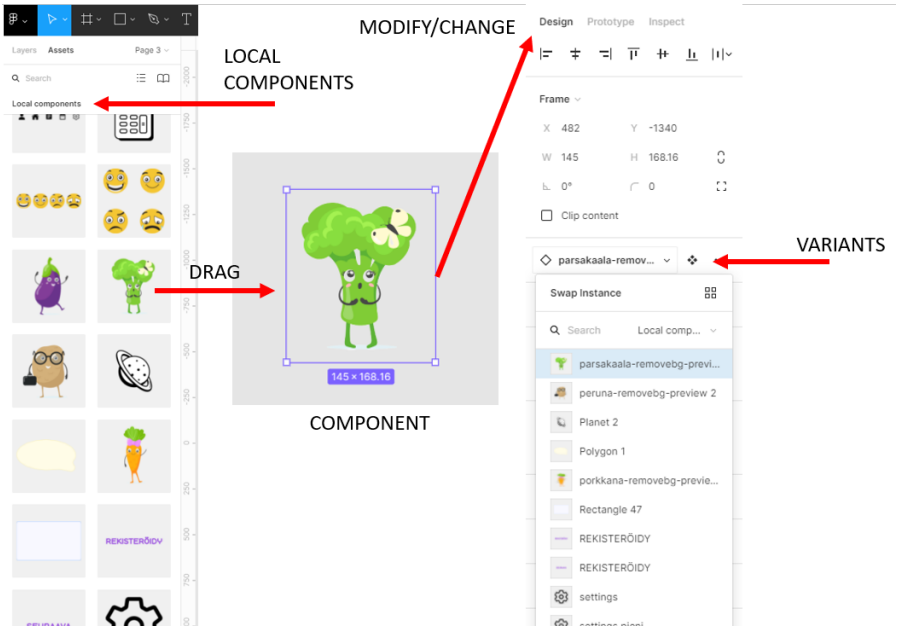

Figure 9 Showcasing the use of local components and the variants.

During the design and creation of the School Helper prototype, the transitions were used to simulate different interactions between frames and to fake simulate things like inputting text and selecting time as seen in Figure 10, since in Figma user input is currently not possible.

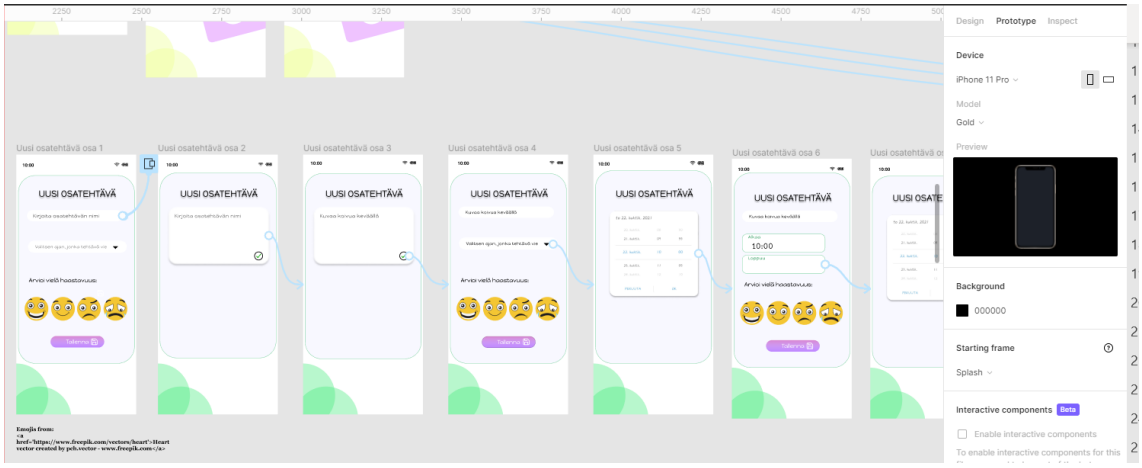

Figure 10 Showing the interactions between different frames to fake simulate change of states in text input fields.

The lack of user input was possibly the biggest cons in using Figma, as the application and initial paper prototype is heavily based in teaching students to

self-reflection with each task by asking questions to activate the cognitive thought process to reflect how it made them feel to complete a task or to think about what they can or want to learn from doing the assignment an example of this is showcased in the Figure 11. The emojis used in the prototype were taken from Freepik, created by pch.vector (www.freepik.com).

Figure 11 Showcasing the question used to activate cognitive thought process. (Freepik.com)

In the next chapters I will explain in more detail the designing process of the actual prototype and some additional features that where added that were not present in the original paper version.

4.2 Designing prototype

Creation of the mobile prototype in Figma started by getting used to the tool together with simultaneous ideation phase. The ideation begun from revising the walkthrough of the paper template in order to get familiar with the paper prototype as a guideline to help plan all the necessary features and steps to make the app idea work in mobile setting.

In many cases it is encouraged that designers and developers should use the usability processes, methods, and techniques together with the recommendations given in designing accessible websites and mobile applications. (WAI 2021.)

4.2.1 Colours

While working on the general plan it was clear that to make the application tempting to children it was important to choose fun and bright colour palette. Light bright colours were tested in the beginning of the designing phase by illustrating the colours for 4 children between the ages of 7 and 10. The results of that small interview with the children were that though they liked the colours, it was unanimous that they preferred bright colours. This is backed by the studies by the study conducted by Nielsen (2010). Based on those opinions from the children and my own, it was decided that bright colours expressed a more vivid and positive image to the school children and help catch their attention when using the application. To keep the application balanced and calm I used most of the colours for the background with transparency and for buttons, to indicate action or selection, I used the bright colours. For the main background white and grey was used as is shown in Figure 12 .

Figure 12 Illustrating the use of colours.

For future enhancement it was considered that a dark theme with dark grey and black base colours could also be nice additional feature where the users could choose a different colour theme to their liking.

4.2.2 Turning paper template into mobile application

In the final paper prototype, there are eight steps guiding students to organize their tasks that are shown in Figure 13. I noticed right in the beginning of the design process that it would not be as easy to transform the concept into mobile format.

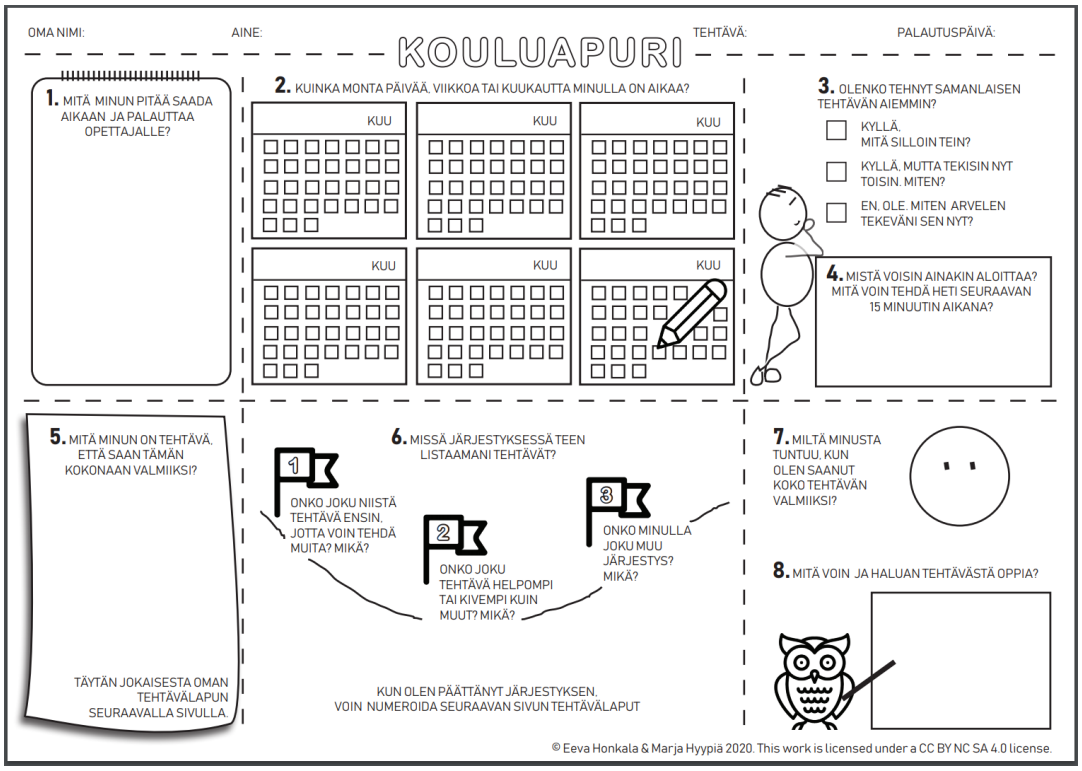

Figure 13 The first page the paper prototype showing the intended workflow (Hyypiä 2020: 1)

First obstacle was to figure out how to make the first step work where the idea is to help school children to clarify what it is they need to accomplish and return to their teacher. After some long hours of ideation and going back and forth with different ideas, I decided to separate and combine some of steps as well as change the order of them to make it easier to navigate in mobile format. One of the first changes were to the step 1 of the paper prototype, where in the mobile prototype I combined the first step and the fifth step which is illustrated in Figure 14.

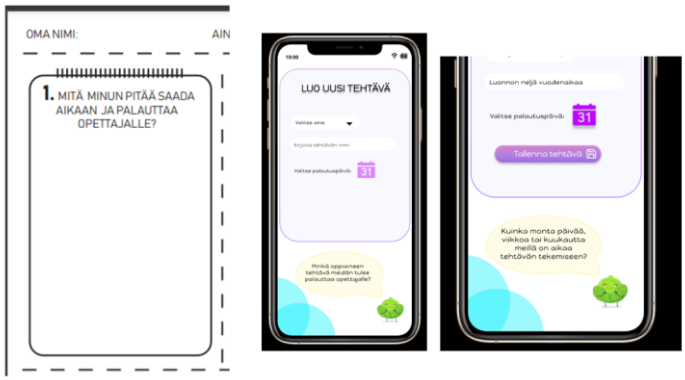

Figure 14 Paper prototype (left) and mobile prototype (two on right) side by side.

Next step in the paper prototype was for children to mark down how many days, weeks, or months they had to do the assignment. Because naturally paper and mobile screens work differently, I chose to create a calendar view that could be used in different parts of the application easily where user needs to navigate from day to a week to a month. The selection of return day is illustrated in Figure 15, where user is first guided to click calendar icon which then takes user to a calendar view to select the date for the return and by tapping a day in the calendar it then saves the choice and returns user to the task card where it shows the chosen day in number format. Real world conventions should be presented as they work outside the application for better usability, but I chose in the mobile prototype to follow the general design concept that is seen in other similar features in mobile applications.

Figure 15 Calendar frames showcasing the designed transition for picking return date and to help children visualize timeline to return the assignment.

Next, I will describe in more detail some additional design choices that I made to see how some potential features would look and work in mobile application, such as landing screen, Study Buddy and registering feature.

4.3 Additional features

One of the first new design choices that are not present in the paper prototype, but that I chose to add to the mobile prototype was creating a landing screen together with registering and returning user screen also known as sign in - screen. Registering was chosen as there are some future development ideas already: for example, about the potential digital format being based on a yearly subscription by school authorities or monthly subscription by individual students/their parents. A freemium version would potentially be used alongside subscription version, allowing the use of the app without some additional features added to the application in the next steps of development of the final application. (Hyypiä & Honkala 2020: 23)

4.3.1 Landing screen and registering

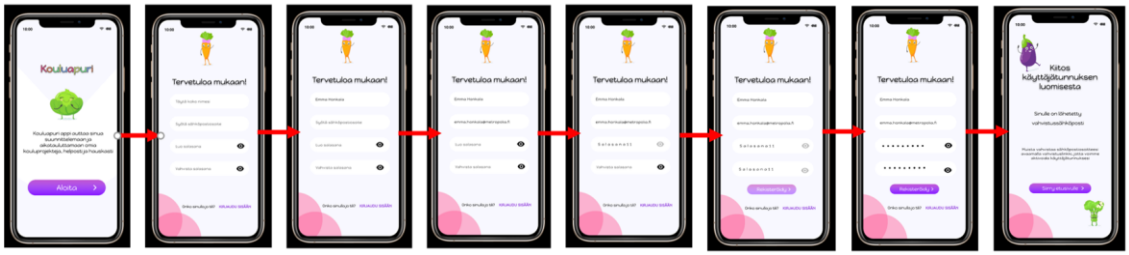

Figure 16. Three first screens to guide a new user to register in the mobile prototype.

The first steps from landing screen to the succeeded registration are visualised at the top in Figure 16. The created mobile prototype of the application starts from landing screen with some info about the app. The second screen is used to welcome the user on board and guide user to either register by filling their personal information to create an account. In the registering screen the option

to sign in is also introduced for situations where the user might have changed phones or deleted the application and has installed it again. The registration process flows through by guiding the user to fill in whole name, email address and a password of choice. Because personal information is required for the registration, a star is used in the end of each placeholder used in the input fields to alert the user of this. Placeholders have lighter contrast and are intended to be replaced by when user types into the text field. This approach was chosen as it follows the general Material Design guide rules (2021).

During creation of password, the input is disguised by default and each character is represented as midline dots. Because our users are children, I decided to also add visibility icon to be displayed next to the password input fields as this will give child users the possibility to ensure they have typed the password correctly and is what they intend to use or if they face problems during the signing in process. In the final mobile prototype produced for this thesis the visibility icon used is not the one suggested by Material Design guide as the use of that icon is not free to use without a fee. Therefore, I used the one and same eye icon (which is usually used to indicate visibility) but used difference in contrast to indicate the visibility and invisibility states, which can be toggled on and off. The use of the icon as described in this prototype most likely will not affect crucially to the results of the usability user testing. Later, if wanted or needed, it can be easily replaced to meet the common practice in the final prototype for final user testing before the development to actual final mobile application. The three different stages of password input and functionalities are visualised below in Figure 17.

Figure 17 The three different stages of password input in order.

Because the option to sign in at the registering screen is assumed to be secondary choice and it is customary that it usually is positioned in the lower part of the screen, so was done also in School Helper. The placement of the signing in text and the text that forwards user to sign in screen are circled with red in Figure 18Figure 18 to indicate the placement on the screen. The question asking if user has an account, is written in black and the text to forward user to the sign in screen is bright violet in bold letters indicating a link to another screen.

Figure 18 Registration screen with registration text input fields and the sign in link. The sign in option at the bottom of the mobile screen is indicated with red box around it.

In the next chapter I will describe how the sign in -feature was designed to the School Helper mobile prototype. This was added as owners of the School Helper tool addressed some preliminary thoughts about making the application work with subscription, which would mean that the user would have to be identified when using the application.

4.3.2 Sign-in feature

The sign in -process flows from filling in email account used when registering to the typing in password in the text field assigned to it which then activates the Sign in -button to become visible as can be seen below in Figure 19.

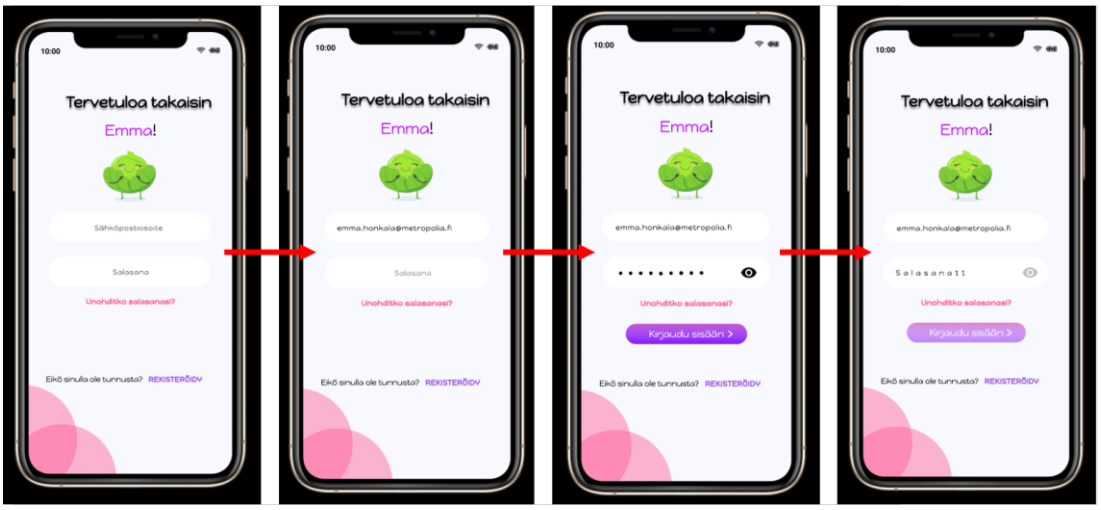

Figure 19 The sing in process flow visualised.

As mentioned before user can toggle the visibility and invisibility states when they have the password input field active. The same eye icon is used here as well with full contrast to lighter contrast to indicate varying states as in other parts of the prototype where password input fields are used. The midline dots are also represented here as mentioned before where we first described the password function. When the password is visible to user, the Sign in-button is shown in lighter contrast, and without any drop shadow. This was chosen to indicate the user, that while password is visible it is not possible to Sign in. Because our targeted users are children, I wanted to use the most common design principles to make the perceived affordance as apparent as possible without compromising too much of the overall design. When toggled back to invisible the Sign in-button changes back to full contrast with drop shadow to indicate that it can be tapped. The varying states of the Sign in -button is visualized below in Figure 20 to showcase the underlying connection between password visibility and the functionality of the Sign in -button.

Figure 20 The underlying connection between password input field and the Sign in -button functionality is showcased in these two screen captions side by side.

In the Sign in -screen (Figure 21) user also can request a new password through clicking a link indicated in pink text as shown in Figure 22 under the overall transition flow of the process. A small mobile screen together with relatively small buttons can easily lead to miss clicking's. As a result, I decided to add linking back to registration page, if the user accidently chooses Sign In, when they do not have account. The placing of the functionality is same as that of Sign in in the registration page, which is at the bottom of the screen.

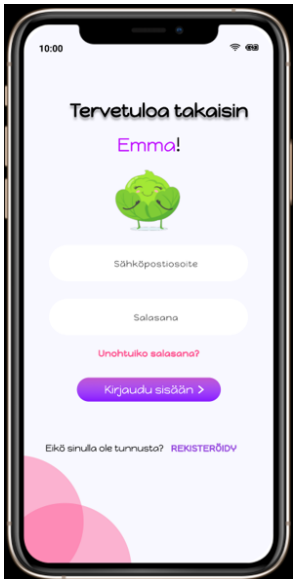

Figure 21 Caption of sing in -screen.

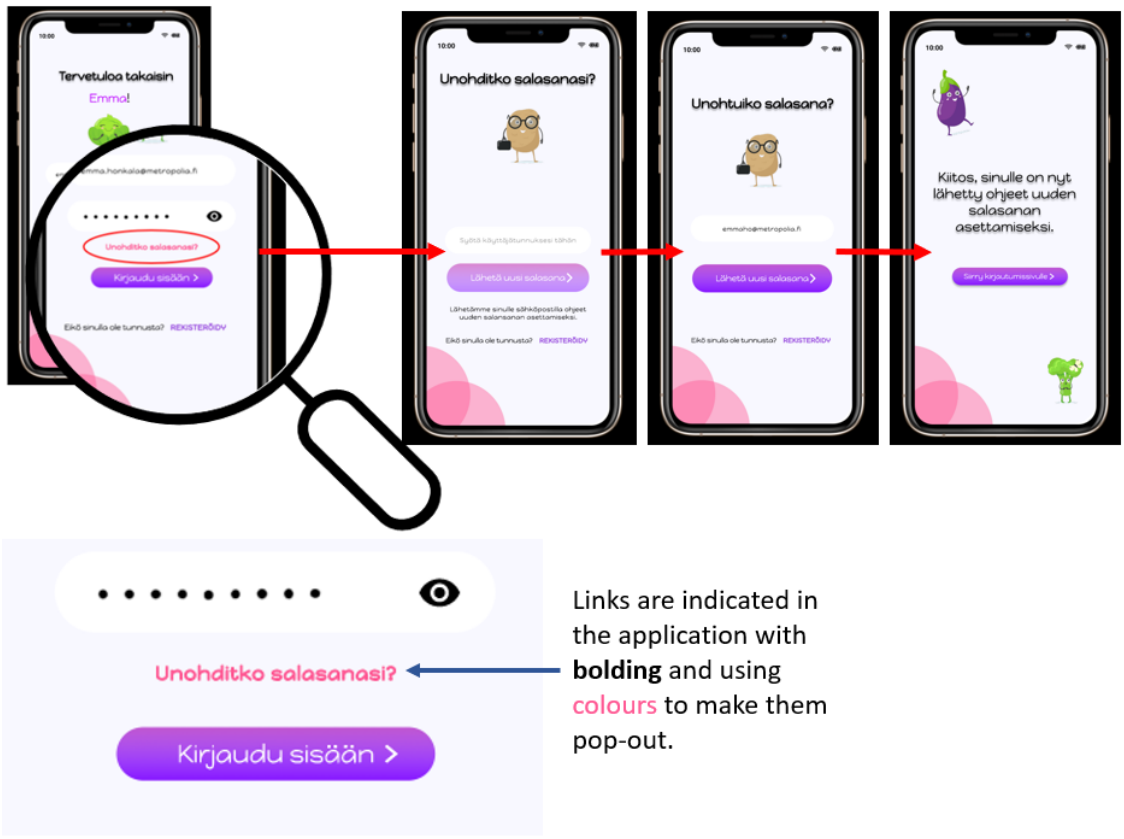

Figure 22 The blue arrow points toward a bold pink text, which is used to indicate to the user that by clicking it, it will forward user to screen where they can request a new password. The whole process can be seen above the detail.

4.3.3 Study buddy

Some extra features that are not in the original paper prototype, but which I decided to add because of the target group is children is study buddy. Users can choose from group of buddies one they like. The selection is made easier for children to perceive by using the same principal as is used in between password input field and the Sign in -button functionality, with the exception that with choosing a buddy the selected buddy gets a violet circle around it when tapped activating the save buddy -button simultaneously. The illustrations used for Study Buddy was taken from Freepik, which offers illustrations free with attribution.

Figure 23 Showing the use of circle to fake interaction in the prototype.

It is usually recommended to use short words or icons with buttons as well as use uppercases for example “BUTTON” instead of “Button”. (Material Design guide, Buttons.) There are some situations where it could be argued that using lowercase and longer texts make more sense. My experience is, that when you need to provide the user with contextual information sometimes longer texts are accepted. I tried to consider children’s mental models in my approach when designing the choose a Study buddy -feature and when saving the chosen Study buddy, as in this case, I wanted to help children to act intuitively when using the feature when deciding their buddy which is visualised in Figure 23. The same approach was taken when I decided to use the Study Buddy-picture on the main page to be used as icon to change the Study Buddy as is visualized in Figure 24.

Figure 24 Visualizing the use of a picture of a character as a button.

5 Suggestions for future prototype testing

A lot of attention has been put lately on remote user testing, as COVID19 has brought new demands for conducting user test. To validate the designing choices made in the creation of the prototype and to test the usability of the mobile prototype user test with children are needed: due the pandemic, this would mean user testing remotely with children. At the time of the writing this thesis, spring school semester was coming to an end: usability testing could have been conducted even outside the semester, but would have required extra motivation from the children, as well as imagination to think about tasks that were not required by the school.

As mentioned previously, in the user testing of the initial paper prototype, a conclusion was made that to find out if the School Helper tool has any supportive or positive effects regarding school children's management and control skills or in reducing their emotional stress, the paper prototype should be tested and developed further in a longer (at least 1 semester) pilot and with a larger sample of school children (e .g. of 2-3 classes in different grades).

A longer testing pilot for the mobile prototype, and the idea of mobile solution overall, was also preferred and although shorter usability testing could have been conducted earlier with the limitation mentioned earlier, it was decided to postpone both the user and usability testing. As of result, the user testing of the prototype had to be left out of the scope of this thesis.

As this project is targeted to be used as a tool for school tasks and there is need to user test it with children, some thought was put in the planning of how it should be done and what needs to be considered: for example, since the testers are young of age and cannot be in all aspects treated as adult tester would be, whether a teacher's involvement in the testing would be beneficial or if any adult would do. Also, there are some ethical and moral questions to consider, such as should a parent be present during the test, or if not, should there be signed permission from the parent and is some type of contract needed to ensure that the children participating in the test are not exploited in any way. The used tools and equipment needed to conduct the user test also raise the question of who provides them. In addition, if user test is done remotely and recorded then there are some aspects to considering the usage of the recording and the time it is kept and then destroyed, if destroyed.

A case study by Pardon, Vetere and Howard from 2002 suggests that there is no strong evidence that would support the need for a teacher's involvement in user-based evaluation of an educational software when compared to evaluation where teachers were not involved, and evaluation was done by designers. However more research is needed for deeper understanding. (Pardon, Vetere & Howard 2002.) Preliminary literature review showed that there are already some guidelines available for usability testing with children that could be applied in the plan for future remote user testing of the School Helper application (Hanna, Risden & Alexander 1997). Some study experiments even suggest that by choosing children for user testing based on different personality characteristics makes testing more effective (Barendregt, Bekker, Bouwhuis & Baauw 2007). What is currently lacking is the experience from how to conduct remote testing

with children, and what aspects need to be considered for ethical and sustainable practice.

Nevertheless, future user testing of the mobile prototype was taken into consideration when deciding to use Figma as prototyping tool as it offers cross-platform usage. And so, Figma can be easily used in remote user testing together with Microsoft Teams, Zoom or another similar application to share the screen between the tester and observer. The tester can test the prototype using their phone and the observer can both see the reactions on the camera as well as follow in real time how the tester moves in the prototype. Whether or not the owners of School Helper decide to user test remotely it felt meaningful to be able to at least have considered the possibility with the created mobile prototype.

6 Conclusions

The purpose of this thesis was to design and create a mobile prototype which would be based on an existing paper template tool that was designed and created to be used as a tool to help children organize their school assignments.

The theoretical framework of this thesis is based on the demands that child users pose on mobile application design, the Cognitive Load theory, usability of mobile applications, and was formed through desktop research. The actual development work started by ideation and research on how to turn the School Helper paper template tool into a mobile prototype that meets the requirements found during the research. In addition, a light comparison of prototyping tools that could be used both to design and create the prototype and later user test it, was conducted and based on this, Figma tool was selected to be used in this project. Thus, the mobile prototype which matches both the already existing functionalities of the paper prototype and requirements from the theoretical framework, was finalized using the tool. Furthermore, the learnings from the theory and development work were used to present a suggestion of things the case team needs to consider when remote user testing with children.

The development work proved that the paper prototype could be translated successfully into digital format, though the new format did require creation of additional features. To keep children interested and occupied with the mobile solution, features such as Study buddy helping and supporting the use of the application, and child-friendly use of colour, images and other functionalities were added, and it can be concluded that the mobile format allows the benefit of added interaction and guidance to the user when compared to the paper prototype.

Some additional ideas considered during the prototyping process include the possibility to use voice recording or AI together with voice detection and voice-to-text software in the future development of School Helper. This would allow children to fill their task cards in the application by voice detection.

Based on the research on theory and work on the prototype show no implications that the created mobile prototype could not be used later to evaluate the potential of the solution and aid justify, whether the case School Helper should be invested in further development of the application by conducting first user tests and usability tests. The biggest challenge caused by the limitations of prototyping tools is that the children cannot be asked to interactively fill in the fields of the School Helper app.

6.1 Answers to research questions

In the Table 1, below I summarize the answers to the research questions I set at the beginning of the thesis.

Nbr	Research question	Answer to research question	Further information
1.	What special needs do children have for usability in mobile solutions?	Children have shorter attention span and tend to skip long instructions, so keep it short but clear.	Chapter 3

2.	How do the cognitive models affect the usability of a mobile solution?	The usability of a software or application is dependent partially on the level of cognitive development of child and so interactions and use of icons etc. need to me thought trough.	Chapter 3.2
3.	How the user experience theory (usability, accessibility etc.) can be applied to the design of a mobile solution?	Designing mobile applications for children one should clarify and set goals for the usability and choose methods to prototype accordingly.	Chapters 3, 3.1, 3.3
4.	What should be considered when conducting remote user testing of a mobile application prototype with children?	Should an adult be present during testing? Who provides the tools used in the user test? How the possible recordings and notes are kept.	Chapter 5

Table 1. Summary of answers to research questions.

6.2 Reflection

Looking back on the development process, the tool comparison and selection offered chance to develop my personal prototyping skills and knowledge about Figma. Early on, I decided to just start using the tool without too much preliminary preparation which proved to be mistake later: I discovered that most of the difficulties that I faced in the beginning of building the prototype were due to not knowing to use components, pages, and variables correctly. Nevertheless, I liked using the tool and can see many good opportunities in using it in the future.

I learned a lot about personal time management and how much time the prototyping process takes when the innovation and designing of the usability goals are high and one is working alone. It would be beneficial to collaborate with other people and it would allow more diverse perspectives to the

development of the service. The literature has contrasting views about the necessity of using wireframing prior to starting the user experience design, but my experience shows that it helps to streamline the process and to consider the needed features and the implementation of those features. This would have speeded up my process.

6.3 Ideas for future research

The next possible steps for the development of School Helper would be to study what are the best practices currently to conduct a remote user test and what tools there are available for remote testing. Secondly, more research is needed about the usability of a mobile applications from children's perspective, as the children from next generations will grow into a highly digitalized world and will learn to use mobile devices from a very young age. It is important to conduct research on how the digitalization will affect children's cognitive development and whether or not the result is positive or negative. Thirdly, more research is needed about how new innovations could be used together with mobile applications to help children learn and develop the cognitive skills.

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Appendix 1. Main components of School Helper prototype