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Communicating a Child's Learning Progress in a Digital Interface

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June 25th, 2020

Master's Thesis in Interaction Technology and Design, 30 credits

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Abstract

The educational digital games are both used at school and at home by children. However, if used at home, how should parent's be able to tell a child learning progress in the game when they have limited knowledge in children's education? The purpose of this thesis is enhance the knowledge on how to design a digital interface that communicates the learning progress of a child to its parents. This by establishing a suggested framework on this subject.

To be able to create the framework the *Design thinking* method were used. First suggestions, based on literature and interviews with teachers, for the design and framework were created. Then a Hight fidelity prototype of the digital interface based in the suggestions were designed. And lastly the prototype where tested in a Usability test.

The usability test showed what in the suggestions that worked. The parts that worked were summarized in the suggested framework that the study where successful in creating. The framework contained both suggestion in how to visually represent a learning progress and how to communicate it.

Sammanfattning

Pedagogiska digitala spel används både i skolan och hemma av barn. Men om de används hemma, hur ska föräldrar kunna förstå vad ett barns lärandeutveckling i spelet när de har begränsad kunskap om barns utbildning? Syftet med denna uppsats är att öka kunskapen om hur man utformar ett digitalt gränssnitt som kommunicerar ett barns kunskapsutveckling till sina föräldrar. Detta genom att fastställa en föreslagen ram för detta ämne.

För att kunna skapa ramverket användes Design thinking metoden. Först skapades förslag till design och ramverk, baserade på litteratur och intervjuer med lärare. Sedan designades en High fidelity prototyp av det digitala gränssnittet baserat på förslagen. Och slutligen testades prototypen i ett användbarhetstest.

Användbarhetstestet visade vad i förslagen som fungerade. Delarna som fungerade sammanfattades i det föreslagna ramverket som studien lyckades skapa. Ramverket innehöll både förslag på hur man visuellt ska representera en inlärningsframsteg och hur man kommunicerar den.

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Chapter 1

Introduction

Digital games for children with an educational aspect as a complement to more traditional learning methods have been around for many years now. It has been shown that students result are equivalent when students learn through an educational digital game as if they were to use a more traditional learning method [1]. It was even shown by Virvou et al. [1] that students with low performance in school, performed better when learning through a digital game. Other than learning the knowledge in the game, the player improves other skills like decision making, strategy planning and problem-solving [2].

If educational digital games are looked at in the same way as traditional learning methods, introducing them at home could have a positive effect on a child's educational achievements. The Chicago Longitudinal Study¹ was analyzed with a focus on parent involvement in their child's education. This study showed that if parents are involved in a child's education, it could have a positive effect on educational achievements, all through the child's teenage years [3]. The same thing has been shown for involvement in homework, if parents involve themselves in a child's homework, this will most likely have a positive effect on the child's learning [4]. However, when Hover [5] studied homework from a parent's point of view, many parents feel like they do not have the skills and information to help their children in a good way.

To give all the children the same chance of succeeding in school, parent's involvement is significant, and because educational digital game has proven to be an effective learning tool, this could represent that involvement. However,

¹The Chicago Longitudinal Study is a study that began in 1986 and studied children in the Chicago public school system from when they were in kindergarten to their 20th, <https://innovation.umn.edu/cls/>.

a parent with limited knowledge about children's education could have a problem evaluating what a child's learning progress is in the educational digital game.

In the literature and frameworks today, there is a gap in the knowledge about how to visually illustrate and communicate the learning progress of a child to its parents through a digital interface. The purpose of this thesis is to enhance the knowledge about communicating learning progress in a digital interface to a parent with limited knowledge about children's education.

1.1 Objective

The objective of this master thesis is to establish a framework on how the learning progress of a child in an educational digital game should be communicated in a digital interface to a parent with limited knowledge about children education. This where the learning content is based on the Swedish curriculum².

1.2 Research Questions

The problem that this thesis will investigate is how the learning progress of a child in an educational digital game should be communicated to a parent in a digital interface. There are several challenges with this problem that have been summarized in two research questions:

1. How should the complex content of the Swedish curriculum be explained to a parent that has limited knowledge about children education?
2. How should the graphic visualization of the learning progress be designed for the parent to understand the progress correctly?

The first problem derives from complexity on the Swedish curriculum. Because the content of the communications should be based on the Swedish curriculum, a challenge will be to communicate the complex content of the curriculum to a parent with limited knowledge on children education. The second one is the graphic visualization and how this should be designed for a parent to understand the learning progress correctly.

²Läroplan för grundskolan, förskoleklassen och fritidshemmet 2011. REVIDERAD 2019

These two research questions will be the foundation this study and the aim is for the framework this to be able to answer them.

1.3 Zcooly

This master thesis will be written in collaboration with Zcooly in their office at Gothenburg during the spring of 2020.

Zcooly³ is a service that has existed since 2012, mostly containing mathematical educational games for children between 5 and 12 years old. The company has an aim to make the teaching in educational games as relevant as possible without losing the fun gaming experience. Zcooly works with experienced educators, game designers, game developers and the curriculum as a base to achieve their goal. Zcooly has for many years been an in-house project in the consultant firm IUSinnovation⁴, with a focus on the use of the games in a classroom environment. However, in 2018 the service became a separate company and switched their focus from the classroom to the home environment. The company has the same goal and the games are still played by children. However, the games are now played at home and then it is families instead of schools are the company's main customer.

1.4 Thesis Outline

The study follows the structure of the chosen research method, Design Thinking [6]. This method has three steps: *Understanding*, *Explore* and *Materialize* and this is also the general structure of the study. The results from the studies made in a step are both presented and analyzed in each step. The *Materialize* step contains the thesis discussion and the framework that the thesis aims to create. The study ends with *Final Remarks* to discuss the method and present the conclusions of the study.

This structure is chosen to make it easier for the reader to follow along on the study. The understanding of the results and analysis of the results in a step is dependable on the analysis of the results from the previous step. Because of this is made more sense to structure the thesis in this way.

³<https://zcooly.se>

⁴<https://www.iusinnovation.se>

Chapter 2

The Swedish curriculum

Because the content in the learning progress communication should be based on the Swedish Curriculum, an overview of the curriculum is here presented to clarify what the foundation of the framework is.

The Swedish curriculum is a document that guides all the Schools in Sweden. It is divided into 5 parts:

1. The school's values and mission.
2. Overall objectives and guidelines for education.
3. The preschool class.
4. After-school centre.
5. Syllabuses for all subjects.

Part 1 and 2 should permeate all the other parts and describes the cognitive approach, values and objectives and guidelines for the entire education. However, the most significant content from the curriculum is from part 5, the syllabuses [7].

In general, all the subjects in the Swedish school have a syllabus, each subject starts with a purpose. The purpose describes what knowledge in a particular subject the student should be given the opportunity to develop. The purpose ends with long term goals that summarize what subject knowledge that should be graded. The second part of the syllabus is the central content, this describes in particular what the student should learn. All the syllabuses central content is divided into three grades, 1th - 3rd, 4th - 6th and 7th

- 9th. The central content is also divided into knowledge areas. However, these should not be seen as work areas and the teacher does not have to plan teaching according to these knowledge areas. The central content should have a major part in the educational content. The third and last part in the syllabus is the knowledge requirements, this describes what knowledge that is acceptable knowledge at the end of grade 1 and 3 and the grade levels for grade 6 - 9. However, it is pointed out that the knowledge requirements are not something that should be taken out of context, it should be read and interpret in relation to the subject's purpose and central content [7].

Chapter 3

Research Method

The research method was conducted to investigate how the learning progress of a child should be communicated and visualized for a parent in a digital interface and aimed to establish a framework for this particular objective. The goal of the objective is to be able to answer the research questions.

3.1 Case study

Since Zcooly became its own company and started to focus on the home environment, a challenge has been to involve the parents in their service. The company's way of involving the parents today is to inform them of their child's progress in an email sent out every other week. The email contains several in-game achievements the child has achieved since the last email and short description of the child's learning. Zcooly would like to enhance this experience because they believe that including the parents more in their children's educational progress in the game could be a valuable part of their service.

3.2 Limitations

Even if this thesis aimed to establish a framework that is as general as possible, some limitations were defined for this work:

The Swedish curriculum Other curriculums than LGR11 were not included. This because the interviewed teachers use the Swedish curriculum and this curriculum is the foundation for this thesis.

Data Because of the time limitations in the project, the data of a child's achievement in a game were not be implemented in the finished prototype.

Subject This study was done in collaboration with Zcooly and they focus on mathematical educational digital games. Because of this the prototypes and user testing were done with a focus on mathematic.

General The framework will serve as a guide to how the learning progress of a child should be visualized for a parent with limited knowledge about children education. However, the framework will not contain specific design elements and should, therefore, be used as support when designing this specific type of visualization.

3.3 Design Thinking

The research method that was chosen for this investigation was *the Design thinking process* [6] because of the user-centric approach in it.

The idea behind this process is the *Design thinking ideology* [6]. What this says is that a hands-on, user-centric approach to solving a problem will lead to innovation. The *Design Thinking process* has an overall flow with three steps, *Understanding*, *Explore* and *Materialize*. Within these steps there are 6 phases:

Empathize The first phase of the design thinking process is about gathering information about the user, the goal is to empathize with the user in problems and thoughts about the product.

Define The second phase is about summarizing all the collected data and define where the user experience problems within the product.

Ideate This is the brainstorming phase, here the design team gathers and brainstorm how to solve the problems that the user has. An important part of this phase is to not constraint the ideas, no idea is too farfetched.

Prototype In this phase the designer build prototypes of the ideas from the *Ideate* phase. The goal is to understand which components of the ideas work and which do not.

Test In this phase the designer takes the designs that have been made to the user. Do some of the designs solve the problem for the user? Does the design execute the vision?

Implement The last phase, and in design thinking, the most important one.

Don Norman said that we need more design doing. If the design process should be effective, the design needs to be implemented as well [6].

A representation of how the research method and the design thinking process were connected can be seen in *Figure 1*.

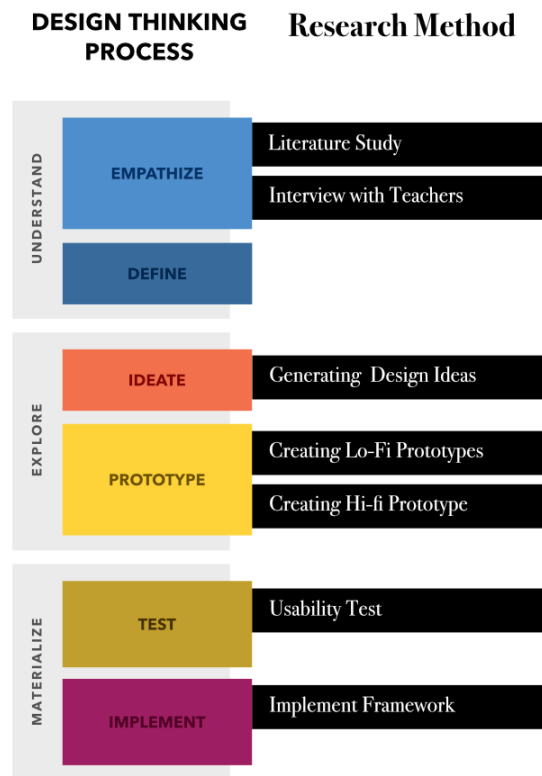


Figure 1: How the Research Method follows the Design thinking process [6].

3.4 Understanding

The understanding step contained the *Emphasize* and *Define* phases. The understanding step had the aim to understand both in practice and theory how to communicate and visualize learning progress to a parent. The research method did not in this step follow the *Design thinking method* completely. The

understanding step should be about understanding the users and empathize with their problem. However, for this study, the problems were already defined in the *Research Questions*. Because of this, the *Understand* step were about gaining an understanding of how the problems should be solved.

3.4.1 Emphasize

This phase aimed to gain understanding, both in theory and in practice, on how to communicate and visualize the learning progress of a child to its parent. To investigate this, a *Literature study* and *Interviews with teachers* were conducted.

Literature Study

The literature study was conducted to gain knowledge about communication and visualization of progress in different situations. The literature study focused on these parts in the theoretical approach, in other words, how it should be done, not how it is done. The theory about communication was obtained by collecting studies both on feedback in different settings and on how to talk with parents regarding their child. The theory on visualization conducted in the same way, however, focused the collected studies on how the visualization of progress has been done in other settings, e.g. business.

The result of the research were many relevant articles and reports. The sources for *Feedback in School* and *Communication with Parents* were found on Google Scholar¹, the online library of Umeå University² and by searching the references of other literature. The *Visualizing Progress* articles were found by searching on Medium³.

Choosing articles from Medium instead of studies and articles published in a scientific journal (as the articles from the other sections) have both *disadvantages* and *advantages*. The disadvantages are that they are not as reliable as studies and articles published in a scientific journal. However, they have the advantage of being more closely connected to business world than most scientific articles and studies. The close connection to the business world in the *Case Study* (Section 3.1) was the reason for choosing articles from Medium. This because of the connection to the business world in the

¹<https://scholar.google.com>

²<https://ub.umu.se>

³<https://medium.com>

case study. The content of the articles from Medium has been strengthened by using numerous articles that say the same thing.

The keyword that was used when searching literature were *Parents-teacher communication*, *Feedback School*, *communicating progress*, *Visualizing progress* and *Dashboard design*.

The results from the Literature Study are presented in Chapter 4 *Theoretical Framework*.

Interviews with Teachers

The interviews with teachers aimed to gain understanding on how, in practice, learning progress of a child is communicated to its parent. Because the aim was to gain understanding and the knowledge on the subject were limited, a *semi-structured interview* [8] method was chosen. In preparation for the interviews, an interview guide was created. The interview started with (after an introduction of the interview and questions regarding the teacher's career) a question regarding what situations that the teachers talk or in any other method communicated with parents regarding their child's learning progress. The following questions in the interview guide were then grounded in those situations. This with the aim to establish how the teacher communicated the learning progress to the parent in a particular situation.

The interviews were conducted in Swedish, performed remotely and recorded using the service Zoom⁴ (as a video conference). Four teachers were interviewed, three subject teachers and one special needs teacher. The subject teachers teach or have taught the students spanning from age 6 to 16 and the special needs teacher teach students between 6 and 9 years old.

An interview was analyzed by listening through the entire interview and summarizing all the facts regarding a question in one place. This was done for all the interviews. The relevant parts for this study were then summarized and translated to English, however, the interviews were kept separate. The result can be seen in Chapter 5, *Interviews with teachers*.

3.4.2 Define

The Define phase is a conclusion and summarization of the *Literature Study* (Chapter 4) and *Interviews with teachers* (Chapter 5). The aim was to

⁴<https://zoom.us>

find common grounds both between the different sources in the theoretical framework, between the interviewed teachers and between the theoretical framework and the interviewed teachers. The purpose was to find suggestions for the design for the learning progress communication. The results from the conclusion are presented in Chapter 6.

3.5 Explore

The Explore step contains the phases *Ideate* and *Prototype*. This step aimed to investigate learning progress design ideas and with the understanding step as a base design an interface that visualized and communicated to parents the learning progress of their child.

3.5.1 Ideate

This phase focused on the design of the learning progress, without taking into account the suggestions from the understanding step. This included a *Generating Design Ideas* session.

Generating Design Ideas

The generating of design ideas began with two brainstorming phases. The first one had a focus on generating how the progress should be visualized (e.g. type of graphs) and the second one had a focus on other objects and elements that could be included in the design. The brainstorming was conducted by writing ideas down on post-it notes for 5 minutes for each phase. The post-it notes were then grouped by the research questions to get an image of what ideas could give answers to these questions.

3.5.2 Prototype

This phase aimed to take the ideas sketches from the previous phase, combine them with the suggestions from *Understanding step* and design a finished testable prototype. This involved *Creating Low fidelity prototypes* and *Creating High fidelity prototype*. How the prototype was designed in to follow the suggestions created in the *Understanding step* are presented in Chapter 8.

Creating Low Fidelity Prototypes

The lo-fi prototypes that were made were first drawn on paper, this because it is easier (according to the author) to focus on the bigger picture if no digital tools are used. To create the lo-fi prototypes, different post-it notes were picked and a design was made from these notes. When the design was done, several new post-it notes were picked and a new design was made from the new notes. This procedure was repeated 3 times to get some different concepts of how the ideas could be materialized. To make the sketches easy to understand they were made digital and intractable by the tool wireframe.cc⁵. The purpose of these sketches was to have something to discuss around during the workshop.

The Workshop was a non-structured session where the tree design were discussed. A design team (including the author) got together and picked elements, layouts and ideas from the different lo-fi prototypes that contributed to visualize the learning progress in the most understandable way. The result of this session was a new concept regarding the design of the prototype.

The concept that the workshop resulted in were then designed and made intractable in wireframe.cc. All the lo-fi prototypes created in wireframe.cc can be seen in *Appendix 2*.

Creating High Fidelity Prototype

The High fidelity (Hi-fi) prototype was created using Figma⁶ both for design and prototyping. The finished sketch from the previous step was created into Figma and designed both with the correct elements and the correct layout. During this step, an ongoing discussion in the design phase had to be able to answer the research questions in the usability test. Animations were excluded from the design so they would not disturb the usability test. The Hi-fi prototype are presented in Chapter 7.

⁵<https://wireframe.cc/>

⁶<https://www.figma.com/>

3.6 Materialize

The Materialize step contained the *Test* and *Implement* phases. They aimed to establish a framework for how to communicate learning progress in a digital interface. This by testing the interface design suggestions from the *Explore* step through a *usability test* to confirm which suggestion from the *Understanding step* worked and which did not and to draw conclusions from this.

3.6.1 Test

This phase aimed to test which suggestion from the understanding step that worked. This was done through a *Usability test* of the Hi-fi prototype created from the suggestion.

Usability Test

The usability test focused on the understanding of the content in the digital interface instead of understanding the interactions. This because the research questions focused on the content more than the interactive part of the digital interface. Because the understanding of the content was the major part of this investigation, the usability testing were a combination between a task scenario-based usability test [9] and a semi-structured interview [8].

The participants in the test were three parents with children spanning from 6 to 12 years old, one parent with children spanning from 22 to 26 years old and one person without children. The number of participants is motivated by Moran [10], she recommends using 5 participants to uncover the most common problems in the design. The interviews were held for four participants held in Swedish and for one participant held in English.

The usability test was performed remotely using the service Zoom. During the introduction of the test, the participant got a link to the Figma prototype and opened it in a web browser. The participants shared the screen with the test leader and the sound and the shared screen with the prototype were recorded.

The introduction of the test included the background of the child which the learning progress in the design represented. The background included age, grade and for how long the child has played the Zcooly games.

First, the participant got two different tasks focused on understanding the learning progress in general in the design. Then several questions were asked, both about the activities that they performed during the test and what their thoughts were of the content.

A recording was analyzed by summarizing the information from the interviews regarding one area below in the same place.

Areas:

- Perception of the learning progress
- Next step for the child
- The mathematical language and terms
- The feeling of the prototype
- Other opinions
- Background of the participants
- Misunderstanding in the design

When this had been done separately for each participant, the information from each area was den summarized and translated. The result from the Usability test are presented in Chapter 9, *Usability test*.

3.6.2 Implementation

This phase aimed to materialize the framework this thesis has established in a prototype, this involved the *Implement Framework* step.

Implement Framework

This thesis aim was to establish a framework of how learning progress should be communicated to a parent, this is what is done in this step. The suggestions from the *Understanding step*, the design choices made in the *Export step* and the usability test were combined and analyzed with the aim establish a Framework for how learning progress should be communicated to a parent in a digital interface. The result of the analysis is presented in Chapter 10, *Discussion* and Chapter 11 *Suggested Framework*.

Step I

Understanding

*This step presents the results from the Literature Study in the **Theoretical Framework** and the Results from the **Interviews with teachers**. The results from these two chapters are here also discussed and combined to suggestions for the design and Framework on how to communicate learning progress to parents.*

Chapter 4

Theoretical Framework

This chapter will present the Literature study that has been done for this thesis. The theoretical framework has been divided into three subjects, *Feedback in School*, *Communicating with Parents* and *Visualizing Progress*. The *Feedback in School* section will review what feedback is and how it should be communicated in a school environment. The section *Communication with parents* will review how communication with parents should be done in a school environment. And lastly, the *Visualizing Progress* section will contain literature on how progress is visualized effectively through dashboard design.

4.1 Feedback in School

The American Heritage Dictionary [11] defines feedback as an evaluation process, information about a result or achievement. This is the definition that is used in this paper.

Much of the feedback that as a connection to education and learning is applied in a school environment. In this section knowledge and different strategies on how feedback should be provided to be effective in a school environment are presented.

Hattie and Timperley [12] has created a model for effective feedback to students, the model says that the feedback that is given to a student should answer three questions: *Where am I going? (What are the goals?)*, *How am I going? (What progress is being made toward the goal?)*, and *Where to next? (What activities need to be undertaken to make better progress?)*. By answering these questions, the student is aware of what that current situation

is, what the goal is and how to get there.

4.1.1 Formative Feedback

One feedback for that has shown potential in education is formative feedback [13, 14]. Formative feedback is defined by Shute [13] in the review *Focus on formative feedback* as information communicated to the learner that is intended to modify his or her thinking or behaviour for the purpose of improving learning. In the review Shute [13] presented guidelines on formative feedback that enhance learning, the relevant ones for this thesis are:

Present elaborate feedback in manageable units To not overwhelm the receiver, provide feedback in manageable portions.

Keep feedback as simple as possible but no simpler Simplify and focus the feedback as much as possible. Generate only enough information.

Give unbiased, objective feedback, written or via computer Feedback is often considered more serious when it derives from a trustworthy source.

Do not give normative comparisons Indirect or direct comparisons with other students as feedback should be avoided.

Be cautious about providing overall grades Feedback should note strength and provide information on how to improve. Overall grades have proven to not be effective.

William and Leahy [14] have in their book written about formative assessment and how to give formative feedback. To provide feedback, the teacher needs to establish trust among the students, a student that does not trust the capacity of the teacher will most likely not make an effort to improve [14, p. 139]. The authors also suggest that for the feedback to be effective it should not focus on what that student has done, but to focus on how the student could improve [14, p. 156].

4.2 Communicating with Parents

Communication with parents regarding their children is difficult and needs to be well thought through to be effective. This section will establish communication methods and tactics on how to communicate effectively with parents regarding their children in a school environment.

Graham [15] suggest in a review that as well as teachers need skills in the art of teaching, they require knowledge on how to communicate with parents. A teacher should use different effective strategies to communicate a students progress to its parents. The communication, regardless of what medium, should be thoughtfully planned and seen as a way to strengthen the parent-teacher relationship with the to enhancing the student's learning.

Lindle [16] studied this relationship from the parent's point of view. This study shows that schools and parents view on communication are different. School personnel thing that a professional, businesslike approach would win parents respect. However, parents fin this approach patronizing and feel like they were looked down on. Lindle [16] shows that parents want a less formal relationship with the teachers and that a personal touch in the communication is the most enhancing factor in the relationship. Parents want to be an equal partner in the rearing of their child.

Davern [17] has also studied the parent's point of view, but in a more specific medium, the school-to-home notebooks. The notebooks are often used by teachers to communicate the content of a child's day in school to parents, in particular for children with special needs. The information are often appreciate because it provides the parents with insight into their children's day, even if the child does not communicate it. Most parents are often looking for ingoing, respectful forums that lead to tangible improvements in their child's learning. However, according to the study [17], parents want different amount of insight into their child's education and this should according to Davern be respected. The use of educational jargon should be avoided in the notebook, this could make the parent feel like an outsider.

Another way of communicating with parents is through the report cards. Report cards are a written evaluation of a student's progress [15]. Aronson shows that for a report card to be an effective communication is has to be easy to understand. The content should be among other things educational achievements across different content areas and goals for the student associated with what parents can do to help (as cited in [15]).

Communication Barriers

There are also many barriers in the communication between school and home. It is shown by Williams & Cartledge that educational jargon could be a roadblock in communication between teachers and parents. The teacher

should as often as possible avoid advanced terms and language. If an advanced term has to be used, it has to be carefully explained (as cited in [15]).

4.3 Visualizing Progress

The visualization of progress is often done in the form of dashboards. Therefore, this section will present how dashboards should be presented to be as clear and understandable as possible.

The term dashboards derive from the dashboard in a car and serve the same function in the digital world [18]. The term is described by Few in his book as follows:

A dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance. (as cited in [18, 19])

When designing a dashboard there are things to consider for the design to be most effective.

The user Important before starting to design your dashboard is to understand the user [19, 20, 21, 22, 23]. The designer should through the design process keep the user in mind and focus on what the user needs this dashboard for [19, 20, 21].

Prioritize To prioritize what content that is relevant for the dashboard is crucial to not confuse the user's [21, 23, 24]. When prioritizing, what the users intentions are with the dashboards are most relevant [18, 19, 22, 24]. If too much information is visualized for the user, it could both confuse and mislead the user [18, 23], Bakusevych [24] argue to not *tell the full story*, summarize the information and add interaction as a way to add more content and detail.

Appearance The appearance will make the dashboard more structured and clearer and will make the information easier to read. It should be clear which information is the most important one, this could both in the visualization [21, 22] and through placement (top left for the most important and bottom right for the least important) [19, 22, 23, 24]. Content that present similar data should be close to each other or even grouped [20, 23]. Color should be used with consistency, either to alert

the user or to separate different data [19, 21, 22]. Keeping the design minimal and without noise enhance the readability, the spaces between the content (also called white spaces) is important and need to be large if the content is too cramped the information will be harder to readout [22, 23, 24].

Chapter 5

Interviews with teachers

This chapter presents the results of the *Interviews with teachers*. Each interview is separately summarized. This chapter contains the practical suggestions that teachers use in school to communicate learning progress to parents.

5.1 Teacher 1

Teacher 1's (T1) most common way of communicating the learning progress of a student to its parents are during the parent-teacher conference. The discussion about the learning progress starts by looking at the goals from the last parent-teacher conference. Both the student, parent and T1 discusses if the student has reached the goal. T1 informs the parents and students what tasks the students have worked on in school associated with the goal. If the student has *not* reached the goal T1 informs what needs to be done to achieve the goal. If the goal is reached, then what the student has done to reach the goal is discussed. However, according to T1, there are always new things a student can work on and therefore, new goals and what needs to be done to achieve those goals are discussed. T1 finds it important to inform the student and parent what could be done at home to achieve a goal.

According to T1, the parent-teacher conference should answer four questions:

- How has it gone?
- Where are we now?

- Where to next?
- How do we get there?

The language that T1 uses when talking to parents is a correct educational language, however not as advanced as in the curriculum. T1 use the correct term and language but explains them. This way the parents learn what the correct term means.

5.2 Teacher 2

Teacher 2 (T2) talked mostly during the interview about two communication methods, written communication in the learning management system (LMS) and during the parent-teacher conference. T2 empathizes that all the communication that is had with parents are prospective.

The content of the communication in the LMS is how the student is progressing in a particular subject. When T2 communicates with the parents on the LMS the focus is on the faculties of the subject. The faculties can be divided into different amounts of parts. T2 explains that the number of parts in a faculty say nothing about the importance or extent of the faculty. If a faculty or a part of a faculty is complex, T2 clarify the meaning by explaining and giving examples, not by simplifying.

T2 illustrates the learning progress of a part by highlighting it with a color. There are three different colors standing for the three steps: *not reached*, *almost reached* and *has reached*. However, coloring parts in a faculty can, according to T2, give the parent a false image of the learning progress. When coloring a faculty with many parts it looks more extensive, which is as mentioned not the case. This is why the coloring could be misleading and, according to T2, give the parents a false image of the learning progress. Despite of this, T2 emphasize that parents have 15 different subjects to look through and some visual aid in this situation is very helpful.

T2's experience is that the advance language that is used in the communication with parents does work when the parent has Swedish as their native language. When communicating with parents that do not have Swedish as their native language, misunderstandings happen more often and then the coloring that is mentioned earlier is a clearer way of communication.

When T2 communicates with parents during the parent-teacher conference the strategy does not change compared with on the LMS. Even if the focus of the parent-teacher conference should be prospective and how the student should work towards the next goal, a summative assessment is always done to gain an understanding of the current situation.

5.3 Teacher 3

Teacher 3 (T3) communicates learning progress to parents mainly during the parent-teacher conferences and through the learning management system (LMS).

The content of the parent-teacher conference should according to T3 be prospective. The conversations should be about how the student should keep a grade or reach for a higher grade. During the parent-teacher conference, T3 does not use the language from the Swedish curriculum, however, a correct educational language is used. T3 clarify the educational language and terms by explaining and giving examples.

The communication in the LMS is about how the students are performing in the different subject in the curriculum¹. If a part in a faculty has been reached, it is highlighted by T3 with a color, if it is not reached it is not highlighted. T3 thinks that there are *good* and *bad* things about this type of visualization. The highlighting of parts provides the parent with an overview of a student's learning. However, the colors get too much attention and the focus becomes what the student has not achieved when it should be on what the student's next step is.

T3 explains from experience that communication regarding learning progress with parents that have another language than Swedish as their native language often lead to more misunderstandings.

5.4 Teacher 4

Teacher 4 (T4) normally communicate with parents regarding a student's learning progress during the meeting associated with an action plan being made for the student.

¹The information about how subjects are divided into faculties and parts were explained by T3 in the same way as it were by T2 and will not be repeated here (read more in Section 5.2)

An action plan is for children that need more help to reach the curriculum goals than what can be provided in a classroom. When an action plan is to be done, T4 does a pedagogical mapping of the child that includes

- Which goals the student reaches.
- Which goals the student does not reach.
- Which goals the student almost reaches.
- What efforts the school makes already.
- What the goals with the efforts are.

By showing parents the mapping and the evaluation that this results in they better understand the situation that their child is in. T4 simplifies the language from the curriculum for the parents to understand the goals better.

According to T4, the difference between the parent-teacher conference and the action plan meeting is that the action plan is more concrete. T4 give examples to explain what knowledge the student does not possess and how to gain that knowledge. T4 explains that a parent understands better what the student should work on when the exercises are explained.

T4 also informs the parents what they can do at home to help the student to reach specific goals. It is according to T4 important to provide the parent with several different exercise that practices a goal. This because all children learn though different methods.

All the communication that T4 has with parents are prospective. However, to evaluate the student T4 needs to look at what has been done. The evaluation is done to be able to work prospective in the correct direction.

It was also talked during the interview about the relationship with parents and T4 finds that building a good relationship is a good way to get through to a parent. T4 empathizes the importance of communicating to the parents the progress of their child, even if the goal is not yet achieved, to strengthen the relationship.

Chapter 6

Suggestion for the digital interface

This chapter has the aim to discuss and summarize the Theoretical framework and the Interviews with teachers to get suggestions on how to communicate learning progress through a digital interface. The summarizing on the two studies is done below.

Before going into detail, one thing needs to be mentioned. According to the literature on how to design dashboards the user is very important [19, 20, 21, 22, 23]. Because of this, the suggestions below the parents are a central part of these suggestions.

Have a Prospective Focus

Both the literature [12, 13, 14, p. 156] and all the interviewed teachers emphasize the importance of having a prospective focus when communicating learning progress. However, even if the focus should be prospective, according to Hattie [12] and the teachers (T1, T2, T3, T4) to understand the next step, you need to understand the past to understand both the present learning state and how to get to the next goal. According to T1 and T4, a good way of communicating the past is to talk about what knowledge the student does and does not have.

T4 also find it important to communicate to a parent the progress towards achieving a goal, not just when it has been achieved.

Help the Parent on How They Assist Their Child

Aronson (as cited in [15]), T1 and T4 argue that parents need assistance in what they can help their child with at home to reach the goals. They all argue that suggestion on what the parents can help with at home should be talked about in association with the goal for the student. T4 also suggest that a child should be given several different exercises because children are different and do not all like the same exercises. However, if there is no teacher around to tell if the child is having problems and require assistance, how to you get the parent to understand that? How it should be clarified for the parent is hard to say, however, what should be avoided is normative comparisons between students and overall grades [13].

Communicate With a Personal Tone

A persona should be beneficial when talking to parents about their children [16]. However, still keeping the conversation respectful is also important [17]. A personal, respectful tone results in more text and more elements in the design, which should, in fact, be avoided for the content to be easier to understand [22, 23, 24]. However, the personal tone I think gives more to the users than it bothers them.

Use the Correct Mathematical Language

This is the suggestion where the opinions are divided the most, both between articles in the Literature study and between the interviewed teachers. Both Williams & Cartledge (as cited in [15]) and Davern [17] argue that teacher should avoid educational jargon when talking to parents because it makes the parent feel like an outsider. If mathematical terms have to be used, the should be carefully explained (according to the interviewed teachers and [17]). However, teachers need according to William [14, p. 139] shows that they possess expertise with giving feedback to students. It is also considered more serious if the receiver thinks that the source is trustworthy [13], this is something that could be mediated if using the correct terms.

The interviewed teachers are also of different opinions. T1 and T3 use the correct term and simplify the content with examples, T2 uses the exact

language from the curriculum however gives examples and explanations and T4 both simplify the terms, give examples and explain.

The choice was made to suggest the use of correct mathematical term in the framework for the design, however, explaining them carefully through examples and descriptions. The choice was made because of the importance of mediate trust and to talk the same language as most of the teacher does. This so the digital interface and the teachers in the Swedish school speak the same language. Because of the separate opinions about this, the results from the usability test on this subject will be of great significance.

Make the Content Easy to Understand

This suggestion sounds like it is obvious, however, when communicating learning progress this is important to have in mind. Aronson argues that for a report card to be effective the content needs to be easy to understand (as cited in [15] and Shute [13] shows that feedback regarding school needs to be simple to be effective.

Making the content of the interface design more understandable could be done in these ways.

- Keep the appearance structured [21, 22].
- Make it clear which information that is the most important through placement (top left for the most important and bottom right for the least important) [19, 22, 23, 24].
- Similar data should be placed closer to each other or even grouped [20, 23].
- Use colors with consistency [19, 21, 22].

Prioritize the Content

To prioritize both what content that is important and what content that should be included in the learning progress visualization are important to not overwhelm and confuse the user [13, 18, 21, 23, 24]. Davern [17] argue that

different parents want different amount of insight in their child education and this should be respected. A good way of giving the user to get more insight is to present a summarization of the content and add interaction to show more details [24].

Step II

Explore

*This step presents the results **Prototype step** and discusses the design choices made with the base in the **Understanding step**.*

Chapter 7

High fidelity prototype design

This chapter presents a High fidelity (Hi-fi) prototype of the digital interface design that communicates the learning progress, this is the result of the *Explore* step.

7.1 Element Description

In this section, the elements of the digital interface explained, what they contain and what they represent. The numbers in the description below refer to the red number in the Figures in Section 7.2 *Digital interface design*.

Element 1: An introduction to the learning content of the child. In the introductory text is a small description of what game the child is playing now and what is practiced in that game (Figure 2).

Element 2: This element shows the user (Figure 2):

- What that child's next badge in the recently played game.
- How many exercises that the child has left to achieve the badge
- A button the user can press to get help with how the user can help the child in this subject.

Element 3: Suggestions on what parents can do to help their child if the exercise are too hard (Figure 3).

Element 4: The time spent and gained knowledge graph. This graph shows the last 8 weeks, how the played time varies compared with how much

knowledge that has been gained. The gained knowledge line is shown accumulated. If the user presses the more information text an explanation on how to interpret the graph is shown (Figure 4).

Element 5: All the badges that the child has gained are shown, this is the progress of the child in the games. The user gets a quick overview of how many badges the child has achieved in each game (both by number and by a staple) (Figure 4).

Element 6: If the overview of all badges is expanded on a game row the user will more information on which badges that have been achieved, which once that have not been achieved and what the badges and the games educational purpose are (Figure 5).

Element 7: On the right side of the design there is a menu where the user can navigate through different subjects. The same kind of elements is shown when navigated to a different subject but only showing the data for that subject (Figure 6).

Element 8: If the user navigates to a specific subject an explanation shown on what the subject is and what is practiced in that subject (Figure 6).

7.2 The Digital Interface Design

In this section the design of the digital interface that communicates the learning progress is presented. Elements that were not created during the work with the thesis are:

- The character image in the top right corner (in element 1, Figure 2).
- The badges including images, titles and descriptions (in element 2, Figure 2 and element 6, Figure 5).

These elements and texts are created and owned by Zcooly and are used in their products.

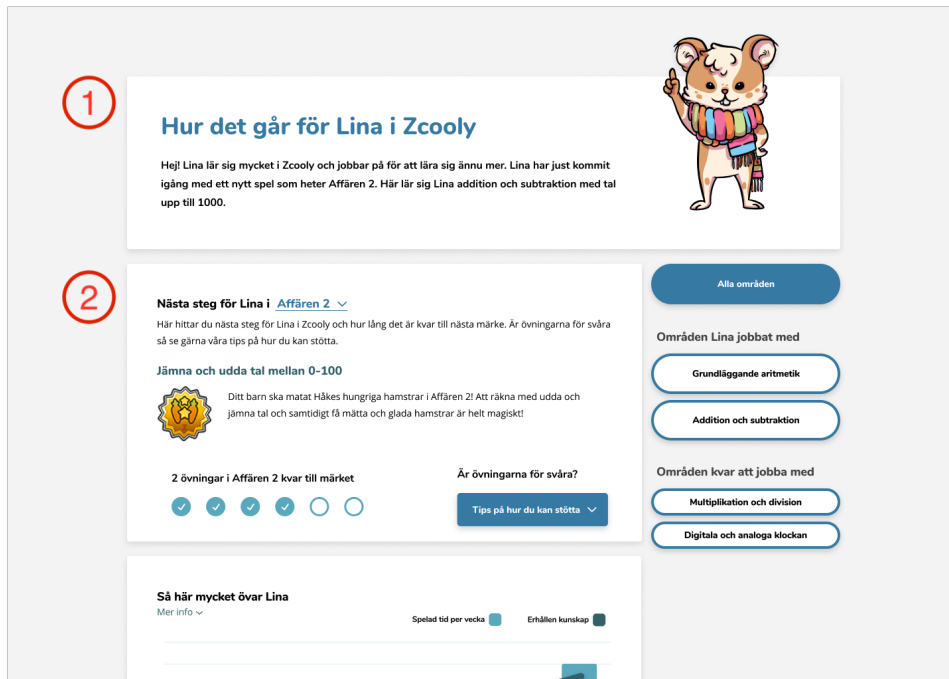


Figure 2: Hi-fi prototype elements 1 and 2

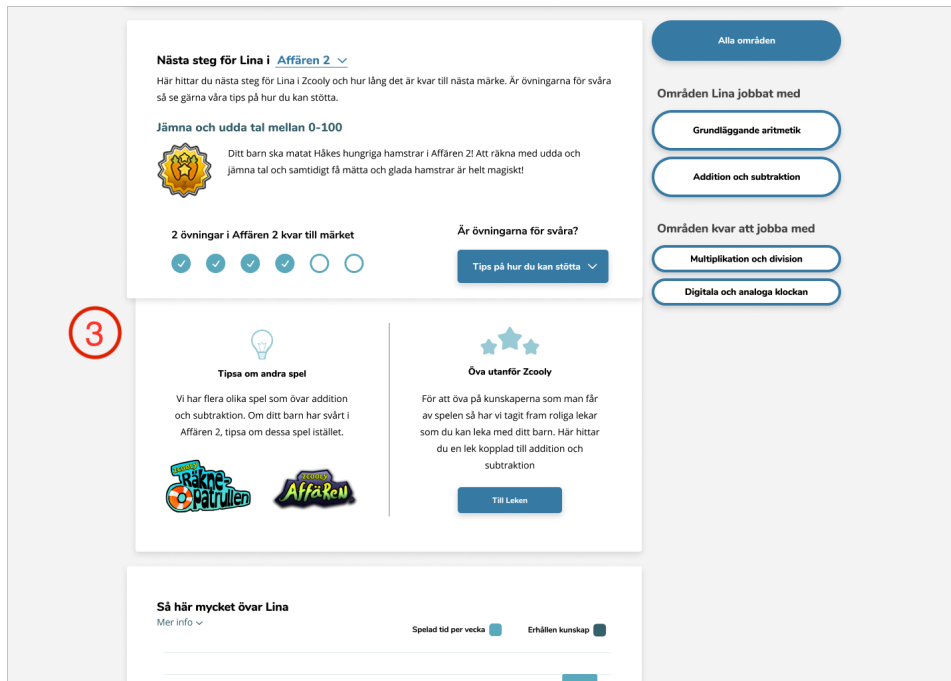


Figure 3: Hi-fi prototype element 3

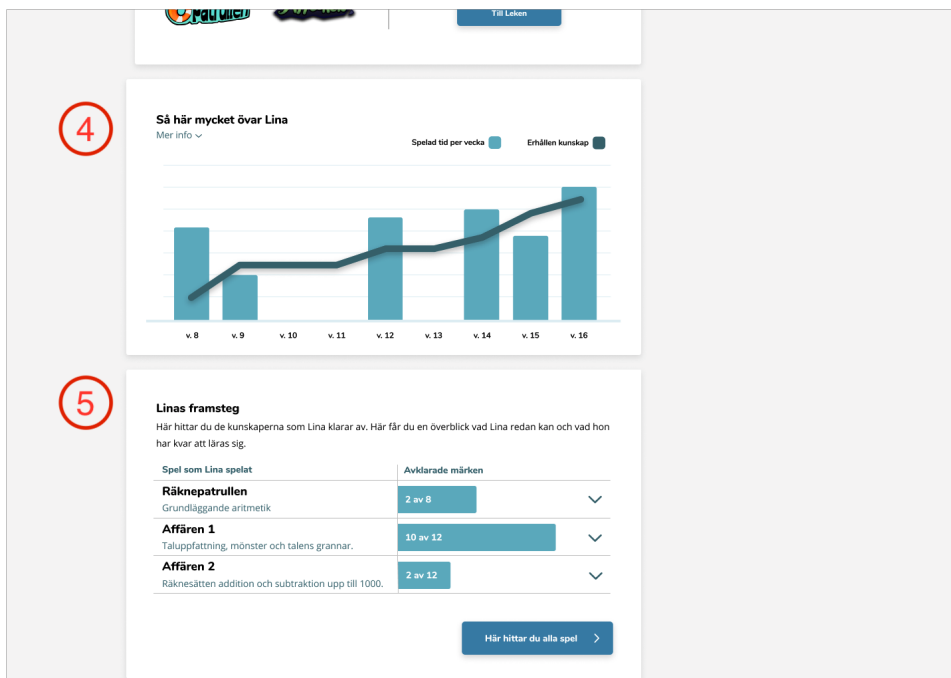


Figure 4: Hi-fi prototype elements 4 and 5

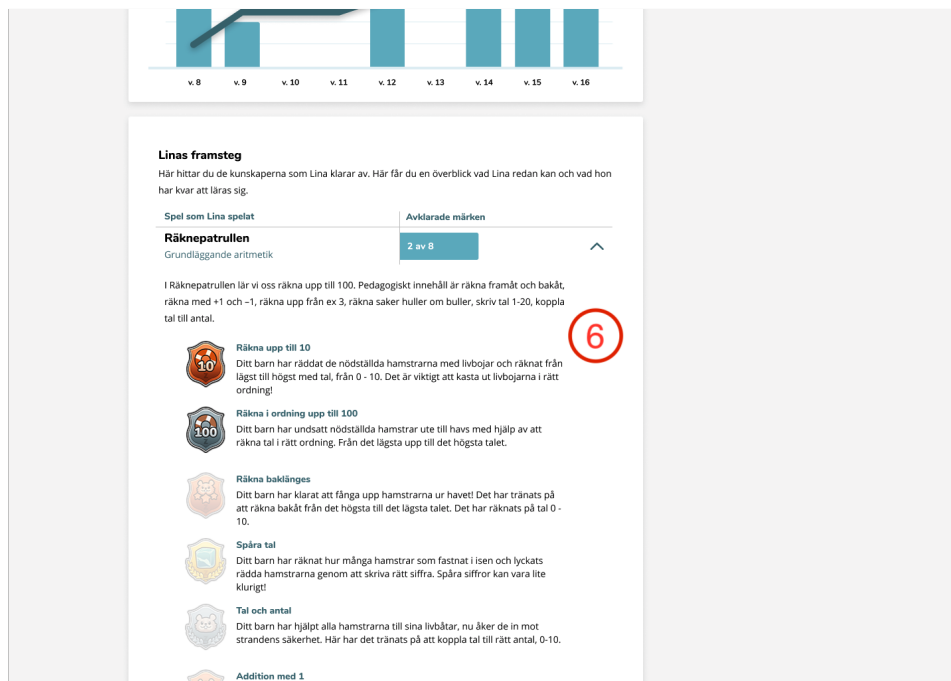


Figure 5: Hi-fi prototype element 6

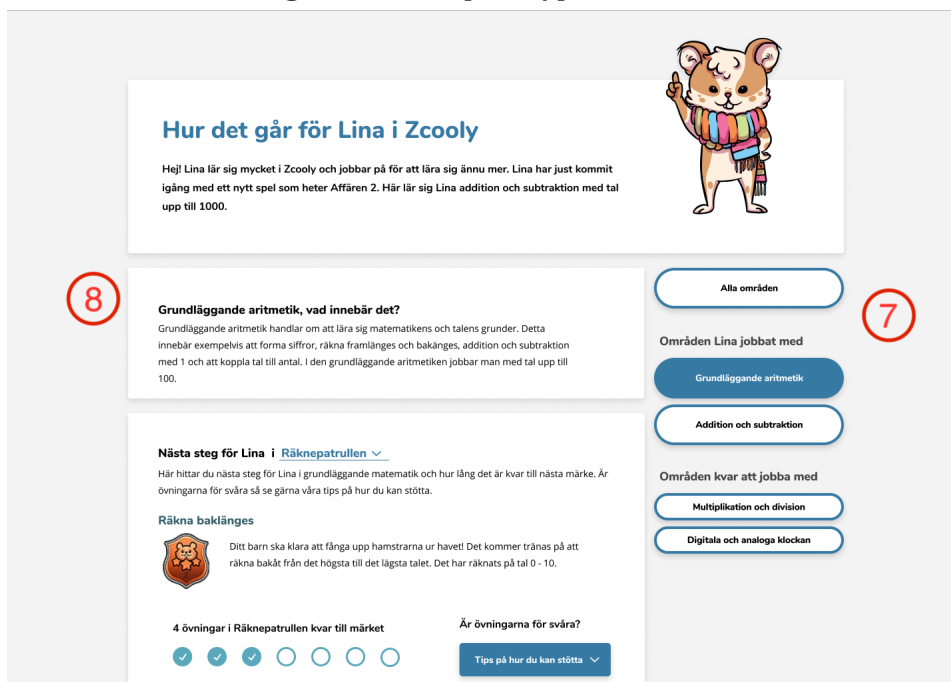


Figure 6: Hi-fi prototype elements 7 and 8

Chapter 8

Design choices based on the suggestions

The finished design that has been made to test the suggestions from the *Understanding step* are here presented. Below each suggestion the design choices associated with that suggestion are discussed.

Have a Prospective Focus

How this suggestion is implemented in the design are mostly through element 2 (in Figure 2). The element shows for the user the child next goal (the badge) and how to get to that goal (how many exercises that needed to be finished in a specific game to get the badge). For the user to understand the past there is element 5 (in Figure 4). This communicates to the user what knowledge that the child already possesses with the aim for the parent to gain understanding on the current situation to be able to understand the next step. Why element 5 is placed at the bottom is to draw focus from it (making it less important through placement [19, 22, 23, 24]). This because the past should just assist the user in the understanding of the next step (according to all the Interviewed teachers and Hattie [12]).

Help the Parent on How They Assist Their Child

This is done in the design by adding an element on how the user can assist the child if the child is having problems in the game (see element 3 in Figure 3).

This element suggests several other exercises that practice the same knowledge as needed to take the badge (as suggested by T4).

Because there are no suggestions from the *Understanding step* on how to clarify that a child is struggling, a visual representation, Element 4 (in Figure 4), is added and tested in the *Materialize step* to see if it is understandable. This element has the aim to make the user understand the connection between played time and gained knowledge. If the time is increasing but not the knowledge, the purpose is for the user to understand that something is wrong without a normative comparison or grade. This is also explained to the user in information text that is shown when clicked more information.

Communicate With a Personal Tone

The personal, respectful tone mediated in the design mostly through the titles, headers and text. To enhance the personal tone the child's name was mentioned in the texts and titles. By adding a name, the prototypes communicate the learning progress about a person, this enhances, in my opinion, the personal tone in the prototype. The other thing that was done with the text were to write them in colloquial language with the aim to sound like you were talking to a friend. This also, in my opinion, enhances the personal tone.

Still keeping the conversation respectful is done by not making the language like talking to a child. Keeping the conversation respectful and not childish is one of the reasons for using the correct educational language (read more about it in the suggestion (*Use the correct mathematical language*)).

The Introduction (element 1 in Figure 2) also aims to contribute to the personal tone by welcoming the user to the interface. Adding the character to this element also has the aim to enhance the persona tone.

Use the Correct Mathematical Language

The mathematical language is present in all the text and titles in the prototype. Examples and explanations are added both for each badge (element 2 in Figure 2, element 6 in Figure 5), the mathematical content of each game (element 6 in Figure 5) and for each subject (element 8 in Figure 6). These have the aim to make the mathematical term that the user did not understand

understandable (as suggest by the interviewed teachers and Davern [17]). The mathematical terms are also present in the menu of subjects (element 7 in Figure 2). The explanations and examples of the mathematical terms are as often as possible combined with the mathematical term to make it easier for the user to understand. The choice was made to not use the facilities that T2 uses when divided up the area to lower the advanced on the educational language a bit.

Make the Content Easy to Understand

The first action to make the content simple to understand is to exclude the numbers or unit on the time in element 4 (in Figure 4). The purpose is for the parent to see the difference in time and knowledge in this element and draw conclusions from this. The hypothesis is that by removing the numbers from the chart the user will be less confused.

Other more general things to enhance the understanding are:

- Having a grid design that gives a structured feel (supported by [21, 22]).
- Adding fewer colors and using them with consistency (according to [19, 21, 22]), one for interactive elements and two different one for graphic representations.
- Placing more important information the communicates the next step (element 2 in Figure 2) closer to the top left corner and elements that presented the past (element 4 and 5 in Figure 4) closer to the bottom right corner (as suggeste by [19, 22, 23, 24]).
- Proximity is important for the understanding of relation between elements [20, 23]. To design choices were made in on this suggestion:
 - Placing the *played time and knowledge* graph (element 4 in Figure 4) closer to the *suggestions on help* (element 3 in Figure 3).
 - Placing the *suggestions on help* (element 3 in Figure 3) within the *next step element* (element 2 Figure 2)

Prioritize the Content

By prioritizing when designing the interface every element in the design have a purpose. The few elements in the design aim to lead to the user not being overwhelmed when entering the interface (as suggested by [13, 18, 21, 23, 24]). By adding the menu (element 7 in Figure 6) more details are offered to the user without adding to much content to the interface. This menu element allows the user to get more insight into the learning progress, however not forcing them to do be more involved than they want (as supported by Davern [17]).

Step III

Materialize

*This part presents the results from the **Usability test** of the prototype created in the previous step and a discussion on what the test showed. From this discussion a **Framework** for how to communicate learning progress through a digital interface is presented.*

Chapter 9

Usability tests

This section presents a summarization of the results from the *Usability test* of the prototype.

9.1 Perception of the Learning Progress

All of the participants had the same perception of the learning progress, that the child are getting better. All of the participants also had the same view on the difference between the learning progress in basic arithmetic's and all subjects, that the child has worked less in basic arithmetic's and therefore had a slower progression in that subject. Even if the participants all could understand the learning progress they all mentioned that to be able to get a clearer view of the child's learning progress they needed to know either the exact time per week or just if the time staples were in minutes or hours in element 4 (Figure 4). For all the participants, the problem with not having the time was that they did not know if the child had any problems in the games.

One of the participants said that it is very important to get the time in comparison with how long it should take for the child. The suggestion from the participant was to have an educator sat a time that it should take and compare the child's progress to that.

All of the participants looked at both at element 4 (Figure 4) and element 5 (Figure 4) when determining how the learning progress is for the child. Three of the participants said when asked what they looked at to determine the learning progress that they combined the knowledge of the two elements

to gain understanding. Element 5 (Figure 4) were by 3 participants seen as a good way of visualizing progress and obtained knowledge.

None of the participants thought that element 4 (Figure 4) helped in the understanding of the learning progress.

No participant commented that navigating to a specific (element 7 Figure 6) subject gave them more understanding of the learning progress.

9.2 Next Step for the Child

When asked about the learning progress, all the participants looked at it bit moved on after a short look further down. All the participants found that element 2 (Figure 2) could be important but not as it is now. However, three of the participants said that the elements position or content needed to be changed for it to be useful. Two participants said that it made more sense if it were placed at the bottom in order because it did not say much without knowing the things below it. One participant thought it lacked the progress and wanted to know where the child has been in relation to what the child's next step is for the element to give something.

9.3 The Mathematical Language and Terms

Four participants found the term basic arithmetic's too hard and did not understand it. Two of the participants that did not understand the term wanted both this term and other to be simplified and one of these participants wanted a term to be explained where they were written. The other three participants wanted the language to be the same as when an educator talked, which were by the three participants what they perceived. Four of the participants found the examples and explanations of the mathematical language sufficient, the one that did not, wanted the explanations to be described more.

None of the participants found the explaining element in the basic arithmetic's page by themselves when talked about the examples and explanations of the mathematical terms.

9.4 The Feeling of the Prototype

All of the participants thought that the feeling the page mediated were desired when talking about their children, however, the feelings that were described were not the same.

Four participants answered this question with many different feelings. These participants got the feeling that the design was serious and accurate. Three of these persons also found it personal, the fourth found it professional. One of these participants felt that the person how has made the page cared about the child.

The participant not included in the section above felt that this page was playful and found it positive.

9.5 Other Findings

All the participants had no problem navigating between subjects (element 7 Figure 6) and understood that this was a sort of filter in a specific subject for the learning progress

The suggestions for parents, both that it was included, and the content of the suggestions was liked by all the participants.

9.6 Background of the Participants

Common for all participants was that their computer skills were good or very good and all the participants worked with a computer. The believed mathematical knowledge varied between good and not good and the knowledge about children's learning progress varied from average too bad.

9.7 Misunderstanding in the Design

Some misunderstandings in the design were made during the test:

- The gained knowledge line in element 4 (Figure 4) were seen as gained badges by tree participants.
- Badges and exercises were seen as the same thing by two participants.

Chapter 10

Discussion

This chapter includes the discussion of the results from the usability test and what from suggestions and design choices that worked and did not work. By looking at what worked and what did not work, a framework were able to be established.

10.1 What the Usability Test Showed

This section will discuss the suggestions from the *Understanding step*, Design choices based on these suggestions and what the Usability test showed. The discussion is divided between the different suggestion from the *Understanding step*.

Have a Prospective Focus

To have a prospective focus were something that derived both from several articles in the Literature study [12, 13, 14, p. 156] and all the Interviewed teachers. When you communicate learning progress, you always have a focus on what the next step is. However, the Usability test showed differently. The results from the test showed that the element showing the next step for the child were of little or no help in communicating the learning progress.

However, three of the participants saw the value if placed in context of the previous achievements in the game and I think that this is the part where the design of the next step had its biggest fault. The placing the goal in proximity to or in context with what the background for this next step is what it is missing. The thought from the design process was that the proximity to

the already reached badges and placing the new goal in relation to what has already been learned were not needed to understand. However, the usability test showed that for the next step to make sense it cannot be placed by itself.

In my opinion, even if the next step is not something that the usability test showed had any value to the participants, it is still important. Several studies [12, 13, 14, p. 156] and all the teachers support that this is important when communicating learning progress. However, for the prospective focus elements to tell the user anything it needs to be able to answer the question that that T1 answers at the parent-teacher conference.

- What is the students' knowledge now?
- What is the next goal?
- What needs to be done to get there?

To be able to answer these questions you both need to know what the child knows already in context with what the next step is and how to get there.

The representation of progress (element 6, Figure 5) was one of the two elements that the participants looked at when determining the progress of the child. The participants, T1 and T2 expressed showing the knowledge the child has learned it a good way of visualizing progress and obtained knowledge.

Help the Parent on How They Assist Their Child

Helping parents with how they can help their child is something that is supported by the Aronson (as cited in [15]), T1 and T4. And, even if the test did not include any question or tasks that specifically were about the suggestion on how to assist the child in the learning, all the participants liked both that the tips were there and the content of the tips.

Even if the suggestions were liked, none of the participants understood when they should be used. They all thought that the Learning over time element should be able to answer this, however, they missed the time and could therefore not conclude if the progress were enough. Even if they expressed this the participants all had the same idea of the learning progress both in all subject and when compared with the learning progress in basic arithmetic's partially based on this element. The conclusion from this is that it tells the user enough to be able to see in which direction the learning

progress is heading. However not enough to be able to tell the user if the learning progress is enough.

The result from the usability test in combination with the lack of foundation in the Understanding step for this type of visualization concludes that this type of visualization of learning progress should not be used to help the user understand if the child has problems. The participants in the test wanted to see the played time, but what will this tell the user? If the child has played four hours and just gained a little knowledge, is this too much or is it normal? For time spent to obtain knowledge to make sense, you need a normal comparison and this is something that should be avoided [13].

However, the gained knowledge over time was something that was liked and used by the participants when determining the learning progress for the child.

Communicate With a Personal Tone

The prototype aimed to communicate learning progress with a personal respectful tone, and by this mediate a personal and respectful feeling to the user. This is supported by the Lindle [16], and Davern [17]

All the participants got a feeling that was desired when communicating a child's progress, however, they did not necessarily talk about the same feeling. Four of the participants got the feeling that the interface were serious and accurate. Three of these participants also got the feeling a personal feeling. The fourth one got also got a professional feeling. The serious and accurate feeling could be a result of the educational language, however this was not expressed by any of the participants.

The correct educational language where never commented as contributed to a respectful tone and none of the participants got this feeling.

It is hard to say anything about this because the results from the usability test are inconsistent. Regardless of what feeling the participant got, even if the feelings were different between the participants, it was desired. What in the prototype the participants thought made them get the feeling where also different for each participant.

Use the Correct Mathematical Language

The choice was made in the design to use mathematical terms. However, there were both opinions that advocated (T1, T2, T3) and argued against (T4, Davern [17], Williams & Cartledge (as cited in [15])).

The Usability test showed that the term basic arithmetics were too hard for the participants to understand. However, the rest of the terms the participants had no or little problem with understanding. If the terms should be simplified or not were something that separated the participants into two groups. Three thought that talking the same language as the school are something that you should do and two wanted the terms to be simplified for better understanding. Despite their opinion, they understood the mathematical language.

The examples and description of what the terms meant (as suggested by T1, T2, T3, T4 and Davern[17], Williams & Cartledge (as cited in [15])) and what the child was learning were appreciated by all the participants. However, the explanations for the subject (basic arithmetic's and multiplication and division) were not found by any participants on their own. One participant found the term basic arithmetic's in the description for one of the game and wondered what it meant and wanted an explanation.

Make the Content Easy to Understand

As talked about in *Help the parent on how they assist their child*, removing the number from the time played time staple did not help with the understanding [13], only confused the user more. Also having both this element and the badges (element 6 Figure 5) as ways of measuring knowledge just confused the participants because they got them mixed up. The hierarchy of placing the next step element fist which should make it seen as more important [19, 22, 23, 24]) did not have this effect.

The the other suggestion in the understanding step regarding the shape of the prototype (e.g. structure [21, 22], placement, proximity [20, 23] and color constancy [19, 21, 22]) could not be determined in the Usability test if they contributed to the understanding of the learning progress.

Regardless of these problems, most of the content in the design was understood as the designer meant it, but it is hard to say if it were because of any of the suggestions from the Understanding step.

Why the participants had no problem with understanding how this type

of interface should be used could be correlated with the high computer skills of the users. If a user with lower computer skills should use this interface several other complications could appeared.

Prioritize the Content

It is hard to say something about this suggestion in the results from the Usability test. None of the participants experienced confusion in the app. All the items besides the next step element were appreciated and used when gaining understanding of the learning progress.

The choice to divide the menu into different subjects to not overwhelm the user (as supported by [13, 18, 21, 23, 24]) were nothing that the users commented on. It came naturally to navigate between the subjects and no misunderstandings accrued by dividing the learning progress in this way. Davers [17] findings on parents want different amounts of information could not be confirmed by the Usability test. The participants did not look at the specific subjects to gain a deeper understanding of the learning progress.

Because the pages for the specific subject were not used by the participants to gain understanding of the learning progress, the usability test could not support this type of division of learning content. Other ways of dividing the content could be better and could also be considered, or even removing the specific subject pages could be better. The conclusion is that nothing could be said about this way of implementing this suggestion.

10.2 Summarization

The usability tests showed that different suggest were more effective than others. This section discusses the suggestions and if they should be *included* in the framework or *excluded* from it. The discussion starts with suggestion that in one way or another should be included in the framework.

10.2.1 Included In the Framework

The first suggestion which will be included, however, not as it is implemented in the Hi-fi prototype is *Have a prospective focus*. What could be seen in the usability test is that the protective element in the design did not assist or interested the participants significantly. However, based on the Literature

Study [12, 13, 14, p. 156] and the Interviews with teachers (T1, T2, T3 and T4) this is important. Why the results from the usability test do not have the same results as the two previous studies are because it lacked context. The user needs to understand both the past and present to understand the future (according to T1, T2, T3, T4 and Hattie [12]). In conclusion, the prospective focus is important, however only if placed in the context of the present and the past.

Use the correct mathematical language is the second suggestion which will be included in the framework. This suggestion in combination with the usability test ended up showing two things that are interesting for the framework. The first thing is the educational language itself. The participants had no problem with the mathematical terms that are well known. The mathematical terms were even appreciated by three of the participants. If the mathematical terms contributed to the serious and accurate feeling that the participants got from the prototype could not be confirmed. However if this were the case, the mathematic language contributes to the communication being trusted by the user, which is important [13] [14, p. 139]. However, terms that are too complex (e.g "basic arithmetic's") should be avoided. These results conclude that a mathematical language should be used if it is not too complex.

The second thing that was shown was that examples and explanations were helpful for the participants to understand hard terms. However, if the term has no explanation in proximity to it, the explanation is not looked for and the user will not understand the term. This concludes that explanations and examples should be placed in proximity to the terms.

The last two things which will be included in the framework are not from specific suggestions. They derived both from misunderstandings and appreciations from the participants in the usability test, and the Interviews with teachers. The first thing is that presenting knowledge in more than one way confuses the user and will lead to the two ways being mixed. Maybe presenting several different ways of knowledge could work if they were distinctly separated. However, keeping it to only one way will remove all confusion. The second thing is how the representation of knowledge should be designed. It could be seen for all the participants in the test and expressed by some of them that presenting what knowledge the child has learned as progress were both used and appreciated when determining how the child is doing. This

was also the way that T1 and T4 communicates learning progress to parents. In conclusion, knowledge should be presented in one way and presenting the knowledge as progress is appreciated and used in the understanding of the learning progress.

10.2.2 Excluded From the Framework

Help the parent on how they assist their child was something that all the participants appreciated and have both results from the literature study (Aronson as cited in [15]), T1 and T4 to support it. However, if a parent should be able to hel their child, they need to know of the child is having problems. Element 4 (Figure 4 had the aim to give the parents this knowledge, however, did not work when tested. Adding the exact time to the element as suggested by the participants would in my opinion not help the user determining thing if not a comparison against normality is added, which should be avoided [13]. For this suggestion to be included a better way of informing the parents when the child requires assistance and help, otherwise, the assistance help would not be useful.

Make the content easy to understand, Communicate with a personal tone and *Prioritize the content* had problems in the usability test. Either the test did not show enough to draw any conclusions, or the results were not specific enough to show what in the suggestion that worked. Because of this, these suggestions are (as they are designed in the digital interface in this thesis) excluded from the framework.

Chapter 11

Suggested Framework

By analyzing the result from the Usability test, an understanding of what issues the design and suggestion had were gained. From this understanding, a suggested framework could be created on how to communicate learning progress for children in a digital interface. This framework is not tested and therefore just a suggestion, further studies need to be done to guarantee that it works. However, the framework content is in line with results from all of the studies done in this thesis and therefore, in my opinion, have a good chance of working.

The suggested framework is based on a study that is limited to communicating learning content from mathematics. However, the study does not indicate that a suggested framework for another subject should be any different. The Literature study is not limited to just mathematic and the interviewed teachers are not just teaching mathematics. Because of this, my opinion that this should work for other subjects, however, have more foundation for working with mathematic

Note that the study this framework is based on is only done with the Swedish curriculum as a base and curriculums for other countries were not included.



Figure 7: The suggested framework

Have a Prospective focus but place it in context to what has been done

To have a prospective focus on through the entire design is important. However, for the next step to make sense, it needs to be placed in context to what has led up to this goal and how to reach it.

Use the correct language if the terms are not too complex

The educational language appreciated by most users will be understood if it is not too complex. When creating a digital interface for learning progress, put some thought into what terms that should and should not be simplified. The educational language could also lead to the communication being more trustworthy, which is important when communicating learning progress.

Explain and exemplify the terms in proximity to them

If correct educational language is used this part is very important. By adding explanations and exemplifying in proximity to the education term the user never has to feel like they do not understand the content.

Communicate knowledge in one way

To not confuse the user, pick one way of communicating the knowledge. If several ways of communicating knowledge are presented, they could get mixed up and could, therefore, be misleading.

Show what kind of knowledge in the progress

Presenting gained knowledge as progress helped the user in understand the learning progress. It is also appreciated because then the user can see exactly what the child has learned.

Final Remarks

*This part includes **Method discussion**, **Conclusions** and **Acknowledgements** as final remarks for the study.*

Chapter 12

Method Discussion

This chapter includes a discussion of the Research method parts and the effect that the Covid-19 pandemic that spread during the spring of 2020 had on the study.

The Research Method *Design thinking* worked in my opinion well and with the minor changes made in the *Understadning step* (Read more in Section 3.4) it where adjusted to the aim of the thesis. In my opinion the chosen research method gave the thesis valid and good results.

12.1 COVID-19

Covid-19¹ were during the work with this thesis a pandemic that had effects on the chosen Research Method. Due to the pandemic, most of the work had to be done from home and meeting new people for interviews and usability testing was not possible.

12.2 Interviews with Teachers

The pandemic resulted in the interviews being conducted remotely. When conducting interview remotely using a video conference service (in this case zoom) you are not getting the relaxed conversation that you get when conducting the interview face to face. This could have affected the results and if the pandemic had not forced the interviews to be held remotely, they would

¹<https://www.1177.se/sjukdomar-besvar/lungor-och-luftvagar/inflammation-och-infektion-ilungor-och-luftror/covid-19-coronavirus/>

have been held face to face. This because I think that the interview would have been more relaxed, and more information would have been received.

The method chosen for the interviews where a semi-structured interview [8] which were both good and bad. By using this method, a lot of information was gathered in each interview. However, the teacher tended sometimes to talk about communicating learning progress to children and school-related tests and material that were not relevant to the study. With that said, I think that if I had not chosen a semi-structured interview method the information regarding communication with parents would not have been of the magnitude it ended up being.

The two of the teachers that were interviewed worked with older students than the target group for the framework. These interviews had more mentioned about the grades, however, the communication methods that these teachers used did not vary from the methods that the other interviewed teachers used. Therefore, I found these interviews valid as well.

12.3 Explore Step

The explore step were affected the most in the research method by Covid-19. The plan was to have closer collaboration during this step with the team at Zcooly. In the *Generating Design Ideas* step it was planned a brainstorm with the team which had to be cancelled. This resulted in a one-person brainstorming that in my opinion would have generated more design ideas if more people had been involved. Even if this session had to be cancelled a brainstorming session were had about the lo-fi prototypes, this helped in moving the design process along and ended up being the base for the finished hi-fi prototype. The work from home also hampered the communication about the design and the sporadic communication that normally helps in a design process was lost.

My opinion is that the effects on the finished hi-fi prototype were small because it did still include the design choices motivated by suggestions from the *Understanding step*.

12.4 Usability Tests

The Usability tests were as the Interviews with teachers conducted remotely. This resulted in the participants using the prototype on their own computer and in their own homes. I think conducting the study remotely this gave the study more real-life results by removing some of the controlled environment aspects like having someone looking over your shoulder and using another person's computer.

The question regarding what feeling the prototype mediated was hard for several of the participants to understand and had to be explained. In future work this question should be explained before it is asked, this could remove the misunderstandings.

The participants were not all in the target group for the framework. However, any general difference in answers between the participants that were and were not in the target group could not be seen.

12.5 Validity

The chosen research method has contributed to validity and the results have some validity. However, several things could have contributed to more validity.

The number of participants is one of the things that the could have contributed to the results being more valid. More interviewed teachers would have contributed to more informed and better suggestions for the design. More participants in the usability test would also have contributed to a better understanding of the results of the design choices and suggestions.

Another thing that would have contributed to the validity of the results is modifying the usability test. The usability test had a general theme of understanding the learning progress. If this would have changed to have a more focus on the design choices and suggestions the results would have shown more.

The last thing is that would ha contributed to more valid results in evaluating the research method during the study. Design Thinking has been a good research method, however, a more suited method would have been better for some parts of the study. By evaluating this during the work with this thesis, a more suitable method could have been found that would have given even more valid results.

Chapter 13

Conclusions

This thesis aimed to establish a framework for how to communicate the learning progress of a child in a digital interface. This to a parent that had no knowledge about children education.

In the progress of establishing the framework the design method *Design Thinking* was used. By using this method, both a theoretical and practical understanding was gained on the subject. Because of this, the framework can answer the questions in a well-founded way.

The framework had the goal to be able to answer the research questions established in the introduction:

1. How should the complex content of the Swedish curriculum be explained to a parent that has limited knowledge about children education?
2. How should the graphic visualization of the learning progress be designed for the parent to understand the progress correctly?

The framework both have parts regarding communicating complex content from the curriculum to parents and part on how to visualize learning progress in an understandable way. This means that the aim of the framework and therefore the aim of this thesis are accomplished.

13.1 Future Work

Even if this study were successful in establishing a framework, there are several things needed to be further investigated.

The suggested framework that this study resulted were never tested. Further studies need to be done to ensure that this framework work. Also, because the case study limited the study to only work within the mathematical subject, the framework should be tested on other subjects to see if any changes need to be done.

Curriculums from other countries than Sweden should also be investigated if the learning progress in these curriculums should be communicated in any other way. It would also be interesting to investigate T2 and T3 experiences on communication being more misunderstood when the educational content is not in the user's native language and what this would mean for the framework.

Finally, this study could be extended, especially in the number of interviewed teachers and other types of usability tests. This could lead to more specific suggestions for the learning progress communication and extend the framework both with new parts and include parts from this study that were excluded.

Chapter 14

Acknowledgements

First and foremost, I would like to thank...

- The entire Zcooly team for the encouragement and help with this project. Especially, I would like to thank Johanna Barre who has been a great help with the design work.
- Louise Flodén for being supportive both with the writhing and motivations throughout the entire project.
- Kerstin Hessle for helping out with finding teachers to interview.

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Appendix

Appendix 1: Guide to interviews with teachers

Tack för att du ville ställa upp på denna intervjun. Den här intervjun är en del av mitt examensarbete som jag skriver i samarbete med företaget Zcooly som jobbar med utbildande spel i matematik. Examensarbetet handlar om hur lärande utveckling ska kommuniceras till vårdnadshavare när grunden till lärandet är läroplanen. I denna intervjun skulle jag vill ta reda på hur du kommunicerar lärande utveckling utifrån läroplanen till en vårdnadshavare.

Denna intervjun kommer med din tillåtelse att spelas in, inspelning kommer efter avslutat arbete att raderas.

Har du några frågor nu innan intervjun? Bra då tar vi och börjar.

Först så skulle jag vilja få lite basfrågor om vilken typ av lärare du är.

- Vilka årskurser och vilka ämnen jobbar du med?
- Har du jobbat med andra ämnen och åldrar tidigare?
- Hur långt tid har du varit lärare?

I min undersökning så försöker jag förstå hur jag ska kommunicera lärandeutveckling för ett bran till deras vårdnadshavare.

- I vilka situationer pratar eller kommunicerar på annat sätt du som lärare med vårdnadshavare om lärandeutveckling?

För varje situation så tas följande frågor upp.

- Hur brukar situationen med kommunikationsformen gå till?

- På vilket sätt brukar du kommunicera innehållet i läroplanen under denna situation?
- Brukar du förenkla innehållet?
- *Om ja:*
 - Brukar vårdnadshavaren förstå vad du försöker förmedla?
 - På vilket sätt brukar du förenkla?
- *Om nej:*
 - Brukar vårdnadshavaren förstå vad du försöker förmedla?
 - Har du någon annan taktik för att vårdnadshavaren ska förstå?

Efter att alla situationer tagits upp:

- Är det något mer som du vill tillägga om kommunikationen med föräldrar kring lärandeutveckling

Intervjun ska ha öppna frågor och om det är något som är intressant som läraren tar upp som inte ingår i intervjun så fråga vidare om detta

Appendix 2: Low fidelity prototypes



Figure 8: Lo-fi prototype suggestion 1, main page

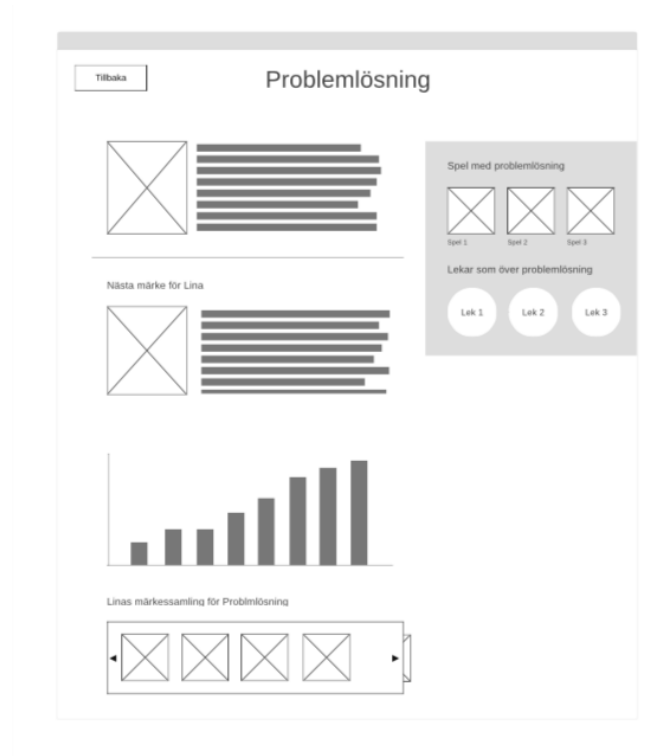


Figure 9: Lo-fi prototype suggestion 1, subject page

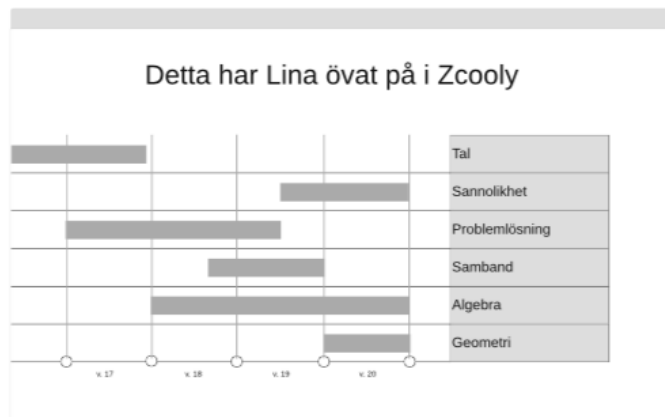


Figure 10: Lo-fi prototype suggestion 2, main page

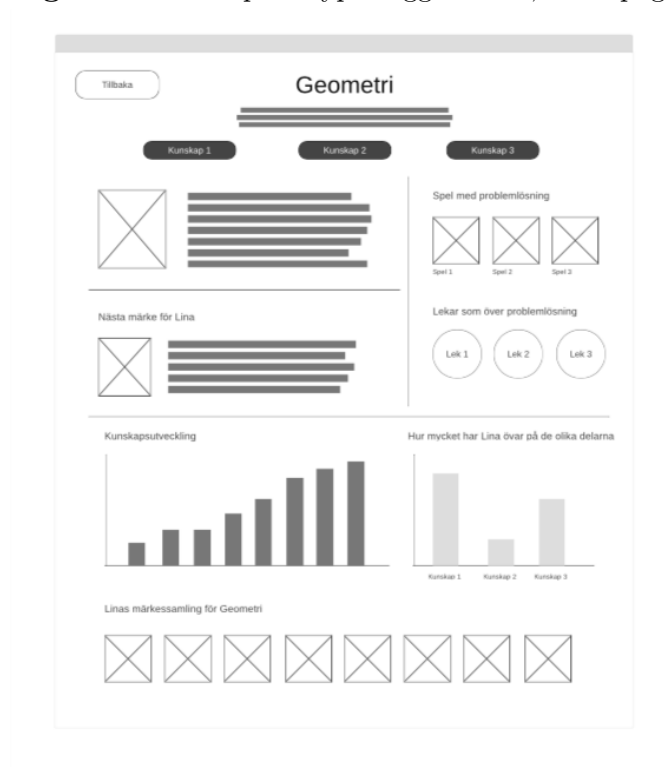


Figure 11: Lo-fi prototype suggestion 2, subject page



Figure 12: Lo-fi prototype suggestion 3, main page



Figure 13: Lo-fi prototype suggestion 3, subject page

Hur det går för Lina i Zcooly



Linus utveckling i Zcooly

Nästa steg för Lina

Nästa målte i Zcooly

Öva utanför Zcooly

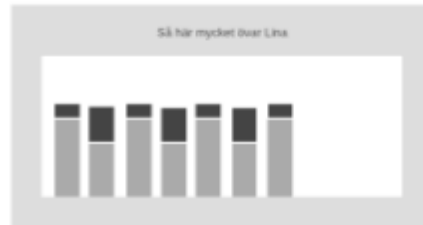
18 Lektion

Alla kunskap

Armen

- Problemlösning
- Genusvet
- Starkt och svagt
- Starkt
- Svenska

Hur har det gått för Lina i Zcooly



Spel som Lina har spelat



Figure 14: Lo-fi prototype final suggestion, main page

Hur det går för Lina i Zcooly



Linus utveckling i Zcooly



Figure 15: Lo-fi prototype final suggestion, subject page

Appendix 3: Usability test Swedish

Test startup

Tack för att du vill ställa upp på detta användbarhets testet. Detta är som ett del av mitt examensarbete där jag tillsammans med Zcooly ska undersöka hur vi ska kommunicera lärandeutveckling för barn till föräldrar. Jag vill inte säga mer än så just nu för att inte påverka testresultatet för mycket. Men har du några frågor så kan jag säkert svara på dem.

Jag skulle vilja att du öppnar länken som jag skickar till dig nu i en webbläsare.

För att testerna ska i efterhand kunna loggföras så kommer jag att spela in din skärm, dig och ditt ljud. Inspelningen kommer ingå i rapporten i skrift att raderas efter avslutat arbete. Resultatet från testet kommer att anonymiseras när det skrivs in i rapporten. Är det okej för dig att jag spelar in? Vad bra! Då skulle jag vilja att du sätter igång din kamera och skärmdelar webbläsaren med länken som jag precis skickade. Perfekt! Är det okej för dig att jag sätter igång instpelningn? Toppen!

Då är inspelningen igång och jag skulle bara vilja att du bekräftar att det är okej att jag spelar in dig, din skärm och ljud även när inspelningen är igång. Är det okej att jag spelar in?

Vad bra! tack!

Länken som du precis öppnade kan ta en stund för den att ladda och i början så kan själva prototypen vara lite seg, men det går över efter ett tag. Alla knappar och länkar går inte att klicka på i prototypen, men klickar du på en knapp som inte är interaktiv så kommer de knappar som du kan klicka på att markeras med en blå kvadrat.

Test intruduction

Jag skulle vilja ge dig lite bakgrund till innehållet i prototypen. Barnet som du ser lärandeutvecklingen för i denna protoypen är Lina, hon är 7 år och går i första klass. Under 10 veckor så har hon spelat Zcooly. Det var lite bakgrund

Jag kommer under testet gång att först ge dig ett par aktivitet och sen så har jag lite frågor efter det som du utför och svarar på till bästa förmåga.

Jag tester inte dig, utan jag testar prototyoen.

Testet kommer att bestå av öppna frågor vilket gör att det kan vara lite otydligt ibland vad det är du ska göra, säg gärna till eller fråga i så fall, dock kan det vara så att jag inte kommer svara på dem om jag tror att det kommer påverka testresultatet. Du får avbryta testet när du vill om det inte känns okej.

Tänk gärna högt under testet om vad du gör och tänker

Några frågor innan vi sätter igång med själva testet?

Test

- Som första sak skulle jag vilja att du försöker skapa dig en uppfattning om hur Linas lärande utveckling är i Zcooly och förklara den uppfattning. Du får gärna klicka runt i prototypen under tiden. Om det är något du inte förstår så säg gärna det. Du får gärna förklara undertiden du skapar dig en uppfattning, vad du tittar på och vad du tror att det betyder.
 - Vad är det för något som gör att du får den uppfattningen?
 - Är det något du saknar för att du ska kunna skapa dig en tydligare uppfattning?
- Om du går in på grundläggande aritmetik. Vad får du för uppfattning om lärandeutveckling inom de området?
 - Vad skulle du säga är skillnaden mellan utvecklingen för alla ämnen och utvecklingen i grundläggande aritmetik?
 - Vad är det som gör att du upplever det så?
- Vilken del av prototypen upplever du som den som beskriver lärandeutvecklingen hos Lina på bäst sätt?
- Upplever du att delen "Nästa steg för Lina" bidrar till förståelsen för lärandeutvecklingen?
 - På vilket sätt?
 - Upplever du att den är viktig på något annat sätt?

- Om vi går över och pratar lite om texterna, förstår du de matematiska texterna och termerna?
 - Vilka termer har du svårt att förstå?
 - Upplever du att förklaringarna och exemplen är tillräckliga för att förstå?
- Om du går in på någon av ämnes sidorna så ser du en till förklaring för ämnet, har du samma upplevelse av den förklaringen som du har av dem andra?
 - Skulle du föredra att termerna var förenklade? Kan du motivera varför?
- Vilken känsla tycker du att denna sidan förmedlar?
 - Är detta en önskad känsla när man pratar om barn lärandeutveckling enligt dig (ditt barns utveckling)?
 - Skulle föredra någon annan känsla, i så fall vad för känsla?
- jag skulle vilja avsluta med lite frågor om dig. Dessa frågor finns med för att jag ska kunna diskutera kring bakgrund på test-deltagarna i rapporten
 - Har du barn och i så fall vilka åldrar är barnen?
 - Om du skulle uppskatta hur god din kunskap är om barns lärandeutveckling, hur god är den?
 - Om du skulle uppskatta hur din kunskap i matematik är, hur bra är den?
 - Hur mycket tid sitter du vid datorn?
 - Hur bra är dina datorkunskaper enligt dig?

Appendix 4: Usability test English

Test startup

Thank you for participating this usability test. This is part of my master thesis where I, together with Zcooly, investigate how we should communicate learning progress for children to parents. I don't want to say more than that right now in order to not affect the test too much. But if you have any questions, I can probably answer them.

I would like you to open the link that I sent to you now in a web browser.

In order for the tests to be logged after the test, I will record your screen, you and your sound. The recording will be included in the report in writing and will be deleted after completed work. The results of the test will be anonymized when it is entered in the report. Is it okay for you to record? Perfect! Then I would like you to turn on your camera and screen share the browser with the link I just sent. Perfect! Is it okay for you if I start the recording?

Then the recording is running and I just want you to confirm that it is okay for me to record you, your screen and sound even when recording is on. Is it okay for me to record? Great!

The link you just opened may take a while for load and in the beginning the prototype itself may be a bit slow, but it will run smoothly after a while. Not all buttons and links can be clicked in the prototype, but if you click on a button that is not interactive then the buttons that you can click will be highlighted with a blue square.

Test introduction

I will now give you some background on the content of the prototype. The child you see the learning progress for in this prototype is Lina, she is 7 years old and is in first grade. For 10 weeks she has played Zcooly. There was the background for the prototype.

During the test I will first give you a couple of activities and then I have some questions. You perform the activities and answer the questions to the best of your ability. I'm not testing you, I'm testing the prototype.

The test will consist of open questions, which means that it may be a little unclear sometimes what it is you should do, please tell me if so. However it may be that I will not answer the questions if I think it will affect the test result. You may cancel the test at will if it does not feel okay.

Feel free to think aloud during the test about what you do and think.

Any questions before we start the test itself?

Test

- First of all, I would like you to try to get a perception of how Lina's learning progress are in Zcooly and explain it. Feel free to navigate around in the prototype. If there's something you don't understand, please say so. Feel free to explain while you get your perception of the learning progress, what you watch and what you think it means.
 - What is it that makes you get that perception?
 - Is there something you miss in order to create a clearer view of the learning progress?
- If you go into Grundläggande aritmetik. What is your perception of the learning progress in this areas?
 - What would you say is the difference between the progress of all subjects and the progress of Grundläggande aritmetik?
 - What makes you think it is like that?
- What part of the prototype do you experience is the one that describes Lina's learning progress in the best way?
- Do you feel that the section "Nästa steg för Lina" contributes to the understanding of learning progress?
 - In what way?
 - Do you think it is important in some other way?
- If we continue and talk a bit about the language, do you understand the mathematical text and terms?
 - What terms do you find difficult to understand?

- Do you feel that the explanations and examples are sufficient in order to understand understand ?
- If you go to one of the subject pages, you see an explanation for the subject, do you have the same opinion of this explanation as you have of the others?
 - Would you prefer the terms to be simplified? Why is it so?
- In your opinion, what kind of feeling does this page meditate?
 - What is it about the prototype that makes you get this feeling?
 - Is this a desired feeling when talking about child learning progress according to you (your child's development)?
- I would like to end with some questions about you. These questions are included in order for me to be able to discuss the result based on participants background in the report
 - Do you have children and if so, what ages are the children?
 - If you would estimate how good your knowledge is about children's learning progress, how good is it?
 - If you would estimate how your knowledge in mathematics are, how good is it?
 - How much time do you spend at your computer?
 - How good are your computer skills according to you?

