Kunskapsskolan Final Report

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1 Introduction

This project is about Kunskapsskolan's educational web portal called Kunskapsporten. Specifically, the project is focused on Loggboken that is a tool on the web portal students use for choosing tasks in various subjects along with other things. Today, adequate tools for strategy-based learning are missing in the web portal, with the current solution lacking in terms of both user experience and interconnectivity with other parts of the web portal. The current version has no support for strategy-based learning. Management at Kunskapsskolan has asked for this feature and this project seeks to address the above issues. The digital learning model is a major marketing as well as diversification strategy for Kunskapsskolan. The digital learning model which is embodied by the web portal "Kunskapsporten" is the pivot of daily learning activities, involving both students and teaching staff. It is thus of highest importance to continuously develop and enhance the web portal functionality. Tools related to strategy-based learning is one of such areas.

1.1 Background

The Swedish education system was deregulated through reforms in the early 90's making it possible for other actors than the local municipalities to operate schools. The formal education in Sweden is conducted in elementary school, high school and universities. The education is free and is mandatory for all Swedish citizens from 6 to 16 years of age. The school year is divided into two semesters, one in the fall and one in the spring with summer and winter holidays dividing them.

Elementary school is divided into nine years and grades are given in year six and up. The nine years in school are supposed to prepare the children for higher education as well as give them good democratic values to make them good citizens. High school by contrast, is not mandatory and divided into three years. The selection to high school in Sweden is called "free school choice" and means that the student can apply to any high school of choice within the regional municipality. The selection when openings are limited is based on grades. Thus, to apply for high school the students first need to qualify for the specialization they seek and secondly, have high enough grades. Because of the free school choice, schools compete for the students, making the high school market in Sweden very competitive.

In Sweden, the public schools are owned by the municipality since 1991 (Skolinspektionen, 2018). Before that they were owned by the state. In 1992 a new law was passed that made it possible for private companies to start "independent schools", privately owned schools that competed with other schools for the students (Riksförbund, 2018). The schools in Sweden gets a fixed monthly income amount per student. This is funded state and indirectly by the taxpayers. Both independent privately-owned schools and public schools has the right to receive this funding.

2 Problem statement

Early findings from peer group discussions suggest that the current setup for strategy-based learning on the web portal is less than ideal. Few students utilize the current elements aimed at encouraging strategy-based learning, mainly due to its lack of usability and interconnectivity with other elements on the web portal. Therefore, there exists an evident need for an improved user experience regarding the strategy-based learning elements on the web portal.

Currently, Loggboken is constructed is such a way that there is a blank text field that the students can fill in with study strategies and how they plan to achieve a learning goal. The problem is that very few of Kunskapsskolan's students use this text field. To get students to use it, Kunskapsskolan have started building a strategy bank, where different strategies are stored with a small description of how to follow them. To get help with the implementation of pushing out the strategies to the students through Loggboken, the goal is to come up with a smarter way for collecting data and increasing usage of the strategies at schools. Kunskapsskolan contacted a group of students at KTH Royal Institute of Technology with an aim to solve this problem.

2.1 Scope

The scope of the project involves research, design and building of a web-based prototype for improved strategy-based learning. The delivery goal of the project is a clickable web-based prototype of the strategy-based learning module of the web portal. The prototype will, apart from frontend, also contain a dummy backend to enable presentation of possible AI or machine learning solutions for a strategy recommendation system. The prototype will not connect to any of Kunskapsskolan systems, but instead use a local database for simulation purposes.

2.2 Stakeholders

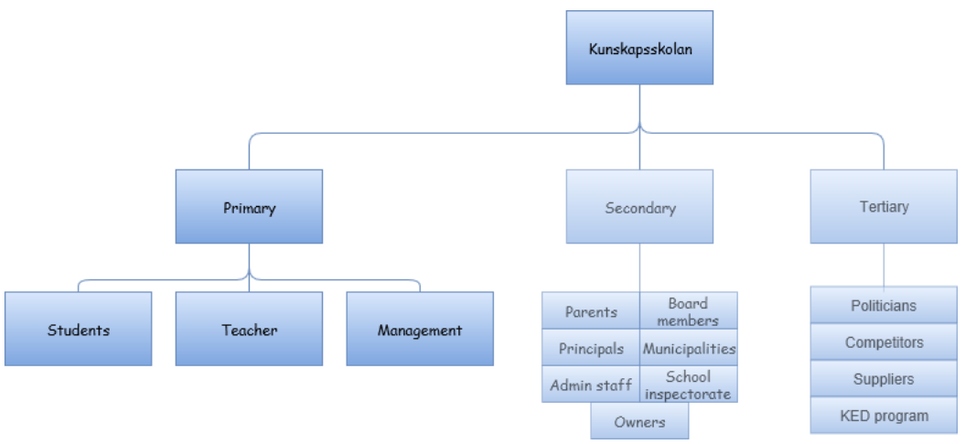

Figure 1: Stakeholders

For the purpose of this project three primary stakeholders has been identified. The stakeholders are Kunskapsskolan Management team who has ordered the project, the students who will use it and the teachers that will encourage the students to use it. This stakeholder analysis has shaped the project feedback gathering through discussions with the relevant parties and focus groups.

2.3 Delimitation

The project was constrained by the time to expected final delivery. Four months after the project start date the final presentation and delivery of the prototype was held and handed over to the project owner. The project team members are also taking part in other subjects and thus the time spent working on the project was not that of a full-time worker. No budget was given and no data (besides from a set of strategies) at the side of Kunskapsskolan was present. This meant the project was built on dummy-data.

The project was also constrained by the current design of Loggboken as it was not inside the scope of this project to change the underlying design of this tool. The partners of Kunskapsskolan hold the rights to the backend and frontend code and the lack of access to the code also constrained the project.

3 Theoretical Background

3.1 GDPR

GDPR stands for The EU General Data Protection Regulation and is a EU law that aims to protect EU citizens from privacy and data breaches. In 2018 the 25th of May GDPR came into force within the EU zone. GDPR reshapes the way in which businesses manage data and affects not only organizations inside the EU but also companies operating within or selling/buying goods from EU subjects. Not complying with GDPR will result in a fine of four percent of the annual turnover with a maximum fee of 20 Million. The key changes and most relevant knowledge about the act can be summarized in three points.

3.1.1 Consent

The law introduced stricter rules for asking consent to store private information and personal identifiers. Organizations now must state a purpose for storing said information. The request for consent of storing information must be presented clearly and be distinguishable from other matters.

3.1.2 Data minimization/ Privacy by design

Data controllers shall implement the rightful measures for data protection in the designing of systems. Furthermore, data controllers also hold and process the data necessary for the completion of its tasks.

3.1.3 Right to Access / Right to be forgotten

Any subject can at any time have the data controller erase personal data and or cease further processing of the data. Subjects can also request to see personal information concerning them. The law gave power back to the data subjects as they no can gain insights on how data is being processed, where and for what purpose.

The above explanations are a big simplification of GDPR with the purpose to explain the key principles and implications of the act to the reader. As the reader probably understand the entire GDPR act is more complex and it does not serve a purpose explaining it in its entirety (EUGDPR, 2018).

3.2 Contextual interviews

Contextual Interviews is an ethnographic method where people within their working context are interviewed. During an interview session the analyst observes the interview, looks for details for deeper understanding and asks questions for clarification. There are four interaction principles that are proposed to guide the interviewee: partnership, focus, interpretation and context. The principle of partnerships emphasizes that the interviewer should try to establish a master-apprenticeship relationship with the interviewee, making it clear that the interviewer has inferior knowledge about the domain but a high interest in understanding. The interviewer has to be focused through the analysis therefore one of the interviewers should ask the pre-prepared questions followed by complementary questions while the other one document the answers carefully. The collected data, pictures and more from all the contextual interviews are interpreted to get a pictorial representation. This gives a better understanding of the context that can be used within the design team.

3.3 Focus groups

A focus group is a qualitative research method, which can be used both as a primary research method or as a supplementary activity to give insight into a research topic or problem. The focus group as a technique, when put in contrast to open-ended interviews and participant observations which are two of the most used qualitative research methods, could be a middle ground between the two.

Although, focus groups still has an identity of its own and contributes in ways the other two methods cannot. [Morgan, D. L. (1996). Focus groups as qualitative research (Vol. 16). Sage publications.] Focus groups is a way of obtaining data for social research based on the discussion between a small group of people, with the presence of one or more moderators, focused on a topic that needs to be

investigated in depth. The flow of information is not unidirectional as in a survey. There are both moderator-participant and participant-participant interactions.

In practice there exists a set of guidelines for how a focus groups should be prepared, organized, performed and analyzed. Below the process is divided into three separate aspects, namely Composition, Setting, and Moderating and describe each one separately.

3.3.1 Composition

The sample of participants should be planned beforehand

- The group should be homogeneous and non-representative.
- The group should be homogeneous and non-representative.
- The group should share common interest or experiences.
- Know or not know each other.
- Each participant can only participate once.
- Hierarchical relationship or no hierarchical relationship.

The size of the sample should consist of 6 to 12 people for each, usually 8. Very small groups can be more easily dominated by one or two participants. They can become undynamic if only a few people contribute actively. They may also lack enough depth due to fewer different experiences. Very large groups on the other hand lack cohesion and can be divided into multiple sub-conversations. Some participants can be frustrated if they must wait a long time to participate.

These guidelines have been proved to facilitate fluid and productive conversation. And ensures that each focus group held represent different views. (Fritis, 2018)

3.3.2 Setting

The focus group should hold in a spacious room with a table and chairs and ideally be provided with a catering service (drinks, juices, coffee / tea, cocktail, breakfast, lunch). (Fritis, 2018)

3.3.3 Moderatingway

Focus groups can run off track, or even discourage discussions if the moderator is not able to provide an open atmosphere in the group. It is common that participant with strong views take over the discussions and discourage others from sharing their opinions. This is something the moderator has to be mindful about, and thwart if possible. (Morgan, 1996)

The moderator should direct the conversation to address a list of predefined topics and questions. A formula often used by moderators is to start the conversation by asking each participant to introduce himself (name, duties and hobbies, etc.). He proceeds to mention some basic rules of participation such as: there are no good or bad opinions, try to answer one at a time, etc. As the group responds, the moderator probes to find more information, request more opinions, ask more specific questions, verify conclusions, change to the next topic, etc. (Fritis, 2018)

3.4 Relational Database

A database consists of multiple relations, information that can be broken up into parts with each relation storing one part of the information. For example:

- account: stores information about accounts
- depositor: stores information about which customer owns which
- customer: stores information about customers

These related data can be stored as a table in a structured format within the database consisting of columns and rows. In relational databases a table has a specified number of columns but can have any number of rows. Query languages like SQL can be used to make a specification of a set of relations and information about each relation in databases. Information about the schema for each relation, the domain of values associated with each attribute and integrity constraints are also example of database design and data integrity.

To make the database more efficient and to reduce redundancy a database can be designed to follow Boyce-Codd Normal Form (BCNF). This is a set of rules that ensures a good design. If a relational schema is in BCNF then all redundancy based on functional dependency has been removed, although other types of redundancy may still exist.(Silberschatz et al., 1997)

3.5 Tagging system

A tag is a type of metadata that helps describe a piece of information. This is primarily used in systems where data items need to be searchable. There are two primary ways of tagging data, taxonomy or folksonomy. A taxonomy is a classification system where the owners of the data decide on the different possible classifications and tags. In contrast, a folksonomy is when the users of a system tag the data and creates their own classification system. (Yee, 2008)

3.5.1 Tagging best practices

Establishing a tag system
Tags should be general and descriptive. Figure out high-level tags, these types of tags divide your content into the most general categories possible, which usually means by type. A bookstore, for instance, creates separate spaces for books depending on their genre: mystery, romance, historical fiction, etc.

Establishing a tag system
It is important to strive for consistency with the tags. Important things to think about when creating tags are: Use of singular and plural terms Lowercase or uppercase Symbols or characters How many words a tag should have as a maximum Consistency means having a set of rules for all tags that must be followed. It also means that the tags should be set and preferably not change.(Zapier, 2018)

3.6 Recommendation system

A Recommendation Systems (RS) is a software tool and a set of techniques providing a user with suggestions of specific items. RS are commonly implemented, and are essential, for many companies in their products and services they provide. For example, YouTube, Netflix, and Amazon rely heavily on their RS to provide users with appropriate suggestions of videos, movies, and products. To further understand the importance of RS, the concept can be deconstructed and explained in terms of data and recommendation techniques.

3.6.1 Data and knowledge

RS and its data consist of three primary parts; Items, Users, and Transactions. It is based on this data the system draws information and then knowledge to provide the user with the output, often in form of a recommendation.

Items
Items are the objects which the system aims to provide recommendations about. Items vary in level of complexity, which is very important for the system designer to understand prior to building the system. The features of each item are essential to the system designer to understand, since this defines how items are related or separated. The utility of each item depends on its features.

Users
Typically, RS rely on information about its users to provide proper suggestions. A user is anyone using the system as it is intended, i.e. getting suggestions from the system. Depending on the recommendation technique used, the system views its users differently and handles information

about them in different ways. There are also non-personalized RS that do not require data about the user to provide recommendation, however these recommendations can never be personalized.

Transactions
Transactions are the interactions between the RS and its users. It can be described as the data gathering part of the system, and this is how the system grows to better fit recommendations to its users. One of the most common transactions are ratings of items.

3.6.2 Recommendation techniques

The recommendation technique is at the heart of every RS. It is the model by which the system recommends items to the users. Different techniques rely on different types of data and treats its users differently. The technique used depends heavily on the domain in which it is used, and what the end goal of the system is. There are six primary recognized types of recommendation techniques which are cited in the literature, and they are: Content-based, recommends items similar to items the user has previously liked. Collaborative filtering, recommends items that similar users have liked. Demographic, items are recommended based on the user's demographic profile. Knowledge-based, recommends items with features that best fit the user based on user's needs and profile. Community-based, similar to word-of-mouth as it recommends items that the user's friends have liked. Hybrid recommendation system, are mixes of any of the above-mentioned techniques. Powerful to use as it can gain advantages from several techniques.

3.7 Machine learning

Machine learning techniques are often separated into two broad categories.

3.7.1 Supervised learning

Supervised learning is a machine learning technique used for building predictive models from a known dataset called the training and testing set. In supervised learning, the training set contains input data and appropriate response values. In other words, the data is organized as N input-output pairs. Given the training set, the aim of a supervised learning algorithm is to create a model that makes predictions on the response values (Output) of new unseen data when introduced to a presence of uncertainty. The presence of uncertainty is the untested input the algorithm has never seen before. The adaptive algorithm searches for patterns in the data when given observations determining the relationship between input and output. More observations will therefore generally improve the algorithm's predictive performance.

Figure 2: Machine Learning Model

3.7.2 Unsupervised learning

Unlike supervised learning, unsupervised learning algorithms does not use a known training set consisting of input and response values. Instead the dataset contains data without labeled responses. The aim of an unsupervised learning algorithm is to understand the input data and draw conclusion from it by searching for a deeper understanding and hidden patterns in the attributes and features of the data. This characteristic makes the unsupervised algorithms useful in cases where little or nothing at all is known about the outputs of the data.

3.8 Decision Support System

Decision Support Systems (DSSs) are information systems that supports decision making in organizations and businesses. It is primarily used by employees in managerial positions, required to make important decisions in business environments that are rapidly changing. (Nižetić et al., 2007) The term DSS is used in many contexts and is hard to pinpoint to one type of system or use case. There are different definitions for the term, but they all seem to agree upon that DDSs are to support human decision making and is data driven." (Keen, 1980)

4 Method

4.1 Project Plan

To ensure that the project delivered expected results, the project was continuously monitored and evaluated. The project varies considerably regarding the number of staged parallel processes during different time periods. Therefore, it was essential to follow up on the progress of the project through regular meetings and reporting. The project leader reported a status update continuously to the project manager and to the supervisor at KTH.

At each meeting, the following questions were discussed:

- Is the work in phase with the time planning?
- Will the project encounter / has the project encountered any problems?

4.2 Pre-study

Before the project started a pre-study was conducted. In the pre-study the project team explored how schools in general operates in order to better understand Kunskapsskolan's business model. This was before the first meeting with Kunskapsskolan so no information about the project was given at this stage. Thus, the pre-study was more general and covered all schools and how IT was used.

The aim of the pre-study was to learn more about Kunskapsskolan, the domain they act in, the market, their competitors, technology, and the organization itself. In the pre-study, different stakeholders were analyzed in the school domain, in which Kunskapsskolan is active. The primary stakeholders in the Swedish education system were identified to be customers, employees, investors and governing bodies. Investors are only important when the schools are owned by private companies, which Kunskapsskolan is.

Contextual interviews, where also conducted to get a firsthand experience in how schools work from different perspectives and how they use IT was obtained. As the theory on contextual interviews suggests, the team tried to do the interview in the workplace to get the full context. At the interview sessions two or more project members were present so that one performed the interview and the others could write down everything that was being said.

The interviewed were a student at Kunskapsskolan, a parent to said student at Kunskapsskolan, two teachers in elementary school, one teacher in high school and lastly one assistant principal in high school. During the interviews, they were asked about their workday in general with a focus on how they interact with IT.

During this study patterns emerged that indicated that the school system in the very beginning of its digitalization. Due to budget constraints and less than ideal procurement processes where needs are not clearly defined, schools seem to be stuck with poor IT. Furthermore, the school domain, in which Kunskapsskolan acts, is very competitive and schools compete fiercely for their students. Having a good IT system can be a competitive advantage which sets the school apart from the rest.

4.3 Design study

4.3.1 Focus Group

After the first meeting at Kunskapsskolan office with the project owners a low-fi prototype was built for the first round of focus group study. The method and process of dividing the focus group study into composition, setting and moderating that was introduced in section 3.3 was used as a guideline.

The composition was planned beforehand with 9th grade students from Kunskapsskolan with group of four students with two project members. The four group members that were brought in knew each from before and most of them were good friends and where on the same hierarchical level.

Regarding the setting, a smaller room with a table and chairs outside the student's classroom was booked to conduct these focus group studies.

Before the prototype was demonstrated to the students at Kunskapsskolan Nacka they were asked the general questions about the design and user experience. For the specific questions asked see appendix. One of the project members had the role as moderator using the pre-prepared questions followed by complementary questions while the other one document the answers carefully. Each group was interviewed for about 15-20 minutes. The project members started each focus group study by introducing themselves and what the project was about and asked the participants to give a brief introduction about themselves.

Based on the feedback of the focus group study at Kunskapsskolan Nacka the prototype was rebuilt and improved as a high-fi prototype and presented as an alpha prototype at the second round of focus group study for some last improvements.

This time eleven questions were pre-prepared and just like in the first focus group study four students was interviewed and observed by two project members with the same setting and same class of 9th graders.

4.3.2 Individual talk with teacher

During our visit to Kunskapsskolan Nacka we had the chance of sitting in on a individual talk between a student and the teacher. During the discussion between the teacher and student we sat in the background observing and taking notes, we did not in any way interact or interrupt.

These talks are a crucial part of the learning process at Kunskapsskolan and take place once a week. In them, the teacher and student discuss the progress and development of the student. They also discuss strategies and how the student uses them to reach their goal. The main points in these discussions were:

- Self reflection
- Planning
- Individuality
- Responsibility
- Planning

4.4 Design prototype

Using the prototyping program called Balsamic we created a clickable prototype based on the design of Kunskapsskolan portal and incorporating the ideas we gathered in the first round of focus groups to improve the overall user experience.

The prototype had a screenshot of the portal as a background and we created clickable buttons on that background. We added a button for adding strategies to the portal and a system for choosing them. The demo was not interactive and followed a predetermined path of a sequence of events.

The functions were:

- A clickable button "Add strategies"
- A pop-up screen were strategies could be added with a "+" sign.
- On the next screen the added strategies were displayed in the logbook
- A button "evaluate strategies" were the strategies could be evaluated with a thumbs up, a thumbs down and a button "did not use"

4.5 Prototype

After showing the design prototype to both Kunskapsskolan management and students in a second round of focus groups and receiving positive feedback, we went ahead and created our first prototype.

4.5.1 User Interface

The user interface for strategy is supposed to follow the same design idea as the "lärandemål" does today. This means that an add-button should exist and that students can choose from a drop-down menu.

The user interface is designed based on user feedback from the focus group. The big design decisions were:

- Ease of use. The whole process of choosing strategies should take less than one minute. Because of this the design of "+" to add strategies were chosen as this design is already used by other functions in loggboken today.
- Putting the strategies on step level, for each step the students can chose new strategies.
- Visibility, the strategies should be placed on top and always be visible, even when a lot of different subjects clutter the loggbok.
- Students read about the strategies later. After the strategy is chosen, students can click on it to read about it. This also follows the already existing design of tasks.
- Limiting strategies to just one or two. Students only want a limited amount of strategies per subject.
- No visible rating for the strategies. The decision was made not to have visible ratings for the strategies even though we have that information in the backend. We want to encourage choosing other strategies than the highest rated. The strategies are presented in order with the highest rated on top.
- Evaluation, to encourage students to evaluate the strategies they must be done quickly and easily. A thumbs up or down is all the feedback that is needed.

4.5.2 Frontend

The frontend language we used is HTML, CSS and Javascript. The prototype tries to mimic the real website and therefore React was used. The whole stack is written using Laravel. Laravel is a php framework and is used to fix web routing, api routing, templates etc.

Languages (framework in parenthesis)

- HTML
- CSS (bootstrap)
- Javascript (react, bootstrap)

One big challenge for us was the replication of the original website from Kunskapsskolan. Our prototype design relies heavily on the already existing website portal from Kunskapsskolan as it hopefully will be integrated as a module in that system. We did not have any source code from Kunskapsskolan, so we had to recreate the design ourselves. This was much more difficult than we expected, and we spent a considerable amount of time just to understand how this should be done. Another challenge was the deployment of the Laravel application since it requires many different dependencies on the server.

4.5.3 Backend

The main part of development is data-centric with high requirements on stored data, therefore a database will be used to maintain both the data that will be displayed in the frontend along with metadata used in processes.

The web portal will communicate with the database and the web portal will only use the database to get data while the web portal will also add and modify data.
The information about strategies will be delivered by Kunskapsskolan themselves, however the data will have to be exported to an SQL database for more efficient use and compatibility with the frontend design of the prototype.

Database
The database where the strategies provided by Kunskapsskolan is stored is built using SQL. An effort has been made to make the database as efficient as possible. Therefore, the database is normalized, and all tables follow BCNF (Boyce–Codd normal form).

The goal when designing the database was an efficient and modular design which Kunskapsskolan could easily integrate in their own system. Furthermore, the database is designed to scale up with new fields of data as they become available. A full breakdown of all the fields in the database, relations and an explanation of the data is available in the appendix.

5 The result product

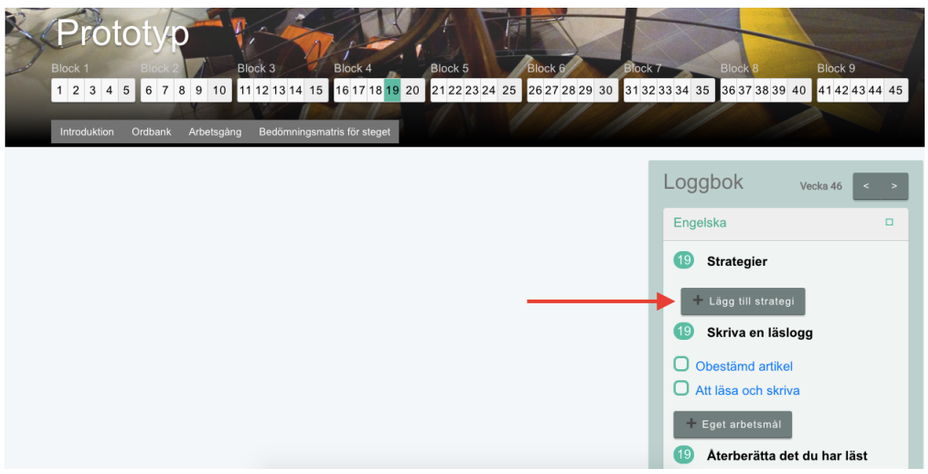

Figure 3: Prototype1

We follow the design principles of the current design and added a “add strategies” button in the top field of the “Loggbok”.

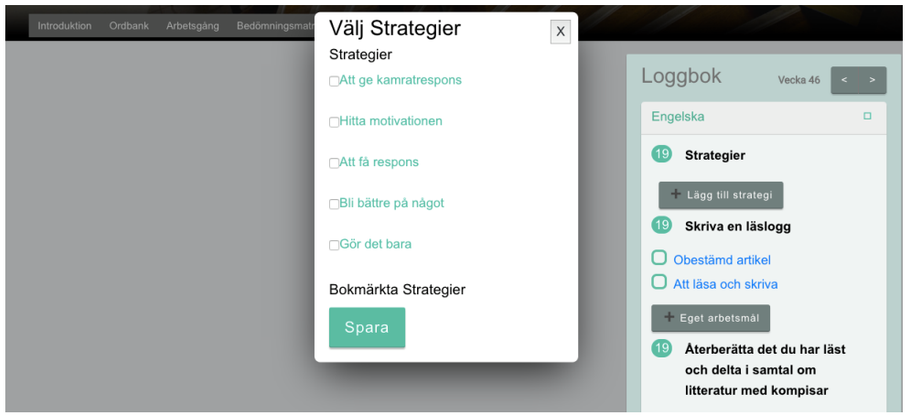

Figure 4: Prototype2

When you press the button, a pop-up appears with the curated strategies based on the current step. Here, our recommendation algorithm chooses the appropriate strategies based on tags and ratings from both teachers and students. The rating is not visible to the user.

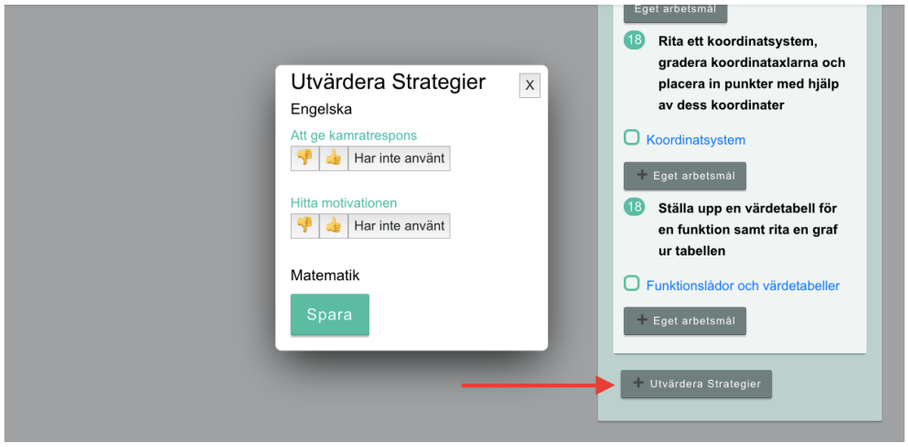

Figure 5: Prototype3

In the final step the user evaluates the chosen strategies and data is collected. The user has the choice of liking the strategy, disliking it or clicking "not used". The data from these choices are collected and stored in the database together with information such as which step this was for. An overall rating for the specific strategy, subject and step is created in the database.

5.1 Decision Support System

Creating a comprehensive backend opens possibilities for data analytics. The process is rather straightforward as it is only querying the database for key statistics. Therefore, a visual decision support system was created with D3.js Data-Driven Documents. The aim of this analytical tool is to use it to show insights about the performance across the different schools. This information can be useful for Kunskapsskolan management to track the usage of strategies, compare different schools and how the work and evaluate strategies that does not work.

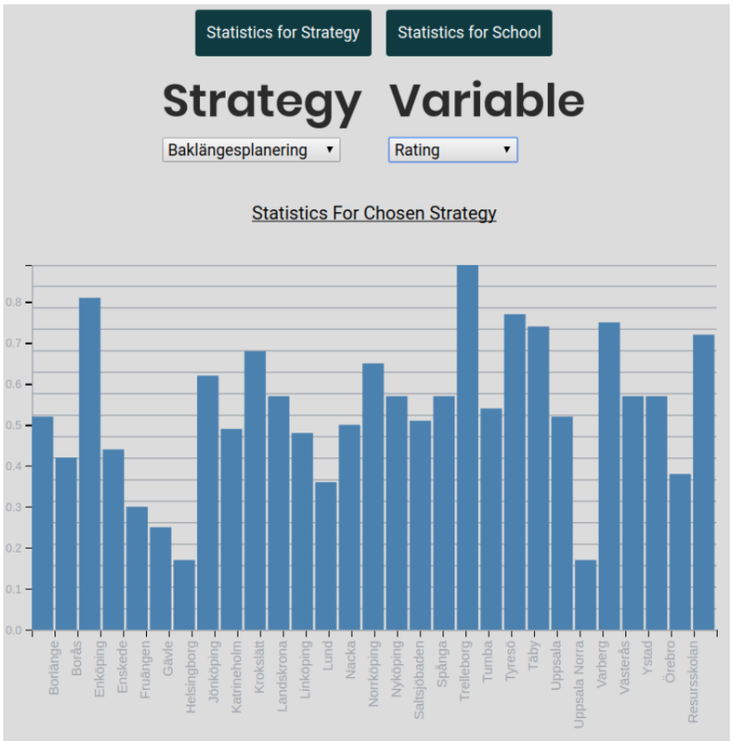

Figure 6: Decision Support System

6 Discussion

6.1 The role of GDPR in our project

GDPR has been present in all IT projects since it came in effect in May 2018 and has created a lot of uncertainty on what it means for IT-projects. GDPR has led to several limitations for us in regards to what data we can use for our recommendation system. To be sure we did not violate consent/personal data and have personal identifiers in our database we decided to use dummy data instead. The rules regarding this are a bit unclear and we got different answers from different persons so to be on the safe side we decided against using personal data. GDPR also states that everyone

should have the right to be forgotten which means that all functions we build must have an easy delete button. This is especially important in databases where different tables can have different dependencies and information can be stored in different places. This was something we had to think about when we designed our database schema.

6.2 Focus group and individual talk

During both sessions the moderators selected a group of volunteering 9th graders. The sizes of the groups stayed within the recommended limits as stated in section 3.3. As the students all belonged to the same school and class, the participants all knew each other. In this investigation the judgement was made that the participants knowing each other was not a bad thing but instead would facilitate the communication and will to share ideas with the rest of the group. Since the access was limited to one school, getting participants that did not know each other was not an option. To the furthest extent possible the moderators tried to replicate the setting of a professional focus group session also presented in section 3.3.

The moderators also adapted to the situation and accounted for factors such as the participants being children and not adults when it came to ask the questions and probing for explanatory answers and insights. An example of this is that the moderators had to keep the children on subject as they tended to go off-topic and outside the scope of this project. Their thoughts and ideas were also a bit unorganized, so the moderators had to continuously have the children explain their thoughts and ideas.

To summarize the key takeaways from the first focus group session it can be stated that the students use very general strategies that they always use and finds the current strategy input text field very unusable. However, they were willing to try new strategies especially if the strategies were rated and if the teacher was involved in the recommendation process. Strategies that was recommended by a teacher had a lot of trust among the students. One wish from the students was to have the recommended strategies on a subject-level and a better visible strategy field. Also, it was important that the rating of the strategies was easy and simple since they did not want to put too much time on evaluating different strategies. In other words, a rearranged simplified design clear objects and functionalities would be needed.

Based on these findings the next step was to create a high-fidelity prototype of the strategy input field and had a second round of focus group at Kunskapsskolan Nacka. The feedback was positive, the students thought that the improvements was clear and simple and much better than having strategies appearing at the bottom of the site. The free-text input field would not be missed, however they wished for the ability to be able to make own choices and put in own strategies. To rate the strategy in a easy and fast way, as was wished by the first focus group study, the design team decided to implement a “thumbs up or thumbs down” rating. Another reason for this implementation was to avoid the scenario of ultimately receiving a rating with every strategy with 3 of 5 stars.

6.2.1 Issues with focus group

The optimal number of focus group studies was not obtained, due to lack of resources and time constraints from both the project group and the focus group. The visits had to be scheduled with the school, so we did not interrupt their schoolwork. As stated in section 3.3 the sessions should be performed with homogeneous and non-representative samples. More than two of them needs to be

performed to find reliable patterns and draw conclusions. In the case of this project both sessions involved 9th grade students from a school known to be dominated by highly motivated students. These students had a high level of engagement and gave a lot of good feedback. However, this is not representative since the finished product is something that is going to be used by several students in different grades and different schools.

A more complete and through process would have been to perform more focus groups with, for instance, a group of 6th graders, a group from a different location or school. The project team was aware of this issue and wishes to have performed even more sessions. The team also had to consider the priorities and manage time in a optimal way to deliver a final product of good quality.

6.2.2 Individual talk

The most interesting take-away from the observation of the individual talk between a student and a teacher was how they already talk quite a lot about strategies and how to use them to reach good results. This opened up some possibilities for us regarding evaluation of the strategies. A problem for us was how we could collect data if the strategy was good or not from the students and how we make them do it. If the evaluation process becomes a part of the individual talk the students have more incentives to do it and take the evaluation seriously, which will give us better data.

6.3 The final product

6.3.1 Recommendation system

When building and implementing our RS there were several limiting factors which had to be considered in order to create a useful system. First of all, the strategies (items) had to be categorized or structured in a way that made it possible to distinguish between them, and since some strategies were subject-specific we had to come up with a tagging system to be able to give proper recommendations.

Secondly, since it was not possible to gather user data during the development of the prototype some of the recommendation's techniques, which would have been preferable, were not possible to implement. However, if user data can be used in a future implementation of this system, that the recommendation system should be reworked to fit this change in input.

With that said, the system that was built best resembles a community-based recommendation system where all users are thought of as friends. This is the best fitting technique for the current circumstances regarding how data can be gathered and how the users interact with the system. The transactions, i.e. how the user picks and votes on strategies also limits possible alternative implementations of techniques.

6.3.2 Why we choose step level for the strategies

One common feedback we received from the focus groups was that the students wanted the strategies to be implemented on task level, for example if they had a math problem the algorithm should propose a strategy to solve that problem. This would naturally increase the complexity of the problem quite a lot for us, but it was something we had to consider as we strived for a user created design. This question of where to "place" the strategies, on a subject level, on a step level or on a task level was one of our biggest discussions during this project. In the end it was the nature of the strategies that made the decision for us.

The strategies, which have been developed by Kunskapsskolan themselves, were all premade, with no option for alteration. We got access to these strategies relatively late in the design process and we came to realize that the strategies were a lot more general than we had anticipated. A strategy could for example be "study together with a friend". This created a peculiar situation for two reasons: 1) as we previously mentioned, during the focus groups it became apparent that the users wanted strategies designed for each step, which was not the case now. 2) Strategies had to be put on a much higher level, which caused further design problems during the development of the RS.

In the end we decided to put the strategies on a step level which in retrospect seems to have been a good decision.

7 Conclusion

Based on the studies with the user it could be concluded that the students did not use the strategy text field today because of lacking functionality and motivation to use it. In this report we have argued for a recommendation system for the strategies for Kunskapsskolan. We have made an implementation based on user feedback that follows the current design principles of Kunskapsskolans webportal today.

We have designed a database system for the strategies that is modular, implements a good data strategy to build on and is prepared for GDPR. This platform sets the foundation for future data gathering and analysis. We have provided an example how this data analysis can look like with our analytic tool. Furthermore, we don't think AI and machine learning is suitable for this kind of problem, we explain why below but in short the data structure is not there yet.

7.1 What is next?

The next step for Kunskapsskolan is to think about the implementation process. They need to evaluate our solution and decide if it should be implemented or not. They can then, together with their IT provider, start to map out a specification and an implementation process. The code provided by us should be helpful.
Overall we think Kunskapsskolan should really evaluate their data strategy. Data collecting and having a clear structure is very important if more advanced functions should be implemented. In our project it has become clear that the prerequisites for AI or analytical systems like decision support tools are missing today. Having a clear data strategy is essential to move forward. Below we have outlined a few suggestions for future work.

7.1.1 Suggestion for tagging system

We have also noticed that Kunskapsskolan needs a more structured way to store data. We have therefore suggested a taxonomy tagging system for the strategies and steps, were both the strategies and steps uses the same tags. The total number of tags should be a fixed amount and tags should be maximum one word in order to make the tagging consistent. The tags should describe the high-level learning outcome of the step, as well as describing what the strategies can support. Examples of tags are:

By consistently tagging the steps and strategies opens up for the possibility to easy implement new tags and assign them appropriately. If the steps are tagged with the high-level learning outcome tags, it is easy to map a new strategy with a set of tags to a step.

The new tagging system also makes it possible to create new analytic tools. We analyze the strategies with respect to the tags to see if a high-level learning outcome does not have any, or only a few, strategies. This is could be time saving and makes it possible to know what kind of strategies that needs to be improved. It also makes it possible to automatically detect if a student is a visual, auditory or kinesthetic way of learning and change strategies based on that to get a more personalized learning process.

7.1.2 Data mining

The purpose of our prototype is for students to utilize strategies in their education. We therefore created a prototype that helps student find strategies while we gather data in order to improve the recommendation of strategies. Data, or structured data, is essential for machine learning and analytic tools, we want to gather as much data as possible to lay the groundwork for future implementations of analytic tools and machine learning.

The next step for Kunskapsskolan is to gather more data about the students such as, average grade, grade given a strategy, how many "tasks" the given week, strategies chosen for a specific student. This open up for the possibilities for more analytic tools and machine learning algorithms. Kunskapsskolan sits on a potential goldmine of user data.

7.1.3 Machine learning

When we first started this project, we evaluated whether an AI using machine learning could be implemented to solve this problem. When we learned more about the task and realized the limitations, we had in available data we concluded that a machine learning model is not appropriate for this kind of problem.

In machine learning, there are no such thing as a straightforward process. The problem at hand presented us with an unsupervised problem, where we want to give suggested strategies for a student given a history of strategies. A common method used is model-based collaborative filtering which gives predictions about a person's interest. With deep learning for collaborative filtering, such as the fast implementation, it is possible to achieve state-of-the-art results.

However, the advantages of machine learning models for recommendation system is that it is efficient when you have many users who interacts with many items. Since we only have 70 strategies at the moment, we can easily provide good recommendations with a simpler recommendation system like the one we propose in this report. But if the number of strategies expand to the point where the recommendation model is underperforming, a machine learning recommendation system could perhaps be implemented in the future, if a good data collection model is present.

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8 Appendix

8.1 First focus group study 8th of October

Questions

- Do you use the strategy input field today? If so, how? What kind of strategies do you use?
- If not, what would make you use strategies and select/evaluate them on the platform?
- How would you structure/design the strategy selection field? Grouping by (Visual/Textual etc)
- At what level would you like to be able to select strategies? (Subject level/Learning outcome level/Task Level)
- Should strategies be tied to the logbook? Separate field? Share your thoughts! Draw!

Feedback from Focus Group 1

- I cannot think of any strategies so I fill in the same as I always do.
- It should be easy to do, just click on things. We require support from our teacher in choosing strategies.
- (Showed us)
- Strategies on a subject-level
- (Showed us)

Feedback from Focus Group 2

- I would definitely use recommended strategies
- Strategies are so far down below the other things that we never see it on the web page the should be more visible. Not being forced to do reflection of strategies to often.
- (Showed us)
- Strategies on a Learning outcome-level
- (Showed us)

Feedback from Focus Group 3

- Haha, no. Nobody uses it. I always use the same strategies so I can't bother writing them down every week.
- If it is something that is recommended I would use it. It would be nice to add my own strategies also so I can choose from them. Doing reflection of a strategy maby once a month.
- (Showed us)
- Strategies on a Learning outcome-level
- (Showed us)

8.2 Second focus group study 14th of November

Questions

- Are you using the strategy field today?
- Would you use this? (our solution)
- What do you think about the position of the strategies?
- How many strategies would you use?
- When do you read the description of the strategies? Before or after you select them?

- When do you want to evaluate the strategies?
- Do you want to have personal strategies?
- How do you feel about teacher-recommended strategies?
- General or more specific strategies based on subject?
- How do you feel about a weekly strategy you can't choose?
- Does the ordering of the strategies affect your decision?

Feedback from Focus Group 1

- Move out the week's strategy
- "I think it will help you more and more with the steps"
- Can plan to test type 1-2 strategies a week, one at stitch level and one at the level
- Getting messed up if you have to change steps all the time if you work with seven different steps at the same time.
- May those who take strategies seriously put in their own strategies.
- Sample Strategies? Willing to try more then. More motivated to use more strategies at trial.
- Free text will not be missing

Feedback from Focus Group 2

- As long as there are choices, it is good
- Make sure you can put in your own strategies. If you can not choose what you want you can feel compelled. They do not feel better than you do yourself.
- Good to be able to check how fare you have come in the blocks
- Good for the evaluation to get fast, do not want to take time from working on strategies.
- Top Strategies?
- We have been here for 3-4 years so it may take a while to get the old ones to use. Different to those who have been here for a while compared to those who are starting to type now.
- Would probably take the one recommended by the teacher.
- Should be open to using more strategies at trial.
- Samples were every fifth step.

Feedback from Focus Group 3

- Clear and simple. Much better than having strategies that appear instead of having it at the bottom.
- Select who you want and who you want to delete
- Believe that you get a better overview of school work
- "It will help me to take a smarter one"
- In the beginning you will try but after a while you have found your favorites and will use them,
- Finds some assurance that there are recommendations from the teacher. Maybe not going to be used but you may read through
- The free text field will not be missed
- Include scope NO / SO

8.3 Database

Tables (all tables have an id field to identify the rows as unique).

- KS_Strategies
  - Title
  - Category
  - Description
  - *Comment:* Information regarding the strategies in the KS strategy bank
- KS_Strategies_Tags
  - Tag
  - Strategy_Id
  - *Comment:* The tags related to the strategies, easy to manipulate as they are in their own table (insert or delete instead of update/alter).
- KS_Schools
  - Name
  - Municipality
  - City
  - Country
  - *Comment:* The data of elementary schools owned by KS in Sweden.
- KS_Users
  - School_Id
  - *Comment:* Fabricated data of users, only contain information regarding what school they attend.
- KS_Subjects
  - Subject
  - Step
  - Expert_Strategy
  - *Comment:* Rows contain a specific subject and block/step and their teacher recommended strategy.
- KS_Subject_Tags
  - Tag
  - Subject_Id
  - *Comment:* Contains relevant tags for each step.
- KS_Ratings
  - Rating
  - User_Id
  - Strategy_Id
  - Subject_Id
  - *Comment:* Contains strategy rating done by students.
- KS_User_Strategies
  - User_Id
  - Strategy_Id
  - Subject_Id

  - *Comment:* Contains users' current blocks for each subject.

- KS_User_Bookmarks
  - User_Id
  - Strategy_Id
  - *Comment:* Contains users' saved strategies for re-use.