A Search Tool for Pedagogical Techniques and Supportive Technical Aids

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Abstract

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Teaching pedagogically has been found to be crucial for students’ learning. There are hundreds of technical aids that are developed with the aim to facilitate the use of different pedagogical techniques, but only a small collection of these are used at Uppsala University. To find alternative pedagogical techniques and relevant technical aids for each technique can be difficult for educators. It is believed that creating a web service as a search tool for finding pedagogical techniques and technical aids would benefit educators to improve their teaching.

The purpose of this project was to create a search tool which educators can use for finding pedagogical techniques and suitable technical aids for their teaching. The search tool should inspire educators to use unfamiliar technical aids, widen their use of these aids and give them sufficient information of how to use them. To create a search tool which educators would find useful, the search tool was developed based on user stories from educators at Uppsala University.

The search tool was found to be user-friendly by educators whom tested the web service. They also believed that the search tool will help them find new ways of teaching and improve their pedagogical technique.
**Sammanfattning**

Att undervisa pedagogiskt har visat sig vara av stor vikt för studenters inlärning. Att finna alternativa pedagogiska tekniker och tillhörande tekniska hjälpmedel tenderar att vara problematiskt för utbildare. Att skapa ett sökverktyg, i form av en hemsida, för att finna pedagogiska tekniker och tekniska hjälpmedel anses gynna utbildare i deras strävan efter en pedagogisk utbildning.

Målet med skapandet av sökverktyget var att utbildare ska använda denna hemsida för att finna pedagogiska tekniker och tekniska hjälpmedel som passar deras utlärande. Sökverktyget ska inspela utbildare att använda tekniska hjälpmedel de är obekanta med genom att tillhandahålla information om hur de olika hjälpmedlen används. Sökverktyget utvecklades baserat på user stories från utbildare vid Uppsala universitet i syfte att skapa ett sökverktyg utbildare ska finna användbart.

Sökverktyget utvärderades genom att låta utbildare använda hemsidan. De ansåg att sökverktyget var användarvänligt och att det kommer vara till stor nytta i deras sökande efter nya pedagogiska metoder, vilket i sin tur kommer hjälpa dem att utveckla deras pedagogiska utlärning.
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1 Introduction

Educational development is defined as the practice of helping those who teach to be better at what they do through resources, one-on-one assistance, workshops and other means [5]. Universities that strive for an educational development want a platform for methods of teaching. The problem of finding different ways of teaching, through more than the recommendations from other educators, has been recognized at Uppsala University when interviewing educators [26].

Our solution to the problem mentioned above was to create a search tool for finding pedagogical techniques and technical aids, which henceforth will be referred to as the search tool. Our search tool consists of a web interface connected to a database on a server provided by Uppsala University.

The search tool is accessible to educators by a web interface. It is developed for educators who want to explore different pedagogical techniques and relevant technical aids to improve the use of the specific pedagogical technique. The search tool is also useful for those educators who would like to increase their knowledge in the technical aids they are already using or to find similar aids. In addition, educators can browse among the pedagogical techniques and technical aids to find inspiration.

The search tool is delimited to help educators at Uppsala University. However, the web service is accessible for people outside of Uppsala University as well, but there is some information that is specific for Uppsala University. This information is, for example, where the educators can get a physical aid which the university provides.

2 Background

Our stakeholder, Dr. Ho, is a Director of Studies at Uppsala University and is currently active in the pedagogical advancement. For instance, he is a member of the Council for Educational Development at the Faculty of Science and Technology (TUR), an organization for the pedagogical development at Uppsala University. Dr. Ho recognized the problem of educators having trouble finding relevant pedagogical techniques and proposed the idea of developing a search tool to help educators find these techniques and suitable technical aids.

Pedagogical techniques are different techniques which can be used by educators when teaching in order to increase students’ learning. Examples of pedagogical techniques are
In order to practice these pedagogical techniques during education, there are suitable technical aids that can be used. Some technical aids are more suitable than others when practicing different pedagogical techniques. Examples of technical aids are Screencasting [19] and student response systems (also known as mentometers) [7].

Educators at universities such as Uppsala University claim that it is difficult to find new pedagogical techniques according to our research (see Section 5.3), which is based on interviews conducted with educators at Uppsala University. After the interviews we compiled user stories, which are system software requirements focused on the end users perspective [2]. Some examples of these user stories are:

“I want information regarding pedagogical techniques and technical aids gathered in one place to avoid time-consuming exploration.”

“Want to find new technical aids, be informed of how the technical aids work as well as why they would be beneficial for my pedagogical advancement.”

“I would like to browse among numerous new technical aids on the same web service to avoid having to spend time using a regular search engine.”

“I want a way to find teaching methods besides getting tips from other educators.”

As mentioned in the first user story above, there is a need of having the ability to browse among pedagogical techniques and technical aids in one platform. Ordinary search engines, such as Google and Bing, do not fulfill this need. By using these ordinary search engines, the user may get a wide variation of search results. Some search results may be studies, some may directly lead to a technical aid and some can be fully irrelevant for the user’s purpose of finding pedagogical techniques and technical aids. By having information and useful links regarding pedagogical techniques and technical aids gathered in one place, the user will delimit the search result and get more relevant hits.

Generally, the most common way to gain knowledge of other forms of teaching is by recommendations from other educators (see Section 5.3). The lack of knowledge regarding suitable technical aids may result in the outcome of outdated and inefficient teaching, since it might lead to educators using irrelevant technical aids or no technical aids at all. This exclusion or incorrect handling of technical aids can in its turn lead to less pedagogical teaching in comparison to when an educator uses suitable technical aids for a specific pedagogical technique.
However, this problem does not only occur at Uppsala University. The problem has been found at schools and universities in multiple countries, for example, in the Czech Republic. In the Czech Republic, it has been found that the educators are either too doubtful of their ability to use new technical aids or too unfamiliar with modern pedagogical techniques to practice them in their educational work [3].

The problem definition in this project, is that we want educators at Uppsala University to see our search tool as the primary resource for finding information about pedagogical techniques and technical aids. Whether their aim is to find new aids or if they want to learn about more features about aids they are already familiar with, the search tool will help educators improve their pedagogical practice.

3 Purpose, Aims and Motivation

The purpose of this project is to make it easier for educators to find pedagogical techniques and technical aids. Moreover, the purpose is to make it simple to explore new pedagogical techniques by having a collection of different technical aids related to the specific technique.

The technical era we live in provides us with new technologies more frequent than ever before. This includes technical aids which would benefit the pedagogical education at schools and universities all over the world. The problem several educators are facing is narrow knowledge of technical aids, besides the ones recommended by colleagues. The aim of this project is, therefore, to help educators explore a diversity of pedagogical techniques and technical aids, focusing on the educators located at Uppsala University.

The ambition was to make our search tool user-friendly. In other words, an educator should be able to directly understand how to use our search tool and instantly find what they are looking for without any prerequisites of our web service. Another ambition was to make the search tool self-propelled. This meaning that we wanted to design an administrator interface which makes the database manageable for future administrators, even though they might not have knowledge of how to handle a database. Hence, the information in our database should be simple to edit.

Information regarding each pedagogical technique should be intuitively accessed and the related technical aids should be displayed. The information about these technical aids will contain clear instructions about how they are used and where to find additional user guides. In other words, it should be intuitive for educators to navigate through the web interface and to receive desired information.
3 Purpose, Aims and Motivation

3.1 Target Groups

The goal of the search tool is also to satisfy the two main different target groups identified (see Figure 1).

Firstly, we have the target group including educators who have knowledge of technical aids and are either using some technical aids or are not using any at all. For the ones already using technical aids, the goal is to inspire them to widen their use of appliances and give them insight into why and in what circumstances a specific aid is suitable in terms of pedagogics. In addition, it might be valuable for the educators to find technical support for a specific aid they are currently using or would like to use, such as resources of how to use the aid more efficiently.
For the educators who have knowledge of the existence of technical aids but are not using any, the goal is to inform them about the pedagogical benefits of using technical aids in their teaching. There are several reasons for not using any technical aids despite having knowledge of them. Some of these examples are:

- Inexperience of how to find guides on how to use a technical aid.
- Disbelief in pedagogical benefits of using technical aids.
- Fear of receiving negative course evaluation.
- Lack of time for learning how to use an unfamiliar technical aid.

Our search tool aims to satisfy the inexperienced users’ need of indicative instructions for each aid and to contain information that convinces them to start using aids based on pedagogical support.

Secondly, we aim to inspire educators that are unfamiliar with technical aids. These educators are unfamiliar with the opportunity to use aids in their education, and instead stand up in front of the class and speak without any facilities. If they are introduced to our search tool, they will be able to browse through pedagogical techniques and technical aids. They should not have to have any knowledge of a specific pedagogical technique beforehand. The goal which needs to be satisfied for this specific target group is that when these educators browse among the various pedagogical techniques they will find one that strengthens their belief in the use of technical aids. From there, they will be able to find a suitable technical aid to use in their teaching.

A web service for finding pedagogical techniques and technical aids is an accessible solution to educators’ problem of not using technology to improve their teaching and their students learning outcome. Every educator at Uppsala University has access to a computer, which makes it easy to visit our web service in order to obtain information about different teaching forms. Ho considers it to be difficult and time consuming to meet with an educator in person who can share information of a new technical aid [11]. Ho stated that a web service for this purpose could be a better solution than than only talking to other educators. Moreover, substantial information of how to use the technical aid might not be obtained when discussing with other educators. The search tool possesses information about the different techniques and aids, and will be available for educators. Hence, it will no longer be necessary to meet with another educator in person to receive information regarding pedagogical techniques and technical aids. This will be time-efficient for numerous educators, since necessary pedagogical information and technical information will be on the web service. Those who are stuck in old patterns and constantly use the same teaching aids will have a great opportunity to either
find similar but more pedagogical ways to educate or discover entirely different ways to teach. The information educators today most often get by coincidental meetings with the right person at the right time, will now be accessible via the search tool using the database developed by us. The database can be accessed by simple and customized searches through the provided search tool, or by browsing through pedagogical techniques and technical aids.

However, our project is not the direct solution for non-pedagogical educators way of teaching, but a part of the solution towards educators becoming more pedagogical. One of the difficulties is to market our search tool. Since it is supposed to be a solution to the given problem, the educators must get knowledge of and be introduced to it. In addition to Uppsala University, it is desirable at universities and schools all over Sweden to teach in a pedagogical way to increase students’ learning.

3.2 Delimitations

As mentioned previously in this section, we aim to help educators to explore a diversity of pedagogical techniques and technical aids. We also mentioned that the lack of knowledge regarding these techniques and aids are found in several countries all around the world. However, we have chosen to focus on helping educators located at Uppsala University.

The reason for delimiting the search tool to Uppsala University is, first of all, that our stakeholder is located at Uppsala University. We were given a server at the university and our search tool will be provided by the university.

Secondly, some of the technical aids are not accessible through the Internet and instead require physical devices. These appliances are often provided by schools and universities, and it was not possible to gather information regarding delivery points for all schools and universities. We chose to find delivery points for Uppsala University to avoid creating a search tool too wide to be considered useful. Instead, our search tool can be the basis for similar search tools oriented at other schools and universities. Our database and web service layout can be used to create a related search tool specified for a certain school or university.

Since our search tool was developed as a web service there was also an issue of availability on different browsers and devices. The development was restricted to only encompass interfaces displayed on the latest versions of the Internet browsers Google Chrome, Mozilla Firefox and Safari on Apple and Android based devices. The motiva-
tion for this was that the authors of this report considered those browsers and platforms to be the most common, and that due to time constraints it was not possible to expand the scope to include less established alternatives.

The search tool was provided with an administrator interface so selected educators handling the tool in the future can be granted access to change the contents of the database. A feature requested by an educator at Uppsala University was integration with the Joint Web Login (CAS), a login system used by the University to allow individuals’ access to several of the University IT-services using one login credential. Due to time constraints this option was not explored and instead a separate login was created uniquely for the search tool.

3.3 Ethical Concerns

We identified two ethical concerns during our project, both regarding the users of our search tool.

We had to ensure that the educators who are listed as references for the pedagogical techniques and technical aids in the database have consented to have their names and contact information listed.

There were several concerns regarding the accessibility of our search tool. The design had to be accessible for people with visual impairment as well as adapted to variations in perception of color. Both concerns where present during our design of the search tool. The accessibility was achieved by ensuring that no design feature was dependent on color and that the displayed layout of the search tool was drastically modified by changes in display size. Care was also taken to ensure that descriptive text was included with all images, so image interpreting aids could be utilized effectively by the search tool users.

4 Related Work

In this section, work related to our search tool is presented. This is done to demonstrate other solutions and similar work and how our search tool differs from them.
4 Related Work

4.1 Other Universities

There are several other web services with similar tools providing information about technical aids for education, especially made by other universities. Eminent universities in for example England and the United States, like Brown and Sussex, have created resembling web services. At Brown University, developers have divided technical aids into different categories [4]. However, an educator must request this resource from the university and will not get an answer about different types of aids in the selected category until 10 days after the request has been made. Moreover, information about the technical aids or pedagogical techniques is not always available on the web service.

The University of Sussex, on the other hand, has categorized their technical aids into different pedagogical terms (e.g. active learning) [22]. When clicking on the desired pedagogical term, different related articles appear. These articles are, for example, guides of how to practice pedagogical techniques and how to use the technical aids provided by the website. However, there are limited amounts of articles about the different aids. Hence, it is not easy to find information about the desired technical aid. We knew that the lack of informative articles might be problematic for our users as well, and therefore our solution was to add external links where the user can find relevant information regarding the technique or aid.

4.2 Uppsala University

At Uppsala University, there have already been some attempts at solving parts of our problem, although none have fully satisfied the need we have seen. This subsection will go through known attempts and how they are not completely solving our problem.

4.2.1 MedfarmDoIT

Uppsala University has an initiative at the Faculty of Medicine called MedfarmDoIT [25]. It provides support and resources for the areas of medicine and pharmacy at Uppsala University to create technical aids for educators.

MedfarmDoIT consists of a staff of ten people connected to the initiative [24], which provides several systems. They help educators hosting educator videos, creating surveys and course evaluations, as well as several services directed towards specific needs of the medical and pharmaceutical education at the university. They also provide the service of creating new systems based on the specification and needs of an educator at
the university.

The main difference from our search tool is that MedfarmDoIt depends on their staff keeping the initiative going and when they are not available, no help is given to the educators. MedfarmDoIt is also designed for the educators working within medicine and pharmacy, while our search tool is not focusing on any specific area of education.

4.2.2 Medarbetarportalen

Uppsala University has some pedagogical information published on their site Medarbetarportalen [23], a site dedicated to information for the university employees. They provide a short introduction to some teaching methods, such as casework, how to apply Active Learning using clickers and Problem-Based-Learning. There is also a reference to another section of Medarbetarportalen: E-learning.

However, the information is widely distributed throughout the web service while our search tool is offering a collection of information about the pedagogical techniques and technical aids which also can be kept up to date by the administrators. It is therefore easier to navigate throughout our search tool since all technical aids relate to one or many pedagogical techniques and vice versa. The search tool also provides contact information to reference users at Uppsala University, a detail which Medarbetarportalen lacks.

4.3 Teachthought

There are also non-university-based web services containing information about different technical aids. At the web service teachthought.com [1], aids are divided into different groups for types of teaching, for example, presentations and project-based learning.

Though the web service contains substantial background information of the technical aids, an educator can only get an overview about the aid and does not receive neither pedagogical nor technical support or any contact information for reference users. By not possessing this information, an educator might be hindered to use the aid since he/she does not get the required information about how to use it.
5 Method

This section describes the methods used to design and create our search tool. To understand the essential knowledge of how the search tool was made, we begin by describing the database and all the different web service technologies used. Thereafter, we describe how and why we did the interviews with educators and how we integrated their opinions into our search tool.

5.1 Database

To create our search tool, we decided to develop a database in MariaDB [16] where all information regarding the different aids are stored. Hypertext Preprocessor (PHP) was used for accessing the database from the search tool which in its turn was developed using Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), JavaScript and PHP.

The database is hosted on the already existing IT-infrastructure of Uppsala University. MariaDB was chosen since the relevant servers at the University support MariaDB. Access to install other database management software was not available since the database implementation had to be adapted to what Uppsala University provided as using the University IT-infrastructure was a requirement set by our external stakeholder.

5.2 Web Service Technologies

To create the front-end, different programming languages were used. More specifically, we built the web interface using HTML, JavaScript, CSS, and PHP. The reason that HTML was chosen and not, for example, Extensible Hypertext Markup Language (XHTML) was because XHTML is not as used as HTML. Therefore, it is harder to find examples of how to code in XHTML [17]. On the other hand, HTML has stopped evolving whereas XHTML continues to do so. Nonetheless, HTML is more well-spread than XHTML and hence used on more web services. In addition to this, XHTML is not always well-supported by browsers. Thus, an extension of HTML, such as XHTML, would not be advantageous for us to use in this project.

The JavaScript programming language was used for adding visual effects, revealing details or hiding contents, giving a behavior for the web browser [9]. It is embedded within HTML and is therefore functional to use together with HTML.
CSS is a programming language used for designing a web service [18] and mainly used in combination with HTML and XHTML. It can be written independently of HTML and offers separation from the document’s presentation and structure. Moreover, CSS does not absorb much bandwidth, which means that the web service loads faster than the languages that consume more bandwidth [18].

5.3 Interviews with Educators

Since our search tool was made for educators, continuous interviews were held with educators. More specifically, most interviews were held with the Directors of Studies. This was done to get an overview of what information educators at different departments at Uppsala University find hampering when looking for pedagogical techniques and technical aids. The interviews mainly covered two areas of interest, namely requests for information on the search tool and feedback on the design. Another alternative to receiving requests and information would be to do surveys. However, we choose to do interviews since they allow more detailed questions to be asked, ambiguities and misunderstandings can be resolved and they are also useful in order to obtain more detailed information about personal opinions and perceptions.

In order to make an informative web service for educators at Uppsala University, we needed to know why educators need a search tool to discover technical aids for educating and what kind of information that might be helpful for them. It was valuable to have the educators’ perspective of what information they wanted on the web service as well as receiving feedback on the web service layout since no one in the project group has any experience of teaching. During the interviews, some standard questions were asked such as, “What do you think would be an important attribute for the web service”. The questions asked in the interviews also depended on what feedback that was needed to proceed with the project and some of the questions were supplementary questions.

Shortly after the interviews were held, they were analyzed and summarized by extracting the most concrete and important statements. The summarized interviews validity for the search tool was then evaluated by verifying the possibility to include the information or feature in the search tool. All valid ideas were then developed and subsequently confirmed by our stakeholder, Dr. Ho. The results of the interviews were used to further develop the already existing basic design and functionality of our search tool. The interviews provided valuable information of what hampers educators at Uppsala University to use pedagogical techniques and technical aids in their teaching.
6 System Structure

Our system consists of a database, a web server, and a web interface. The database communicates with the web server in order to receive the required information, which in turn is published on the web service (see Figure 2). The system structure implemented a Model-View-Controller design pattern (see Figure 3).

The MariaDB database and web server were provided by the IT Department of Uppsala University as well as the URL http://www2.teknat.uu.se/TLT/ on the TekNat-domain, which is the official domain of the Disciplinary Domain of Science and Technology at Uppsala University. The provided URL points towards the University server where the search tool is hosted, thus, providing a path to access the search tool through any Internet browser.
The techniques and aids cataloged by our search tool were initially provided by our external stakeholder. In order to keep the search tool up-to-date, we provided functionality through an administrator interface to add, remove or update the pedagogical techniques and technical aids stored in our database.

6.1 Database

The database was implemented using MariaDB, a relational database management system released under the open source license General Public License (GNU). It is represented by the icon labeled “MariaDB Database” in the System Structure Diagram in Figure 2. One of the requirements for the search tool, imposed by our external stakeholder, was that the search tool should be hosted by Uppsala University. In order to accomplish this, we were provided with a virtual server on the Uppsala University IT-infrastructure by the Uppsala University IT department. This server required the search tool to be implemented using a MariaDB database together with PHP. We were not able to be granted privileges to install other software on the server.

The database was designed with database normalization in mind. The concept of database normalization, or just normalization, is to achieve data integrity and low redundancy of data by structuring the database according to a set of formal rules, initially proposed by Edgar F. Codd [6]. These rules are divided into categories called norms and if a database complies with a set of rules within a category the database, it is said to be normalized according to that norm. Some of the categories are the First Normal Form (1NF), the Second Normal Form (2NF), the Third Normal Form (3NF) and the Boyce-Codd Normal Form (BCNF). Usually, the process begins by ensuring that the data is normalized to the 1NF, then the result is re-factored to achieve 2NF, continuing until the desired normal form is met. According to Lee, former employee at Korea Advanced Institute of Science and Technology in Seoul, South Korea, higher normalization form can improve database access speed and make future changes require less refactoring. Higher normalization forms are achieved at the cost of increased work to enter records and increased maintenance [15]. Lee concludes that there is an equilibrium to be found using his proposed model to decide which degree of normalization is best suited to a given problem.

Initial data for the search tool was provided by our external stakeholder. To store the data in a way suitable for our search tool, we utilized the database normalization theory to achieve 3NF in our database (see Section 8). The data was categorized according to the database diagram depicted in Figure 4 in Section 8.
6.2 Interface

The interface created was used to connect the browser component with the Uppsala University Virtual Machine component, as seen in the System Architecture in Figure 2. The users and administrators’ access the web service through the browser component, and in turn the web service utilizes the interface to request data from the database, and then displays it for the site visitor.

PHP was used to implement the database interface in order to read, submit and update data for our search tool. This constituted the layer between the database and the web service, as depicted in Figure 3.

PHP utilizes Hypertext Transfer Protocols (HTTP) POST- and GET requests to receive requests from the controller. HTTP POST- and GET requests are, as defined by the Internet Engineering Task Force (IETF)[13], methods for sending and retrieving data using the HTTP protocol. The HTTP protocol in its turn is the data communication protocol for the World Wide Web [12]. Our database interface returns data represented using JavaScript Object Notation (JSON). JSON is a text format used to handle serialization of structured data, represented as key-value pairs and was chosen due to it being portable [14].

6.3 Web service

There are two parts of the web service created: the user site and the administrator site. They were constructed using the same methods. The division into two separate web services was based on their functionality. The user site is the part of the system where users can access the search tool. The administrator site grants access to add, remove and edit the contents of the database, for persons selected by our external stakeholder. The administrator site was created to fulfill the requirement of having a system where it is possible to keep the content up to date after the release.

Our search tools web service was developed using HTTP, CSS, JavaScript and PHP. First, HTTP was used to create the basic structure of the search tool. HTML also integrates CSS, JavaScript and PHP for these files to be included on the web service. Different HTML files were created for each web page.
CSS was used to make the presentation of the web service. In other words, CSS was used for fixing the colors, font sizes of texts, placing objects, determining the sizes of objects, etc. CSS used the HTTP structure and added the presentation code into it.

The actual functions of the web service were made in JavaScript. These functions handle what happens if a user for example presses submit in the search function, wants to go to another side or uses the browse function, etc.

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**Figure 3** Model-View-Controller showing how the information in our database is sorted and displayed based on the users requirements. The model represents our database, the view is the web interface and the controller is the content managing component.
7 Requirements and Evaluation Methods

For our search tool to be successful, the requirements listed under Section 3: Purpose, Aims and Motivation, had to be fulfilled. To evaluate if this was accomplished, various methods of evaluation depending on the nature of the requirement were used.

For the evaluations requiring interviews, participants were chosen from the different user target groups identified in Section 3.1, to ensure that the search tool was useful for educators of each identified target group. By using interviews, we were able to interact with the participants to immediately follow up on and clarify any interesting finding. Since the search tool has a specific target audience of educators, the interviews allowed for in-depth evaluation by educators in the two main target groups. We chose to mainly interview Director of Studies to get a wider knowledge of what the educators at the different departments found important. Every interview was approximately 30 minutes long and notes were taken. We got most feedback regarding features and the design of the web service. We received feedback from our presentation that was held in the middle of the project. The feedback came from various educators that had different experiences within teaching methods. Other forms of evaluation for design requirements would not yield the depth of answers which were needed to ensure that the requirements were met. To test performance requirements, automated load testing was used to provide measured results to compare against the outlined response time requirements.

7.1 Database Evaluation

We gathered several requirements for the search tool regarding the interface and the performance of the tool. The database needed to be able to handle data sets of methods, reference users, descriptions, etc. The database also had to be able to process queries for information from multiple users without affecting the performance of the search tool. We tested our database through the web service by having 20 users entering a search at the same time. We believed that this was a suitable number of educators that would try to access the search tool at the same time. We tested our database through the web service by having 20 users entering a search at the same time. We believed that this was a suitable number of educators that would try to access the search tool at the same time.

To evaluate if these requirements were met, the database was populated with the data provided by our external stakeholder, then automated tests requesting different pages of the web service to engage the database queries were run. 20 users simultaneously requesting all available tools and aids of the database were run, and the response time of the search tool was measured. The requirement was considered met if the response time was kept under 2.0 seconds. Any longer and the user was considered having to wait for too long.
7.2 User Interface Requirements

As for the requirements for the user interface part of our search tool, the interface needs to be user-friendly. User-friendly meaning that for most users, a guide or manual should not be needed for educators in their aim to find pedagogical techniques and technical aids suitable for their need. To evaluate if this requirement was met, it was necessary to receive someone else’s opinion regarding the search tools design. It will be easy to use the web service whether the user possess previous knowledge regarding pedagogical techniques and technical aids or not. Therefore, multiple interviews with Directors of Studies at different departments at Uppsala University, our stakeholder, educators and non-educators were held. To get various opinions from educators, the interviewed educators were chosen based on what level of education they teach. For example, some interviews were held with professors and some with teaching assistants.

The graphics were supposed to be adaptive and look the same when using different browsers. As stated in Section 3.2 regarding delimitations, the requirement for the search tool was that the interface is consistent over the Mozilla Firefox, Google Chrome, and Safari browsers. The interface should also be adaptable to smartphones and tablets, either manufactured by Apple or based on Android. This was evaluated by testing the web service using the three mentioned browsers and devices as well as comparing the rendered sites to check for any discrepancies.

Another important requirement for our search tool is the speed of loading the web service. A slow web service impacts the users experience negatively, so it was of great importance that when a user makes a command there should be minor time-delays. This meaning that it should not take a long time to browse between the different pages on the search tool or to receive the desired technical aids when entering a search on the web service. To evaluate these requirements, interviews were held with Directors of Studies to see how they perceived the speed of the search tool. The response time to a web request was also measured using automated tools. A response should not take more than 2.0 seconds for any part of our page for it to be considered fast by the authors.

7.3 Content Management Requirements

It is necessary that the database can be easily maintained in the future. It should, for example, be straightforward how to add and edit new pedagogical techniques and technical aids for future administrators. To ensure that the upcoming administrators can maintain the web service and database, we tried to make the code as understandable and documented as possible. We also made sure that they have access to the project report.
to get an overview of the system, and that they have our contact information for further questions. To make sure that the database was simple to maintain in the future we had our external stakeholder together with two educators of Uppsala University to test the administrator interface.

8 Construction and Structure of the Database

The database we created contains the information required to fulfill the goal of our search tool. We divided the data into categories which then was represented as tables. Data was then added as columns of the respective tables to create a logical storage of the pedagogical techniques and technical aids. The division can be viewed in Figure 4, which illustrates what data was represented within the database and the relations between the tables.

To ensure optimal database performance we created a database schema that was normalized to the 3NF. If a database is in 3NF it means that categories in a table are not dependent on other values in the same table, and the only way to determine a value is by looking at the ID of the table [8]. By doing this we guaranteed that every instance of data is only stored at one place within the database. This was accomplished by creating integrity constraints which enforces their dependencies. Another benefit was that by conforming to the normalization standards, the database was prepared for future extensions with minimal impact on the current functionality.
To keep the existing pedagogical techniques and technical aids in our database up-to-date and have access to add new techniques and aids, an administrator interface was implemented. Selected educators at Uppsala University by our external stakeholder were granted access to the administrator interface by providing them with login credentials. A member of the Faculty of Science and Technology at Uppsala University
suggested using the Joint Web Login System CAS used by the University, but due to time constraints this was not implemented and instead a separate login was created for this purpose.

The administrator interface provided functionality to add, remove and update all tables and records of the database through an interface available on the search tools web interface. The main purpose of the administrator interface was to provide functionality to add new pedagogical techniques and technical aids as they are discovered, to keep the current information relevant and to ensure that the reference users for the techniques and aids are kept up-to-date.

10 Evaluation Results

One of the requirements explained in Section 7, is that our search tool must be user-friendly and intuitive to use. To evaluate this, interviews were made with different Directors of Studies at Uppsala University as well as meetings with other educators working at Uppsala University. In addition, non-educators were also asked to test the search tool, since it should be simple to use for any visitor at the web service. The person testing the search tool had some tasks: to do a detailed search to find a technical aid and find a pedagogical technique and find related technical aids. The tests were successful and the educators testing the search tool were able to find the desired technical aids.

In the interviews made with educators, the speed perception of the search tool was also covered. According to the educators, loading between two pages on the web service was not slow. However, the educators mentioned that it took a while longer to load the search results. Still, this was just a marginal difference and was not something that hindered them from using the search tool.

11 Results and Discussion

The aim for this project was to create a search tool that will help educators explore a diversity of pedagogical techniques and technical aids. We believe that we met this requirement, due to following reasons.

Firstly, our search tools database met its requirements. The search tool is editable and user-friendly, as long as the administrator has basic knowledge in database usage. For
future administrators to be able to handle to the database, information of how to use it was given to them.

Secondly, the functionality of our search tool met its requirements as well. The two main target groups, educators who have knowledge of technical aids but want more information or educators who do not possess knowledge about technical aids (see Section 3.1 for further information), were taken into consideration when implementing. For educators familiar with technical aids, the search tool has the functionality to enter an advanced search. For users unfamiliar with technical aids, the functionality to browse among various pedagogical techniques and technical aids was implemented.

Thirdly, we believe that the requirements regarding a user-friendly and self-propelled web service were met. When having educators testing our search tool, there was no confusion of how it was to be used. When the educators were asked to find a specific web page or use one of the functionalities on the web service, it took them only a couple of seconds of thinking before finding the right way. This is, for us, an indicator that we made a user-friendly and self-propelled search tool, since no help was needed when the educators tested the web service.

In order for the search tool to be an optimal solution to our given problem, the database should contain more pedagogical techniques and technical aids than the once available now. As to this date, there are approximately ten pedagogical techniques and technical aids in total. The reason behind this lack of information is that when creating the search tool, we focused on the different functionalities of the web service and not on the actual information the database contains. This is because adding information to the database is something our external stakeholder and his colleagues will have to do before launching the web service for Uppsala University. Instead of adding all of the known pedagogical techniques and technical aids when creating the search tool, we implemented an administrator interface in order for future administrators to add new content and edit existing techniques and aids. We believed that making this administrator interface was necessary to make, since the web service will be launched and handled by future administrators whom might not have basic knowledge of databases beforehand.

To sum up, the end result of our search tool was satisfying since it met the requirements. In addition to the requirements being met, our search tool is something that our external stakeholder can continue developing and eventually launch. Hence, it is more important for him that the functionality of the search tool works than that it contains a lot of information, and therefore we believe that the result met our requirements.

When a user enters a search, the desired keywords matching the search will result in
the search result. This might also have to be developed further in the future with more possible keywords. However, it might be necessary in the future to have more search choices.

To work with an external stakeholder has proven to be a good experience for the future. We had regular meetings with our external stakeholder, but misunderstandings occurred anyway. Therefore, we understand how instructions and requirements can be misunderstood or interpreted in different ways. We have recognized the importance of clear instructions that cannot be defined in different ways and that regular communication between stakeholder and group members are one of the most important parts of a project. The communication between the group and our external stakeholder worked most of the time, but sometimes the interpretation of the instructions from the stakeholder differed among the group members. We found that having additional meetings immediately when instructions were interpreted differently among group members, were the only solution for the whole group to interpret the instructions alike. Furthermore, requirements did differ after the interviews because of new user stories or new ideas from our stakeholder that we found would make positive adjustments in our search tool.

An unexpected time delay was to get user stories for our project. At the beginning it was hard to find educators to interview, but our external stakeholder made recommendations of educators that we could contact. After emailing approximately 20 educators, it was only about half of the contacted educators that responded to our email. Mostly, it took a few weeks before we got an appointment for a meeting or an answer on the poll that we attached in the email. This resulted in fewer user stories than predicted but on the other hand, we had fewer demands to satisfy as a result of this.

12 Conclusions

Educators at Uppsala University foremost get information about pedagogical techniques and technical aids from other educators’ recommendations. However, this results in a limited use of different technical aids at the university. Hence, it is considered that a search tool to find pedagogical techniques and technical aids is a user-friendly and accessible way to help benefit the education at Uppsala University.

Pedagogical techniques are different techniques that can be used by educators when teaching to increase student’s learning. Examples of pedagogical techniques are Active Learning and Just-In-Time Learning. Technical aids on the other hand, are aids which educators can use when educating. Examples of technical aids are for instance Screen-casting and Student response systems.
The main goal of the search tool is to satisfy the needs for information for the different target groups identified. These main target groups include educators who are unfamiliar with using technical aids, and those who knows about technical aids but either want to find more information about it or those who knows about technical aids but does not use them. Therefore, the search tool should inspire educators to use unfamiliar technical aids, widen their use of technical aids and give them sufficient information of how to use them.

In terms of content, the search tool is not yet finished. As to this date, the search tool does not contain many different pedagogical techniques and technical aids which it should in order for educators at Uppsala University to use it. This is something that will be added by our stakeholder in the future and will hence make the search tool an attractive alternative for educators to use to benefit their education.

13 Future Work

Due to time limit, there is future work that can be developed. One of the developments that can be done is to make our web service graphically unitary with the TekNat-domain where our web service is hosted. Uppsala University has guidelines to follow regarding design of web pages including how to use their logos, which fonts to use, etc. However, this was not something we took into account when creating the layout for the web interface due to time constraint.

As mentioned in Section 3.2, the lack of knowledge regarding useful pedagogical techniques and technical aids does not only occur at Uppsala University, but is a problem in industrialized countries all around the world. To extend our search tool and make it relevant for international use would bring us closer to achieving our aim. This can be done either by handing out our version to other schools and universities to be modified for their specific needs or by making our version more global. To globalize our search tool could be done by not specifying exactly where physical aids can be provided but instead only having links to the suppliers’ web service. It could also mean that we create some kind of log in to the web service which would redirect the user to a web page specified for the users’ country, school or university.

Since we focused on the different functionalities of the search tool, the web service lacks a lot of information. This is something that needs to be added in the future in order for the search tool to be an attractive solution for educators at Uppsala to obtain information about pedagogical techniques and technical aids.
The search tool should be adjustable for smart phones. This is something that was not prioritized when making the search tool, but it is important for the use of the search tool. People nowadays use their smart phones to go on different web services, hence our search tool needs to be applicable for it. As well as being graphically applicable for smart phones, the search tool should have the same graphical design for all browsers. This was also something that was not prioritized due to the time limit, but this is something that should be done since the users of the search tool most likely use a lot of different browsers (e.g. Safari, Google Chrome and Internet Explorer). When implementing, Google Chrome was the chosen browser we used to test the search tool. With that said, the search tool works on different browsers but looks best graphically (images, text-boxes, etc) when using Google Chrome.

A functionality that should exist in the future, is the ability to see the most clicked and used technical aid. This would exist, so the educators can see the most popular technical aids used, which might benefit their education as well.
References


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