Analysis and Design of Geographical Information Systems (GIS) in Geography Learning

Erik Konttorp

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Department of Computer Science and Media Technology
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Avdeling for
informatikk og medieteknikk
Høgskolen i Gjøvik
Postboks 191
2802 Gjøvik

Department of Computer Science
and Media Technology
Gjøvik University College
Box 191
N-2802 Gjøvik
Norway

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Abstract

This report takes a look at the practical and technological challenges when implementing Geographical Information Systems(GIS) into high school geography learning. Locating challenges discovered by other researcher as well as challenges discovered through teacher interviews resulted in the following key challenges: Time constraints, software complexity, installation issues, and GIS usage focus. Locating challenges is important for the further work with developing a GIS application with learning intentions. Focusing on the challenges discovered in every aspect of the development process have resulted in a web based GIS application. This application have further been used in a implementation process involving students i a student workshop. The workshop was used to evaluate how the previous challenges have been avoided and to locate new ones.

Preface

I would like to thank my main advisor Sverre Stikkbakke and co advisor Rune Hjelsvold for the advices and guidance that they have given me. I would also like to thank the two high school teachers Per Gundersen and Geir Sormbroen for participating in this project process, providing important data both from their own experience and expertise, and finally the high school students who also provided some of the results used in this thesis.

Erik Konttorp, 2010/04/20

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1 Introduction

1.1 Background

Computer based Geographical Information Systems(GIS) have been around for almost 5 decades now [1], and even though the GIS technology has existed for several years it is only in the last ten years that people have began to realize the potential that lies within GIS technology. It is the arrival if GIS applications on the Internet that can take most of the glory of it recent popularity. What was earlier known as an expert only desktop technology can now be used by every average computer user with an Internet connection. Companies like Google, Yahoo, MapQuest and Microsoft was some of the initiators that helped spread the increasing use of digital maps on the Internet. Now there are numerous different Internet GIS applications available, either as standalone map services or implemented in sites to visualize graphical locations. Also the desktop GIS applications that earlier had almost no graphical user interface (GUI), and required expert programming skills are now more user centered with GUI's understandable by people with basic computer experience. This indicates that GIS is constantly conquering new ground, and it is important to find even new ways of exploiting this huge potential that GIS has developed.

The use of technology in today's society is growing in a rapid speed. Technology has changed the way we live and it affects most people's everyday life, in schools, at work and at home. Computers have certainly changed the way we live and combined with the World Wide Web (WWW) it is now a very important part of many people's life. One problem with new technology, software and hardware is that it also requires new knowledge and competence. Especially schools have a great challenge when they educate their students in new technology. The schools and teaching staff has a great responsibility when it comes to being up to date, this includes choosing what IT equipment to use while lecturing, what teaching styles to use and what technological aids they should use. these are all issues that they have to consider when planning their courses and lectures. New technology arrives rapidly, and knowing what to implement and what not can be difficult for teachers at all levels of education. The primary resource for the teachers is the course textbook, these textbooks usually contain guidelines and suggestions about possible technology and resources available for the specific topics in each chapter. This means that the authors of the textbook hold a big responsibility for introducing new technology as they provide the teachers with ideas and alternatives through each chapter.

How is the potential of GIS used and how can it be used as a technological tool in teaching? In order to answer these questions a closer look has been made into a specific course where GIS obviously has a great relevance which is geography. Geography is a subject which is common from an early age in elementary school and all the way to high school. It is also an very important

subject for understanding the world around us, geographical structures, the environment and the worlds demography.

1.2 Research questions

- What are the technological and practical challenges when implementing GIS in geography course?
- What can be done to increase the use, and simplify the implementation process of GIS in education?

1.3 Methodology

The objective of this master thesis is first of all to evaluate the current use of Geographical Information System (GIS) technology in the Norwegian school system. This evaluation will be a preliminary study of the teachers experience and use of GIS. The results from this evaluation together with findings done by others will further be used in order to suggest and perform a possible approach of implementing GIS technology into a geography course.

The development process will be a user centered design process where the feedback from the teachers will be used together with the expertise of the developer to determine the specifications of the given GIS technology. The design process will also be based on how the GIS technology will be implemented, and for what purpose. The implementation process will consist of user feedback in the form of student's experiences, performances and overall satisfaction with the technology.

The goal of the master thesis is to:

- Evaluate the current use of GIS.
- Look at possible areas in education where GIS can be useful.
- Locate challenges with GIS implementation and adapt accordingly.
- Attempt implementation with GIS based on challenges.
- Evaluate the implementation

1.4 Contribution

Hopefully this research will give some insight in how well GIS is currently implemented into the Norwegian education. Also this research should provide a suggestion of an approach of implementing GIS into the school systems with the focus of teaching with GIS rather than about. And finally it will give some results about the success of the implementation.

1.5 Disposition

This Master Thesis consists of two studies that are highly related. The following report is divided into five different chapters. Chapter 1 is the introduction of the project, containing the back-

ground for the research and the research questions. Chapter 2 contains review of related work. Chapter 3 contains an introduction and description of Geographical Information Systems and the technology behind. Chapter 4 contains the first study, consisting of the subsections Approach and Methods, Result and Discussion. Chapter 5 is the second study, which is a continuing of Chapter 3, it also consists of the subsections Approach and Methods, Result, Discussion and Further work. Chapter 6 is the conclusion.

1.6 Keywords

Usability testing, Web technologies, Education, Learning, Spatial databases and GIS.

2 Related Work

In the last 15 years there have been numerous attempts of implementing and integrating Geographical Information Systems(GIS) into the school systems all over the globe, but unfortunately with various amount of luck. The different approaches of evaluating GIS in education are many, Sarah Witham and Richard Audet [2] tried in 1999 to evaluate the training of both inservice and preservice teachers. By teaching the preservice teachers with and about GIS in their teacher preparation programs, it would increase the possibility of the teachers to incorporate GIS into their teaching programs when entering the classroom. This approach will in theory work well since the teachers are most likely to teach to their students what they have been thought during their preparation programs, but at the same time it would take many years for the current teachers who are uneducated in GIS to be replaced by the newly educated teachers who had been through a preparation program involving GIS.

In 2002 Aaron H. Doering [3] did a study of teacher preparation programs, which showed that having an instructor available who carries expertise in GIS is far more effective than using tutorial based approaches, videos or just Internet based help. This would most probably also be the case in earlier stages of education which again requires the teacher or educator to have a certain degree of expertise in the given GIS technology in order to get the best results and learning environment as possible for their students.

Some researchers at the University of Connecticut did a study [4] where they focused on using Geographical Information Systems in the classroom, the teachers were studied and some critical barriers were found, access to appropriate hardware was one of them. GIS technology was found to be resource demanding, and it requires high performance equipment, which is not always available. Time is another factor that is important, time to incorporate GIS into the curriculum can be difficult, many types of GIS software also have a very steep learning curve which can be quite time consuming. Other studies [5] [6] also found equipment and time as the two barriers that in most cases were the reason that GIS is not more used in education. Complexities in the various GIS softwares are factors that affects the time needed for both the teachers and the students to learn how to use GIS. Results from a workshop held by The Geographic Data in Education Initiative at Northwestern University [7] revealed many critical challenges that students and teachers is facing when using GIS in classroom. The participants of the workshop were researchers, curriculum developers, software developers and teacher trainers who specialized in GIS in education. The results support the assumptions that GIS software are in most cases to complex, both for teachers and students.

Ali Demirci [8] tried in 2008 in Turkey to equip 14 teachers from nine high schools a GIS software, digital data for an application, and the necessary written documents describing the application in order to study the effectiveness of implementation of GIS-based application in geography lessons. The implementation was not successful, only two of the 14 teachers successfully implemented the software in their teaching. The reason was that the teachers had problems using and understanding the GIS software. Although there had been a pre workshop training for the teachers the basic computer skills were lacking. Time was also an issue for some teacher, which again relates to the inadequate experience with the GIS software. A big teacher survey [9] in Finland discovered that the geography teachers did not feel that GIS could easily be incorporated into the curriculum and that the GIS teacher training should not be focused on the technological part of GIS but rather the pedagogical. This points out how important it is to view GIS as a tool for education, teaching with GIS instead of about GIS.When looking at the earlier studies of GIS in education, and the various attempts of implementing GIS into education there seem to be some factors that constantly recur.

- *Time constraints*

  The teachers find it hard to find time for large implementation processes involving GIS software. Also time to learn how to master the given GIS software is a key barrier. For the teacher to have some degree of expertise is proven to be very important in the process of presenting, using and exploring GIS software with their students, but that expertise can not be achieved when there is not time to learn the software.

- *Software Complexity*

  GIS software often have a steep learning curve which requires commitment from the users in order to gain the experience needed to master the software in a way that a teacher most likely would prefer if it is to be used in his or her lectures. Even lightweight applications tends to present the user with far more available functions than needed, which often can be more confusing than helping.

- *Implementation methods*

  Many approaches have been based on implementing existing complex GIS software systems which are usually used by professionals into different levels like for example high school. Schools which may not have the equipment needed to meet the needs of these GIS software systems. Also teachers and student without adequate computer knowledge.

- *Focus*

  In most cases the methods have been to educate student about GIS and the use of GIS rather than what is considered by many as more important, using GIS a a tool in education. The term, teaching with GIS rather than about is something that should be prioritized.

These are all factors that should be taken into consideration before conducting a study about GIS in education, all of these findings may be helpful for supporting results during the research process or more importantly be used as guidelines for avoiding some of the challenges proven by others.

3 Geographical Information Systems

A geographical Information Systems(GIS) combines software, hardware, and data for displaying, managing and analyzing geographically referenced information. This is IT-based systems that analyze and process information and presents the results as digital maps. Basically it connects geographical locations to database entries. GIS is used everywhere, for organizing and planning geographical data by government agencies, fire departments, police departments and emergency services, it is used to track spread of diseases, weather forecasts and other global phenomena. GIS visualizes tabular data in a form that can easily be interpreted and understood by its users.

3.1 ESRI

In this project the idea is eventually to create a web GIS application, which obviously requires some type of technology. Since this project is run at the Gjøvik University College, the choice of software have been affected by the fact that they have a license agreement with Environmental Systems Research Institute(ESRI) to give out students licenses that last for 6 months for all of their software when used in teaching or research. Geographical Information Systems(GIS) technology comes in many shapes and sizes, one of the most known software producers is ESRI. ESRI was founded in 1969 and realized already then that geographical information system technology would be important in the future. Since then ESRI have grown to be one of the leading creators and distributors of GIS technology. ESRI provides software and applications for several levels in the GIS world, including server side applications for publishing, desktop applications for spatial analysis, development editing and viewing of spatial services, and client side web applications. They also provide a great amount of support and documentation on their resource web page. [10] [11] Figure 1 illustrates a typical web GIS architecture model for ESRI.

3.2 Shapefiles

Shapefiles is the spatial data bank, this is where all the spatial data is stored into files. Shapefiles is a type of data storing format developed by ESRI. Another widely used format is Geo databases, Geo databases is often regular databases that have been spatially enabled, which means that they can store Geo referenced objects like points, lines and polygons. Geo databases is suited for large scale projects, while in this project Shapefiles will be used since it will not handle large amounts of data.

3.3 GIS desktop content author

The GIS desktop content author is where the map services is created, styled and completed before publishing. The desktop software provided by ESRI is ArcMap. ArcMap is a powerful desktop GIS application for geospatial processing. Its main purpose is to create, edit, view and analyze geospatial data. This is the part where the data from the shapefiles are used to create and style the map that eventually will be viewed in the client application.

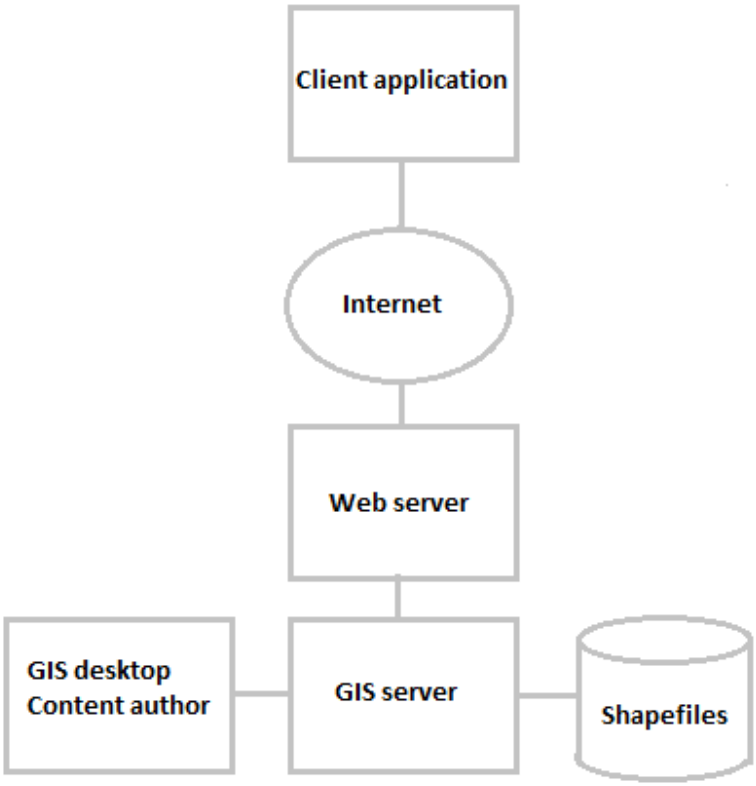

Figure 1: Example of a web GIS structure

3.4 GIS server

A GIS server works as the link between the spatial database and the web-server. It is the GIS server that publishes the map service created for the client. The GIS server can process queries from the client and returns the query result. ESRI has developed a GIS server software called ArcGIS Server, it consists of four different applications:

- *Manager*

  The manager is a web interface program which can be used to publish various services on the GIS Server. With the help of Manager it is possible to add, remove, edit and organize different GIS service. With Manager can the user easy configure and troubleshoot the server system.

- *Web Application Developer Framework*

  The Web Application Developer Framework has a set of tools available for the user to build up GIS web applications. With this ADF it is easy to create an application that does mapping, editing, Geo processing and more. This application was not be used, this application can auto generate for example a Javascript API web application, this would in this case eliminate an important part of the project concerning customizing a web GIS application

- *ArcGIS Explorer*

  ArcGIS Explorer is a free 2D and 3D GIS viewer used to explore, visualize and share GIS information. ArcGIS Explorer is customizable and can be configured to be a user-intuitive interface on the web, processing data from a GIS server.

- *ArcSDE*

  ArcSDE is an application designed to let the user manage GIS data stored in a commercial database such as IBM DB2, IBM Informix, Microsoft SQL Server, or Oracle. This was not of any relevance since the dataset are Shapefiles and not stored in a Geo databases.

There are also open source alternatives to the commercial ArcGIS server software, Geoserver and Mapserver are two of the most commonly known open source GIS server softwares. These two could be considered if one had to look at the financial aspect of this project, but given that they are open source they may lack in compatibility to other softwares, the documentation is not sufficient, and there is a greater chance of security issues. What differs ArcGIS Server the most from these two open source softwares is the previous mentioned step in the web GIS architecture model, the desktop content author, this is not present in Geoserver and Mapserver, this does not mean that the map services can not be styled or customized, but it is done on the server side by a manual programming and a web interface, not as with ArcGIS Server where the service is prepared by a desktop application such as ArcMap before uploaded to the server. ArcMap offers much more advanced and diverse styling of maps than the two other alternatives, and it is also well suited for handling Shapefiles, editing and managing the database tables in the Shapefiles will be important in this project as there will be added data from other sources. ArcGIS server is the software that works as a connection between the source data and the user client. The way this is done is through different services. The Manager application is the basis for the uploading, editing, activating and deleting of different services. Different services supported by ArcGIS server is:

- Map services, Serves cached maps and dynamic maps from ArcGIS.
- Geocode services, Finds address locations.
- Geodata services, Provides geodatabase access, query, updates, and management.
- Geoprocessing services, Provides spatial analysis and data processing.
- Image services, provides access to image services.

In this project the only service that will be used is Map services for displaying cached maps created for the web GIS application. Geoprossesing services should also be considered when creating GIS application for educational purposes as it allows users to do spatial analysis and data processing with the map which really increases the user interactivity with the application.

3.5 Web server

The GIS server publishes the map service, while it is the web server that connects the map service to an client application. In a web GIS application is the web server the host of the client application.

3.6 Client application

A client application is the final output of the GIS service, it is where the map meet its users. ESRI have developed several types of client application APIs (Application Programming Interfaces).

- Javascript API
- JAVA
- .NET
- Silverlight
- Flex

Which type to choose depend on the technology available. Silverlight and Flex are two types which requires the user to download a web browser plugin on order for it to work. JAVA and .NET requires a web server that supports the specific type of server scripting language, while the Javascript API does not require any form of web browser plugin and it can be implemented and used by any type of web server, therefore it is the obvious choice for this project. It was preferred that the web GIS application would not require any software installation, so by using the Javascript API it is possible to avoid the challenge concerning software installation and at the same time be cross browser compatible.

4 Teacher study

4.1 Approach and methods

The main constraint in this study will not be available technology or equipment, but rather the amount of time available for each part in the research. This kind of constraint requires a prioritizing of the work that lies ahead, and some decisions early in the process will affect how narrow and specific the results will be. By setting limitations in some of the processes in the study, the focus can be directed to the parts which are considered most important. In this study there are several elements and uncertainties that need to be clarified in order to conduct the research, meaning that some choices had to be made in regard of which school level to study, which course to select and other loose threads that would strongly influence the course of this study. First of all it should be stated that this research is performed in Norway and will focus on the situation and schools in Norway.

4.1.1 School level

In order to get any answers to the part of the research about how GIS is currently used in Norwegian schools, one needs to consider first of all which school level that is most likely to implement technology into their education, in other words: which school level holds the most resources, equipment and competence. Looking at previous attempts of implementing GIS into education have shown that lack if available equipment is a barrier in many schools [4] [5] [6]. It is also important to consider at what level the students are competent enough to utilize a GIS software, computer skills will in that case be important. Based on the facts that Norwegian high school students age vary from 16 to 19, they were considered a appropriate target group for this study. At levels below high school it is mandatory for children in Norway to attend, while before starting at high school the students have to to choose in some degree what direction they want to proceed, or if they want to proceed studying at all. By choosing the high school level as the primary research area there is a greater chance to reach students who are more motivated, which again may give better feedback in a survey or an interview. The computer skill level of the students in high schools is also most likely to be more developed than students at lower levels of education. Common for all of the public high schools is the school reform 'Kunnskapsløftet' [12] which was introduced in autumn 2006. This reform consists of specific guidelines for the different courses curriculum in the public high school education, ensuring that all students completing high school get the same academic background. This certainly supports the choice of school level since it is more likely that findings done in this research could be applied to the majority of high schools in Norway.

4.1.2 Course

As mentioned can the students applying for the high schools choose what direction they want to go for, and one type of direction and probably the most common is the study preparatory educa-

tion programs 'Sport', 'music, dance and drama' and 'academic specialization program'. Students who choose this direction instead of a more vocational orientation are most likely to continue studying after graduated from high school, which again can support the fact that the students are motivated. All of the programs that go under the study preparation education direction have various courses specified for each program, but they also got three mutual courses that are mandatory for all the study preparatory programs. The three mutual courses are 'geography', 'history' and 'religion and ethics'. By choosing a course from the three mandatory courses it is more likely that the results from this research will benefit more people, and given that these are courses which are mandatory for all programs it is not likely that any of the courses would go through any big changes in either the structure or the curriculum in the near future. All of the three mandatory courses have a potential to implement GIS into their lectures. History is a course where historical events play a big part in the curriculum, and these events are often connected to geographical location. A possible scenario could be to use an interactive GIS application which lets the students browse a map for historical events, or to let students add objects to a map related to historical events. In the same way that the history course contains historical events there is also some parts of the religion and ethics course which is also based on historical events, and it could also implement GIS in the lectures in some degree. But in order to select a course which is most likely to have used any form of GIS earlier, or is currently using it, the most obvious choice of course is geography.

4.1.3 Course Information

The geography course is According to the geography curriculum created by The Norwegian Directorate for Education and Training, is the competence aims in the subject "Geographical sources and tools" as follows: [12]

- Read and use maps in various scales and undertake simple map analysis
- Use digital maps and geographical information systems (GIS)
- Make observations and registrations of geographical features while on excursions or when doing fieldwork and use these to consider nature and society in relation to each other
- Find and present geographical information by reading and assessing text, pictures and statistical presentations from digital and other sources
- provide an overview of geographical main features such as rivers, lakes, mountains, cities and countries, nationally and globally

All of these aims listed contain topics that easily could involve use of GIS, and the second aim is actually directly aimed at the use of digital maps and GIS. Other subjects like "Landscape and climate", "Resources and industry" and "Demographics and development" are also topics that could benefit from the use of GIS.

4.1.4 Locating Qualified Personnel

The first process step in the process of researching the current use of GIS in the geography course at Norwegian high schools is to contact qualified personnel, and teachers responsible for a geography course. The public Norwegian high school Solør Videregående Skole [13] was first

contacted. This school consists of three separate campuses which together holds about 500 students and 150 employees. The reason for choosing this specific high school was simply because of logistics, and previous connections to the school by the researcher. The original idea of researching the use of GIS in Norwegian high schools would require a more thorough research were several, and maybe most of the high schools in Norway would be evaluated to get an overview of were Norwegian schools stand today in the implementation of GIS in education, also in such a research it could be interesting to evaluate different usage in different courses etc. This would then become a very comprehensive research that could not have been completed within the time schedule of this specific project. The desire of focusing more in the implementation process rather than the national use of GIS in Norway became a decisive factor. Therefore is the area of research narrowed down to only evaluate the one high school and its geography course.

4.1.5 Teacher interview

When the connection with Solør Videregående Skole was established an meeting was scheduled with two geography teachers. The meeting would also work as an initial interview, and it was presented as an open dialog without any commitments. The following topics would be discussed:

- *General information*

  First of all it is important to get background information about the teachers, contact information and other courses that they are responsible for. After getting an personal connection the geography course should be discussed, how it is run, how many students attend the geography course, how many hours is granted to the course during a year and which textbook is used in the lectures. This background information may be very important if it is decided to go any further with this research and doing any studies involving students and teachers. The textbook used in the geography course will most likely play a big role in how the teachers are conducting their lectures, and give a good idea of which technological aids and tools that are recommended by the textbook authors.

- *Teachers experience with GIS*

  By mapping the teachers knowledge and experience with GIS one can get an idea of how likely it is for the teachers to use GIS in lectures, it will also say something about the teachers interest in GIS, this interest may be one of the key factor for how much GIS is used in the lectures. Again here will most likely the textbook affect the result based on the recommendations found in it. The teachers experience and use of GIS may also be important to know if later in the process the students experience and use of GIS will be evaluated.

- *Current GIS implementation, what, and how*

  Knowing if some form of GIS is already used in the lectures is key information for mapping what GIS tool is considered usable by both teachers and students. Is the teachers satisfied the current use of technology in their lectures? if not, how can it be improved. This will give an indication about how well GIS have been implemented into the geography education. Studying the current use of GIS will give an idea about the necessity of further implementation.

- *Ideas of GIS use*

  After discussing the current status of GIS in the classroom it is interesting to know the teachers thoughts on implementing GIS. Under what topics in the geography course could the potential of GIS be utilized, and how would they prefer GIS tool to work, as a teaching based tool or as and exercise oriented tool for the students to interact with. Getting ideas and feedback from the actual users is very important in any design or implementation process.

- *Further work*

  Finally a question about the willingness to participate in a project to produce an alternative GIS software for geography teaching. A project where they as teachers will function as advisors and evaluators in the planning of the GIS software as well as during the production. The project will end in an student workshop where they will use and evaluate the software. This would require from the teachers some future meetings during the production process and at the end some available time in their lectures for a student workshop.

4.1.6 Follow-up interviews

The follow-up interviews will consist of two more teacher interviews in addition to the initial interview. The interviews are a part of the design and development process of a GIS application where the teacher will be able to give feedback to the developer. The initial teacher interview will most probably give a very general feedback about GIS, while the two follow-up interviews will give the teacher a deeper look into GIS. The teachers will be given a brief introduction in how a GIS application can be developed and the different components involved. Giving the teachers a insight in what lies behind such application might give them a different perspective on GIS and how it can be used. By combining the pedagogical background of the teachers into the design and development process there is a greater chance that any implementation and use of the software will be successful. In the follow-up interviews will the teachers be presented a beta prototype of a lightweight GIS application, this application will be based on the feedback and discussions from the initial interview.

4.1.7 Hypothesis

Based the findings and conclusions in the previous studies done in basically the same area of research, there is a large chance that the teacher have not utilized GIS in their lectures, and the reasons for that is most likely to be the following:

- lack of IT equipment
- insufficient time for implementing GIS
- lack of computer skills in both teachers and students
- complexity found in most GIS software

But apart from these challenges are teachers often found to be supportive of implementing new technology into their teaching, and hopefully that will be the case in this project so that the research can proceed as first planned.

4.2 Results

Two teachers were interviewed simultaneously where one of the teachers was presented as the current geography teacher, and the other as the previous teacher responsible for the same course. The Initial interview was the first meeting and the goal was to establish information about the teachers, the geography course and the use of GIS.

4.2.1 The Geography course

The course is held once a week as a double lecture going over two 45 minutes sessions. The teacher has two different classes with about 30 students in each. The textbook used to teach the geography course is Terra nova [14].

4.2.2 GIS experience

The teacher who is currently responsible for the course has earlier been on a GIS training seminar with GIS where he among other teachers was presented a ESRI software ArcGIS Desktop application. The course gave an introduction of how GIS desktop applications can be used to view, analyze spatial data, create maps etc. Google earth was also mentioned as a well known GIS application, together with a few lightweight web based GIS applications created to find driving routes, and visualize the weather forecasts.

4.2.3 Use of GIS

When asked about the current use of GIS in lectures, the only answer was Google Earth. This free desktop application by Google has been used as a introductory tool for the students in early part of the course to get familiar with digital maps. Navigating through the map, locating different locations, learning about longitude and altitude are some of the features that were presented to the students. In this specific high school is every student granted their own portable notebook computer by the schools administration.

The ArcGIS training course had not convinced the teacher to implement the GIS desktop application into his lectures. One of the reasons why he was not convinced, were the fact that it was a complicated software which requires special competence beyond what he had learned during the introduction course. Taking the time to learn the software good enough to make full use of it in his lectures would require much more work than it would bring as a contribution to the students and the course. And even if he used the time to master the software at a desired level it would take even more time and effort to install, introduce and educate the students with this software, and more time would be spent on learning the actual user interface and locating functions than on spatial analyzes.

4.2.4 General status

During the interview the geography course was discussed and both teachers had strong opinions about the priority of the course. They both felt that the curriculum that was defined for the geography course by The Norwegian Directorate for Education and Training [12], were to extensive compared to the amount of hours granted during a year (56 hours). Even though the textbook Terra Nova is specially created by the publishing house Aschehoug to cover the topics and subjects that has been defined by the The Norwegian Directorate for Education and Training, the

teachers are not able to get through the different sections in the textbook as good as they would prefer.

4.2.5 Implementation visions

When asked about the view on new technology in education did both teachers show a great amount of interest, and they both felt that implementing new technology is very important. When proposed to participate in a project with the implementation of GIS in one on their lectures the response was very positive. The teacher currently responsible for the geography course agreed to grant a lecture for a possible student workshop later in the process. When asked to list up specifications that they considered to be important in a GIS application to use in the lectures the following points were addressed.

- *Student interaction*

  As one of the most important features in a GIS application is student interaction. Not only to be used for visualization but also a hand-on experience for both teachers and students.

- *Information source*

  The application should be an information source for teachers and students to explore data and information.

- *Related to the textbook*

  The application should be aimed and relevant to the curriculum and content of the Terra Nova textbook.

- *Software installation*

  Ideally the software should not require any installation on the schools IT equipment.

4.3 Discussion

By comparing the result from the initial teacher interview with other results found in similar studies it is easy to see many parallels. First of all it is easy to see that the use of GIS by these two teachers is not significant, which does not separate them from other teachers evaluated in other studies. The reasons mentioned for not trying to implement more use of GIS in their lectures could also be supported by other studies. Time and software complexity is here the main barriers, and the two have a high correlation. The teacher currently responsible for the course had previously been to a in-service teacher training program using desktop GIS software, but this training program did not influence or motivate the teacher to implement the use of the software into his lectures, the share complexity of the software was mentioned as the main reason, finding the time to master the software by himself is one problem, the other is finding time and to learn about 30 students simultaneously how to use the software without having to cut down on the curriculum. Complexity his here again the main issue, together with the lack of time to learn and educate, the reason for the teachers complexity problems could be several, first of all the teachers overall computer skills could be one, but given that the teacher had been through a training program with the specific software indicates that the reason lies elsewhere. Secondly it could be in the software design, more functionality often tends to have a negative effect on usability, having too many options and functions will be confusing, and learning how

to use a heavyweight GIS application is time consuming. Third it could be that the teacher is basically not interested and therefore blocks out the possibility implementing the software into his lectures before even trying. Based on the feedback of both the teachers when suggesting to involve them in a development process of a GIS software it is hard to claim that lack of interest and commitment is the problem. Supported b previous mentioned studies it is easy to claim say that implementing heavyweight GIS software into high school education programs is not any good solution. In order to cope with this problem of complexity a solution could be for the software vendors to create versions of their software where the complexity is reduced and the software are aimed at a specific subject or topic. By reducing the complexity of the software the time barrier would also be decreased, making the implementation process less time consuming and more efficient.

In this study there will not be any attempt to use an existing GIS application for implementation, instead the approach will be to develop a new GIS software specially designed for a specific topic or subject from the curriculum. There are three reasons for specifying the application, one is the fact that it will reduce the amount non relevant options and functions for the users, the second is based on the feedback from the teachers, where they clearly stated that they often experienced technological tools and other Internet resources to be to general, and with too much functionality and information at the same place, which made it difficult to get hold of the actual information you want, ending with the teachers stop using it. A third reason is that this project is on a time schedule, and covering the whole geography curriculum would require much more time, so by selecting a specific chapter in the course textbook to aim the application against would get the development process going.

The textbook Terra Nova is written by Ole G Karlsen and Hans Solerød, the current version was published in 2009 and it is written especially for the mandatory course geography in the study preparation program in the high school level. The curriculum of the book emphasizes that students should develop understanding of the interplay between nature and society at various geographic levels. The geography course will contribute to the understanding of the major global differences in the world when it comes to our nature, living conditions and society. The curriculum emphasizes that an important goal is to develop tolerance and global responsibility. The textbook contains twelve different chapters covering the main subjects: Geographical resources and tools, Climate and landscape, Resources and Business activities, Demographics and Development. Since this project started January 2010 and the initial meeting was held at the beginning of the second semester was almost 50 percent of the textbook curriculum already completed, the course was half way through and the remaining chapters were: 7 Resources, 8 Localization, 9 Industrial structure and Settlement, 10 Population, 11 Moving, and 12 Development. In order to find a suited field for the GIS application to be aimed at a chapter had to be selected. There were four factors which influenced the choice of chapter:

- *Time schedule*

  First of all there was a time schedule of the teacher. During the two semesters the teacher needs to adapt the curriculum in order to get through everything that the curriculum covers. Some chapters of the textbook used are more comprehensive than others and that have to be considered when planning the lessons. The most important job for the teacher is to get through the entire curriculum in decent time before end tests and possible oral exams. Doing the workshop to close to the exams period could be affected by the fact that most students are most likely to only focus on the exam and repetition of earlier chapters.

- *Curriculum*

  The order of the chapter were said to not be so important by the teacher, but at the same time is the order of the chapters in the textbook with most certainty not randomly placed. Changing the order could affect the flow of the textbook as it was meant to be by the authors. The chosen chapter should also contain material which can be utilized using GIS.

- *Development process*

  Developing a GIS application could be time consuming depending on the size and severity of the application. Evaluating how much time required programming, adapting and developing of such application can be difficult.

- *Available data*

  In order to develop a GIS application it i very important to provide data to use in, or by the application. Acquiring relevant data from different sources and adapting it to be used in the development of a GIS application, or to be used and analyzed by the application requires a great amount of time.

Based on the different factors and their influence was the chapter 10 Population selected. This chapter is placed third last in the textbook which would not place any student workshop at the very end of the semester close to the exams. More precise is the chapter placed right in the beginning of the second half of the spring semester. The content of the chapter is very well suited for a possible GIS application as it focusing of demographics. The chapter consists mostly of different values, numbers and amounts which are related to geographical locations, this makes it ideally for visualization with digital maps. One of the things mentioned by the teachers when discussing important factors in an GIS application, or any other application used in education is that is should be highly related to the course textbook. The textbook is the primary guideline and aid that the teachers have at their disposal when planning their courses, it covers the curriculum for the course and with the limited amount of time available is it very important that any technological tools or resources used by the teachers are closely aimed and related to the content of the textbook. Looking closer at the chapters content shows that the data presented and used is collected from the Norwegian bank of statistics (SSB), this makes this data bank an excellent source for collecting additional data which can be used by a GIS application. The example tables, numbers and graphs in the textbook are only small abstracts from the data available at SSB, and by using data from SSB are two of the ideal requirements mentioned by the teachers fulfilled.

- *Related to the textbook*

  The data used in the application would be a selection of the same data used in the textbook, but in a larger scale. This will make the application highly related to the textbook. By using data from sources which is also used in the textbook will the data be relevant, and the time spent on the application will not be outside the curriculum.

- *Information source*

  Making new but relevant data accessible through the application will turn it into an information source. Examples in the textbook comparing two different populations together could now easily be compared to a third population by accessing the application. A problem here could be that a lot of data implemented in a GIS application would become redundant and never used.

SSB is a statistics bank which only contains data about Norway, while chapter 10 in the textbook also covers population data about other countries. Since this is a Norwegian school course is the data about Norway very detailed while the data about other countries is not. But due to time constraints in this project will there not be time to also include data covering the rest of the world. The U.S. Census Bureau [15] is a database containing population data about the whole world from 1950 to today. This database could also be used in the same way as SSB will be used in the GIS application to cover the rest of chapter 10.

The chapter 10 is not all about reading numbers, graphs and statistics, it also introduces the students to some mathematical formulas for calculating the natural growth ,death rate, migration rates, population growth and other demographical calculations. These calculations are introduced in the very beginning of the chapter and they are widely used through the whole chapter and therefore considered very important. In order to do these calculations some types of population data is required: amount of born and dead people, and migrated and immigrated people. These types of data should be implemented into the application in order for the students or teachers to do any practical work with, or with the help of the application.

A third requirement mentioned in the interview was student interaction. This clearly indicates that the teachers would like to have an interactive application for exercise solving rather than a presentation tool for them self. Getting the students to interact with technology forces them to make decisions and choices based on their own analysis, this is considered very important. The student interaction is also closely related to the two previous topics about making the application an information source and relevant for the textbook. The student interaction with this application should therefore be about students learning about the topic of the chapter using technology, rather that learning about the technology itself. The last requirements mentioned by the teachers as important were more about technological challenges rather than pedagogical. Ideally the software or application would not require any installation on the schools it equipment, this would eliminate the use of any desktop GIS application, but it opens up for the use of a web

based solution. On the other hand is the only GIS software ever used by the teachers in a lecture Google Earth a desktop GIS application. But at the same time is the requirements listed labeled as the ideal requirements, and ideally for the schools IT department should not the schools computers contain too much software that requires space and resources. Another technological challenge which has been mentioned in other studies is access to IT-equipment, but in this project that barrier will not be an issue since all of the students are equipped with their own portable notebook computer.

4.3.1 Application requirements

After reviewing and discussing the results from the teacher interviews the following 9 requirements for a GIS web application are set:

1. It should contain historical data about population, born, dead, emigration and immigration. This is to ensure that the data used in the application will be as closely related to the curriculum as possible, it also is the type of data required to do the most important demographical calculations that the students will encounter in the selected chapter. By adding historical data and not just current data will the changes through time also be an explorable features in the application.
2. It should visualize data with the use of different map layers. GIS is basically a tool for visualization of tabular information using different map layers, therefore is it important that the data used can be related to geographical locations.
3. The map layers should be divided into counties and municipalities. Since the data used in the application is only focusing on Norways population should the data be divided into comparable parts. Instead of comparing countries the students will compare counties and municipalities.
4. It should visualize differences and variations between different map objects as well as different years. By using color variations, dot density or object sizes can the population differences between different counties of municipalities be visualized.
5. The map should include features like zooming inn/out and panning. Basic navigation should be added to the digital map in order for the users to locate and explore specific features or objects on the map.
6. Navigation help as well as map description should be included. Complexity has proven to be a challenge when making GIS application and therefore is user guides and help important features of this application as well.
7. The map should have clickable features for data exploration. The teachers requested students interaction with the application.
8. The application should be able to explore, compare and organize the selected data. Collecting data is important but also being able to organize the selected data is should also be possible.
9. The application should give the users the ability to download or visualize the selected data. For exercise solving it is important that students can access the data used in order to deliver

it to their teachers.

4.3.2 Summary

By doing this interview we hoped to establish how well GIS in implemented into the geography course, and what could be done to increase the use of GIS. Based on the findings it is easy to see that there is a time factor that limits the use of GIS, and other factors like, student interaction, easy to use, platform independence and textbook relevance must be taken into consideration when developing GIS applications for educational purposes in the geography course.

5 Student study

5.1 Approach and Methods

In the first part of this project the use of GIS was established, many issues and challenges were also discussed. Mapping the challenges and issues is only one part of the study, the other will focus on how these challenges can be solved, and find out how these challenges can be avoided in order to do an successful implementation of GIS. The challenges have been examined and mapped and the next step is to import that knowledge into the real world, and use it in the best possible way. As a follow-up from the previous study will this part focus on using the previously discovered challenges to create a web GIS application, and implement it into the geography course. The goal is to make the application fit the requirements in the best possible way, try to avoid the known challenges and barriers. In order to implement a web GIS application into a geography course there are many things to consider, some of them already determined. When the technology and software choices is made the next step is the development process, and the first step of the development process is to determine what type of features the application should contain. The requirements set for the application were the following:

1. *Related data*
   Should contain historical data about population, born, dead, emigration and immigration.
2. *Map content*
   The map should contain map layers showing county and municipalities.
3. *Layers*
   Visualize data with the use of different map layers
4. *Visualize*
   Visualize differences and variations.
5. *Navigation*
   The map should include features like zooming inn and out, and panning.
6. *Help*
   Navigation help as well as map description should be included.
7. *Clickable*
   The map should have clickable features for data exploration.
8. *Organize*
   The application should be able to explore, compare and organize the selected data.
9. *Download*
   The application should give the users the ability to download or visualize the selected data.

5.1.1 Related data

The statistical data available at SSB comes in many shapes and sizes, the variation of different data is enormous. Under the topic population are there over 500 different subtopics to select from, and each of these subtopics contain statistical data about a certain situation or subject. The different subjects also contain selectable features. By selecting the subject ”amount of born people in Norway” the selectable features could be year, age, gender, county and municipality. For this application the selected subjects are population, born people, dead people, emigrated people and immigrated people. This means that the web page is divided into five different categories. These five different categories represent the five most important in the chapter. It is with the data from these categories that the students can compare, calculate and analyze differences, growth and other demographic features found to be important by the textbook authors. Figure 2 is an abstract of the population in the different counties. In Norway each county and municipality got an unique ID, this ID is represented in the first column where as the rest of columns represent the population for the different years. These database tables can be downloaded in different formats, for this use it was downloaded in Microsoft Excel format, and imported into ArcMap as a database file. Figure 3 shows how the database file from the shapefiles looks like, this contains information about the shapefiles for the different polygons. This also contains the county ID and this way can the SSB table be joined to the shapefiles table in order to access the population data.

	nummer	1952	1954	1956	1958	1960	1962	1964
	1	18749	19046	19472	19836	20163	20473	20732
	2	18701	19526	20640	21686	22694	24145	25764
	3	43718	44404	45124	46159	47151	48046	48471
	4	17361	17512	17643	17723	17790	17737	17746
	5	16167	16330	16463	16545	16602	16657	16668
	6	15765	15988	16276	16571	16779	16916	18680
	7	15696	16146	16523	16834	17198	17609	16352
	8	13769	14042	14358	14752	14953	15110	15291
	9	76060	76415	76347	76680	77130	77149	77721
	10	97711	10070	10340	10582	10817	11049	11295
	11	21421	22015	22575	23135	23651	24181	24656
	12	20103	20767	21205	21799	22311	22832	23365
	14	97998	98013	98478	99087	10003	10014	10056
	15	19440	19974	20465	20875	21202	21435	21545
	16	19886	20145	20471	20733	21054	21368	21707
	17	11089	11298	11471	11591	11664	11653	11633

Figure 2: The SSB table

```
new esri.layers.ArcGISDynamicMapServiceLayer(
"http://x.x.x.x:xxxx/arcgis/rest/services/population/MapServer");
```

5.1.2 Map content

Each of the categories population, born people, dead people, emigrated people and immigrated people are also divided in two separate parts, counties and municipalities. This means that the application consists of a total of 10 different map services, 5 containing polygons representing counties, and 5 containing polygons that represents municipalities. Other features like age and gender could also be included in order to add more diverse data, but this was not done due to time limitations. The spatial data used to create maps was downloaded from Norway Digital

	FID	Shape *	Fylke	Fylker2.NAVN
	18	Polygon	20	Finnmark
	8	Polygon	9	Aust-Agder
	9	Polygon	10	Vest-Agder
	12	Polygon	14	Sogn og Fjordane
	15	Polygon	17	Nord-Trønderlag
	17	Polygon	19	Troms
	7	Polygon	8	Telemark
	6	Polygon	7	Vestfold
	5	Polygon	6	Buskerud
	4	Polygon	5	Oppland
	3	Polygon	4	Hedmark
	1	Polygon	2	Akershus
	0	Polygon	1	Østfold
	13	Polygon	15	Møre og Romsdal
	14	Polygon	16	Sør-Trønderlag
	11	Polygon	12	Hordaland

Figure 3: Shapefile dbf file

- the national geographical infrastructure. Norway digital is a initiative from the Norwegian government to build the geographical infrastructure of Norway. They provide thematic data, web map services, geoportals and other services. All the partners have access to download data from Norway Digital. All the spatial data used in this project is downloaded by and through Gjøvik University College who are currently a registered partner. The spatial data download were of the format ESRI Shapefile. The spatial data downloaded is name and format N2000 which vector data for use in scale 1:1 500 000 to 1:3 000 000. That type of data is suitable for the production of thematic maps, interactive maps, web maps. This project will not require high map precision as the map only consists of polygons representing counties and municipalities. Reducing the precision of the map also increase the loading speed of the map service, this is important for good performance.

5.1.3 Layers

The way the digital maps in this application i built up is with different map layers for each year. Since this application is only in a testing stage a decision was made to cut down on the available years. With the years ranging from 1952 to 2008 it was decided to skip every second year, resulting in only the even years. This was done to keep the range from 1952 to 2008, and at the same time reduce the amount of data required to implement. Even though there are one

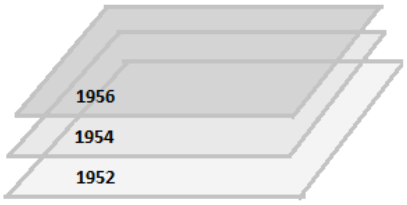

Figure 4: Layers stacked

layer for every year all the layers are using data from the same database table. The difference between the layers is only the styling. Each layer is connected to one column in the database table through the specific year.

5.1.4 Visualize

The different map layers for each year was as mentioned divided into different polygons representing a county or a municipality. Each of these polygons was again joined to the database file which contained data collected from SSB. This meant that each polygon also contained data about the population, born people, dead people, emigrated people and immigrated people for that specific county or municipality. In order to visualize the different amount of people living in each county the regular approach is to use color intensity for different values. Instead of color intensities one can use graduated symbols in terms of size variations or dot density. Dot density is not preferred since it is hard to connect any classification to a given amount of dots, it works purely for visualizations that is not required to be accurate. Using symbols or objects to visualize for example population density can be an issue if the size of the object or symbol extends the boundaries of the map object it represents, so using color intensities to visualize quantities of data is preferred in this project. Visualizing quantities of data using color intensities requires a color palette and color classification. Choosing a color palette is simply done by choosing the color that is best suited for the type of data it is representing. Given the categories population, born people, dead people, emigrated people and immigrated people there are no specific colors that best describe them so the choice of color will be random, it is not the actual color that creates the density differences in the map but the color intensities. ArcMap have some predefined color palettes that is well suitable for this project. Using color intensities in map visualization also requires different color classifications. Color classifications consist of two parameters, the number of classifications and the type of classification. The number of classifications is suitable between 4 and 8, and in this case 8 is preferred, this is because the variation between the largest and smallest value in the SSB database table is so significant. What type of classification to use depends on the data that is presented, if there is an even distribution of samples within the different classifications it would be suitable to use equal intervals. But in this case the distribution is so uneven that it is better to use quantitative intervals.

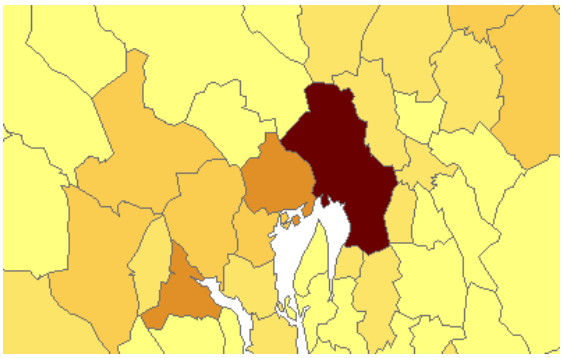

Figure 5: A map layer with color classification

5.1.5 Navigation

Navigation is very important features in a digital map, and as people are becoming more accustomed to the use digital maps over the Internet, they have also experienced different types of navigation settings. Default in the ArcGIS Javascript API map there are some navigation features which are well known and also widespread in other leading GIS applications in the Internet like Google maps, Bing maps and more. The default navigation settings are:

- Drag to pan
- SHIFT + click-centered focus
- Shift + Drag to zoom in
- SHIFT + CTRL + Drag to zoom out
- Mouse scroll forward zoom in
- Mouse scroll backward to zoom out
- Use the arrow keys to pan
- + Key to zoom in
- - Key to zoom out
- Double click-centered focus and zoom

In addition to the default keyboard and mouse button features is it also important to give the user another option for panning, and that is clickable buttons on the map. Added in this application in addition to the default is a zoom-in and zoom-out button in the upper left corner, and also pan buttons are added to each side and corner. This gives the user two options for navigation through the map, this is necessary because not all computer mouses are equipped with a vertical scroll.

5.1.6 Help

Every application should contain some form of help function for the users to look up if there are problems or if they need help. This application is no different, and the help consist of two parts. One explaining the different default navigation functions listed above, and the other is the legend, explaining what the different color classifications represent. Figure 6 shows an example of how a legend description could look like, it gives the user important information about the different values of the colors used in the digital map.

5.1.7 Clickable

One of the criteria that were listed as important in a GIS application in the teacher interviews was student interaction. As known is the most common known interactive feature in digital maps the navigation features, but in order to make a web GIS application more interactive, additional features needs to be added. Until now the GIS applications function is to visualize differences between different counties and municipalities with the help of color intensities. This visualization does not make the web GIS application an interactive tool but rather a presentation tool. In order to make the web GIS application more interactive and at the same time give the users access to

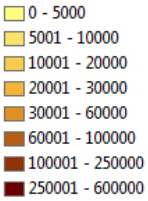

Figure 6: Example legend

the different data it hold, was each polygon made clickable. This meant that the users could select it by clicking on the desired county or municipality to get out information about it. If the user selects the subpage Population for counties and selects the year 2000, the query sent to the shapefile .dbf file would be to return county name, area and population for the year 2000. In order to highlight the selected polygon the shape is extracted and a new polygon is drawn on top of the selected with a gray inner color and a red outer line. In addition to the drawing of a new selected polygon a query is also sent to the GIS server. This query contains some parameters that describe what data to return to the user. These parameter are category, year and polygon id, returned to the user is category, name, year, area and amount of persons.

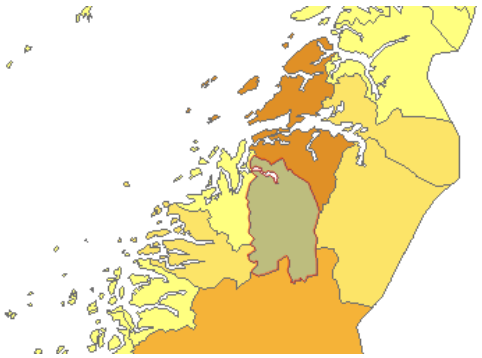

Figure 7: Example Map selection

```
dojo.connect(map, "onClick", ShowLayers);
//Set the new symbol to highlight selected object.
new esri.symbol.SimpleFillSymbol(
esri.symbol.SimpleFillSymbol.STYLE_SOLID,
new esri.symbol.SimpleLineSymbol(
esri.symbol.SimpleLineSymbol.STYLE_SOLID,
new dojo.Color([255,0,0]), 0.5),
```

```
new dojo.Color([125,125,125,0.5]));
```

5.1.8 Organize

In addition to the ability to return query results the web GIS application should also be able to handle the information returned to the user. When a query is returned the information is displayed until the user run a new query. This way there is no function to store the selected information for the user other than writing it down. By adding a pick list that works in the same way as shopping carts in e-commerce applications the user can store each query by adding it to the list. The list consists of 6 different columns:

- Category
- Name
- Area
- Year
- Persons
- Remove

As a tool for the user to do adjustments to the order of the stored data, can each column be sorted descending or ascending with the help of sort buttons. The way the data is stored it through sessions using the server scripting language PHP. As an alternative cookies could be used, but there are cases where users tend to turn off the ability to store cookies on their computers.

5.1.9 Download

In order for the users to make any use of the stored data, two download options are provided. One exporting the table in Microsoft Excel format(xls), the other in text document format(txt). This way can the user access the collected data for further exploration in other applications. This is a very relevant factor when dealing with student exercises. As another download feature can the users save the current map extent as an image on their computer. This can be an useful function for students who wants to visualize parts of their answers in an exercise hand in.

5.1.10 GIS application

Figure 8 shows the structural layout of the web application. The layout is divided into 6 different parts, all of them connected to each other.

1. *Menu*

   The menu section consists of 6 different categories: home, population, born people, dead people, emigrated people and immigrated people. All of these except home got two subcategories each which are similar for all of them, the two subcategories determine if the map is divided into counties or municipalities. By clicking on either of these categories the user is not directed to another subpage but only the content of section 3 the map and the legend in section 6 is changed.

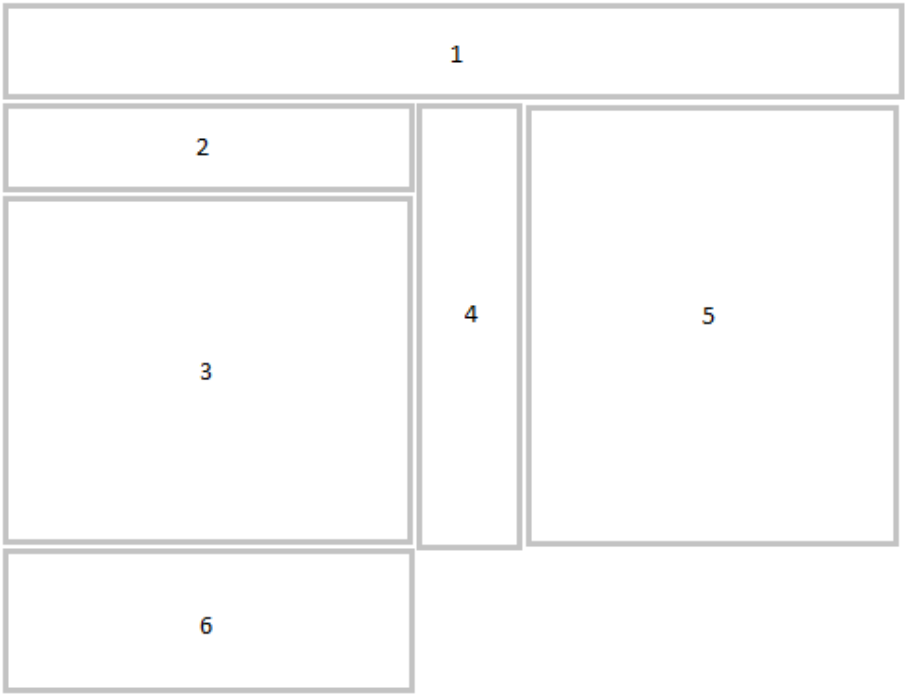

Figure 8: Screen shot of the web application

2. *Query result*

   The Query result section displays the information returned from the query done when the user selects a map polygon. The Query result section is updated whenever the user clicks on the map, or changes the map category. It also has a save to pick list button for the users to temporarily save their selections in the pick list. The values displayed in from the query are category, name, year, area, and persons.

3. *Map*

   The map section is where the web map service is displayed. Which web map service to display is determined by the users choice of category and the layer displayed is determined by the year selected. The map section is equipped with different navigation features explained earlier.

4. *Year list*

   The year list section consists of a list of years that the user can select from. Default the first year in the list is selected. Which year is selected determine which layer to be displayed from the web map service.

5. *Pick list*

   The pick list section consists of an empty table where the users can add and store selected data. The data selected can be sorted ascending or descending to any of the different values category, name, year, area, and persons. The pick list also contain two features, download the list as Microsoft Excel document or text document file button, and display the selected list as a bar diagram button.

6. *Help*

   The help section contain navigation tips and help and also the legend description showing the different values of the graduated colors used in the various maps. The legend changes according to the selected menu category.

5.1.11 Workshop

In order to evaluate the developed web GIS application and see if the methods to avoid the challenges have been successful a student workshop is preferred method, this way will the users that the application is directed to get hands on experience, and give valuable feedback. This workshop is a two hour exercise lab where the students are given a set of exercises to complete. The workshop would be the last session concerning chapter 10 of the textbook Terra Nova and it would work as a summary before embarking on a new chapter. The exercise paper consists of different tasks that cover all of the subsections of chapter 10, most of the tasks are selected from the example exercises in the textbook, and three others were added to include the use of the web GIS application. The three questions designed for the web GIS application were:

1. Compare population trends in the municipality Åsnes with the municipality Grue in the year from 1960 1970 1980 1990 2000 2008. Find out if there is the natural growth or net migration that are the reasons for the population differences.

2. Calculate population growth, for the counties Hedmark and Rogaland in the years 1960, 1970

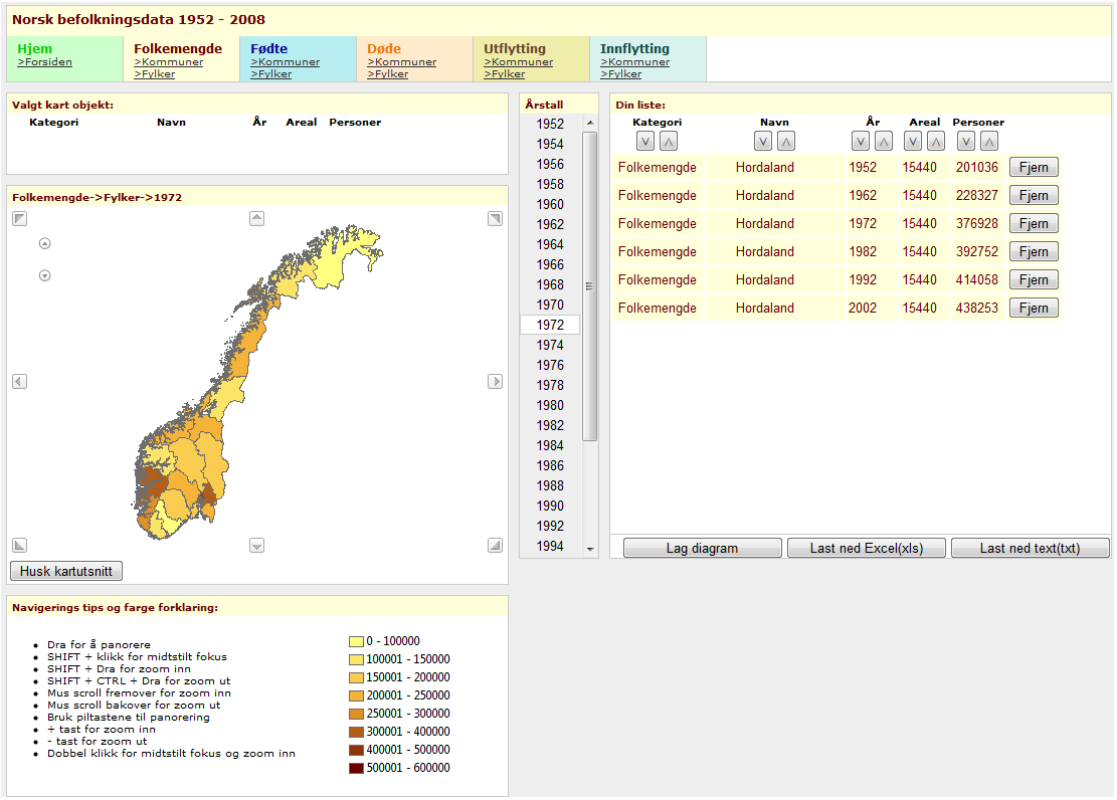

Figure 9: Screen shot of the web page structure

1980 1990 and 2000. discuss possible reasons explaining the differences.

3. Compare the various counties number of births, deaths, emigrations and immigrations in 1952 with 2008, the county has the greatest and least increase. Illustrate.

The composition of the three questions will force the students to explore many of the features implemented in the applications, as well as leaving them to do some choices and analysis. Hopefully will this workshop give some answers on how well the application have avoided the known challenges as well as it will most certainly present new.

5.1.12 Student feedback

In order to get feedback from the students three methods were considered, individual interviews, group interviews and a survey. In the teacher interviews time were mentioned as one of the barriers in the geography course, both for implementation of GIS as well as getting through the whole curriculum, this eliminates the possibility of doing single or group interviews with the students. The two hours granted to the workshop would preferably be used to application interaction and exercise solving, not performing interviews with 60 students. A survey would on the other hand not take up so much time since all of the students can complete it simultaneously. Since all of the students are equipped with their own notebook computer a web based survey

over the Internet is a suitable and effective method.

The students survey is divided into five different categories.

- Background information
- GIS use
- GIS satisfaction
- GIS mastering
- Technology satisfaction

Background information

The group of students is all roughly at the exact same age, all of them live in the same area and they are all at the same school level. This means that in order to classify the students in different groups some more background information about each student must be mapped. This is to see if there are any clear tendencies in any of the later survey questions. The first question is about gender, to separate girls from boys, secondly is the students asked to rank their current courses. The approach is a 5 scale rating using single select matrix of how they like the course, ranging from very good - good - neutral - bad - very bad. This was basically to see where geography stand compared to the other courses. Finally the students are asked about their regular computer use per day, divided into four different situations: total use, school related, Games and Social Medias. Single select matrix is also used and the alternatives are: Less than 1 hour - 1-3 hours - 3-6 hours - 6-9 hours - 9-12 hours. This is to get an idea of how much the different students use their computers, and to what use. All of this background information can later be used to see if there are any correlations between for example students who like geography and students who like GIS.

GIS use

The second part of the survey could be said to be a part of the previous part about the students background. This is about the students use of web GIS applications. The students are presented with 20 different GIS application found on the Internet, mainly Norwegian sites but also some well known international. 12 of the applications are what we can call common GIS applications, showing different thematic maps, weather forecasts and route planning features. The other 8 are more specialized GIS applications which are not so commonly known. The question is how often they use these applications, and the alternatives in a single select matrix are: Never - 1-5 times per month - Once a week - 1-5 times a week - Once a day - Several times a day. This is to see if the students use GIS regularly, and what types of services they use. Included in this part is three open questions. Asking the students to write down what other GIS applications they use, which one they like the best, and why. This is to measure the students experience with GIS which can later be compared to how well they perform with the web GIS application.

GIS satisfaction

The third part is about the students satisfaction with the use of GIS in the workshop. The students are presented with a set of statements in a single select matrix and they will use a 5 scale

agreement meeter ranging from: Strongly agree - Agree - Neutral - Disagree - Strongly disagree. The statements are:

- The digital mapping service used rose my interest in geography.
- It increased my knowledge of geography Norway.
- It helped me to solve tasks in a good way.
- It increased my curiosity to learn more.
- It helped me understand how the electronic chart services can be used.
- It improved my computer skills.
- It motivated me to learn about and use new technologies.

The answers from this part will tell something about the overall satisfaction, each single statement might not be as important as the average score from all the answers.

GIS mastering

The fourth part about GIS mastering is quite similar to the previous, it uses the same setup with single select matrix and the same 5 scale agreement meter. The main change here is the actual statements presented to the students, and the fact this part focuses more on the actual application developed than the general use of GIS.

- I understood at once that you could click on the map.
- I had to take advantage of the navigation tips below the map.
- I quickly realized that the choice of year led to changes in the map.
- I think it was easy to navigate around the map.
- It was easy to extract the desired information from the map.
- The map made it easy to understand the relationship between counties and municipalities in Norway
- It was easy to arrange the requested information in my list.
- I think that the use of maps was an informative and good method to obtain the desired information.

In addition to these statements will there also be three open questions about the mastering of the GIS application. The students may list what types of problems the encountered using the application in the workshop. Also they can imply what types of changes that could be made to improve the application as well as what features they were missing in the application. This may give valuable feedback on what was wrong and what was good about the application.

Technology satisfaction

As the fifth and final part of the survey were the students asked about the use of technology. Three new statements were presented:

- I think my teachers are good to using technological aids in their teaching.

- It is often that my teachers make use of Internet resources in class.
- I consider it very important to adopt new technology in teaching.

The setup used in the three previous parts were also adopted in this final part. This answer was added to see how the general satisfaction of the students are concerning their teachers use of technology.

5.2 Result

In the student survey there were 51 participants. 51 may seem like an insufficient amount of students when thinking on a national scale, but as long as those participants can be viewed as a representative sample for the an average high school the results are can be valid. A tendency that was spotted in the results from the survey was that some participant had a clear tendency of selecting only neutral answers, this can be interpreted in several ways, either the students shows that they are not interested in the topic of the survey, or they just want to get through it a fast a possible. Either way it will affect the tables that is shown below since they are based on the average score. Which means that the score variations are reduced due to the many neutral answers.

5.2.1 Question 1, 2, 3, 4 background

Gender Course evaluation Computer use per day. In the open question where the participants

Type	Percent
Men	57
Women	43

Table 1: Gender distribution

Course	Mean
Norwegian	2,25
English	2,38
Science	2,38
History	2,88
Geography	2,50
Gym	2,00
Religion	3,38
Mathematics	3,25
Information technology	3,00
Physics	3,25
Chemistry	3,25
Bioligy	3,63
Law	3,13

Table 2: The participants course evaluation. Low score equals well liked, high score not liked(1-5).

were asked to list down their most frequently used Internet services the most mentioned were social communities like facebook, nettby, twitter and various bloggs. Some norwegian news papers were also listed but not frequently.

Type	Mean
Total	2,86
School related	2,14
Games	1,39
Social medias	2,16

Table 3: 5 scale rating: 1. Less than 1 hour - 2. 1-3 hours - 3. 3-6 hours - 4. 6-9 hours - 5. 9-12 hours

5.2.2 GIS use. Question 5, 6, 7, 8, 9

The GIS use of the students was varying. Out of the first category of GIS application, the commonly known, were most of the application were used at least 1-5 times a month, the applications that were used more frequently were a route planner application, weather forecast application and a public transport overview application. Out of the more specialized GIS applications there were only one of the applications there were only one that stood out from the rest, with 33 percent of the participants claimed to use it 1-5 times a month. Except from that there were no other specialized applications that were used by the participants. In the open questions about other GIS application that they used was Google Earth the only one mentioned. It was also listed by the majority as the GIS application that they preferred to use. The reasons for that were that it was easy to use, good performance, easy to get the information wanted and good overview.

5.2.3 GIS satisfaction. Question 10

In the seven statements about GIS satisfaction there were are large amount of neutral answers. The neutral answers could be interpreted as the participant do not have an opinion about the specific subject or that they do not care to state their mind and just wants to complete the survey in a fast manner.

Statement	Mean
The digital mapping service used rose my interest in geography.	2,90
It increased my knowledge of geography Norway.	2,80
It helped me to solve tasks in a good way.	2,67
It increased my curiosity to learn more.	3,04
It helped me understand how the electronic chart services can be used.	2,61
It improved my computer skills.	3,12
It motivated me to learn about and use new technologies.	3,12

Table 4: The mean scores given to the statements in question 10. $<$ 3 equals satisfied, $>$ 3 equals not satisfied.

5.2.4 GIS mastering. Question 11, 12, 13, 14

In the open question about challenges and difficulties regarding the application only 15 percent reported to encounter problems, where the main issues were slow response from the application. In the second open question about what should have been done different only one participant came with a suggestion.

Statement	Mean
I understood at once that you could click on the map.	1,78
I had to take advantage of the navigation tips below the map.	3,33
I quickly realized that the choice of year led to changes in the map.	3,00
I think it was easy to navigate around the map.	2,41
It was easy to extract the desired information from the map.	2,53
The map made it easy to understand the relationship between- counties and municipalities in Norway	2,43
It was easy to arrange the requested information in my list.	2,71
I think that the use of maps was an informative and good method- to obtain the desired information.	2,53

Table 5: The mean scores given to the statements in question 11. < 3 equals good mastering, > 3 equals bad mastering, except from statement 11.2 which is reversed.

Statement	Mean
I think my teachers are good to using technological aids in their teaching.	2,41
It is often that my teachers make use of Internet resources in class.	2,55
I consider it very important to adopt new technology in teaching.	1,90

Table 6: The mean scores given to the statements in question 15. < 3 equals satisfied, > 3 equals not satisfied.

5.2.5 Technology satisfaction. Question 15

5.2.6 Correlations

As mentioned are the questions divided into 5 different categories, background, GIS use, GIS satisfaction, GIS mastering and technology satisfaction. These categories were created in order to analysis with each other, to look for correlations that might explain some of the tendencies in the student feedback. First of all was a correlation matrix created, in the matrix the following categories and answers were added: GIS use, GIS mastering, GIS satisfaction, technology satisfaction, students who like geography, students who spend much time with the computer(total, games, school related, social medias).Out of the correlation matrix the following correlations appeared significant.

- GIS satisfaction - GIS mastering
- GIS use - Technology satisfaction
- GIS satisfaction - Technology satisfaction
- Students who seem to like the geography course - GIS mastering
- Students who spend much time on their computer doing school related work - Students who seem to like the geography course

The following correlations were not significant.

- GIS use - GIS mastering
- GIS use - GIS satisfaction

- GIS Mastering - Total computer use, School related, games, social.
- No significant differences between boys and girls.

5.3 Discussion

In the second part of the project the goal is not to measure how much better students perform with the use of GIS technology in the geography class, but rather to look at a way to implement GIS as a educational tool, and evaluate the student mastering and experience using the tool. Until now the GIS application have been adapted and developed accordingly to the curriculum of the course textbook, and to avoid most of the challenges that teachers, developers and geographers face when implementing new GIS technology. The feedback from the student workshop consists of three different parts, the qualitative feedback from the open answers, the quantitative feedback from the selection answers and the quantitative correlations.

5.3.1 Qualitative feedback

When the students were asked about what type of GIS application they preferred the majority answered Google Earth. And the reasons they mentioned for why they preferred it was that it is easy to use, good overview, fast, good details and interesting to use. All of these are factors that all technology developers struggle to achieve when they design new software. Google Earth is the only GIS application that the teacher have introduced to the students in the very beginning of the geography course, which may explain why the students so strongly prefer Google Earth. If this is the case it is safe to say that the teachers have a strong influence on the their students when it comes to learning and liking technology, and it shows that bringing GIS technology into lectures leaves an impression on the students.

When it comes to the problems mentioned by the students when using the GIS application the most common problem was speed, this is a well known problem when it comes to web GIS applications i general, and the reasons can be many. Since the web GIS application consists of so many components it is crucial that all of the components as well as the connection between the components are working properly. In figure 8 shown earlier one can see the different components, all of these and as the connection between them play a big role in the performance of the web GIS application, so when the students experience speed and loading problems it can result from traffic on the GIS server or the Internet capacity at their specific location. This is of course something to note down as a new challenge when it comes to implementing web based GIS technology. A web GIS application cannot be compared to a desktop GIS application that does not rely on any on line GIS service when it comes to speed, but as it is with all technology is the performance always improving. For the students who are used to regular dynamic web pages that respond instantly will in some cases a GIS application seem slow due to more data processing and redrawing of maps.

Another problem that was mentioned about the GIS application was the fact that for every time the students changed year, added queried data to the list or sorted the list the extent of the map

was reset to its default, which meant the students had to navigate again to the previous extent every time they did major changes with the application. This happened because the buttons worked as form submitting buttons which reloaded the page for each click, this problem could be solved by storing the map extent in a session or a cookie for each time it was changed, or as GET variables.

A third issue that was mentioned in the open questions was that there were no way for the students to search for a specific county or municipality, but instead they had to navigate around the map and locate it by clicking on different polygons to query out its specific name. A way this could be solved is by query the polygon name whenever the mouse pointer is over the specific polygon, a problem with this approach using the ArcGIS Javascript API was that for each time the mouse is moved a new query is sent to the GIS server, which again would dramatically increase the server traffic which affects the speed. Another solution could be to add a text box for the users to input a specific name and then outline the specific polygon or to adjust the map extent to the polygons position.

5.3.2 Quantitative feedback

The gender representation in this survey were quite similar, this makes the result more representable for the average high school geography student. The students computer use only shows that they spend quite amount of hours daily on the computer which is not so unnatural as they are allowed to use their computers all day at school.

When it comes to the students current use of GIS application in the daily life the answers were quite as expected, the overall use of GIS is small, but it seems that the students have used or uses the majority of the common GIS applications presented. Out of the more specialized GIS application the result were also as expected, the only application that ever been used was actually mentioned in the textbook and by the teacher as information source. The main reason for mapping the students use of GIS is to see if there are any correlation between their GIS experience and their mastering of the GIS application created. It should also be added that the questions of GIS use did not include the many web pages now have small implemented small GIS applications in their interface, often used to illustrate addresses or events.

In questions 10 about the students satisfaction there is some indications that the majority of the students had a positive experience using the GIS application, and especially the students felt that the application helped them in solving the exercises in a good manner, and that it helped them understand how GIS technology can be used.

Looking at the mastering of the GIS application there were a much clearer indication that the majority of the students performed well. This could either be because of the students earlier experience with computers, and/or GIS, or it could indicate that the application were intuitive and easy to use, or perhaps both reasons played a role.

About the students thoughts on the general use of technology at their school one would expect that the students would require their teacher to use more technology in their lectures, but according to these results are the majority of the students quite satisfied with their teacher, and their use of technology, and finally the students feel that new technology in school is important, which is a opinion they share with their teachers.

5.3.3 Significant correlations

Significant correlations between the quantitative student feedback.

- *GIS satisfaction - GIS mastering*

  The students that seemed to be satisfied with the use of the GIS application also performed well with the application, this comes out as a pretty obvious correlation, if you handle something well it is most likely that you like the product.

- *GIS use - Technology satisfaction*

  The students that are the most frequently users of GIS applications also are the ones most satisfied with the use of technology at their school. This is really supportive of the fact that the teachers actually utilizes technology in their lectures since it would most likely be the students that is most interested in technology that would also require more use of it.

- *GIS satisfaction - Technology satisfaction*

  An obvious correlation is that students who are satisfied with the general use of technology also is satisfied with the use of the GIS application.

- *Students who seem to like the geography course - GIS mastering*

  This indicates that students that have an interest for the geography course also automatically understood how to use GIS application, they could easily relate to the map and its functions.

- *Students who spend much time on their computer doing school related work - Students who seem to like the geography course*

  This correlation could be

5.3.4 No correlations

Not significant correlations between the quantitative student feedback.

- *GIS use - GIS mastering*

  The students GIS use had no correlation to how well they performed with the GIS application, this indicates that the GIS applications features and abilities were easily understandable and manageable by the majority of the students, not just the ones who use GIS regularly. Probably avoiding one of the key challenges mentioned in the earlier part of the project about GIS applications complexity.

- *GIS use - GIS satisfaction*

  Similar to the previous paragraph is not the students GIS use correlated to the GIS satisfaction, it would be expected that the students who had the most GIS experience would also appreciate the use of GIS in lectures, but that was not the case for these students.

- *GIS Mastering - Total computer use, School related, games, social*

  The students computer use had no effect on how well they mastered the GIS application, this indicates that the GIS application was usable by both the students with much computer experience as well as those with little experience.

- *No significant differences between boys and girls*

  There were no significant differences between boys and girls in this survey.

5.3.5 General

In the initial research with the teacher interviews it was easy to sense that the teachers felt they did not have enough time to implement new technology even though they saw the importance of it, and wanted to increase their own use of technology in lectures. The students on the other hand seemed to be satisfied with their teachers current use of technology, but at the same time they are eager to use new technology.

5.3.6 Success evaluation

Based on the challenges mentioned in the early part of the project is it easy to see that most of them have been successfully avoided.

- *Time constrains*

  The web GIS application created did not require any time consuming training of either teachers of students.

- *Software complexity*

  Based on the quantitative measures of the students mastering of the software, and the reported problems, did not the application turn out to be to complex for the students. Neither fot the students with little GIS use or who spend small amount of time on the computer.

- *Implementation methods*

  No time consuming installation required in order to utilize the application. The application is platform independent, and does not require any software except from an ordinary web browser which is default on any operating system..

- *Focus*

  The application is focused on teaching with GIS rather than about GIS. The students are presented with a digital map that can access information rather than presented with information that can be used to create a digital map with heavy GIS desktop applications.

Avoiding challenges also means setting limitations, limitations that may have an negative influence of the further work. Even though this project have shown methods on how to avoid challenges, it should also be noted that the GIS application created only covers a rather small part of the textbooks curriculum, so there is a great amount of work required ahead in order to do further implementations for the rest of the curriculum that is suited for GIS.

5.3.7 New challenges

As some challenges were avoided some new ones arrived.

- *Speed*

  Using web GIS applications can be a challenge since it relies on so many different components to work properly. Web GIS applications are known to be quite slow, and taking the application created here further into a larger scale could be risky when it comes to performance.

- *Responsibility*

  It is not easy to determine who is responsible for implementing GIS technology into education, but what we can say based on this project is that it is very important to include all of the different parts of such project. The teacher, GIS developers and even the textbook authors should all have some sort of communication in order to develop, implement and get fully use of GIS technology in education.

So far it can seem like this project has been in some degree successful by looking at the results, but there are things to consider other than the positive results. How well would these approaches work in larger scales in real life is hard to say. The application has been successfully avoiding some of the biggest challenges when implementing GIS technology into high school geography courses, but at what cost? Even though this application were successfully implemented without any major difficulties is it hard to state that this is clearly the only way to go when implementing GIS. Financially it is not sure that creating new GIS technology is the best alternative since there are so much GIS software out there already created, but given the challenges met when trying to implement existing GIS technology, there has to be alternatives. From a pedagogical aspect the technology should be adapted to the education, not vice versa.

5.4 Teacher post interview

After the students workshop the primary geography teacher was contacted to elaborate on his thoughts on the process and the developed application. The first response from the teacher was positive, he immediately questioned the possibility to use the application in the future with new students. When asked he said that this was a typically example of a suitable application for use in his lectures.

5.5 Further work

In order to take this work further it would require a larger scale, meaning that it should look at it with a larger perspective. First of all try to evaluate what other parts of the geography curriculum that can be used in similar ways with GIS, and then involve more personnel in the form of geography teachers and GIS developers. The information and spatial data is available, but it requires planning and work in order to utilize it in an educational context. The most important to bring from this project into further work is the challenges, and the methods used to avoid them. In a technological aspect would it be wise to convert to using Geo databases instead of shapefiles, as the scale of the web GIS application increases and the use of spatial data is getting greater. Geo databases is more suited for large scale projects and it is easier to update. The implementation evaluation should be redone in order to get more results and more participants to better support the findings.

In this project only one chapter from the textbook were used, and in order for this approach to be of any help it should also be able to support more parts of the textbook. Looking at the different chapters and subjects of the textbook it is easy to see several usage areas for GIS, and many of the quite similar to the approaches used in this project.

6 Conclusion

In this project the goal eventually was to locate what practical and technological challenges we are facing when implementing GIS into geography courses in high schools, and further attempt to learn from that experience and put it into a real case scenario. Based on the process of this project it is safe to say that implementing GIS technology into geography education requires many considerations. There are many challenges to overcome, software complexity and lack of time are the two main challenges from the teachers point of view when implementing GIS in their lectures. At the same time there are methods to avoid these challenges. If the technology and the content is adapted specifically according to the curriculum there is a greater chance that teachers and students will master and hopefully benefit from the GIS technology in their education. Instead of adapting the curriculum to the technology GIS, developers should consider adapting the technology to the curriculum. By creating customized application with a limited level of difficulty and complexity, is it a greater chance that students with different technological background will perform equally good.

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A Appendix A

The electronic survey was created using QuestBack.

Teknologi og digitale karttjenester i skolen

En spørreundersøkelse rettet mot bruk av teknologi og digitale karttjenester i undervisning.
Vennligst svar så ærlig som mulig.

1) * Kjønn?

- Mann
- Kvinne

2) * Av følgende fag liker jeg

	Svært godt	Godt	nøytralt	Dårlig	Svært dårlig	Har ikke
Norsk						
Engelsk						
Naturfag						
Historie						
Geografi						
Kroppsøvning						
Religion						
Matematikk						
Informasjonsteknologi						
Fysikk						
Kjemi						
Biologi						
Rettslære						

3) * Gjennomsnittlig tid per dag:

	Mindre enn 1 time	1-3 timer	3-6 timer	6-9 timer	9-12 timer	12 timer eller mer
Total tid foran datamaskinen	○	○	○	○	○	○
Skole relatert arbeid på datamaskin	○	○	○	○	○	○
Spill på datamaskin(flash, kabal osv.)	○	○	○	○	○	○
Sosiale medier/chat (Facebook, Twitter, MSN osv)	○	○	○	○	○	○

4) List ned noen av Internett tjenestene du besøker oftest

Digitale karttjenester

5) * Jeg bruker, besøker:

	Aldri	1-5 ganger per måned	En gang i uken	1-5 ganger i uken	1 gang om dagen	Flere ganger om dagen
Google maps (maps.google.com)	○	○	○	○	○	○
Yahoo! maps (maps.yahoo.com)	○	○	○	○	○	○
Bing maps (www.bing.com/maps/)	○	○	○	○	○	○
Gule Sider Kart (www.gulesider.no/kart)	○	○	○	○	○	○
yr.no (www.yr.no)	○	○	○	○	○	○
Finn Kart (kart.finn.no)	○	○	○	○	○	○
Norge I Bilder (norgeibilder.no)	○	○	○	○	○	○
Kvasir kart (www.kvasir.no/kart)	○	○	○	○	○	○
Hvor (www.hvor.no)	○	○	○	○	○	○
Trafikanten (www.trafikanten.no)	○	○	○	○	○	○
Norgeskartet (www.norgeskartet.no)	○	○	○	○	○	○
Atlas.no (www.atlas.no/)	○	○	○	○	○	○

Spesialiserte digitale karttjenester.

6) * Jeg bruker, besøker:

	Aldri	1-5 ganger per måned	En gang i uken	1-5 ganger i uken	1 gang om dagen	Flere ganger om dagen
Miljøstatus i Norge (www.miljostatus.no/no/Kart-og-miljodata/kart/)	○	○	○	○	○	○
seNorge.no (www.senorge.no/)	○	○	○	○	○	○
Statens Kartverk (kart.statkart.no)	○	○	○	○	○	○
Kystverket (kart.kystverket.no)	○	○	○	○	○	○
Direktoratet for naturforvaltning (dnweb12.dirnat.no/nbinnsyn/NB3_viewer.asp)	○	○	○	○	○	○
Skrednett (www.skrednett.no)	○	○	○	○	○	○
Norges vassdrags- og energidirektorat (arcus.nve.no/website/nve/viewer.htm)	○	○	○	○	○	○
Globalis (http://www.globalis.no/)	○	○	○	○	○	○

7) Jeg bruker også(digitale karttjenester):

8) Av de digitale karttjenestene jeg kjenner til liker jeg best:

9) Fordi:

10) * Kart i skolen

	Svært enig	Enig	Nøytral	Uenig	Svært uenig
Den digitale karttjenesten som ble brukt i timen økte min interesse for geografi.	○	○	○	○	○
Det økte min geografikunnskap om Norge.	○	○	○	○	○
Det hjalp meg med å løse oppgavene på en god måte.	○	○	○	○	○
Det økte min nysgjerrighet for å lære mer.	○	○	○	○	○
Det hjalp meg å forstå hvordan elektroniske karttjenester kan brukes.	○	○	○	○	○
Det forbedret mine dataferdigheter.	○	○	○	○	○
Det motiverte meg til å lære om og bruke nye teknologier.	○	○	○	○	○

	Svært enig	Enig	Nøytral	Uenig	Svært uenig
Jeg forstod med en gang at man kunne klikke på kartet.	○	○	○	○	○
Jeg måtte benytte meg av navigering tipsene under kartet.	○	○	○	○	○
Jeg skjønte raskt at valg av årstider førte til endringer i kartet.	○	○	○	○	○
Jeg synes det var lett å navigere seg rundt på kartet.	○	○	○	○	○
Det var lett å hente ut ønsket informasjon fra kartet.	○	○	○	○	○
Kartet gjorde det enkelt å forstå forholdet mellom fylker og kommuner i Norge	○	○	○	○	○
Det var enkelt å organisere den valgte informasjonen i min liste.	○	○	○	○	○
Jeg synes at bruk av kart var en lærerik og fin metode å skaffe seg ønsket informasjon på.	○	○	○	○	○

12) Jeg hadde følgende problemer med den digitale karttjenesten:

13) Dette burde vært gjort annerledes:

14) Jeg savnet:

15) * Teknologi i skolen

	Svært enig	Enig	Nøytral	Uenig	Svært uenig
Jeg synes at mine lærere er flinke til å ta i bruk teknologiske hjelpemidler i undervisningen.					
Det er ofte at lærerne tar i bruk nettressurser i timen.					
Jeg anser det som svært viktig å ta i bruk ny teknologi i undervisningen.					

B Appendix B

Following is the results from the survey in tables.

17.05.2010 13:51 QuestBack eksport - Teknologi og digitale karttjenester i skolen

Teknologi og digitale karttjenester i skolen

Publisert fra 14.04.2010 til 19.04.2010
51 respondenter (1 unike)

1. Kjønn?

Alternativer	Prosent	Verdi
1 Mann	43,1 %	22
2 Kvinne	56,9 %	29
Total		51

2. Av følgende fag liker jeg

Alternativer	N
1 Norsk	51
2 Engelsk	51
3 Naturfag	51
4 Historie	51
5 Geografi	51
6 Kroppsøvning	51
7 Religion	51
8 Matematikk	51
9 Informasjonsteknologi	51
10 Fysikk	51
11 Kjemi	51
12 Biologi	51
13 Rettslære	51

2.1 Av følgende fag liker jeg - Norsk

Alternativer	Prosent	Verdi
1 Svært godt	23,5 %	12
2 Godt	43,1 %	22
3 nøytralt	33,3 %	17
4 Dårlig	0,0 %	0
5 Svært dårlig	0,0 %	0
6 Har ikke	0.0 %	0
Total		51

2.2 Av følgende fag liker jeg - Engelsk

Alternativer	Prosent	Verdi
1 Svært godt	11,8 %	6
2 Godt	19,6 %	10
3 nøytralt	31,4 %	16
4 Dårlig	31,4 %	16
5 Svært dårlig	5,9 %	3
6 Har ikke	0,0 %	0
Total		51

2.3 Av følgende fag liker jeg - Naturfag

Alternativer	Prosent	Verdi
1 Svært godt	17,6 %	9
2 Godt	37,3 %	19
3 nøytralt	35,3 %	18
4 Dårlig	9,8 %	5
5 Svært dårlig	0,0 %	0
6 Har ikke	0,0 %	0
Total		51

2.4 Av følgende fag liker jeg - Historie

Alternativer	Prosent	Verdi
1 Svært godt	5,9 %	3
2 Godt	17,6 %	9
3 nøytralt	11,8 %	6
4 Dårlig	2,0 %	1
5 Svært dårlig	2,0 %	1
6 Har ikke	60,8 %	31
Total		51

2.5 Av følgende fag liker jeg - Geografi

Alternativer	Prosent	Verdi
1 Svært godt	11,8 %	6
2 Godt	35,3 %	18
3 nøytralt	45,1 %	23
4 Dårlig	7,8 %	4
5 Svært dårlig	0,0 %	0
6 Har ikke	0,0 %	0
Total		51

2.6 Av følgende fag liker jeg - Kroppsøvning

Alternativer	Prosent	Verdi
1 Svært godt	41,2 %	21
2 Godt	31,4 %	16
3 nøytralt	21,6 %	11
4 Dårlig	3,9 %	2
5 Svært dårlig	2,0 %	1
6 Har ikke	0,0 %	0
Total		51

2.7 Av følgende fag liker jeg - Religion

Alternativer	Prosent	Verdi
1 Svært godt	0,0 %	0
2 Godt	5,9 %	3
3 nøytralt	9,8 %	5
4 Dårlig	9,8 %	5
5 Svært dårlig	2,0 %	1
6 Har ikke	72,5 %	37
Total		51

2.8 Av følgende fag liker jeg - Matematikk

Alternativer	Prosent	Verdi
1 Svært godt	9,8 %	5
2 Godt	27,5 %	14
3 nøytralt	37,3 %	19
4 Dårlig	9,8 %	5
5 Svært dårlig	15,7 %	8
6 Har ikke	0,0 %	0
Total		51

2.9 Av følgende fag liker jeg - Informasjonsteknologi

Alternativer	Prosent	Verdi
1 Svært godt	2,0 %	1
2 Godt	2,0 %	1
3 nøytralt	7,8 %	4
4 Dårlig	2,0 %	1
5 Svært dårlig	2,0 %	1
6 Har ikke	84,3 %	43
Total		51

2.10 Av følgende fag liker jeg - Fysikk

Alternativer	Prosent	Verdi
1 Svært godt	0,0 %	0
2 Godt	5,9 %	3
3 nøytralt	5,9 %	3
4 Dårlig	3,9 %	2
5 Svært dårlig	2,0 %	1
6 Har ikke	82,4 %	42
Total		51

2.11 Av følgende fag liker jeg - Kjemi

Alternativer	Prosent	Verdi
1 Svært godt	0,0 %	0
2 Godt	5,9 %	3
3 nøytralt	7,8 %	4
4 Dårlig	3,9 %	2
5 Svært dårlig	2,0 %	1
6 Har ikke	80,4 %	41
Total		51

2.12 Av følgende fag liker jeg - Biologi

Alternativer	Prosent	Verdi
1 Svært godt	3,9 %	2
2 Godt	7,8 %	4
3 nøytralt	2,0 %	1
4 Dårlig	3,9 %	2
5 Svært dårlig	2,0 %	1
6 Har ikke	80,4 %	41
Total		51

2.13 Av følgende fag liker jeg - Rettslære

Alternativer	Prosent	Verdi
1 Svært godt	0,0 %	0
2 Godt	5,9 %	3
3 nøytralt	3,9 %	2
4 Dårlig	3,9 %	2
5 Svært dårlig	2,0 %	1
6 Har ikke	84,3 %	43
Total		51

3. Gjennomsnittlig tid per dag:

Alternativer	N
1 Total tid foran datamaskinen	51
2 Skole relatert arbeid på datamaskin	51
3 Spill på datamaskin(flash, kabal osv.)	51
4 Sosiale medier/chat (Facebook, Twitter, MSN osv)	51

3.1 Gjennomsnittlig tid per dag: - Total tid foran datamaskinen

Alternativer	Prosent	Verdi
1 Mindre enn 1 time	5,9 %	3
2 1-3 timer	31,4 %	16
3 3-6 timer	37,3 %	19
4 6-9 timer	21,6 %	11
5 9-12 timer	3,9 %	2
6 12 timer eller mer	0,0 %	0
Total		51

3.2 Gjennomsnittlig tid per dag: - Skole relatert arbeid på datamaskin

Alternativer	Prosent	Verdi
1 Mindre enn 1 time	15,7 %	8
2 1-3 timer	60,8 %	31
3 3-6 timer	17,6 %	9
4 6-9 timer	5,9 %	3
5 9-12 timer	0,0 %	0
6 12 timer eller mer	0,0 %	0
Total		51

3.3 Gjennomsnittlig tid per dag: - Spill på datamaskin(flash, kabal osv.)

Alternativer	Prosent	Verdi
1 Mindre enn 1 time	72,5 %	37
2 1-3 timer	19,6 %	10
3 3-6 timer	3,9 %	2
4 6-9 timer	3,9 %	2
5 9-12 timer	0,0 %	0
6 12 timer eller mer	0,0 %	0
Total		51

3.4 Gjennomsnittlig tid per dag: - Sosiale medier/chat (Facebook, Twitter, MSN osv)

Alternativer	Prosent	Verdi
1 Mindre enn 1 time	19,6 %	10
2 1-3 timer	52,9 %	27
3 3-6 timer	19,6 %	10
4 6-9 timer	7,8 %	4
5 9-12 timer	0,0 %	0
6 12 timer eller mer	0,0 %	0
Total		51

5. Jeg bruker, besøker:

Alternativer	N
1 Google maps (maps.google.com)	51
2 Yahoo! maps (maps.yahoo.com)	51
3 Bing maps (www.bing.com/maps/)	51
4 Gule Sider Kart (www.gulesider.no/kart)	51
5 yr.no (www.yr.no)	51
6 Finn Kart (kart.finn.no)	51
7 Norge I Bilder (norgeibilder.no)	51
8 Kvasir kart (www.kvasir.no/kart)	51
9 Hvor (www.hvor.no)	51
10 Trafikanten (www.trafikanten.no)	51
11 Norgeskartet (www.norgeskartet.no)	51
12 Atlas.no (www.atlas.no/)	51

5.1 Jeg bruker, besøker: - Google maps (maps.google.com)

Alternativer	Prosent	Verdi
1 Aldri	56,9 %	29
2 1-5 ganger per måned	29,4 %	15
3 En gang i uken	11,8 %	6
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	2,0 %	1
6 Flere ganger om dagen	0,0 %	0
Total		51

5.2 Jeg bruker, besøker: - Yahoo! maps (maps.yahoo.com)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.3 Jeg bruker, besøker: - Bing maps (www.bing.com/maps/)

Alternativer	Prosent	Verdi
1 Aldri	98,0 %	50
2 1-5 ganger per måned	2,0 %	1
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.4 Jeg bruker, besøker: - Gule Sider Kart (www.gulesider.no/kart)

Alternativer	Prosent	Verdi
1 Aldri	45,1 %	23
2 1-5 ganger per måned	47,1 %	24
3 En gang i uken	5,9 %	3
4 1-5 ganger i uken	2,0 %	1
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.5 Jeg bruker, besøker: - yr.no (www.yr.no)

Alternativer	Prosent	Verdi
1 Aldri	33,3 %	17
2 1-5 ganger per måned	37,3 %	19
3 En gang i uken	19,6 %	10
4 1-5 ganger i uken	3,9 %	2
5 1 gang om dagen	3,9 %	2
6 Flere ganger om dagen	2,0 %	1
Total		51

5.6 Jeg bruker, besøker: - Finn Kart (kart.finn.no)

Alternativer	Prosent	Verdi
1 Aldri	82,4 %	42
2 1-5 ganger per måned	15,7 %	8
3 En gang i uken	2,0 %	1
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.7 Jeg bruker, besøker: - Norge I Bilder (norgeibilder.no)

Alternativer	Prosent	Verdi
1 Aldri	88,2 %	45
2 1-5 ganger per måned	11,8 %	6
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.8 Jeg bruker, besøker: - Kvasir kart (www.kvasir.no/kart)

Alternativer	Prosent	Verdi
1 Aldri	92,2 %	47
2 1-5 ganger per måned	7,8 %	4
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.9 Jeg bruker, besøker: - Hvor (www.hvor.no)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.10 Jeg bruker, besøker: - Trafikanten (www.trafikanten.no)

Alternativer	Prosent	Verdi
1 Aldri	80,4 %	41
2 1-5 ganger per måned	13,7 %	7
3 En gang i uken	3,9 %	2
4 1-5 ganger i uken	2,0 %	1
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.11 Jeg bruker, besøker: - Norgeskartet (www.norgeskartet.no)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

5.12 Jeg bruker, besøker: - Atlas.no (www.atlas.no/)

Alternativer	Prosent	Verdi
1 Aldri	98,0 %	50
2 1-5 ganger per måned	2,0 %	1
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6. Jeg bruker, besøker:

Alternativer	N
1 Miljøstatus i Norge (www.miljostatus.no/no/K art-og-miljodata/kart/)	51
2 seNorge.no (www.senorge.no/)	51
3 Statens Kartverk (kart.statkart.no)	51
4 Kystverket (kart.kystverket.no)	51
5 Direktoratet for naturforvaltning (dnweb12.dirnat.no/nbinns yn/NB3_viewer.asp)	51
6 Skrednett (www.skrednett.no)	51
7 Norges vassdrags- og energidirektorat (arcus.nve.no/website/nve /viewer.htm)	51
8 Globalis (http://www.globalis.no/)	51

6.1 Jeg bruker, besøker: - Miljøstatus i Norge (www.miljostatus.no/no/Kart-og-miljodata/kart/)

Alternativer	Prosent	Verdi
1 Aldri	98,0 %	50
2 1-5 ganger per måned	2,0 %	1
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6.2 Jeg bruker, besøker: - seNorge.no (www.senorge.no/)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6.3 Jeg bruker, besøker: - Statens Kartverk (kart.statkart.no)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6.4 Jeg bruker, besøker: - Kystverket (kart.kystverket.no)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6.5 Jeg bruker, besøker: - Direktoratet for naturforvaltning (dnweb12.dirnat.no/nbinnsyn/NB3_viewer.asp)

Alternativer	Prosent	Verdi
1 Aldri	98,0 %	50
2 1-5 ganger per måned	2,0 %	1
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6.6 Jeg bruker, besøker: - Skrednett (www.skrednett.no)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6.7 Jeg bruker, besøker: - Norges vassdrags- og energidirektorat (arcus.nve.no/website/nve/viewer.htm)

Alternativer	Prosent	Verdi
1 Aldri	100,0 %	51
2 1-5 ganger per måned	0,0 %	0
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

6.8 Jeg bruker, besøker: - Globalis (http://www.globalis.no/)

Alternativer	Prosent	Verdi
1 Aldri	66,7 %	34
2 1-5 ganger per måned	33,3 %	17
3 En gang i uken	0,0 %	0
4 1-5 ganger i uken	0,0 %	0
5 1 gang om dagen	0,0 %	0
6 Flere ganger om dagen	0,0 %	0
Total		51

10. Kart i skolen

Alternativer	N
1 Den digitale karttjenesten som ble brukt i timen økte min interesse for geografi.	51
2 Det økte min geografikunnskap om Norge.	51
3 Det hjalp meg med å løse oppgavene på en god måte.	51
4 Det økte min nysgjerrighet for å lære mer.	51
5 Det hjalp meg å forstå hvordan elektroniske karttjenester kan brukes.	51
6 Det forbedret mine dataferdigheter.	51
7 Det motiverte meg til å lære om og bruke nye teknologier.	51

10.1 Kart i skolen - Den digitale karttjenesten som ble brukt i timen økte min interesse for geografi.

Alternativer	Prosent	Verdi
1 Svært enig	3,9 %	2
2 Enig	23,5 %	12
3 Nøytral	52,9 %	27
4 Uenig	17,6 %	9
5 Svært uenig	2,0 %	1
Total		51

10.2 Kart i skolen - Det økte min geografikunnskap om Norge.

Alternativer	Prosent	Verdi
1 Svært enig	2,0 %	1
2 Enig	33,3 %	17
3 Nøytral	49,0 %	25
4 Uenig	13,7 %	7
5 Svært uenig	2,0 %	1
Total		51

10.3 Kart i skolen - Det hjalp meg med å løse oppgavene på en god måte.

Alternativer	Prosent	Verdi
1 Svært enig	5,9 %	3
2 Enig	41,2 %	21
3 Nøytral	37,3 %	19
4 Uenig	11,8 %	6
5 Svært uenig	3,9 %	2
Total		51

10.4 Kart i skolen - Det økte min nysgjerrighet for å lære mer.

Alternativer	Prosent	Verdi
1 Svært enig	3,9 %	2
2 Enig	13,7 %	7
3 Nøytral	60,8 %	31
4 Uenig	17,6 %	9
5 Svært uenig	3,9 %	2
Total		51

10.5 Kart i skolen - Det hjalp meg å forstå hvordan elektroniske karttjenester kan brukes.

Alternativer	Prosent	Verdi
1 Svært enig	11,8 %	6
2 Enig	35,3 %	18
3 Nøytral	37,3 %	19
4 Uenig	11,8 %	6
5 Svært uenig	3,9 %	2
Total		51

10.6 Kart i skolen - Det forbedret mine dataferdigheter.

Alternativer	Prosent	Verdi
1 Svært enig	2,0 %	1
2 Enig	19,6 %	10
3 Nøytral	52,9 %	27
4 Uenig	15,7 %	8
5 Svært uenig	9,8 %	5
Total		51

10.7 Kart i skolen - Det motiverte meg til å lære om og bruke nye teknologier.

Alternativer	Prosent	Verdi
1 Svært enig	3,9 %	2
2 Enig	15,7 %	8
3 Nøytral	51,0 %	26
4 Uenig	23,5 %	12
5 Svært uenig	5,9 %	3
Total		51

11. Empty

Alternativer	N
1 Jeg forstod med en gang at man kunne klikke på kartet.	51
2 Jeg måtte benytte meg av navigering tipsene under kartet.	51
3 Jeg skjønte raskt at valg av årstider førte til endringer i kartet.	51
4 Jeg synes det var lett å navigere seg rundt på kartet.	51
5 Det var lett å hente ut ønsket informasjon fra kartet.	51
6 Kartet gjorde det enkelt å forstå forholdet mellom fylker og kommuner i Norge	51
7 Det var enkelt å organisere den valgte informasjonen i min liste.	51
8 Jeg synes at bruk av kart var en lærerik og fin metode å skaffe seg ønsket informasjon på.	51

11.1 Empty - Jeg forstod med en gang at man kunne klikke på kartet.

Alternativer	Prosent	Verdi
1 Svært enig	43,1 %	22
2 Enig	35,3 %	18
3 Nøytral	21,6 %	11
4 Uenig	0,0 %	0
5 Svært uenig	0,0 %	0
Total		51

11.2 Empty - Jeg måtte benytte meg av navigering tipsene under kartet.

Alternativer	Prosent	Verdi
1 Svært enig	0,0 %	0
2 Enig	15,7 %	8
3 Nøytral	45,1 %	23
4 Uenig	29,4 %	15
5 Svært uenig	9,8 %	5
Total		51

11.3 Empty - Jeg skjønte raskt at valg av årstider førte til endringer i kartet.

Alternativer	Prosent	Verdi
1 Svært enig	7,8 %	4
2 Enig	15,7 %	8
3 Nøytral	51,0 %	26
4 Uenig	19,6 %	10
5 Svært uenig	5,9 %	3
Total		51

11.4 Empty - Jeg synes det var lett å navigere seg rundt på kartet.

Alternativer	Prosent	Verdi
1 Svært enig	15,7 %	8
2 Enig	35,3 %	18
3 Nøytral	41,2 %	21
4 Uenig	7,8 %	4
5 Svært uenig	0,0 %	0
Total		51

11.5 Empty - Det var lett å hente ut ønsket informasjon fra kartet.

Alternativer	Prosent	Verdi
1 Svært enig	9,8 %	5
2 Enig	35,3 %	18
3 Nøytral	49,0 %	25
4 Uenig	3,9 %	2
5 Svært uenig	2,0 %	1
Total		51

11.6 Empty - Kartet gjorde det enkelt å forstå forholdet mellom fylker og kommuner i Norge

Alternativer	Prosent	Verdi
1 Svært enig	17,6 %	9
2 Enig	29,4 %	15
3 Nøytral	49,0 %	25
4 Uenig	0,0 %	0
5 Svært uenig	3,9 %	2
Total		51

11.7 Empty - Det var enkelt å organisere den valgte informasjonen i min liste.

Alternativer	Prosent	Verdi
1 Svært enig	9,8 %	5
2 Enig	21,6 %	11
3 Nøytral	58,8 %	30
4 Uenig	7,8 %	4
5 Svært uenig	2,0 %	1
Total		51

11.8 Empty - Jeg synes at bruk av kart var en lærerik og fin metode å skaffe seg ønsket informasjon på.

Alternativer	Prosent	Verdi
1 Svært enig	13,7 %	7
2 Enig	23,5 %	12
3 Nøytral	60,8 %	31
4 Uenig	0,0 %	0
5 Svært uenig	2,0 %	1
Total		51

15. Teknologi i skolen

Alternativer	N
1 Jeg synes at mine lærere er flinke til å ta i bruk teknologiske hjelpemidler i undervisningen.	51
2 Det er ofte at lærerne tar i bruk nettressurser i timen.	51
3 Jeg anser det som svært viktig å ta i bruk ny teknologi i undervisningen.	51

15.1 Teknologi i skolen - Jeg synes at mine lærere er flinke til å ta i bruk teknologiske hjelpemidler i undervisningen.

Alternativer	Prosent	Verdi
1 Svært enig	9,8 %	5
2 Enig	54,9 %	28
3 Nøytral	23,5 %	12
4 Uenig	7,8 %	4
5 Svært uenig	3,9 %	2
Total		51

15.2 Teknologi i skolen - Det er ofte at lærerne tar i bruk nettressurser i timen.

Alternativer	Prosent	Verdi
1 Svært enig	11,8 %	6
2 Enig	41,2 %	21
3 Nøytral	29,4 %	15
4 Uenig	15,7 %	8
5 Svært uenig	2,0 %	1
Total		51

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15.3 Teknologi i skolen - Jeg anser det som svært viktig å ta i bruk ny teknologi i undervisningen.

Alternativer	Prosent	Verdi
1 Svært enig	35,3 %	18
2 Enig	39,2 %	20
3 Nøytral	25,5 %	13
4 Uenig	0,0 %	0
5 Svært uenig	0.0 %	0
Total		51