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Can a code snippet portal contribute to greater learning outcomes in other fields of science and technology?

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INF-3981 Master Thesis in Computer Science June 2021

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*To my family,
Thank you for your love and support*

Abstract

Fall of 2020, a capstone project was carried out as part of the KVANT-project, with a focus on programming in the sciences at Science and Technology Faculty. The capstone project researched on whether students belonging to the Faculty of Science and Technology at the University of Tromsø, found programming useful in their study field or discipline. The results found was that the use and usefulness of programming was different in the different fields of study. But the basic programming that the students learned during their first semester of study has been of great benefit to most people, because over the years programming has been more useful than expected.

This thesis aims to find a solution to one of the problems that arose from the questionnaire carried out in the capstone project. The problem was that not all science students had enough competence in programming to be able to solve problems and find solutions for the problems in their science subjects. In this project we developed a web portal for students and by students in order to be able to help each other understanding coding in the different subjects across fields of study. The web portal is implemented using HTML programming language and its templates, and running the front-end with flask web application framework. A database has been made for collecting and storing code snippets.

Acknowledgements

There are a number of people that I would like to thank for their support during the writing of this thesis. I would first and foremost like to thank my supervisors at The Arctic University of Tromsø, Edvard Pedersen and Hilja Lisa Huru for their continuous guidance and support during this thesis. I really could not ask for better supervisors than the two of you, thank you for all the effort. Thank you Edvard for reading over my overleaf document at 10pm in the evening and 8am in the mornings.

To my fellow classmates: Thank you for all the good and stressful times, UiT truly would not have been the same without you. Thank you!

To my beloved family and closest friends, thank you for your support and understanding throughout all five years. Without your support, I would not have been here. I'm forever grateful.

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Introduction

We constantly read and hear that today's students will probably work in jobs that do not yet exist. This development means that the focus must be on skills, knowledge and competence that will be relevant today and in the future. Society is constantly evolving, which requires the school to keep up with this change. Society is constantly evolving, which requires the school to keep up with this change. To prepare today's young people for a future we do not yet know what to expect, various measures have been initiated.

The expert group of the Norwegian Directorate for Education and Training stated in a report published in 2016 that technology and programming should become a practical subject in basic education[3]. Algorithmic thinking and programming are seen as central knowledge for acquiring knowledge of how digital technology works. Such knowledge will have an impact on the development of a digital society.

Internationally it has in recent years, an movement has emerged to promote programming in schools. A website named Code.org was launched back in 2013, where they believed "(...) every student in every school should have the opportunity to learn computer science"[11]. This website has among other things been supported by many big IT companies such as Google, Microsoft, Amazon and Facebook. What we see happening in schools has also become a trend that is reflected in higher education in recent years. We can specifically look at Faculty of science and technology at University of Tromsø that have had several fields of study which until now did not have any programming in

them. Which it now is determined that all fields of study belonging to Faculty of science and technology must have at least one programming subject throughout their study course.

Having a common programming subject for different fields of study, brings together students and makes a connection between them, which again leads to cooperation. Students not steady enough in programming, can through this cooperation get knowledge and make their programming skills stronger together.

We will through qualitative method interview students from different fields of study to find out if students find this web portal as a tool that can provide learning outcomes.

1.1 Background

The development of the technology in the society today and in future challenges the way we learn and the skills that becomes important. As much as we are depended on technology today, is today and future's technology depended on our generation. And programming has become a necessary skill for learning, working and living in today's and tomorrow's society.

Changes for the future and new elements in the sciences in schools and universities have caught my interest over the past year, especially after the survey conducted in the fall semester at the faculty of Science and Technology at University of Tromsø. The project assignment completed in the fall semester focused on the usefulness of programming in the science subjects at the faculty, and how science students used programming to solve assignments or problems either school-related, job-related or only leisure-related code problems.

Programming provides the opportunity to link theory to a practical context where students create the technology of the future. And therefore, it is important to see a connection between what we learn and how we can use it. And that new knowledge is seen in connection with the competence we already have.

1.2 Motivation

As an computer science student, I have only had programming subjects in recent years, with the exception of some electives courses that do not have programming in them. In my first semester of computer science, I had a programming subject that was common to most students belonging to the Faculty of Science and Technology. Since 2017, this subject INF-1100 (Introduction to Programming) has only been compulsory for computer science students, while for other science students this has been an elective subject. The other fields of study, on the other hand, have been given a new subject as compulsory in the first semester, INF-1049 (calculation-oriented programming). The aim of this change was to introduce a lighter computer science subject than INF-1100 for science students, which is included as an important application in the other science subjects. After this change, I was convinced that other fields of study have more need for programming than I thought, and it became more and more interesting to find out about how they use programming in other science subjects.

1.3 The purpose

This thesis describes and evaluates an idea to give science students a tool that can be used as an aid to become steady in programming and whether this tool can provide learning outcomes in the science subjects.

1.4 Thesis Statement

The application made in this project should be used as a tool to provide learning outcomes in the science subjects. The purpose is to spread knowledge and learning across fields of study, so that it provides the greatest possible learning outcomes.

The main research question of the project is:

- *Can a code snippet portal contribute to greater learning outcomes in other fields of science and technology?*

The main research question is divided into sub-problems in order to be able to answer to the main research question.

1. *How can the application be a useful tool to become more steady in program-*

ming and to strengthen students programming skills?

- 2. Can the application be a useful tool to strengthen understanding in mathematics and physics and the other science subjects in solving their problems?*

/2

Theory

In this chapter, relevant theory that will strengthen the study will be explained. The thesis' problem is to investigate how a prototype of a web portal can provide learning benefits to science students and promote their competence in programming and help students become more stable in programming. It is therefore relevant to understand some concepts within computer science and programming, to understand the relationship between the science subjects and programming. In this context, the difference between informatics and computer science are explained, and what Computational Thinking and algorithmic thinking are, is also explained. At the end of the chapter we will look at the definition of the concept of learning outcomes and Collaborative learning.

2.1 Computer Science

Computer science is the science behind any software, from individual computer programs, mobile apps and games, to large IT systems, databases and web portals. A computer science teacher, Sheena Vaidyanathan, explains the difference between computer science and programming briefly: "Computer science is about solving problems using computers, while programming(coding) is about implementing these solutions. This makes programming the most visible component of computer science"[20].

2.1.1 Informatics versus Computer Science

Informatics is described differently around the world, and it does not have a single widely-agreed meaning. In most countries, specially outside of Europe, they have a difference between Computer Science and informatics. Some see informatics as a cousin to Information technology(IT), others say it contains concepts from Computer Science(CS). Computer science concerns the analysis of computation and design of computing systems[15]. It is informed by other disciplines and goes more in depth on subjects as mathematics, physics, programming and other engineering electives. Informatics is also informed by other disciplines, such as mathematics, biology, physics. However, it provides a link between disciplines with their own methodologies and perspectives.[8] It is often linked to the study of information and engineering. For keeping it short, most of countries sees computer science as a bigger field than the informatics, where they have informatics as a separate field of study. While in Norway informatics is equivalent to computer science. It is still the study of how computer systems are constructed and used, it's just the word computer science which is called informatics in Norwegian and is considered as the same field of study.

2.2 Problem Solving

Problem solving, algorithms, logical thinking and argumentation have always been a central part of mathematics, and now also other science subjects. Programming in sciences is about taking a scientific problem and solving it with the help of a computer program. The project Assessment Teaching of 21st Century Skills defines programming skills in four different categories, how we think, how we work, tools we use when we work and how we live in the world.[11] Students who take higher education bring a number of varying prior knowledge into the education. Prerequisites that have been shown to influence students' ability to program include problem-solving skills, mathematics and programming experience.

A Norwegian study done by physics students who programmed at UiO showed that this was precisely one of the challenges the students faced. When students were left to work on programming assignments on their own, a lot of trial and wrong-tactics were often used in the assignments.[1] Sørby and Angell believe that students must receive sufficient follow-up so that they have a more conscious relationship to the strategies they use when programming.

2.2.1 Computational Thinking - CT

Computational Thinking is a reality that is crucial skill for today's workforce. Jeannete Wing, a computer science professor finds computational thinking as a skill in line with reading, writing and arithmetic.[24] In an article Wing explains computational thinking this way:

(...) computer science offers not just useful software and hardware artifacts, but also an intellectual framework for thinking, what I call "computational thinking". Everyone can benefit from thinking computationally. My grand vision is that computational thinking will be a fundamental skill just like reading, writing and arithmetic - used by everyone by the middle of the 21st Century. (Jeannete Wing)

What process one follows to formulate and solve a problem, and how the abilities of human thinking can be combined with the technical abilities of a computer to do so, they are at the core of what computational thinking is all about.

An important key concepts of Computational thinking is, algorithmic thinking. Often, is CT translated into algorithmic thinking even if it is not completely comprehensive. It usually uses as a concept to improve children and young people for the challenges of the future in an increasingly digital society[3].

Algorithmic Thinking

Algorithmic problem solving is about transforming a general problem into a form that can be solved using programming.[3] Algorithmic thinking sees as a part of the core element of "exploration and problem solving", it is important for developing strategies and procedures. A core element group in mathematics belonging to the Directorate of Education in Norway, describes the importance of programming in science subjects as follows: «In order to give life to algorithmic thinking, it is therefore important that it is combined with learning programming. When we have entered algorithmic thinking as a core element, it therefore also means that the mathematics subject must provide basic programming training from an early stage.»[14]

2.2.2 Programming in other science courses

In order to be able to discuss the introduction of programming in other science courses, it is important to form a modern and detailed picture of what

programming is and what it entails. The Norwegian Directorate for Education describes programming as follows: «Programming means breaking a given problem down in a set of commands and then get a computer to perform these commands.»[3] The commands is a code written in a programming language to get the computer to do as desired. Programming can help to make it visible and strengthen the key subject areas such as mathematics and aesthetic subjects. Where we can combine subject-specific skills with programming skills. This provides an opportunity to link theoretical mathematical concepts to a practical context where students gain an understanding of knowledge in a larger context. Programming as a subject requires subject-specific competence in the practice, such as logic, algorithms and syntax. Programming requires many of the same skills that are also associated with subject-specific competence in mathematics and other science subjects.[11] The combination of algorithmic thinking and programming is powerful and diverse. For example, it makes it possible to systematize, structure, delimit and analyze a part of reality and then create a computer program that performs a specific task related to this reality. But it can also be creating a new reality.

2.3 Learning outcomes

The term "Læringsutbytte" in Norwegian is a direct translation of the English word "learning outcome". The European Qualifications Framework describes the term as follows: «Statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence.»[6] Learning outcomes as the concept is inextricably linked to concepts of qualifications or competences, because they express what a person with specific qualifications can be expected to be able to, understand and be able to do. The concept of qualification forms a connection between the knowledge that is developed within the education system and the requirements that are set in working life.[4] In Norway, the term is often used in the form of a compilation of knowledge, skills and general competence, which collectively describe learning outcomes in a subject or study program. This states that the term is used in a way it includes both the prescribed goals for students' learning, as well as the results of this learning as it is captured through learning activities such as exams and grading.

Higher education has expanded a lot in the past two decades. The development of a mass education system in higher education raises the question of whether the criteria for what students should learn can be determined and measured simply by the academic communities themselves, as is done through exams.[4] In addition, there are requirements from working life that the candidates

must master more than purely professional knowledge, such as abilities for collaboration, analytical skills, etc. Due to the fact that the term is linked to qualifications and competence, which will help organizations and other types of institutions to recognize the students' qualifications, and content of learning. It is required clearer requirements are set for universities and colleges to report on their results, and requirements for formal systems for quality assurance.

2.4 Collaborative Learning

Collaborative Learning (CL) is an e-learning educational approach to teaching and learning by which a group of persons interact to learn and understand a problem or reach a common goal.[10] In short, the concept can be explained by how individuals, students, learn with concrete tools in groups, how they interact and develop shared understanding of the the problem over time and that they are responsible for each other's learning.

It is often difficult to distinguish between the term collaborative and cooperative. According to the article written by *Heisawn Joeng and Cindy E.Hmelo-Silver*,[10] both terms mean that the members of a group need to be collaborative and cooperative in the process of working together. But what the collaborative really focuses on is the process by which a group of people engage in activities towards a shared goal. And that the finale result promotes collectively of knowledge to both individuals and collectives.

2.4.1 Computer Supported Collaborative Learning - CSCL

The main purpose of dedicated Collaborative learning is to create tools, activities and environments that provide better learning and practice in group work. Which can lead a group of students around the same computer to solve a problem. It represents both a sub field in pedagogical research and expands the framework for educational research since it is based on the use of informatics and information systems. CSCL thus requires tools that promotes social interaction and support the transition from social interaction to learning and development.[10] Within CSCL, the focus on learning is that one learns through collaboration with other students, instead of directly from the teacher. Therefore, the computer must be able to instruct and provide feedback, contribute facts and support collaboration by acting as a communication medium and scaffolding for productive student interaction.

CSCL can also take place through social media such as Twitter, weblogs, wiki

pages for collaboration, and some other. While Cloud services to share information. Web technology is suitable for collaborative learning, collective knowledge building, knowledge management, social networks and social interaction, which means that both teacher and student become more active and personally involved.[2]

According to Stahl, Koschmann and Suthers, the use of technology aims to increase learning outcomes. It is the participants' ability to adapt to a form of communication that sets the limit for what can be achieved, so technological adaptation alone does not improve the learning outcome.[18] In this thesis project I will use this theory about CSCL and its 7 affordances to try to find out whether the web portal as a tool can provide learning outcomes.

7 core affordances based on theories of collaborative learning and CSCL

1. Engage in a joint task
2. Communicate
3. Share resources
4. Engage in productive collaborative learning processes
5. Engage in co-communication
6. Monitor and regulate collaborative learning
7. Find and build groups and communities

Further in the thesis I will only focus on four of these affordances, number 1 to 3 and number 5, will be the focus when I talk about CSCL.

/3

Method

This chapter will explain the method choices made in connection with the research project. At first the methodological approach is presented with a brief explanation of qualitative methods as well as execution of the method. We will go through the process of how the informants were chosen, the interview guide, and how I conducted the interviews. In section 3 of the chapter we will look at the analysis methods that I will use, before looking at quality assurance and design prototyping methods.

3.1 Research Methods

The method chosen in this thesis is based on the qualitative research method. My approach to this method is largely based on the theories to Tove Thagaard, from her book "systematikk og innlevelse". Most qualitative methods are characterized by direct contact between the researcher and those being studied, in forms of interviews or observation[19]. The goal of qualitative research is to achieve an understanding of social phenomena. Interpretation is therefore of great importance in qualitative research, it makes demands to the researcher's ability to interpret.

According to Thagaard, interview provides information about informant's life

and experiences, and interview as a method provides a particularly good basis for insight into the informant's experiences, thoughts and feelings.[19] The method this thesis is based on is the qualitative research interviews.

3.1.1 Background for chosen qualitative method

As mentioned above, qualitative studies can be aimed at a desire to gain insight into social phenomena as they are understood by the people the researcher is studying. Therefore, a conversation can be a good starting point for gaining knowledge about how individuals experience and reflect on their situation[19]. This means one of the strengths of qualitative methods is the researcher's ability to manage the project along the way when there are interesting findings. For example, in an interview, interesting topics may emerge that the researcher was not aware of in advance. Then the researcher can choose to direct the interview into these topics and therefore capture new, interesting findings that can fit into the project. At the same time, qualitative methods are at the mercy of researchers' ability to, for example, interview or observe.

3.1.2 The selection of informants

The question about who the researcher should receive information from involves defining the sample on which the study is based. Qualitative studies are based on so-called strategic selections. That is, one chooses informants who have the characteristics or qualifications that are strategic in relation to the thesis problem[19].

The selection of informants in my study consists of seven informants, five women and two men, all of whom students belonging to the science and technology faculty at UiT. The informants had to belong to the faculty of science and technology in order to be selected. The informants are students from different fields of study within the faculty and at different stages on their studies, for best possible results. The informants were chosen regardless of whether they have any programming background or not. My supervisors had some contact with students belonging to other science fields of study than informatics, so we agreed that they should find some students who could be interviewed. They got the email addresses of the students and I contacted them for the time and place, and conduct of interviews. While I was in contact with some informatics students, regardless of cohort or programming skills. The chosen informants have different subjects, where each gets to use programming for their own purposes. Therefore, I believe that these students have qualifications that are

relevant to the project's problem.

I think that a selection of seven informants may be appropriate in relation to having time to go in depth in the analysis, time period and level of the master's thesis. The selection of informants was made by an agreement between me and both my supervisors.

3.2 Interview as a research method

An interview is a tool for keeping focus on what is being explored, as the interview questions are intended to open up so that the phenomenon or topic is illuminated from different perspectives and angles[12]. The most commonly used method in qualitative interviews is a partially structured, or in other words semi-structured approach. A semi-structured interview is used when topics from daily life are to be understood from the interviewee's own perspectives. It is conducted in accordance with an interview guide that contains specific topics and any suggestions for questions.

I have chosen to conduct the interviews in the form of a semi-structured approach and with help of an interview guide. It is a face-to-face type of interview because as an interviewer I can read the body language, and it also becomes easier to avoid misunderstandings. At the same time, it is also easier to gain trust, which is very important for the informant to give open and honest answers.[19] The interview questions are relative predetermined, but there is room not to follow the questions in order or may ask more questions during the conversation.

In order to collect data that can be analyzed for the project, it is chosen to use audio recordings during the interviews. This is both to strengthen the reliability and validity of the data material and to make it easier for data analysis later. The use of audio recordings adds an extra dimension to the data collection for ethical reasons in accordance with the processing of personally identifiable information. This is discussed later in a separate section 3.4.

3.2.1 Preparation of interview guide

When preparing the interview guide, it is important to focus on: what (the topic of the problem), why (the purpose of the interview) and how (interview

techniques, data collection, transcription and analysis)[12]. The interview questions often have a descriptive form with mainly what and how questions. Too many why questions can turn the interview from being descriptive to becoming explanatory and argumentative. This can lead to dropping out of the topic for the interview easily. It is therefore important that the interview questions are short and easy to understand.

The questions in the interview guide were asked on the basis of the capstone project which was carried out in the autumn of 2020. A questionnaire through the Norwegian online form "Nettskjema" was carried out with questions about how useful programming can be in other fields of study, and the use of programming in the various of science courses. The results from that survey, formed the basis for the questions in the interview guide for this master thesis. The survey conducted fall semester was only for students belonging to other fields of study in science and technology than computer science students. So the results are not based on computer science students, but only other science students at the faculty.

To what extent do you use programming for the following:

Where 1 being *never or almost never*, and 5 being *very often*

Svar fordelt på antall

	1	2	3	4	5
For mandatory assignments (obliger) *	2	1	4	2	3
Work on exercises or solve tasks in tutorials/seminars *	2	3	4	2	1
Preparation for lectures *	9	2	1	0	0
To understand concepts in your courses *	5	4	2	0	1
Work related (outside your studies) *	10	0	1	1	0
Personal interests/hobby/in leisure time *	4	4	1	2	1

Svar fordelt på prosent

	1	2	3	4	5
For mandatory assignments (obliger) *	16,7 %	8,3 %	33,3 %	16,7 %	25 %
Work on exercises or solve tasks in tutorials/seminars *	16,7 %	25 %	33,3 %	16,7 %	8,3 %
Preparation for lectures *	75 %	16,7 %	8,3 %	0 %	0 %
To understand concepts in your courses *	41,7 %	33,3 %	16,7 %	0 %	8,3 %
Work related (outside your studies) *	83,3 %	0 %	8,3 %	8,3 %	0 %
Personal interests/hobby/in leisure time *	33,3 %	33,3 %	8,3 %	16,7 %	8,3 %

Figure 3.1: Showing the results on one of the question from Nettskjema on the survey that was conducted fall semester 2020

The questions from interview guide were just what and how questions. In total, there were no more than five or six questions. Before getting started with the interviews, I told the informants that the interview guide is intended to be a kind of "guideline" for me. That it would give me a certain structure

to the conversation and an overview of how we get into key topics, but that other questions could be asked along the way. It is good to be informative and explain the purpose of the various aids. This can help to more easily establish a relationship of trust between the informant and me, and at the same time create a safe context for the conversation. It can make the informant better concentrate on the questions asked during the interview, that he does not have to sit and wonder about things.

3.2.2 Performing student interviews

The interview consisted of two parts, one part was to evaluate the web portal for approx. 20 min or as long as they wanted, the second part consisted of asking questions based on an interview guide that was made in advance. At the beginning of the interviews, I told the informants a little about my master's thesis, what it is about and the reason why they are chosen as informants. It could be that the web portal gave error messages or had bugs, so that the focus of the informants does not remain on these error messages when the questions were to be asked afterwards. They would know if any bugs in the web portal then they know what the thesis problem is aimed at and not the bugs that may arise when using the web portal. The first part of the interview the informants were to evaluate the web portal without any supervision, they were to add posts, change them and search for things in the web portal, without me helping or saying anything other than questions they had along the way. The second part of the interview started when they said they did not had anymore to do on web portal.

I used a digital audio recorder, also called a dictaphone, which is not connected to internet in any way, during all seven interviews. The informants agreed that this was fine by signing on a consent form. The informants were also made aware that in addition to audio recordings, I may would write down key words on a sheet of paper, and not only ask them questions from the interview guide, but also based on what is being said in the conversation. I tried to follow the questions in order with all the informants, to keep it easiest when later to transcribe the interviews. The questions were relatively open anyway, and I went back to the previous questions if I needed the informant to say more about a specific topic. If a question was a little badly formulated by me, and I saw that the informant did not quite knew what to answer, or that they gave too short answers to the questions. I tried to share my thought and ideas about the topic, to help them get back on track with the topic I was looking for.

3.3 Analysis of interviews

The aim of the analysis of qualitative data is to give the reader an increased understanding about the topic of the research. The first steps in a qualitative analysis process is that the researcher should get better acquainted with the data material. After performing the interviews, the analysis work is about reading or listening to the interviews several times. In this process, it is important to take notes on what the various informants say about the topics that are most interested and suitable for the thesis problem.

3.3.1 Transcription

According to Kvale and Brinkmann, transcripts are translations from spoken language to written language[12]. When the interviews are transcribed from oral to written form, the interviews are structured so that they are better suited for analysis[12]. In other words, transcription is to convert the audio files into text files, i.e. write down literally every word that is being said by both interviewer and respondent in the interviews. Transcribing the content gives an overview of the information that is been collected. Therefore, the collected data in form of audio recordings, are usually transcribed when the interview process is finished.

In total, the audio recordings lasted less than 60 minutes. In transcribed form, this was about 15 000 words. My transcripts are word for word in the sense that I have included all words, including writing down that the respondent is thinking. However, some of the respondents had other dialects than the official written standard for the Norwegian language(Bokmål). The transcripts were not word for word transcribed in term of language variant, the respondents statements are translated into Bokmål.

I started transcribing the first interviews before I finished doing all the interviews. As previously stated, two weeks were set aside to conduct all the interviews. It gave me time to transcribe the interviews while the information was fresh. The positive thing about transcribing along the way is that you get to listen to the tapes and make improvements for the next interview. I found that I had to formulate differently on some questions in my interview guide, and add some questions to get better answers suitable for my thesis problem. For example, I found that some questions led to answers that were not relevant to my project, and I found that as an interviewer I had to be a little more hesitant to move on to the next question, so that the respondent can finish talking.

3.3.2 The analysis process

The purpose of data analysis is to move from observations to science [19]. This means by analysing and interpret the data we will be able to answer our research questions. It is common to reduce and structure the amount of data generated through the qualitative data analysis. Then, the purpose of analysis is to interpret the content, and be able to answer the research questions. To structure and interpret the interview data, I have chosen to use thematic analysis method.

Thematic Analysis

Thematic analysis is a method that is common when identifying, analyzing and interpret the meaning content of the topics that emerge in the qualitative data material[5]. Braun and Clarke, the authors of the paper "*Using thematic analysis in psychology*" also describes thematic analysis as looking for topics that appear to be important or representative, in order to be able to describe the phenomenon being investigated. So this method is about analyzing themes across multiple data sets, rather than looking for themes within each data set. The advantage of thematic analysis is that it is very flexible and is not tied to a specific form of theoretical framework in steps itself.

There are several varieties of thematic analysis, but usually they are put together and one can therefore say that there are mainly 2 types of thematic analysis[5].

1. Realist: essentialist, inductive, semantic, and descriptive
2. Relativist: constructivist, deductive, latent and interpretative

I have chosen to use what is included in variant number one, *inductive analysis*. With an inductive approach, the analysis is started without any theoretical starting point, with the purpose of finding patterns in the data that can form theory or general concepts. The reason why I choose to have an inductive approach to the study, is because even though I have my wishes and hopes about how the results should be, there are always different opinions and views from other people. Thus, I went for inductive method, to listen to what the informants have to tell me, and thus find the focus of the study.

Together with the thematic analysis, I will also draw in four of the seven affordances from CSCL to find the positive and negative aspects of the web portal, and any challenges with those strategies. To see the connection between

those and the student statements. the four affordances I will be using further are: 1. *establishing a joint task*, 2. *communication*, 3. *sharing resources* and 5. *engaging in co-construction*.

3.4 Quality Assurance

According to Kvale and Brinkmann[12], the researcher should take ethical issues into account right from the beginning of the study to the end. This means that we must protect the informants, any information that can identify a person, at all stages of the study. The data has to be reliable, valid, replicable, and ethical in order to be used in the research.

3.4.1 Consent and confidentiality

All research projects that involve other people as participants, have the principle that the researcher must have the participant's informed consent before they participate in the study. The consent can be oral or written, but it is common for the consent to be in writing, in case it should be needed at a later time. By having a consent informants can at anytime choose to withdraw from the research project, without having negative consequences for the person. According to Tove Thagaard, a consent form should be free and not come from external pressure, the informant must understand what the participation entails and the informant must have the opportunity to withdraw at any time from all or parts of the research.[19].

In accordance with the principle of informed consent, all participants in my project were informed before the interview about the purpose of my study, and what the focus of my master's thesis was about. They were also told that I, as a researcher, would transcribe their interviews, analyze them and present the results in my master's thesis. And that the audio recordings were just for me to listen to and transcribe later to make the whole analysis easier. The informants were also informed that consent also means that they participated voluntarily. I double-checked that they were sure they would participate, and asked if they had anything they were wondering about right before start of the interview. In addition, all the informants were informed that they were one hundred percent anonymous, that their anonymity is protected and they could not be identified.

All of my informants agreed to the interview, as well as to the use of an audio recorder during the interview itself. The informants' informed consent also means that they participated voluntarily.

The consent form used is a consent belonging to another research going on at the Faculty of Science and Technology, the **KVANT-project**. The research project KVANT is based on "*quality in education science and technology*", and my research project fit well as a sub-project, since it already involves students from all fields of study within the faculty. I received approval from the project manager to use the consent form, when they had already received approval from Norwegian Center for Research Data(NSD). And everything is done in line with research ethics guidelines prepared by the Norwegian Center for Research Data (NSD) and to protect the informants' confidentiality. The consent form used in my thesis can be seen here [6](#)

3.4.2 Reliability and Validity

Reliability in scientific studies, often involves the study being verifiable. The reliability of the research has to do with the consistency and credibility of the research results. Questions related to reliability may be about whether the result of the study at another time can be reproduced by others.[12] The objectivity and credibility of the research will depend on my understanding and my interpretations as a researcher in the project, and whether others will accept these.

A question related to the study's reliability is whether one would have obtained a similar result if the survey had been done by another interviewer or on another group of informants. Since the study is qualitative and consists of a sample of seven students, the research will not be able to be generalized or given general validity. On the other hand, the fact that the research is qualitative means that a comprehensive and thorough analysis and interpretation of the data obtained has been carried out.

Validity in research is about truth, correctness and strength in what is said. Validity in social sciences is in the simplest sense that the study examines what it is intended to examine.[12]

3.5 Design prototyping methods

Before we move on to the next chapter, I will show how I have proceeded with the prototyping and design of the web portal. A prototype is a fully functioning model of a product, system or service we want to create, to explore

the problem area closer[9]. With other words, prototyping makes it possible for us to present the idea we have in front of somebody else to see if our idea has value. To get to an almost finished product at the end, different prototype methods were used.

3.5.1 Design process

To give a better picture of the design process I have used a slightly simplified version of the design model to the Software Development Life Cycle (SDLC) which they call for "the iterative design approach"[7]. Their design model includes 5 stages, planning, Analysis and Design, Implementation, Testing and Evaluation. I looked specifically into three parts of this model that I mean was the most important parts of a design process to get to an end result:

- Design - concept and specifications
- Prototyping - Implementing and preparations
- Evaluation - User feedback and analysis

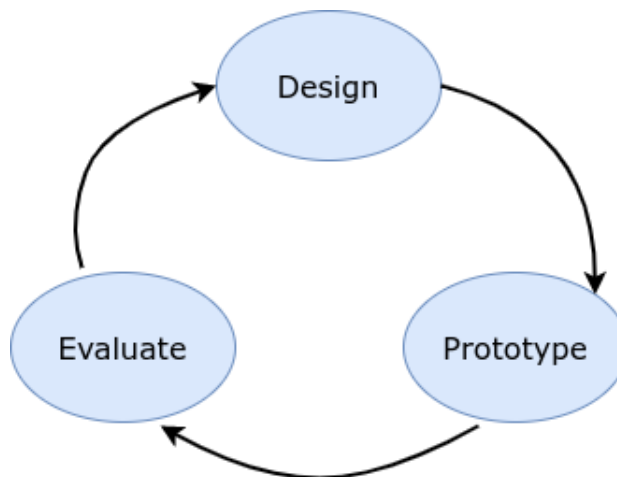


Figure 3.2: Iteration process

The illustration in Figure 3.2 shows that developing a prototype is an iterative process that goes on and on until you have reached the goal or are satisfied with a result. The process starts with designing a simple prototype of the product, this design is then tried by making a prototype of it. When a prototype exists, then one can involve users and evaluate the feedback we get from users of the prototype.

3.5.2 Paper Wireframe

WireFrame is the structural construction of the website with all the elements, drawn with lines and circles[13]. It is often easier to make a sketch on paper than it is to make a digital sketch with a program on computer. During this part of the process, there were no user tests, rather than myself to see the concept and structure before the final design. This is an early stage in the design process that I used to get an idea of how I should get started with the implementation, and types of features that I wanted to include in the application.

3.5.3 Digital prototyping

There are a number of different programs for digital prototyping. For example we can find Adobe XD, Marvel, AXURE, Google drawings etc. Which all of them are suitable for developing prototypes for both apps and websites. I chose to use google drawings because I have used it earlier, it does not cost anything and it is easy to use.

/4

Design and Implementation

The first section gives a description of the requirements set for the platform, the second section shows the architecture and goes through most important components of the platform in use. The third and last section describes the design and implementation of the platform.

4.1 Requirements

The main purpose of developing this application is to be able to solve the thesis problem. And even though this is supposed to be a prototype, I have set some basic requirements for how the system should be. I had the four CSCL affordances that I have focused on and user interactions in mind when requirements were set, and below are the set requirements on what the web portal should contain.

1. The web service shall make available a page a data form, where a user should be able to add course title and code snippet to the form and also be able to save, edit and delete

2. The web service shall have a sidebar with categories of different course codes
3. The web service shall have a page containing a list of all the posts added by the users

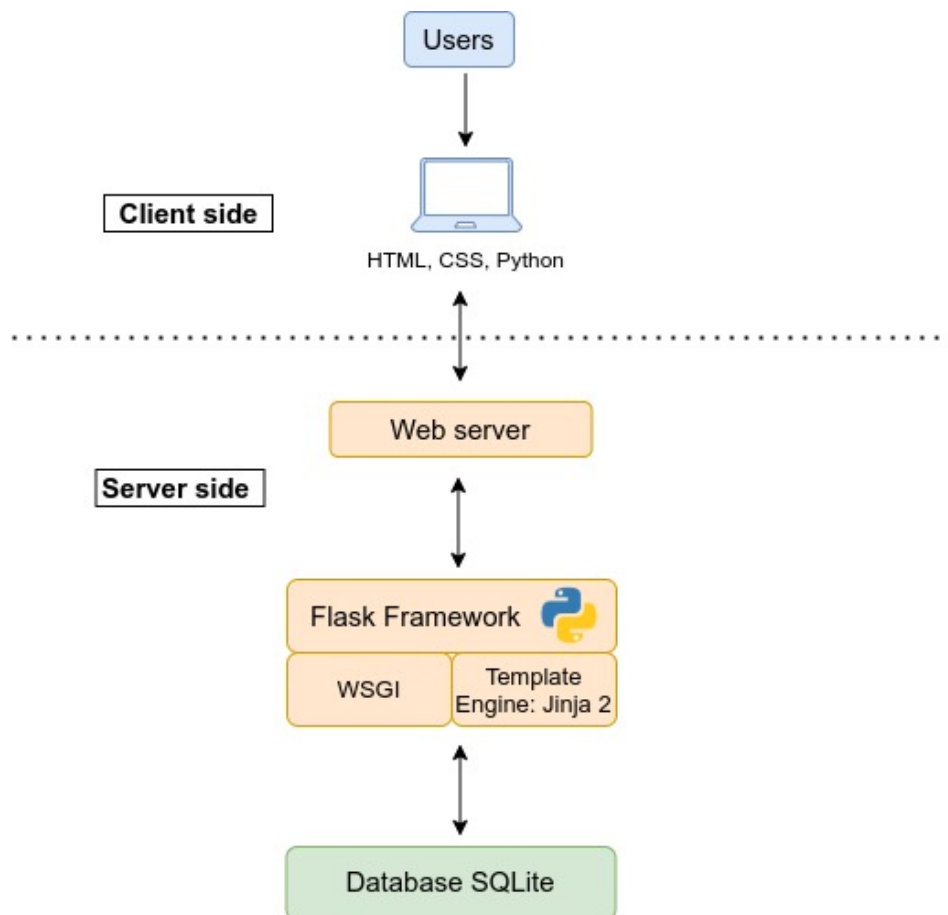


Figure 4.1: The architecture of the web application

4.2 Architecture

In order to be able to fulfill the set of requirements for the prototype, I have chosen to develop a web application system. The web application system has a client side and a server side. The client side is the front-end and generates the results on the users web browsers. The server side is the back-end of the web application, where it is possible to maintain, design and build the application. Figure 4.1 shows the architecture of our system.

4.2.1 Client side

The client side is what sends a request to the server side, it is also known as frontend. Frontend is responsible for receiving requests from the user interactions and forwarding them to the backend to do something about it. Once backend has received these requests, it understands them and returns a response back per request and creates the user interface.

4.2.2 Server Side

The backend is responsible for storing data. In our architecture 4.1 we see the components that belong to the backend are for example the web server, a framework and database that stores data. Through the web server the backend interacts with frontend. The web server communicates with the database that serves requests that the frontend presents. We use flask that allows us to create HTML markup formats through the templating language Jinja2 to return HTTP requests.

4.3 Design and prototyping

In order to resolve the thesis problem, a prototype of a web portal was created. As explained in section 3 the purpose of prototyping is to check that we are actually able to produce the proposed product in the intended way through the feedback from the users.

4.3.1 Prototyping process

Prototyping process first step was with paper presentations to both realize the idea and to get started with the development. The idea was that the web portal should be easy to understand, easy to use and straightforward. The process started with designing a simple prototype of the web portal, first draft on paper, then digitally as explained in the previous chapter 3.5.

The figure 4.2 shows the first digital sketch of the web portal. The sidebar would categorize course codes, and not a list of individual posts. This way, the

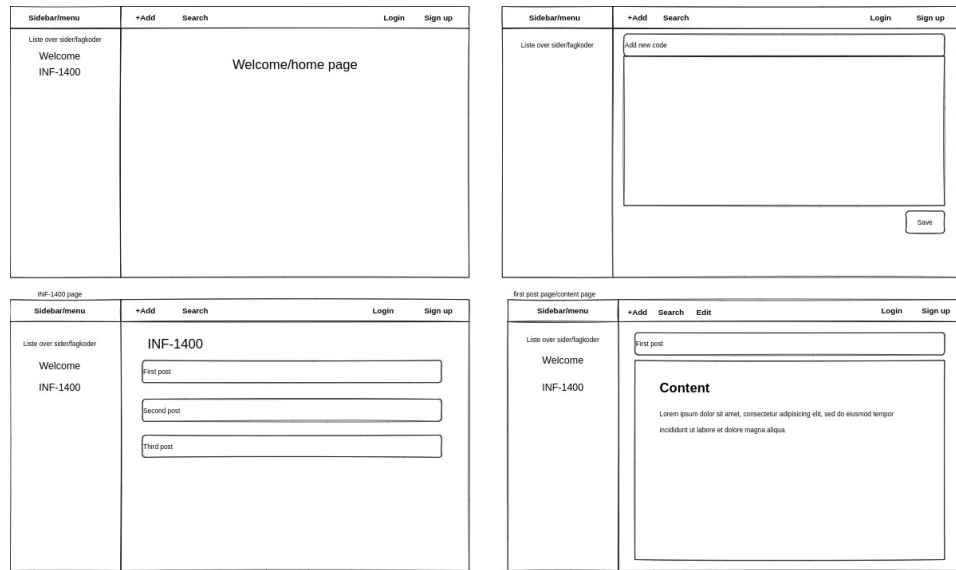


Figure 4.2: The first digital prototype design of the web application

students could easily enter the individual course code in the sidebar, and find content aimed only at the course they clicked on. The idea behind registration on the web portal is to keep things in order and calm while in use. Only registered students should be able to add posts and make changes.

4.3.2 User testing

The prototype does not have to fulfill every needed requirement in order to share it with others. The requirement number 2 mentioned in 4.1 was not implemented when the first user testing took place. By sharing early with others can provide feedback to better product design. It is important to get frequent feedback about the prototype, to find out how well the web portal corresponds to its purpose and what the users want through the feedback they give. Therefore, some informal interviews were conducted with few students at IFI, to get some underway feedback on the prototype. These informal interviews, I rather considered as feedback on the prototype.

This process with getting feedback from the students on the existing design, was conducted twice before the final interviews were to be conducted. Each time, a chat was held with two students at different study stages. By conducting these small conversations with the students, gave more ideas and made a lot of changes on the design and features of the web portal.

4.4 Design of web application

Under this section we will look at the components which played an important role in the design and appearance of the web application, and also presenting a piece of the web portal in form of images.

4.4.1 Flask Framework

Flask is a micro Python web framework based on Werkzeug and Jinja 2 libraries. It provides useful tools and features, such as url routing, template engine(Jinja 2), for creating web applications in Python easier. It classifies as a micro framework because it does not include an ORM(Object Relational Manager), or require particular tools or libraries. It allows us to build web application easily, by using only a single Python file[21].

With this being said, Flask does most of the job efficient and easy for us. In this case, we have only to do with one server to run our application. Whenever we make some changes in the code it automatically gets changed on the browser, without having to restart the server.

Jinja 2 Template Engine

Jinja is the Flask template render that comes bundled with the Flask Framework. It allows us to input variables and data to our template files which easily can render the HTML files to the final document and display on the browser[16]. When a template is returned from python, Jinja iterates through the data in it and separates the template code from the data fetching. When SQL query is executed, the cursor function will return a list of data which will go through python functions and to the Jinja variable in html file.



Figure 4.3: How jinja2 works between the template files and database

4.4.2 Storage

SQLite is an open-source relational database management system, using the most common database system, SQL. The most noticeable feature of SQLite is that it does not require a server and can be embedded into the end program. SQLite is therefore considered very user-friendly[23]. A database was created for storing all the data, which in this case, it is posts that are added by the users, and stored in the database. The database was made using the Python `sqlite3` module. This way, all the posts added to the web portal are visible to any user using the web application, and by clicking on the title of the post from the homepage they should be able to see the content of the post.

4.4.3 The various pages of web application

Figure 4.4 compares the design of the first prototype that was implemented versus the last design that was shown to the students during the interviews. If we compare this implemented design to the prototype design made on google draw 4.2, we see changes were made. For example the login and sign up forms, has not been implemented.

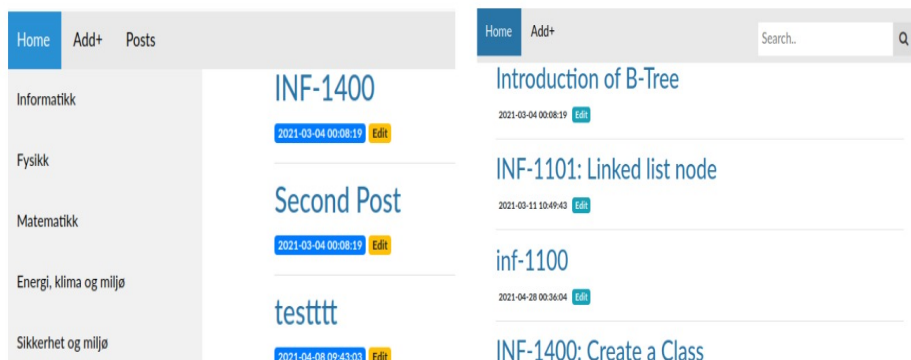


Figure 4.4: Comparison between the first prototype and the latest one

The design on the right shows the first draft of the implementation of the web portal before user testing took place. This design has a navigation bar, a page bar, in addition to a separate page for only posts marked with "posts" in the navigation bar. In the image on the left, which is the final design of the web portal, we still keep the navigation bar. But have removed the sidebar, and colors have changed slightly. And also a search bar has been added to the navigation bar. The side bar was removed on the basis that a search bar will be able to give the student the opportunity to search for what they need help with, a little more effective way to find information than a side bar that categorizes

posts by course codes. What we see in both images is the main page "home page" of the web application.

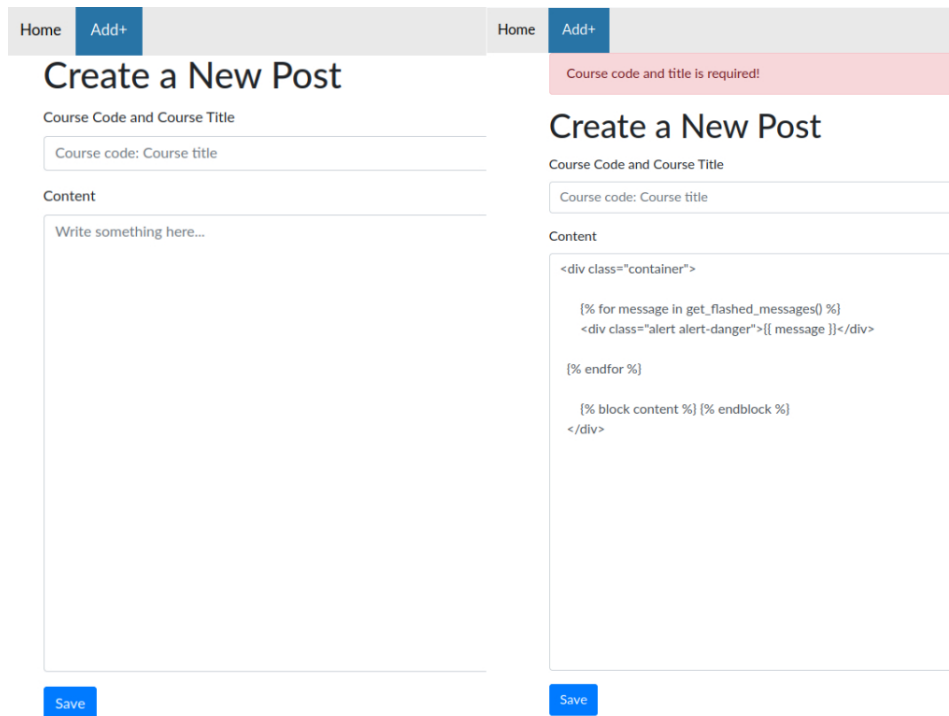


Figure 4.5: Comparison between the first prototype and the latest one

When a student wants to add code snippets, they can from the homepage press the add button to get to the add page. On the Add page, "Create a new post" form is implemented so students can add the content they want in the field. Figure 4.5 shows the design of the Add page. There are two fields on this page that must be filled in in order for the content post to be saved and displayed on the web page. If the field with "Course code and course title" is left empty, and the user clicks on save button. The user will get a warning message in red on top of the page saying "course code and title is required". This way users are notified that the subject code and title are required and the post with code snippet will not be saved if the field is left empty. The second field on the page is for content. There is currently no limit how much one can add of lines in the content field.

The page on Figure 4.6 appears when a user chooses to change a post from the homepage on web application. The user has the opportunity to make changes on the forum, save the changes or delete the entire post.

Go Back

Edit "INF-1400: Create a Class"

Course Code and Course Title

INF-1400: Create a Class

Content

```
class Person:
    def __init__(self, name, age): #explain

    #explain what this code do

    self.name = name
    self.age = age

p1 = Person("John", 36)

print(p1.name)
print(p1.age)
```

Submit

Delete Post

Figure 4.6: Presentation of the edit page. When a user choose to edit a post

4.5 Implementation

A Python virtual environment was created before getting started with the Flask framework. The environment is for ability to isolate different projects that require different dependencies. This means that packages and versions needed for a project are isolated in an environment that is only used for that specific project. In this way, one can organize the packages, and only run the necessary packages for a specific project. In this project, *virtualenv* was used to install Flask. Virtualenv is a python library that allows us to create isolated python environments[17].

Program	Version number
Python3	3.8.5
Flask	1.1.1
Virtualenv	20.4.2
Werkzeug	0.16.1

Table 4.1: The programs with version numbers that were used in the implementation of the web application

4.5.1 Bootstrap

Bootstrap is a free front-end open-source CSS framework that allows us to build fast responsive sites. It contains mainly CSS, and optionally JavaScript based design templates for typography, buttons, forms, navigation and other interface components[22].

4.5.2 The web application

With the use of HTML and Flask python libraries students are able to interact on the platform through a web browser. HTML templates makes it possible for students to submit content(code snippets) by using a web browser to send data over the internet to the database. HTML provides the structure and meaning of the content on our platform, while CSS provides the styling and layout.

Since the web portal is for students to be able to add code snippets, and do interactions, as described earlier the Flask framework is used to receive the form data and have the opportunity to store it in a database. This is because HTML on its own can not access a database. HTML files combined with CSS displays web pages, while Flask with Python code renders these HTML files using routes to return the created web pages.

Requests

The communication between the web browser and the server happens through HTTP requests. The requests used in this project are "GET and "POST requests. They are used to fetch data from the server and to submit form data to the server correspondingly.

Database

Every web application comes with a database to store the data needed, and the platform made for this thesis is powered by SQLite in python3 to store the data of posts containing snippets of code, which are added by users. The database contains only one table with the purpose of storing the posts that are added.

/5

Evaluation and Results

In this chapter, we will first get to know a little background about the 7 informants, before we move on to analysis. The first part of interviews are analyzed in the first section and the second section analyzes the second part of interviews. Finally will look at CSCL affordances in the discussion section and at the very end we will look at some future work.

The goal in this thesis is to research on how to achieve learning outcomes in science subjects through a simple tool(web portal) for snippets of code. Whether this web portal can be suitable for storing code snippets from various courses at the faculty, can promote programming competence in students. To research the problem, I have chosen to analyze the data material through the two given research questions below:

1. *How can the application be a useful tool to become more steady in programming and to strengthen students programming skills?*
2. *Can the application be a useful tool to strengthen understanding in mathematics and physics and the other science subjects in solving their problems?*

Through the first question, I will try to find out how the web portal can be used to strengthen students programming skills and abilities. Question 2 is

based on finding out whether students use science knowledge to program and/or whether they use programming to solve their problems in their science subjects? The answer to this has emerged through the interview conversation with the students.

As mentioned in chapter 3, the interview was divided into two parts, the first part was about the informants being allowed to use and get to know the web portal, while the second part was about asking the questions.

Informant	Field of study
Person 1	Chemistry
Person 2	Energy, climate and environment
Person 3	Chemistry
Person 4	Space physics
Person 5	Computer science
Person 6	Computer Science
Person 7	Computer Science(Health technology)

Table 5.1: Showing which field of study the 7 informants participating in interviews belonging to

The students were at different levels in their studies, some master's students, and others were on a bachelor's degree. Some were in their very first year at the university, while others had come a lot further. Further in the chapter to identify the informants, we will be using the person numbers given in the table 5.1.

As explained in the Method chapter 3 I will use thematic analysis to analyze the data collected from student interviews. And through the context between CSCL 4 chosen of 7 affordances of Heisawn and Cindy, explained in 2.4, and student statements, I will try to answer the thesis questions.

Presentation of the results from the interviews creates a basis for being able to say something about how CSCL is expressed in the 7 student interviews. In the first part of the analysis, I will go through the students' opinions about the design and simplicity of the final prototype of web portal. And through their statements, we will see how design helps to influence students' learning. In the second part of the analysis, individual extracts from the transcripts are presented and analyzed, based on the CSCL affordances and my own interpretations.

5.1 Results of the first part of the interviews

The first part of the analysis is based on the first part of the interview, where the students used the web portal without any supervision.

5.1.1 Use of the web portal

When informants were asked what they think of the web portal and its design, the only word that came out was "simple". Person 4 said "*The web portal is very simple to use, and easy to find posts one is looking for*".

Person 1, 2 and 4 mentioned the search bar, they were very positive to the fact that there were a search bar, which made it easy for anyone to search for a theme or a topic. While person 3 and 7 mentioned that the idea and background for it is very important, and the way it looks like now is very easy to understand. And person 5 and 6 meant when everything was on one page, put the material in the focus.

"It's a simple design, so there is not much happening but then the material is in the focus" - Person 5

Some of the informants also had some tips and ideas for further development of the web portal. Person 3 and 5 were the only ones of the informants who came with ideas about what can be done better. Person 3 mentioned that on the page where you add content, you could have the opportunity to add which programming languages the post is written in.

Person 5 also recommended to make it possible to comment under the posts on the web portal. Person 5 meant that when one add a snippet of code, and someone else has a question about it, they can comment below that post and ask the question. Person 5 believes that since this tool is meant locally only for the Faculty of Science and Technology, then it should not be a problem to discuss with their classmates and fellow students. According to CSCL's second affordance, communicating about a common task is important in order to learn and collaborate.[10] More about this is explained in the discussion section 5.3.

5.2 Results of the second part of the interviews

During the interviews, the questions that were asked were the same for all the informants. Assuming something unexpected came up or something interesting,

I chose not to interrupt while the informants were talking, regardless of topic. Through the conversations with the students, it became clear what the students appreciated, and their opinions and views about the web portal and the purpose of the master's thesis in its entirety. To be able to answer the thesis questions, I have chosen to focus only on some of the data material from the transcript, and divided this into 3 categories. As explained in the Theory chapter 2.3 that "learning outcomes are the knowledge, skills and competencies the student has after completing the study program, subject group or subject", have I named the three categories as follows:

- **Learning and understanding** - whether this can provide learning and better understanding
- **Skills** - Whether this tool can help strengthen students skills in programming and other science subjects.
- **Collaboration** - whether this can lead to more contact, interaction and collaboration between students across fields of study.

5.2.1 Learning and understanding

It's not just about accessing the information you need either digitally or in other ways, without really gaining understanding and using it to learn. Person 2 has had experience in computationally oriented programming in the subject INF-1049 early in study stage. When asking how programming helps to understand problems in science subjects, person 2 uses examples of some science subjects that they have a great need for programming.

"In signal processing, we worked a lot with the theory, so one had to program based on that theory, it was pretty hard. While in image analysis we work with image and then we get a fairly visible result on what happens when we program. And then it is much easier to understand the basics, you get to see what it is you are really working on."

Here person 2 claims that by visualizing the problem they are working on, and in provides better understanding both about the code and what the assignment is about, and to know what results they should expect.

"... they do not know what is happening, but those who have had an introduction to programming on the other hand."

With this quote person 1 specifies that for those of the students who have not

had programming before, may not fully understand the code snippets in the web portal and do not understand what is going on. It seems so person 1 thinks that once you know a little programming, such a tool can be helpful to become confident and skilled in programming, but it won't if you are a complete new beginner in programming. Person 1 also adds "as long as there is an explanation with the code that explains what the code does". With this seems that person 1 means, there are not everyone can look at the code and understand what has been done, and that there must therefore be explanations in the code that explain what has been done for others to understand the code.

Person 6 mentions that the tool can especially be of great help for assistant teachers from fields of study other than computer science. Who do not have enough programming experience from before, to be able to strengthen their understanding of coding, and be able to help other students in their studies as well. For example, there are certain things students are wondering about in colloquium, which the assistant teacher does not have enough information about, but can quickly find it on the web portal and try to understand, because they should already have some knowledge to understand someone else's code. Both to strengthen their understanding of the code and to help other students understand as well. This goes so far under all three categories, learning and understanding, their skills and collaboration.

Assistant teachers are often higher level students in the program who become a assistant teacher for students at lower levels than themselves. The fact that this can help assistant teachers to strengthen their programming skills is a sign of learning outcomes.

"Having the opportunity to see something others have done, and gain understanding based on it, helps a lot on your own understanding" - Person 3

5.2.2 Skills

All the seven informants have never had programming before their first semester at the university with the obligatory programming subject. I would say person 5, 6 and 7 have a range from medium to high in programming skills, while person 1, 2, 3 and 4 had a range between low to medium. Through the conversations with the students, it seemed that the more they program, the more they fail in coding, the more they learn and more confident they become on themselves in the programming.

"(...) it is only when I started with image analysis and moving

towards the machine learning direction now that I realize how much programming is involved. Now I have much more control over programming than I have had before" - Person 2

Other ways to strengthen their coding skills are according to person 5 through learning from their code errors. Because anyone that have programmed before knows how tricky it is when writing code at sometimes. It often happens that the code does not work right away, many attempts are needed, many errors are needed for the code to work eventually the way we want it to.

"Seeing code errors, and correcting those errors is valuable"

"When I look at others' codes, I say "wow, this is so smart" had I somehow known this a few years ago, I would not only have learned to do things more efficiently, but improved my programming skills as well. Learning small details and syntax about specific things generally provides inspiration on how to do things" - person 6

We can look at affordance number 3 "sharing resources" when we read the statement from person 6. It is about sharing resources with each other, in this case it is about sharing inspiration and ideas with each other on the web portal.

"... I have had to run code through image, and understood what it means"

Through the students statements, it look like they generally agree that programming makes many of the science problems easier. And that they get more motivated and interested in programming when they see the connection between it and other science subjects. This is where computational thinking and problem solving gets involved. Students gets the opportunity to use programming in their science courses, helps them to understand the theoretical problems in the sciences that they would not otherwise understand, if it was not for programming. And it also seems that they get strengthen their programming skills when they get to work with programming in several subjects and not only an introductory subject.

5.2.3 Collaboration

We have been through what the collaboration is about in the 2 chapter. We know that for most professions, is the ability to work with others absolutely crucial. And in fact, not a single interview took place without the students mentioning the word "collaboration" during the conversations. In order for

students to be able to collaborate across fields of study, they must participate in a joint task. According to the first affordance of CSCL stated in 2.4

"An important aspect of tasks in CSCL is to give learners something to talk about. This may be through a shared database and joint multimedia activities." -(Peters Slotta, 2010, van Aalst, 2009)

Among the positives of collaboration is, for example, for students who struggle to learn and understand programming on their own. These types of students will have the opportunity to get help from other students, read how other students explain code and how other students write code in an easier language than, for example, a lecturer uses in lectures, or someone else on the internet.

"There must be some kind of interaction between students with little programming experience, those who can a lot and those who have not started having programming in their study yet"

"A unified place for students to share coding and knowledge with each other"

"I think this can create a lot of unity and cooperation among everyone across fields of study, because we all contribute what we can in it"

"I wish something like this was available last semester when I had a programming course, that one had the opportunity to look at something like that. Searching the internet is not always the easiest way to find things, especially when you do not know programming before." - Person 3

From the students statements shown above it seems that the students really appreciate collaboration. It seems that the students find it to work together in groups with programming tasks very instructive. The quotes show that the students both learn and work with programming assignments in groups, and especially from computer science students that this comes out very well. At the same time, several of the students say that if they are stuck on a task, instead of spending a lot of time on the internet to find answers to their problems, they go quickly and ask for help from each other.

5.2.4 Other questions

At the very end of each interview, I asked these two questions to the informants only to hear their opinions on how positive this could be in the future or among a larger number of students if this was put to use at a later date. The questions that were asked were: *Is this something students will appreciate?* and *Can this be used in the future?*

Is this something students will appreciate?

Most of the informants expressed that they are relatively positive to the web portal and especially about the background for why the web portal was created and that most students will appreciate incredibly much that something like this exists at the faculty. Some of the informants justified this with the fact that the web portal is useful because it can contribute to a good community and cooperation between the fields of study at the faculty. And that this will lead to stronger professional discussions among the students.

Can this be used in the future?

Person 5 on the other hand agreed with other students on the previous question, that students would most likely appreciate this tool, but whether if this can be used in the future the informant was a little skeptical of the intentions of many students. Because the purpose of the web portal is to provide learning outcomes, that students can have the ability to help each other understand programs and problems, and become more steady in programming. Person 5 means that students can misuse the web portal by handing out finished code to each other.

"(...) this is very much dependent on the intentions of the students, if they have good intentions then this will certainly be a tool that can provide learning benefits and strengthen programming skills. But if the intentions of some of the students are negative, then this can be abused to get their tasks done without understanding the content and learning from it. So it must be used by the right people for the tool to be used as it is intended." - Person 5

"This is going to be the platform that brings everyone at the faculty together, because it is a local platform" - Person 6

Although person 5 believes this could be abused by some students, other

students including person 6 believed that this can at least bring together students at the faculty.

5.3 Discussion

Despite the fact that there may be some students who have different intentions for the web portal, and that it may not provide the same amount of learning and understanding to everyone, since everyone is at different levels, some may benefit greatly from the web portal, some may use it infrequently, while some others may think that it does not benefit them at all, and that they therefore choose not to participate in collaboration either. It all depends on the students' own intentions and interests.

5.3.1 Simplicity

Simplicity was always in the focus when implementing the web portal, and it is very important because minimalist and simple direct designs fulfill their role and makes it easy for the users to understand and use it more efficiently. The students also meant that this was important.

5.3.2 Collaboration

On the statement mentioned in 5.1.1 from person 5 about allowing users to comment below each other's posts. This cover the CSCL's second affordance of Heiswan and Cindy which is "*communication*". In the second affordance, they believe that communication can create collaboration if a group of people meet, or find a common channel where they can communicate on a common task. By having the students commenting below the posts, a conversation can be created between two or more parties, where they share their thoughts and ideas on the topic that the post contains. Students may feel uncomfortable sharing their explanations and snippets of code if they are not 100% sure of themselves. And making it possible to comment during the posts can therefore be more suitable to be anonymous, that students can anonymously ask each other questions. Because even though this is a local offer, some may still dislike having to share their knowledge with others.

From the students belonging to other fields of study than computer science, it seemed that they find it challenging to program alone. This may therefore be an explanation for why they greatly appreciate collaboration, because they are already used to collaborating in programming.

5.3.3 Number 1. Establishing a joint task

This is about that students must have a task to be able to collaborate. The challenge with this strategy is that the students want to collaborate but that they do not have a common task to collaborate with. Now that the students have got this web portal to work together, to share knowledge and learning, and strengthen each other's competence by sharing their own work, their own code snippets from different topics each student has. As person 6 mentioned "*when everyone contributes, this will be good*".

5.3.4 Number 2. Communication

As stated in student statements, this tool was seen as a kind of collaborative tool that brings students together across fields of study. In order for students to be able to communicate with each other on the web portal, as mentioned, comment fields should be added below the posts, so that students can keep communication on the web portal while they are already there. This is one of the challenges of this strategy, that the web portal is not designed and implemented in a way that it allows students to communicate with each other.

5.3.5 Number 3. Sharing resources

The positive thing about this is that students can share their code with each other through the web portal. What emerged from student statements is that they greatly appreciate being able to see how others have done their code to get inspiration. But the challenge with this strategy is that as the web portal is for now, it is impossible to give each other feedback or share with each other sources that can be useful for the topic one is looking for. Students can share code with each other by adding a new post, but the challenge is that they do not get feedback on whether there are things that should be done better or be changed.

5.3.6 Number 5. Engaging in co-construction

The goal of this affordance is for students to be able to use the web portal to share useful information with each other, which everyone can contribute and work with. But that the challenge is that a common foundation is not maintained, that students do not contribute to building on each other's contributions or to co-construct a common understanding. This can happen if, for example, some students get to use the web portal to their advantage, they think they are collaborating, but fail to show respect to others' views, contributions

and ideas. By, for example, keeping an understanding of themselves or that they only obtain information from but never share contributions with fellow students.

5.3.7 Future work

The web portal as it is now, is very simple and not really much code. If this should be something to be used at the faculty at a later date, the code should be reviewed and needs a good deal of changes or improvements. It is also anonymous and any user can add posts and change others' posts. This is something that can be worked on to give users the opportunity to register on the web portal where they can log in to their own accounts. You may also want to allow only those who have registered to change posts. Another thing that can be done is to allow a registered user to view their own posts on their own profile, where they can easily go find their own posts.

It can also be done so that students have the opportunity to register on the web portal, but that the posts are kept anonymous for users of the web portal. It can also be done so that only the developer of the web portal can see who is adding and changing posts, to keep the credibility and order of the web portal.

5.3.8 Use another server-based RDBMS

SQLite is a small library and is an embedded database(cant for example access on another machine and has no network capabilities). Changing the database to a larger database for example MySQL will be better suited.

/6

Conclusion

This thesis combines two facilities, social sciences and natural sciences and technology. The aim of the thesis was to implement a simple web portal for storing code snippets, and then investigate whether this web portal can contribute to learning outcomes in the sciences. When I started with this thesis, the only thing I had in mind was to offer a tool that could help students become confident in programming. While the implementation was taking place, and the process of interviewing started, there became greater and greater focus on collaboration. What I had in mind was that this should be a learning tool, where students individually add code snippets. But until the last interview, it became clearer that the students looked at this as a tool that will bring students from different fields of study together through collaboration, and hopefully this collaboration will provide learning.

Learning the technology often need more heads than just one, also in programming, it is always advisable to discuss and talk with others to be wiser or simply understand better some topics. Collaboration is therefore of great significance because we strengthen our own power by learning from each other.

Technology has made it easy for us to retrieve the information we need on the internet, but how much understanding it provides depends on the intention of each individual. If in case students abuse the web portal, by handing out the finished code to each other, this will in no way be able to provide learning benefits. Because the way it is meant to be used is that the students should help each other to understand subject-specific things and become more confident

in programming. It should provide learning benefits and create collaboration, not the other way around.

The reason why I used the theory of CSCL is because over the years several have tried to show that it is through technology and collaboration that we learn better. The goal of CSCL is to use technology to support collaboration.[10] Because the more of clever people work together on a common goal or problem, the more solutions and ideas can emerge. When we then look at the learning outcome definition:

«Statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence.» - The European Qualifications Framework

And what CSCL focuses on can be merged and form the basis for learning and understanding in a subject field. Technology and collaboration can thus influence students' presentations to learn and understand more effectively.

What we can conclude with, is that this web portal should not only provide competence in both programming and other science courses, but also form collaboration between students both within a field of study and across fields of study. And through this collaboration they strengthen each others learning and understanding. If students learn in collaboration with others and by regulating their own learning, they will to a greater extent be left with a competence that equips them to become an active and reflective participant in society and professional life.

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Appendix

Vil du delta i forskningsprosjektet

”Kvalitet i utdanning naturvitenskap og teknologi ”? Delprosjekt “programmering i MNT-fag”

Dette er en forespørsel til deg om å delta i et forskningsprosjekt hvor formålet er å forbedre undervisningskvaliteten i begynneremnene innen matematikk, fysikk og kjemi. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Prosjektet “Kvalitet i utdanning naturvitenskap og teknologi ” (KvaNT) er opprettet av fakultet for naturvitenskap og teknologi, og har som mål å forbedre undervisningskvaliteten i begynneremnene innen matematikk, fysikk og kjemi og heve den kollektive undervisningsfaglige kompetansen på fakultetet. Vi fokuserer på problemstillinger knyttet til gjennomstrømning, studentaktive undervisningsformer, bruk av programmering og IKT.

Dette skrivet omhandler et delprosjekt/masterprosjekt om programmering i emner ved NT-fak.

Hvem er ansvarlig for forskningsprosjektet?

Fakultet for naturvitenskap og teknologi er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?

Du mottar denne forespørselen siden du er registrert på et emne ved Fakultet for naturvitenskap og teknologi, UiT – Norges Arktiske Universitet (UiT). For å undersøke problemstillingene er vi helt avhengig av tilbakemelding fra dere studenter, så vi håper at du vil delta i studien. Dette forskningsprosjektet vil gi verdifull informasjon som vil bidra til å forbedre utdanningen deres.

Hva innebærer det for deg å delta?

Å delta i prosjektet innebærer å delta i en eller flere av følgende datainnsamlinger

- Intervju eller gruppeintervju. Det vil bli tatt lydopptak.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg. Undervisningen du mottar, tester, underveisevurdering og annet vil være det samme om du deltar i prosjektet eller ikke.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Alle personopplysninger vil bli behandlet konfidensielt og i samsvar med personvernregelverket. Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet.

- Datamaterialet vil lagres i et lukket område i Office365
- Ditt navn og kontaktopplysninger vil bli erstattet med en kode som lagres på en egen navneliste, adskilt fra annet datamateriale.

Følgende har tilgang til personopplysninger:

- Prosjektgruppen, bestående av masterstudent, veileder og biveileder ved NT-fakultetet

Det vil ikke være mulig å identifisere deg i publiserte forskningsresultater og rapporter fra prosjektet. Ingen personidentifiserende data vil publiseres.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Dette masterprosjektet skal etter planen avsluttes 31.12.2023. Senest ved prosjektets slutt vil opplysningene dine bli anonymisert.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg,
- å få rettet personopplysninger om deg,
- få slettet personopplysninger om deg,
- få utlevert en kopi av dine personopplysninger (dataportabilitet), og
- å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra Fakultet for naturvitenskap og teknologi har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- Fakultet for naturvitenskap og teknologi ved prosjektleder Hilja Lisa Huru, på epost (hilja.huru@uit.no) eller telefon: 77660253
- Vårt personvernombud: Joakim Bakkevold, epost: personvernombud@uit.no, tlf. 776 46 322 og 976 915 78
- NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon: 55 58 21 17.

Med vennlig hilsen

Hilja Huru

professor/prosjektleder *Kvalitet i utdanning naturvitenskap og teknologi*

Institutt for matematikk og statistikk

Samtykkeerklæring

Jeg _____ har mottatt og forstått informasjon om prosjektet KvaNT, og har fått anledning til å stille spørsmål. Jeg samtykker til:

- å delta i datainnsamling ved *intervju*

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet, ca. 31.12.2023

(Signert av prosjektdeltaker, dato)

