Design and Evaluation of an E-learning Platform to support Active Learning

Design och utvärdering av en E-lärande plattform för stödjande av aktivt lärande

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Upphovsrätt

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Abstract

Engineering students at Linköping University are given the opportunity to improve their soft skills through the course *Professionalism for Engineers*. Soft skills are becoming more and more important in succeeding professionally as well as personally, especially among engineering students, who are more used to improving their hard skills. The course presents the students with a mixture of in-class and out-of-class activities, in which the latter makes use of three different platforms to provide the students with necessary information regarding the course.

This study has focused on combining the three platforms by creating a new E-learning platform, where further improvements and additions have been added to create a more supporting environment, in which the out-of-class activities are at the centre. The platform was evaluated through qualitative user tests and the quantitative *User Experience Questionnaire*, in which four students, enrolled in the course Professionalism for Engineers, participated. Every category in the User Experience Questionnaire received a positive value, implying that the users were overall pleased with the platform and experienced it as being intuitive, efficient and motivating.

The proposed platform, with the added functions and design elements, has the potential to support the students in doing their out-of-class activities, and the circumstances whilst doing these activities has been changed to enhance the students' active learning experience.

Acknowledgments

To begin with, I would like to thank my supervisor Aseel Berglund and examiner Mikael Asplund for allowing me to be a part of this project, as well as providing me with feedback throughout the duration of this study. I would also like to express my gratitude towards the users who participated in the user needs analysis and the user test, and thereby helped the evaluation of the project. Lastly, I want to thank my project peers Björn Möller Ehrnlund and Erica Ahlqvist for the support and fun collaboration during this project. I send an extra special thanks to Björn who helped me enormously throughout the project and taught me a lot - even though it was not your responsibility to do so.

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1   **Introduction**

The role of an engineer primarily involves developing their technical skills, which is an essential part in becoming successful within the profession. However, the engineering profession involves more than the ability to solve complex technical problems. Regardless of field, engineers are often part of a team-based environment, which entails an ability to collaborate, interact and communicate effectively with colleagues as well as with customers. These are interpersonal attributes, mainly referred to as soft skills [1], which in addition to technical skills are important in succeeding professionally as well as personally in the field of engineering.

Engineering students at Linköping University are given the opportunity to develop their soft skills, in order to prepare themselves for their professional careers after they graduate. During the first three years of their education, students studying *Computer Science and Software Engineering*, with the short name U-programme, and *Computer Science and Engineering*, shortened D-programme, are enrolled in the course TDDD99, Professionalism for Engineers[1]. It is a mandatory course and is divided into six parts, where one part extends over the course of one semester. Through lectures, assignments and seminars, the course focuses on the students' social competence, personal effectiveness and personal development.

The course TDDI83[2], has a similar concept to the course TDDD99, and shares the same title, but is more compact, as it is only a one-year course. The students taking this course, study either *Bachelor of Science in Computer Engineering (Di)* or *Bachelor of Science in Engineering Electronics (El)*.

Both courses involve in-class activities, such as lectures and seminars, along with out-of-class activities, which includes handing in assignments and reading topic material. The out-of-class activities make use of a total of three different platforms, in order to provide the students with information and functionalities used in the courses. Although the use of three separate platforms is necessary, it is also superfluous and leaves room for misunderstandings. With the use of a separate platform aimed for learning, called E-learning, these three platforms can be combined, in an attempt to better support the learning of soft skills.

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[1]TDDD99, `https://www.ida.liu.se/~TDDD99/index.sv.shtml`
[2]TDDI83, `https://www.ida.liu.se/~TDDI83/index.sv.shtml`

1.1 Motivation

E-learning tools are today commonly used in schools and universities as a gateway for information and communication between students and teachers. Students can receive information about their courses, find relevant materials, check their schedule and explore other useful functions. However, these platforms are more focused on providing relevant content for the student, rather than focusing on how to engage students as well.

Active learning is a student-centered learning method where the student actively participates and engages in the learning process [2]. This method contradicts the more traditional passive learning method, in that students need to do more than just listen in order to learn. Lectures are a classic example of passive learning, where the focus lies on the teacher rather than the student. It focuses on handing out information to the student, but whether that information is absorbed or not is usually unknown to the teacher.

Engineering students reading either the course TDDD99 or TDDI83 at Linköping University, are faced with understanding the importance of soft skills and how improving these skills can be useful after they graduate [3]. The courses focus on personal efficiency and development, social competence, as well as the role of an engineer. These are skills that rely more on experience and gaining experience, as opposed to absorbing information by reading or listening during a lecture. Active learning is useful here, since it focuses on the student and gives them the opportunity to develop their personal skills. The courses involve both in-class and out-of-class activities, which are shaped to actively involve the student in the learning process while simultaneously improving their soft skills. Information and results regarding the courses, as well as relevant functionalities are shared through three different platforms. Although the course activities are shaped to actively engage the student, the platforms are not. For this reason, the development of a new E-learning platform, which focuses on student engagement is of interest. A platform which combines the three platforms and centers around the student, can help create an active learning environment which better support the students in their out-of-class activities.

1.2 Aim

The aim of this master thesis is to design and evaluate an E-learning platform, with the intention to create an active learning environment to support students learning soft skills. The intended target audience for the platform is engineering students reading one or the other of the courses TDDD99 and TDDI83 at Linköping University. The platform will be developed using the frameworks Angular[3] together with Flask[4] and SQLAlchemy[5].

1.3 Research Question

In order to fulfill the aim, this master thesis seek to answer the following research question:

- How should an E-learning platform for learning soft skills in engineering education be designed to accomplish an active learning experience?

1.4 Delimitations

The project will be centered around the development of the student page and the functions which the students can interact with on the platform. Thus, due to the limited time frame, the

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[3]Angular, https://angular.io/
[4]Flask, https://flask.palletsprojects.com/en/2.0.x/
[5]SQLAlchemy, https://www.sqlalchemy.org/

study will not include admin and teacher specific interfaces. The platform will exclusively be developed with regard to the content and activities as part of the course *Professionalism for Engineers*, and the user tests will be conducted on students within the target audience of the platform. This refers to students who are currently attending these courses. However, due to the ongoing Covid-19 pandemic, the user tests will occur remotely through a video conferencing service, which might create limitations. Furthermore, the framework Angular will be used to develop the client side of the platform, together with Flask and SQLAlchemy on the server side. These are the agreed upon frameworks with the client and for this reason, a motivation for using these will not be discussed.

2 Background

This study centers around the creation of an E-learning platform, specifically to be used in the courses TDDD99 and TDDI83 at Linköping University. Both courses have the title *Professionalism for Engineers* and focuses on developing the students' soft skills to better prepare them for their professional careers [3].

2.1 Professionalism for Engineers

The course Professionalism for Engineers focuses on four soft skills areas, personal effectiveness, personal development, social competence and the engineering profession role [3, 4, 5]. The overall content and structure of the course can be seen in Figure 2.1. As mentioned in chapter 1, these soft skills areas are developed through a mixture of in-class and out-of-class activities, which includes lectures, seminars, assignments and reflective essays, as well as individually going through topic material. The in-class activities consist mainly of lectures and dialogue seminars, as can be seen in Figure 2.2. Berglund [1] explains how the dialogue seminars are used to better support the students' learning, where the students learn from experience through reflection and discussion. During a dialogue seminar, the students in their groups discuss the reflective essays, which they have written previous to the seminar. The reflective essay is part of the out-of-class activities, where the student explores different levels of reflection based on the Gibbs reflective cycle [1, 5]. In addition to the reflective essays, the out-of-class activities involves assignments with the general purpose of allowing the student to gain experience in the different soft skill areas included in the course.

2.1.1 Course Organisation

Currently, three separate websites and tools are used in the course. Information and topic material are shared through the Linköping University website, which can be seen in Figure 2.3, while submission of assignments and essays occurs through the SharePoint-based platform Lisam[1]. In addition to this, students register to the courses via the tool WebReg, where their results in the course are posted as well [3, 4, 5]. Aseel Berglund, who is the examiner of

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[1]Lisam and the Student Portal, https://www.student.liu.se/studentstod/itsupport/lisam-och-studentportalen?l=en&sc=true
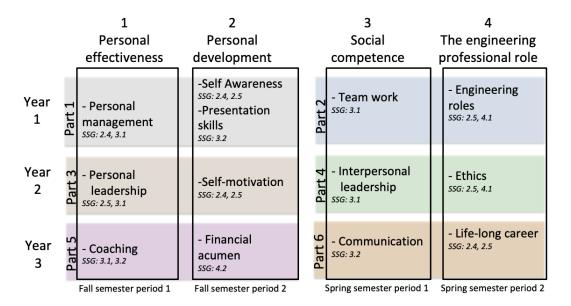
Figure 2.1: The content and structure of the course TDDD99 (Berglund [3])
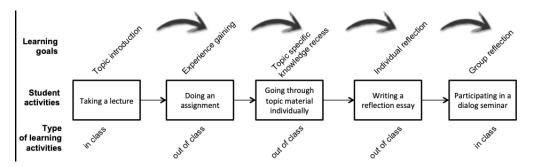
Figure 2.2: The learning goals and activities in the course (Berglund [3])

these courses, as well as the client of the project, has explained the use of three separate tools and pages to be superfluous, resulting in misunderstandings and communication difficulties.

Course Website

As mentioned, information regarding the course is presented through the Linköping University website. The majority of the courses, provided by the department of computer and information science, share their pages through this website. The information consists of course materials, as well as assignment descriptions and grade requirements.

Lisam

Since 2013 the SharePoint-based E-learning platform Lisam[2,3] has been used to share content between students and teachers at Linköping's University. Lisam is used in many courses available at the university, and they all have a separate course room where the teachers can share information and course material, as well as allow students to submit assignments. Figure 2.4 shows an example of a course room on Lisam.

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[2]Lisam and the Student Portal, https://www.student.liu.se/studentstod/itsupport/lisam-och-studentportalen?l=en&sc=true

[3]Lisam for dummies, https://insidan.liu.se/reportage/lisam-for-dummies?l=sv
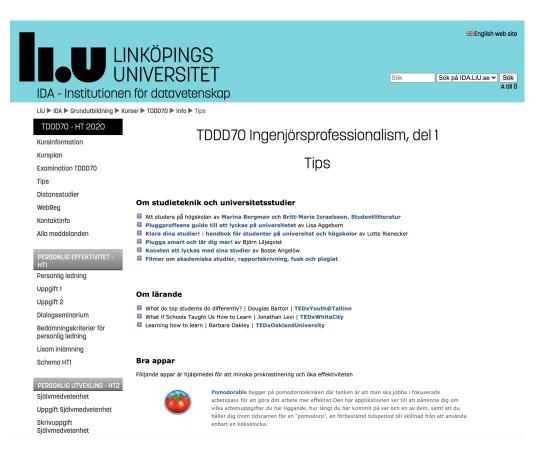
Figure 2.3: An example of a course page in the course TDDD70

Furthermore, students can use Lisam to access their student E-mail, calendar and different Microsoft-tools like OneDrive, Teams and an online version of the Office package.

In 2019, Bergner and Kunwaryanto [6] conducted a study as part of their bachelor's degree at Linköping's University, with the purpose to evaluate how a mobile version of the E-learning platform Lisam could be designed. The authors performed, at the start of the study, a survey where they asked students from the university what their thoughts were on Lisam and if they would consider using a mobile version of the platform. The survey showed that some functions on Lisam were used significantly more than others, and the majority of the respondents believed there to be too many functions available through Lisam. Furthermore, the respondents described some disadvantages with Lisam, those included difficulties in navigating through the platform, a complicated structure and incoherent use of several functions.

WebReg

The department of Computer and Information Science (IDA) at Linköping University uses the tool WebReg[4] to let students sign up for labs and projects, as well as keep track of their results. It can be used as an addition to Lisam, or a separate course website, since these sites do not provide the functionalities of WebReg. Figure 2.5 shows an overview of the start page on WebReg.

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[4]About Webreg, `https://www.ida.liu.se/webreg3/about.en.shtml`
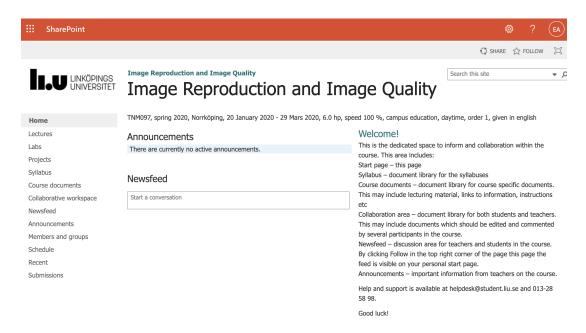
Figure 2.4: Course room for the course TNM097, Image Reproduction and Image Quality held at Linköping Univeristy

Figure 2.5: Student start page at Webreg

2.1.2 Prototype of the Platform

At the start of the project, Berglund (the client of the project), had put together a prototype of the new platform's interface. It gave the project members a visual idea of the expectations regarding the interface of the platform, as well as an overview of the functions Berglund wanted to include in the finalized product. Figure 2.6 shows an example of a course page on the platform, which involves links to all activities in the course and a progress bar for the student to see their progression in the course. Figure 2.7 presents an overview of the student's courses.
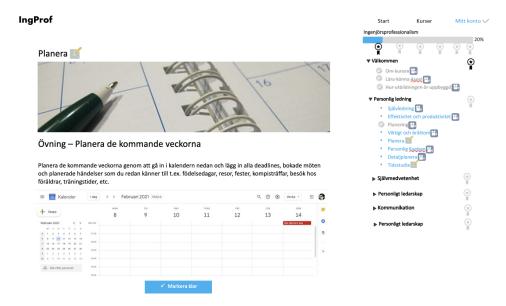
Figure 2.6: Prototype of a course page
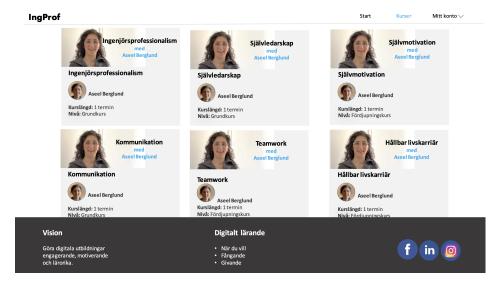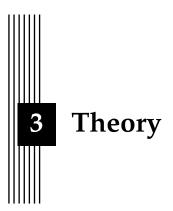
Figure 2.7: Prototype displaying a course overview

3 Theory

The following chapter brings up relevant theory to be used as a foundation for this master thesis. It covers theories regarding learning, motivation and active learning, as well as the terms E-learning, soft skills and user experience. Furthermore, the courses TDDD99 and TDDI83 will hereby be referred to as one course for the sake of simplicity and avoidance of confusion.

3.1 Learning Process

In order to develop a learning environment suitable for virtual education, it is relevant to first explore theories on the subject of learning. There are several theories and studies related to receiving, processing and preserving knowledge. Akpan and Kennedy [7] refers to a few learning theories. Three of them are the behaviour, cognitive, and constructive approach.

- **Behaviourism**
  One of the earlier psychologists who studied the theory of behaviourism, John B. Watson [8], proposed that behaviour can be controlled and predicted and is promoted through environmental and material reinforcement. Although Watson concluded this in 1913, the view on behaviourism today is based off of the theories from Watson and other behaviourists theorists who were active during the beginning of the 20th century [7]. Another of these theorists was the psychologist Edward Thorndike, who first developed the theory in which behaviours are viewed as responses to stimuli. Thorndike, as referred to by Akpan and Kennedy [7], conducted a series of learning experiments on animals and children, and noticed how behaviours followed by positive reinforcement were likely to recur, while followed by negative reinforcement were likely to be avoided. Positive and negative reinforcement can, for example, be used when teaching students how to behave in a classroom environment. Furthermore, this approach can be useful in an online learning environment as well, by using sounds and animations to positively reinforce a student when they give a correct answer on, for example, a quiz.

- **Cognitivism**
  The cognitive approach looks at how people think, and how both internal and external factors influence an individual's learning process [7]. This approach points out, for

instance, how attention, memory and understanding is vital for learning. Changes in behaviour are observed, but unlike behaviourism, the observations are used as indicators as to what is going on inside a learner's mind. Learning is not just about changing a person's behaviour, but about how their knowledge increases as well. It teaches the students how to learn more effectively and allow them to reflect on the new learning.

- **Constructivism**
  The final approach, the constructive approach, states that people actively create their own learning based on previous learning experiences [7]. It focuses on involving the fact that each person is unique and therefore perceives knowledge differently. Constructivism is related to the method active learning, which encourages students to be more involved in the learning process. This approach uses, for instance, social interaction and reflection to let students construct their own meaning and understanding of the information being taught to them. Further information regarding the term active learning is mentioned in section 3.3.

3.2 Motivation

Motivation, in short, defines the things we do and why we do them [9]. The concept is individual, and people are driven by different amount and kinds of motivations. The theory behind motivation was defined by Deci and Ryan [10] in 1985 as the self-determination theory, and suggests that people are driven by a need to grow and gain fulfilment. The self-determination theory explains how the need for growth drives behaviour, and focuses on intrinsic motivation.

Motivation is often divided into two parts, intrinsic and extrinsic motivation. Intrinsic motivation refers to what drives a person from within, by interests or curiosity [9]. Extrinsic motivation, on the other hand, is temporary and is driven by external factors, like rewards and punishments. Deci and Flaste [11] depicts that it is extremely hard to affect the intrinsic motivation of other people. In the process of trying to motivate someone, it can have the opposite effect instead. They consider that people's extrinsic motivation can be affected by specifically supporting their autonomy. The behavioural learning approach, mentioned in section 3.1, uses rewards and punishments to affect students' behaviours and has been described as to what drives a person's extrinsic motivation. However, it is not as effective as one once thought. Deci [9] explains, with the support from several studies, that these consequences makes people feel controlled and can, as a result, affect their intrinsic motivation negatively. Pink [12] supports this conclusion as well. With rewards and punishments, people become more focused on the outcome rather than the task itself. Deci [11] conducted an experiment to test this out, how students' intrinsic motivation were affected by how controlling the teacher was. As a result, the students' intrinsic motivation were affected negatively by teachers who were more controlling and did not give space for the students to actively take part in their studies. Nevertheless, there is possible to hand out rewards without negatively influencing intrinsic motivation. Deci further refers to a study conducted by his college, Richard Ryan, where he examined this theory. The results showed that rewards given without the intention to control and only as a way to acknowledge accomplishment, would more likely affect the intrinsic motivation positively.

Furthermore, Deci and Ryan [10] explains how the self-determination theory has identified three basic psychological needs: autonomy, competence and relatedness. Autonomy refers to self-determination and being in control of one's behaviours and choices. Competence is about a sense of mastery of one's knowledge and skills, which is needed to succeed. For example, if students think that they are able to succeed in their schoolwork, they are competent. Barkley [13] refers to studies explaining how the effort people are willing to

spend on a task, depends on how likely it is for them to achieve a desired outcome from the task, as well as if they value this outcome. In a classroom context, these outcomes could refer to rewards like higher grades and praise. However, as mentioned, these rewards can be counterproductive in increasing student motivation, since it can shift focus from the task itself to the outcome. If students feel optimistic regarding their ability to succeed and sees a value in the learning and task itself, their motivation is more likely to increase. Lastly, relatedness is about interacting and feeling connected to others. In a classroom setting, this involves minimizing the gap between teachers and students, and encouraging students to be more involved in their learning. The overall goal with these three characteristics is to increase intrinsic motivation and actively engage students in their learning.

3.3 Active Learning

Students are unique individuals who have different preferences when it comes to learning. University students are used to attend lectures, where they learn by listening, which is defined as passive learning [13]. However, this learning method does not guarantee that the students understand or absorb all the information brought up during a lecture, since everyone is different. Active learning is a method where the student learns by actively participating and engaging in the learning process, and as mentioned in section 3.1, is related to the constructive approach to learning. Bonwell and Eison [2] defined the term active learning as *"involving students in doing things and thinking about what they are doing"*. They mention, with the help of several researchers, that active learning is an important part of a student's education, because it helps them understand and learn significantly more compared to learning through lectures. When students discuss what they are learning and becomes more involved, it is easier to construct new knowledge and connect it to previous experiences, as explained in section 3.1. Thus, this new knowledge becomes a part of themselves and lasts longer. Barkley [13] explains this definition as being a crucial part of student engagement. They further define student engagement as a product of active learning and motivation. A high motivation among students is meaningless if it does not result in any learning, as well as students involved in active learning are not engaged if they lack enthusiasm towards the learning.

Berglund and Heintz [3] describe using dialogue seminars in the course TDDD99 as an essential way for the students to learn from experience and reflection, which is first mentioned in section 2.1. Previous to the seminars, the students individually write a reflective essay, based on the Gibbs reflective cycle, and discuss and reflect over these essays during the seminar in smaller groups. Barkley [13] also refers to seminars in combination with a written essay as an active learning activity. They further explain that the use of essays, as a basis for discussions in small groups, can help them better understand concepts and theories used in the course. It can also help the students receive a relatedness to one another, which refers to the self-determination theory described in section 3.2.

Since active learning is about letting the student take more charge and be involved in the learning process, it requires them to receive feedback and assessment from the instructor. Otherwise, it is hard for them to know how well they are doing and if they can improve [13]. Feedback helps students reflect on their work and decide on what to change to improve it. The feedback should be related to achieving course goals. Barkley refers to self-assessment activities, such as quiz, surveys or discussion forums, which can help the student receive an idea of how much they have understood of the course topic and what they need to practice more on. The purpose of self-assessment is for the student to better identify their strengths and weaknesses. Berglund [1] explains how self-assessment is intertwined in the assignments and reflection essays included in the course TDDD99, where the students are urged to

write what grade they are aiming for and a motivation to why. This is used to help students take charge, as well as make judgements on their own learning. Barkley [13] also supports the idea of letting students take more control over their grades.

3.4 E-learning Tools

The term E-learning was coined by Jay Cross in 1998 and has since then been defined in various ways along with the development of computers and the Internet [14]. E-learning is an approach to learning, which is based on the use of electronic and communication technologies to represent the contents of a course, or part of it. Nowadays, computers are more affordable and commonly used privately as well as professionally by people. This development has opened up possibilities to organize courses online, where the required tools are a computer or any other type of device which can access the Internet. Since the invention of smartphones, it has been possible to make E-learning mobile, where the students can access the contents of a course wherever they are and whenever they can.

Tomšič et al. [15] describes the advantages as well as the disadvantages with using the E-learning platform Moodle as a supplement to the traditional approach to learning. They explain the flexibility with using E-learning tools, where the students do not have to worry about being in the right place at the right time, and can plan their studies more freely. It gives the opportunity to understand important concepts in their own time and at their own pace. Another advantage with E-learning is how the use of interactive content in the form of, for example, videos, pictures and quizzes, can be used to make learning more fun and interesting compared to traditional materials used inside the classroom.

Despite the advantages with using E-learning, Tomšič et al. [15] also mentions some disadvantages with this learning approach. When the element of personal contact is removed between students and teachers, it creates a lack of communication between these and leaves room for misunderstandings. Moreover, it is easier for the teacher and the school to provide materials for the students in a classroom environment, while an E-learning approach to learning requires the students to have access to a personal computer or device with an internet connection. This does not take into account that some students might not afford to buy a computer or faces other types of difficulties with taking part in an online course.

3.5 User Experience (UX)

A product or a service is created to fill a purpose, to be something people can use and want to use. Without any users, an object would never be bought and a website would never be visited. Therefore, one crucial aspect when designing an interface, is to create a pleasant experience for the user [16]. User experience refers to how a user interacts with a design system and their feelings towards it. The international standard on ergonomics of human-system interaction [17], defines the term user experience as "*user's perceptions and responses that result from the use and/or anticipated use of a system, product or service*". It is further stated that user experience both is a result of the general construction and background behind the product, as well as the user themselves and their experiences and skills.

If an interface is unpredictable and difficult to understand, it tends to make users feel frustrated and confused, since it is not behaving as expected [18]. In the case of an interface aimed for learning, if it feels complicated and overbearing, it is unlikely to carry out engaging and motivating learning. This as a result will drive users away from the website and will discourage student's learning experience rather than stimulate it. The goal is to strive towards a pleasant user experience, where the interface is understandable and creates a feeling

of control and satisfaction for the user [16]. Good user experience is achieved when the user understands how a product or a system should work, what it is supposed to do and how it should behave just by looking at it. This is referred to by Norman [16] as a combination of the characteristics *discoverability* and *understanding*.

3.5.1 Fundamental Principles of Interaction

In order to receive an understanding of what designs are more effective and pleasurable than others, Norman's fundamental principles of interaction can be used [16]. These principles can be used to guide the designer into creating interfaces which are intuitive and easy to use. The principles mentioned by Norman include *discoverability (visibility)*, *affordance*, *signifiers*, *feedback*, *mapping* and *constraints*.

Discoverability (Visibility)

The components of an interface should be clear and visible, in order for the users to know about them and what to do with them. In contrast, it is difficult to find these functions, let alone use them, if they are not visible. A function that is not visible has the same purpose as a function that does not exist. The most important elements in an interface should be more prominent, to catch the user's attention. When the available space in an interface is limited, for example on a mobile application, it is essential to only include the most needed functions.

Affordances

An affordance refers to the relationship between the user and the product. It takes into account that the user has basic knowledge of how the world and nature works. The product is easy to use if the affordance of this product matches its purpose. For example, a chair affords ("is for") to sit on, but it would have a bad affordance if it broke when someone tried to sit on it. The visibility of affordances is critical in order to provide clues of how to operate an object or a system, without the need for labels or instructions. These clues are called signifiers.

Signifiers

Signifiers is a complement to affordance. It not only shows which actions should be possible, but more clearly which actions that are actually available. Signifiers are signals which guides the user through the interface and gives them clues on what actions will work. These signals could be sounds, images, icons or words, for example the word "push" on a door. On a website, affordance tells the user that they can click anywhere, but signifiers shows the user which clicks that will give them a result.

Feedback

When the user performs an action on a system, it is important that they receive some kind of indicator which tells them whether that action was successful or not. Feedback is about communicating with the user about what actions were made and what has been accomplished. The feedback should be clear, immediate and synchronized with the specific action which the user just performed. If the feedback takes too long, the user might think that they have done something wrong, or that the particular action is not working. Not only will this make the user annoyed, but the function becomes useless because nobody knows that it is actually working. Norman explains the risks with making the feedback from an action feel distracting and annoying, rather than informative. Feedback should catch the user's attention, but if too much of it is used or used in the wrong way, the user tend to get confused instead.

Mapping

The design of an object should reflect its purpose, as well as what will happen while it is being used. Mapping refers to the relationship between the attribute of an object and their function. For instance, a button should be placed near the thing it controls. Mapping takes advantage of physical analogies and cultural standards. For example, a natural and logical choice of icons is using arrows pointing left and right on a touch screen, which indicates to the user to swipe left or right.

Constraints

Constraints is the restrictions applied to an interface or a product. They exist to simplify the interaction and keep the user from performing the wrong actions. While affordances refers to all possibilities which can be performed on an interface, constraints limits these possibilities and can help avoid the feeling of being overwhelmed.

3.6 User Tests

A method of testing and evaluating a product or a system is through user tests. During the course of a design process, it is useful to bring in potential users and allow them to give their feedback and thoughts on the product at the current stage. By bringing the user in to the design process, it can help identify unknown problems or difficulties regarding the interface of the product. At the start of the project, when only the idea of a product is established, or a first prototype, it is interesting to identify needs and expectations from potential users through a user needs analysis. Towards the end of the project, when nearly all implementations to the product have been made, the user can then interact with the interface and explain what they think about the different functions. Arvola [17] refers to a method which is useful during these tests, which is the *think-out-loud* method. As the name suggests, the user is asked to verbalize their thoughts regarding what they are doing and what they want to do, as well as share their impression of the interface while navigating through the product. This method helps identify parts of the interface which are difficult to understand.

The participants chosen to conduct the analysis and the test, should be part of the product's target audience [19]. These are users for whom the product is aimed for. To receive as much diverse feedback as possible, Rettig [19] explains how choosing users who fit the whole range of the target audience can be of advantage. If the users are too similar, the feedback might be similar as well. Therefore, it is interesting to receive feedback regarding every aspect of the product, which in turn will improve the end product.

During the test session, it is common for the organizers to assign roles among each other, as explained by Rettig [19]. To begin with, the role of the greeter is to welcome the test participant and give them an introduction. Rettig further explains how each test needs a facilitator, who provides the participant with instructions during the test and keeps track of the time. The final role is the observer, which more than one person can take on, and whose part is to take notes and quietly observe the test.

3.6.1 User Experience Questionnaire, UEQ

At the end of a test session, it is common to evaluate the user's overall impression of an interface through a standardized questionnaire [17]. An example of such a questionnaire, is the *User Experience Questionnaire*[1]. The UEQ can be used to collect quantitative data regarding the immediate impression of an interface, and receive statistics on how well the interface

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[1]User Experience Questionnaire, UEQ. `https://www.ueq-online.org/`

satisfies expectations.

The UEQ consists of 26 items, where every item is a seven-stage scale represented by two terms with opposite meanings on each side of the scale. The answers of the questionnaire is divided on a scale between -3 and +3, with -3 being in full agreement with the negative term and +3 in full agreement with the positive term. Table 3.1 shows the English version of the UEQ.

Table 3.1: English version of the UEQ

1	annoying	o o o o o o o	enjoyable
2	not understandable	o o o o o o o	understandable
3	creative	o o o o o o o	dull
4	easy to learn	o o o o o o o	difficult to learn
5	valuable	o o o o o o o	inferior
6	boring	o o o o o o o	exciting
7	not interesting	o o o o o o o	interesting
8	unpredictable	o o o o o o o	predictable
9	fast	o o o o o o o	slow
10	inventive	o o o o o o o	conventional
11	obstructive	o o o o o o o	supportive
12	good	o o o o o o o	bad
13	complicated	o o o o o o o	easy
14	unlikable	o o o o o o o	pleasing
15	usual	o o o o o o o	leading edge
16	unpleasant	o o o o o o o	pleasant
17	secure	o o o o o o o	not secure
18	motivating	o o o o o o o	demotivating
19	meets expectations	o o o o o o o	does not meet expectations
20	inefficient	o o o o o o o	efficient
21	clear	o o o o o o o	confusing
22	impractical	o o o o o o o	practical
23	organized	o o o o o o o	cluttered
24	attractive	o o o o o o o	unattractive
25	friendly	o o o o o o o	unfriendly
26	conservative	o o o o o o o	innovative

A value between 0.8 and 3 is seen as positive, while values between -0.8 and -3 are negative and the rest are neutral. The UEQ overall measures six areas of an interface, which are as follows [20]:

- **Attractiveness:** The overall aesthetics of the product. Do users see it as attractive, enjoyable and pleasing?

- **Perspicuity:** Is it easy to learn and understand the product?

- **Efficiency:** Is the interaction efficient and fast? Does it allow the user to solve tasks without unnecessary effort?

- **Dependability:** Is it trustworthy? Does the user feel in control of the interaction?

- **Stimulation:** Does the user feel excited and motivated while using the product?

- **Novelty:** Is the product perceived as creative and innovative?

Attractiveness, in its own, is a pure valence dimension, while the remaining areas can be divided into two categories - *pragmatic* quality aspects and *hedonic* quality aspects [20]. Pragmatic quality refers to the utility and usability aspects of an interface, which involves the areas Perspicuity, Efficiency and Dependability. Hedonic quality, on the other hand, considers the emotions gained from using the interface, as well as how interesting and original it is perceived as. It takes into account aspects like engagement and motivation, which, as mentioned in section 3.3, are the main elements in achieving active learning. The overall structure of the UEQ can be seen in Figure 3.1.
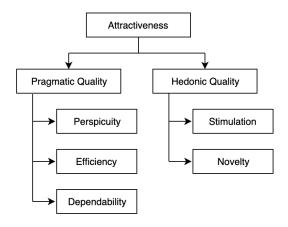
Figure 3.1: Structure of the UEQ

3.7 Related Work

Similar work, or studies somewhat related to the project, were examined to receive insight in what results the authors had obtained from these. The most relevant ones are described below.
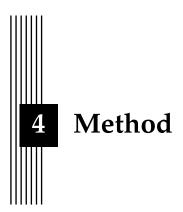
A study was conducted in 2008 by Williams and Chinn, to test if Web 2.0 tools can be used to support students active learning experience and enhance their learning outcomes [21]. The result of the study showed that these tools could be used to increase student engagement and increase levels of active learning. Because of the popularity of social networking, even in 2008, the use of interactions in this instance was perceived as relevant according to the students, and encouraged them to develop their active learning skills both inside and outside the classroom.

Kim et al. [22] conducted a study in 2011, with the purpose to find out how E-learning tools can be used for hotel employees to improve their soft skills, as well as showing the importance of soft skills. The participants of the study consisted of hotel employees from nine international chain hotels located in South Korea. The study reviews the advantages with improving one's soft skills and how these skills are useful in the hospitality industry. Furthermore, the study examines how extrinsic motivation and intrinsic motivation can be used to impact the intention to use E-learning among the respondents. The results showed that employees with a higher extrinsic motivation towards E-learning were more positive regarding using it to improve their soft skills.

Various approaches to how online courses can be designed to better engage students and

maximize learning, were examined by Khan et al. in 2017 [23]. The paper points at how consistency in the design is important to create an engaging and successful course. If the design throughout the platform is similar, it becomes easier to navigate through it. Subsequently, students are more aware of important information shared through the platform, as well as the format of the course materials.

Chen et al. [24] performed a study to examine effective design elements for online courses in the STEM fields (science, technology, engineering, and mathematics). The study consisted of an online survey, in which 537 students participated. The questions of the survey were aimed at discovering the influence of design elements on students' perception of learning and satisfaction. The design elements included active learning activities, interactive engagement strategies and assessment design. The results showed how students valued feedback, and receiving clear and concise information about due dates, grade requirements, and instructions regarding course assignments. This could improve communication between students and instructors. Furthermore, the students were positive towards online formative assessment, such as quizzes, and saw it as a tool that can help improve their grades in a course. Lastly, the study indicated how presenting informative contents in various ways, takes into account how students have different learning preferences.

4 Method

This chapter presents the methodology of the project and the necessary steps taken to be able to answer the research question. The pre-study brings up the initial stage of the project, which involves a literature study and a user needs analysis. Furthermore, the implementation stage and evaluation stage of the project are presented, to discuss the development of the product as well as the evaluation of it.

4.1 Pre-study

Aside from conducting a literature study, the pre-study stage of the project included performing a user needs analysis, with the purpose to receive thoughts, needs and expectations from users within the target audience. The following subsections describe the process of the user needs analysis, along with the initial part of the design process.

4.1.1 User Needs Analysis

A user needs analysis was planned and conducted a few weeks after the start of the project. Although several implementations had been made to the platform at this point, the main focus of the analysis was to identify needs and expectations from users within the target audience. In this case, the analysis aimed at getting to know students currently reading the course Professionalism for Engineers and receive an understanding of what is important to them.

The first step was to find potential users who were willing to participate in the analysis. A form was sent out to students within the target audience, to ascertain if they would be interested in being a part of the evaluation of the product. Subsequently, an email was sent out among the respondents, to provide them with more information, as well as book a time for when they were available to participate in the analysis. Rather than sending out a questionnaire to students enrolled in the course, the analysis was held through the video conference platform *Zoom*[1], in order to receive more elaborate answers. A total of four students took part in the analysis, where one of them studied their first year, two of them studied their

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[1]Zoom, `https://zoom.us/`

second year, and the final one was in their third year. Thus, the participants had different amount of experience with the course. The participants were divided into groups of two and each session was given a maximum time interval of 45 minutes. Aside from the users, two members from the project group and the supervisor of the project were present during the analysis. One of the members had a combined role as the greeter and the facilitator, which included giving the participants an introduction and overall review of the analysis, as well as leading them through the session. The second member and the supervisor took on the role of observers and quietly took notes during the session.

At the start of the session, the participants were given an introduction and a description of the analysis. Additionally, the participants were assured that all data collected during the session would be confidentially and anonymously handled. Lastly, before the analysis started, the facilitator asked the participants for their permission to record the Zoom meeting, and again assured them that the material would only be used within the project group.

During the session, the participants were presented with several questions regarding the course TDDD99 and its structure, which are listed in Appendix A. The first questions aimed at collecting their opinions regarding the course and how well they construct knowledge from lectures and course material. The following questions focused on gathering information of how useful the course has been to the participants, as well as finding out what their thoughts and opinions were on the current structure with all the platforms used. Lastly, the students were asked whether they have had experience with using platforms aimed for learning and the advantages with using them. The questions, as mentioned, aimed to understand users within the target audience and identify their needs and expectations. With every question, the participants were given some time to individually think about an answer before presenting it to the project group and the second participant. The aim of this approach was mainly to give the participants a chance to think for themselves and avoid being influenced by the answer from the second participant. The facilitator lead the participants through every question, without influencing their answers. The supervisor of the project was mainly present during the tests to take notes, but as the role of the examiner in the course, they asked follow-up questions to the participants when necessary.

At the end of each test session, the participants were presented with the current design of the platform. Despite only seeing the platform for a couple of seconds through screen share, they were asked to give an overall impression of it.

After the tests, a transcription of the recordings were written down and shared with the group. The thoughts and expectations from the analysis were kept in mind during the development process and affected the design choices made.

4.1.2 Competitor Analysis

The initial part of the project also consisted of discussions between the project members and Berglund regarding design ideas and choices to be used on the platform. These discussions included identifying and evaluating existing E-learning platforms and applications aimed for learning, with the purpose to receive inspiration from these. The project members spent time simultaneously looking at these platforms and discussed their thoughts and feelings regarding the overall design, as well as advantages and disadvantages with it.

4.2 Implementation

With the knowledge gained from the literature study, as well as the collected design ideas and results from the user needs analysis, the design and functions of the platform were im-

plemented. The following section describes an overview of the development process, as well as which frameworks were used.

4.2.1 Requirement Specification & Design Process

In addition to the prototype mentioned in section 2.1.2, Berglund provided the project members with a requirement specification, which further clarified the requirements regarding the platform. It described all functions and elements to be included in the platform, as well as if students or admin would have access to it. The specification was extensive, which created uncertainties in whether the project members would be able to implement all functions within the limited time frame. For this reason, Berglund prioritized the functions into two categories, where one involved functions more prioritized than the other. A summary of the prioritized requirements for the student page are listed in table 4.1.

Table 4.1: Requirement Specification

Present the student with an overview of all their courses, as well as general info regarding each course
The student can view the schedule of a course
News regarding each course are shared through the platform
The student can submit assignments and essays through the platform
When the student submits an assignment, their name and student-ID is automatically included in the file
The student can find their results in the course and for specific assignments
Give the students relevant notifications, for example when a new result has been published
The student can follow their progress in the course
Written material and video material related to course topics can be shared through the platform
Students can test their knowledge through a quiz-functionality

Furthermore, the specification included a number of keywords to be used as a foundation when discussing the general design and aesthetic of the interface. These were as follows:

- Modern: The interface should have a modernised design

- Simple: The application should be easy to use and understand

- Fast: The user should be able to navigate through the platform without delays

- Responsive design: The interface changes depending on screen size

Moreover, the project group decided on giving the platform a minimalist design, by choosing few and light colours in order to avoid creating a messy impression of it. Since the platform would involve the functionalities of all three platforms used currently in the course, design choices were made to include these without creating an overwhelming feeling for the user. This mainly involved using tabs to structure course activities and thereby avoid presenting the user with too much information at once. The general structure of the platform was based off of the prototype, as presented in section 2.1.2. Norman's fundamental principles of interactions [16], which were listed in section 3.5.1, were used as guidelines throughout the design process, in order to create an understandable and pleasurable design. The principles were aligned to the design when creating and organizing elements on the platform. These include:

- Using a clear blue colour for the majority of the buttons on the platform, to create consistency and thereby signify that these are clickable. The blue colour creates a clear contrast with the light background, and thereby makes it more visible.

- Using the colours green, yellow and red as feedback to the user, which indicates if the user has done right or wrong.

- Applying constraints when handing in assignments, in order to make it more difficult to forget to include all requirements.

- Using natural and logical icons which clearly indicates their functionality. For example, a bell-icon is often used as a notification symbol, and a check mark is used to indicate that something has been accomplished.

- Using signifiers to differentiate clickable elements from non-clickable ones. For example, plain black text does not indicate that it can be clicked on, while blue text in contrast with black text usually suggests it is a link that can be clicked on.

- Giving the user immediate feedback when navigating through the interface and clicking on buttons, to indicate that their actions were successful. If a button does not lead the user anywhere, information should be provided explaining what action was performed.

- If the information on a page is extensive, tab elements or expandable elements should be used to minimize the information visible and avoid creating an overwhelming feeling. By structuring the content, it becomes easier to keep track of the information.

- Using rounded corners for design elements, such as progress bar, background boxes and cards to avoid a sharp design.

- Avoid involving too many elements on a page, which can be unpleasant and overwhelming.

- Avoid including too many links on a page. If possible, put videos and files directly on the page and links should be opened in a separate tab in order to not create distractions.

Further information about the resulting structure and design choices of the platform are presented in chapter 5.

4.2.2 Frameworks

The framework used for front-end development, which involves the client side of the platform, was the TypeScript based framework Angular[2]. This was the agreed upon framework decided by Berglund. Angular is mainly used for building dynamic single page applications and provides a clear structure, which makes the development of larger applications easy to maintain. It has a benefit of providing a selection of tools and libraries, which can help simplify the development process significantly. On the server side, the Python framework Flask[3] was used in combination with the SQL toolkit SQLAlchemy[4]. The database management system SQLite[5] was used for storing all data and files connected to the platform.

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[2]Angular, https://angular.io/
[3]Flask, https://flask.palletsprojects.com/en/2.0.x/
[4]SQLAlchemy, https://www.sqlalchemy.org/
[5]SQLite, https://www.sqlite.org/index.html

4.2.3 Development

Initially, the platform was only implemented on the client side by using mocked data, with the purpose to establish the fundamental logic and structure of the platform. Furthermore, an ER (Entity Relationship) diagram was created and shared among the project members, which illustrated the entity sets to be stored in the database and their relationship to one another. The use of an ER diagram was beneficial in receiving an overview and understanding of the database structure and its logic before implementing it on the server side of the platform. The ER diagram was frequently updated throughout the project whenever a new function, which required a new entity, was added to the platform. As the platform was gradually implemented, the project members had daily meetings with Berglund, who was also the supervisor of the project, where the members gave a status update and discussed eventual problems, as well as looking at the requirement specification and deciding upon how they should proceed with the project.

4.3 Evaluation

In order to evaluate the platform, user tests were planned and conducted with users within the target audience. The goal with the user tests was to reveal areas of confusion regarding the interface of the platform, by allowing users to interact with it and observing their behaviours and reactions towards it. The following section describes how the user tests were arranged and performed, as well as what methods were used.
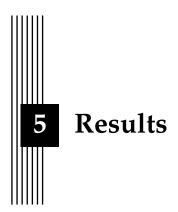
4.3.1 User Tests

The user tests were performed towards the latter part of the project, with the purpose to measure and evaluate the platform among potential users. The participants chosen for the test had previously participated in the user needs analysis at the beginning of the development process, see section 4.1.1. The reason for choosing the same participants was to acquire a more coherent result, since the users had already received an insight into the project during the user needs analysis. Moreover, an email was sent out to the participants containing information regarding the upcoming test, as well as a link to a meeting schedule tool to find a time slot for the test. Unlike the user needs analysis, the users performed the test alone. The time set for the test was 30-45 minutes, mainly because it seemed as a necessary amount of time to perform all the tasks, and to avoid taking up too much of the user's time. Much like the user needs analysis, the user tests were held through the video conference platform Zoom, meaning that the users could not interact with the interface on one of the developers own devices. In order to solve this problem, the users were asked prior to the test to join the meeting on a device from which they could share their screen through Zoom. The test participants were then, at the beginning of the test session, sent a reverse proxy link which allowed them to access the locally running platform from a public endpoint. This link was temporary and gave the users the possibility to interact with the interface throughout the test session.

At the event of the test, only the participant and facilitator were present. To avoid having to take notes, as well as simultaneously leading the user through the test, the facilitator asked at the start if the participant was all right with them recording the test session. The user was further assured of their rights, which meant that all materials collected during the test would be handled anonymously and only shared with members which are involved in the development of the platform. During the test, the users were urged to do a number of tasks provided by the facilitator, which are listed in Appendix B. The instructions were shaped in a way to allow the participants to follow them as how they interpret them as, which meant that they could not be too leading. Throughout the test, the participants were asked to think

out-loud, referring to the method mentioned by Arvola [25], while they interact with the platform. This involved letting the facilitator know what they are doing, why they are doing it, and their thoughts regarding the interface. The purpose of using this method was to better identify problems and difficulties with the platform. All users performed the test on a desktop device and showed the interface in full screen mode at all times.

4.3.2 User Experience Questionnaire, UEQ

After the test, a User Experience Questionnaire were sent out to the users, with the purpose to receive their overall impression of the platform. The questionnaire, as described in section 3.6.1, measures attractiveness and pragmatic aspects such as efficiency, perspicuity and dependability, as well as hedonic aspects which includes stimulation and novelty. The participants were asked to not think too much about their choices regarding the different items in the questionnaire, but rather chose after their initial impression of the interface.

5 Results

The following chapter presents the results of this project. It involves the result of the platform, as well as responses from the users who participated in the user needs analysis and the user tests.

5.1 Pre-study

The focus of the pre-study was to find theories in connection to the research question, as well as collect thoughts and expectations from potential users during the user needs analysis. In addition, initial design ideas regarding the platform were discussed, which involved looking at the prototype provided by the client, along with doing a competitor analysis of existing E-learning platforms. The following section presents the result from the user needs analysis and the competitor analysis.

5.1.1 User Needs Analysis

The results from the user needs analysis were summarized from the transcribed notes and recordings from each test session. To begin with, the participants were asked a couple of questions regarding the course itself, where everyone expressed to be satisfied with the course in general and explained it to have given them useful tools to help themselves grow personally as well as professionally. They further explain it to have helped them discover new sides of themselves, and become more aware of their strengths and weaknesses.

Moreover, the participants gave an insight in what steps they usually carry through in order to get started with the course. This involved looking through the course content available on the course web page, as well as write down relevant deadlines. In addition, the participants were asked how well they absorb information from lectures and course material, in which the overall opinion was that it is necessary to both receive information verbally and in writing. One participant expressed how they have a hard time absorbing information during a two-hour lecture and for this reason prefers reading compare to listening. However, they explained, from previous experience, how shorter lectures are more preferred and make it easier to look back at specific parts of a lecture. The participants expressed how they felt it to be important to have the course content structured. One participant gave a comment on

how the structure can be perceived as widespread, meaning that it involves a lot of external links for the students to follow. For this reason, it becomes easy to get lost among the different links and forget where you were or what you were doing.

When asked about the current structure with the websites and platforms used in the course, the majority of the participants expressed that keeping track of them all is not optimal. One participant explained that it is easier after every course, due to the students getting used to it. All participants expressed difficulties in navigating through the platform Lisam and explained it to be slow with many clicks needed to navigate to the right page.

Furthermore, the participants were asked to share their thoughts regarding a new platform involving more interactions. The participants generally were positive about the idea, as long as the information provided is structured. One participant expressed, from previous experience, how the use of quizzes is a more fun way to solve exercises and helped them increase their learning. It allows the student to receive confirmation on what they know and how much they have understood. Another participant thought that interactions could help increase interest in the course as well.

5.1.2 Competitor Analysis

Similar platforms aimed for learning were evaluated to find useful inspiration when developing the new platform. These included the platforms SoloLearn, Moodle and Udemy.

SoloLearn

SoloLearn[1] is a free learning platform aimed at users who want to learn how to code. The platform provides an overview of different courses, where the user can see which courses they have and have not started, as well as their progress, see Figure 5.1. Every course contains short lessons, code challenges and quizzes. Throughout the course lessons, the user receives feedback depending on if they do something wrong or right, as seen in Figures 5.2 and 5.3. The analysis focused on gaining inspiration regarding design and functionality from the quiz functionality and the course overview, as well as how the platform provided the user with feedback.
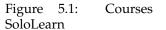

Figure 5.1: Courses at SoloLearn

Figure 5.2: Question answered correctly

Figure 5.3: Question answered incorrectly

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[1]SoloLearn, https://www.sololearn.com/

Moodle

Moodle[2] is a learning platform, which can be compared with the SharePoint-based platform Lisam[3]. The platform gives educators the possibility to customize the contents in their courses and learning environments. The analysis focused on looking at different functionalities provided by the platform, which included assignment, quiz and progress functionalities.

Udemy

Udemy[4] is a platform for teaching and learning, allowing teachers and instructors to build online courses on their preferred topics. Udemy allows the creators to include video and audio lectures, and provides functionalities such as quizzes and coding exercises, which were analysed in search for inspiration.

5.2 Implementation of the Platform

The main focus of the project was to develop a platform aimed to be used in the course Professionalism for Engineers. In this section, the resulting implementations made to the platform is presented, as well as a description of them. Additionally, throughout the implementation, Norman's [16] fundamental principles of interaction were kept in mind with the purpose to create a more understandable and pleasurable interface.

5.2.1 Course Overview

When the user is logged in to the platform, they can see a list of card elements with all their active courses, as seen in Figure 5.4. Each card element contains summarized information regarding the course, which involves course title, course length, course level, as well as registration status. Additionally, the student can see their overall progression in the course and how far they have to go in order to finish it. The overview was based off of the prototype provided by the client, as seen in Figure 2.7 mentioned in section 2.1.2. A similar function is used in both SoloLearn and Moodle, as referred to in section 5.1.2. Figure 5.4 shows all the six course parts within the course TDDD99.

5.2.2 Course Page Structure

If the student click on one of the courses shown in Figure 5.4, they are redirected to the page of that specific course. Figure 5.5 shows an example of the structure on a course page. The structure was based on the prototype provided by the client, as seen in Figure 2.6. On the top of the page, marked with the number *1*, a horizontal *navigation bar* is placed, which contains links to navigate through the platform and is visible to the user at all times. The part marked with the number *2* shows the content of one of the *course activities* available for the current course. All activities are listed in the *sidebar* marked with the number *3*. Lastly, at the bottom of the page, with the number *4*, is another navigation bar, but it is only available when the user navigates to a course page. It gives the user a second option to navigate through the course activities by clicking on one of the buttons with an arrow symbol pointing left and right. The navigation bar is shown regardless of screen size, but are mainly used to give the user a more efficient way of navigating through the platform when using it on a small screen. Apart from the arrow buttons, the navigation bar also consists of a third button with the label "*Markera klar*" (Mark as finished), as can be seen more clearly in Figure 5.6. When the user have finished reading the content for a course activity or finished a certain task, they can click on the button and watch how the progress bar increases in the sidebar. When the button has

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[2]Moodle, `https://docs.moodle.org/311/en/About_Moodle`
[3]Lisam, `https://www.student.liu.se/studenttjanster/lisam-och-studentportalen/?l=sv`
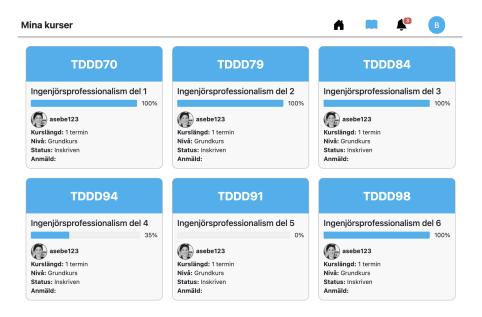[4]Udemy, `https://about.udemy.com/`

Figure 5.4: Overview of the courses read by the student

been clicked, the button text changes to "*Markera ej klar*" (Mark as not finished) and the check mark symbol beside it is filled, as shown in Figure 5.7. For every page marked as finished, its corresponding link in the sidebar changes colour to green and the circle beside it is filled with a check mark symbol. The check mark is a natural icon mapped to this functionality, which signifies that something has been accomplished.

A blue colour theme was chosen for the platform, which is often associated with Linköping University. In order to make the blue colour more prominent, as well as avoid a disturbing mix of colours, an overall white background was used throughout the platform. As shown in Figures 5.6 and 5.7, a blue colour was chosen for button elements on the platform, to be more consistent and create an affordance which better suggest to the user that these can be clicked on.

Navigation Bar

A closer look at the top navigation bar is presented in Figure 5.8. It contains four icons, where the one on the far right gives the user options regarding their account, for example the option to sign out of the platform. However, this functionality has not been implemented. The icons are shown regardless of screen size, and the black icons have a corresponding name shown as a *tooltip*, in order to give more clear information regarding its purpose to the user. The symbol next to the blue icon is a notification symbol, and as the name suggests gives the user notifications regarding news and updates in the courses, see Figure 5.10. In Figure 5.8, there is a small red symbol above the notification symbol, showing the number 2. This indicates that the user has two new notifications in one of their courses.

Sidebar

Below the navigation bar, the sidebar is placed, as can be seen in Figure 5.9. To begin with, the links "*Nyheter*" (News), "*Resultat*" (Result) and "*Schema*" (Schedule), along with a corresponding icon are displayed. Under the news link, the student can read news regarding the course posted by their examiner. The result link shows the student's total result in the course, as well as their grade for each graded activity. Finally, the schedule link shows an
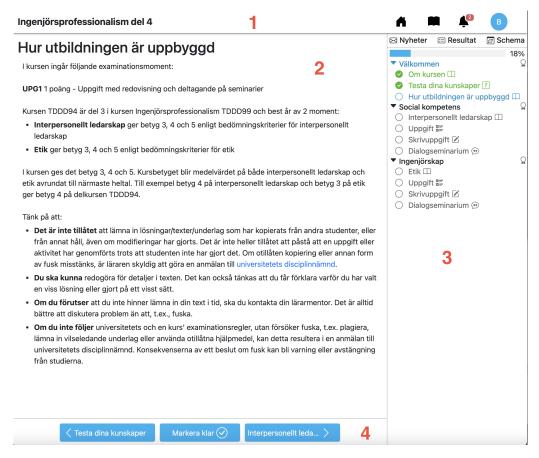
Figure 5.5: Overview of the components of a course page

Figure 5.6: Mark as finished

Figure 5.7: Mark as not finished
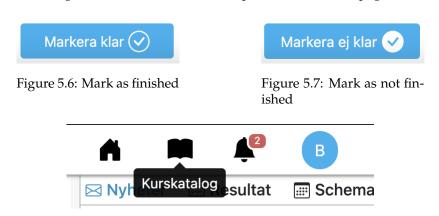
Figure 5.8: Navigation bar

embedded link to the course schedule. These links are the same for every course available on the platform.

Furthermore, the sidebar consists of links to all content pages available on the course web page. These links have a corresponding icon as well, which represent a specific activity for the page. The links are divided into topic specific groups, in which the topic title is not a link to a page. The user can click on the topic title to hide and show the links associated to it. As can be seen in Figure 5.9, the majority of the links have an empty circle next to it, which implies that the student has not finished the activity on these pages. Three content pages are

marked green, which indicates that the student have read the content or done the activity within these pages. As a result, the progress bar displayed above the green links have been filled to 27%.

Figure 5.9: Closer look at the sidebar and navigation bar
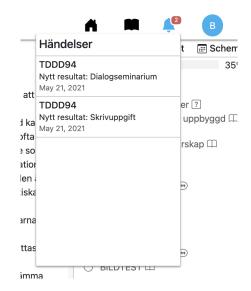
Figure 5.10: Notifications

5.2.3 Content
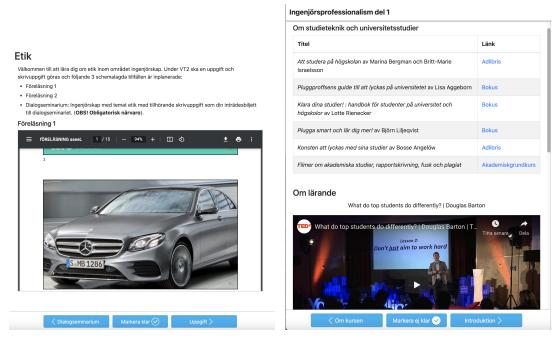
When the user selects a link in the sidebar, they are presented with a course activity. As explained in section 5.2.2, the icons beside the links in the sidebar indicates to the user what type of activity it involves, and there are a total of six different activities. The activities and their corresponding icons are:

- Reading 📖
- Video 🎥
- Quiz ❓
- Writing 📝
- Assignment 📋
- Seminar 💬

Reading and Video

A reading activity presents the user with informative content, which mainly involves plain written information, aimed for the student to read and can include text mixed with images and videos, as well as embedded files. Figure 5.11 shows an example of a reading activity, which involves some text as well as an embedded PDF of a lecture. Another example can be seen in Figure 5.12, where the text has been structured into a table and an embedded video is displayed below it. If a reading activity contains much information, it can be divided and hidden inside expandable elements, as shown in Figure 5.13. At the end of each element, arrows pointing up and down are used to signify that more content is hidden. A video activity
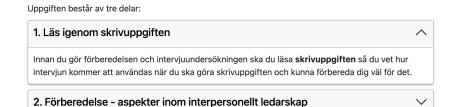
is similar to a reading activity, except that its main focus is to present a video, for example a recorded video lecture. The platforms Moodle and Udemy, from the competitor analysis in section 5.1.2, were used in finding inspiration for these activities.

Figure 5.11: Written information combined with an embedded PDF

Figure 5.12: Informative table combined with an embedded video

Figure 5.13: Expandable elements

Quiz

The quiz activity is a self-assessment tool, which is not graded and allows the student to see for themselves how well they have understood the content of the course. The examiner can choose questions regarding, for example, topics which have been brought up during a lecture. The quiz involves questions with multiple options, where there can be either one right answer or several right answers. The choices are either plain text or can contain images. When the user performs the quiz, they receive feedback on whether they have answered right or wrong. If they give the right answer, the selected option (or options) is marked green and a green banner with the text "*Bra jobbat!*" (Good job!) shows up at the bottom of the page,

as shown in Figure 5.14, and the user is allowed to move on to the next question. However, if a wrong answer is chosen, it is marked red and a red banner is instead shown at the bottom of the page with the text "*Försök igen*" (Try again), which is displayed in Figure 5.15. In this case, the user can not move forward to the next question until they have tried again and selected the right option or options. The functionality is mainly inspired by the platform SoloLearn, referred to in 5.1.2.
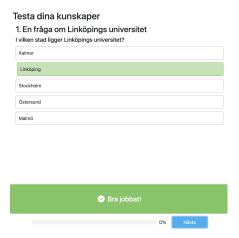
Figure 5.14: A question answered correctly

Figure 5.15: A question answered incorrectly

During the quiz, a progress bar and a button is visible at all time, which can be seen in Figures 5.14 and 5.15. The progress bar fills up after every answered question and shows how much of the quiz the user has left to answer. The function of the button beside the progress bar, is to navigate the user to the next question if they have answered the current question correctly. When the question is incorrectly answered, the button has a different functionality which allows the student to restart the question. When the user has answered the last question, they are presented with a suggested list of subjects which they can practice more on, see Figure 5.16. These subjects apply to the incorrectly answered questions made by the user during the quiz.

Figure 5.16: Overview of subjects the user can practice more on

Writing

As mentioned in section 2.1, the course Professionalism for Engineers involves assignments and reflective essays, for which Lisam has been used to submit these. On the platform, an activity aimed for writing these assignments has been added to replace the Lisam submission functionality. The contents of a writing activity has been divided into four tabs, as can be seen in Figure 5.17.

Figure 5.17: Overview of a writing activity

The first tab, with the title "*Beskrivning*" (Description), presents the user with a title and description of the assignment. The second tab, titled "*Inlämning*" (Submission) shows the main function of the activity, where the user submits their assignment. The submission function consists of a form, involving a number of questions with corresponding text fields for the user to fill in, as seen in Figure 5.18. The questions used in the Figure are derived from a reflective essay within the course Professionalism for Engineers. In the Figure, marked with the labels *2* and *3*, an example of a question and their corresponding text field can be seen. The text with the label *1* indicates that the fields marked with a red star (*) is mandatory for the user to fill in. In the lower right corner of the page, a small box labelled with the number *4* can be seen. The box shows the total number of words for which the user has written in all text fields, as well as how many words the user are allowed to write for that specific assignment. As the principle of constraints suggests, the submission form has been developed to include functions to keep the students from handing in an assignment which does not fulfil all requirements.
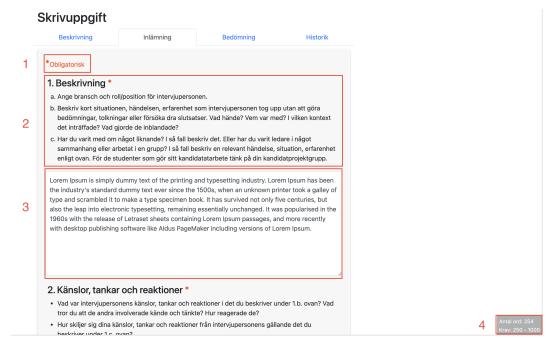

Figure 5.18: The submission form

The final text field of the form is aimed for self-assessment, where the student describe what grade they are aiming for, and a motivation to why. As explained in section 3.3, the students are required to comment their answer to this when they submit the reflective essays and assignments. The text field is mandatory as well and is shown in Figure 5.19. Below the text field, two buttons labelled "*Lämna in*" (Submit) and "*Spara*" (Save) are displayed. As the names suggests, the submit button allows the user to submit their assignment and the save button saves their progress. When the student has achieved all requirements for the assignment, the submit button is enabled and displayed in a blue colour, see Figure 5.19. In order to achieve all requirements, the student has to write in all required fields and reach a word count within a defined range. If the student fails to fulfil these requirements, the submit button is disabled and displayed in a grey colour, as seen in Figure 5.20. Whenever the user saves or submits an assignment, a notification box, informing them that their action was successful, is displayed in the top right corner of the page, see Figure 5.21. When the user submits the assignment, their answers are compiled into a PDF, which also includes the name and student ID of the student.

Figure 5.19: The bottom of the submission form

Figure 5.20: Submit-button disabled

Figure 5.21: Feedback from saving an assignment

A written assignment is a graded activity, and the result from it is displayed under the last two tabs. The tab, labelled "*Bedömning*" (Assessment), presents the student with an overview of the grading criteria for the assignment, as well as if they have satisfied these or not. A further explanation of this functionality is given later on in section 5.2.4. The last tab, labelled "*Historik*" (History), shows all events regarding the assignment. This includes comments from the teacher concerning the grading of the assignment, along with a link to the PDF of the student's assignment, see Figure 5.22.

Assignment

An assignment activity has a comparable structure to a writing activity, in that it is a graded activity and also divided into four tabs. The content is similar, except for the submission tab, which only allows the user to upload a file. A text field, for writing what grade the student
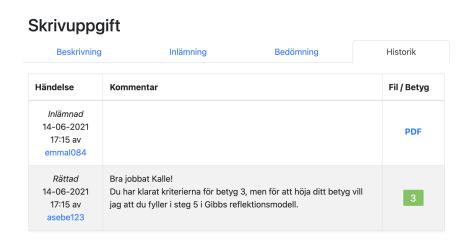
Figure 5.22: Submission history

aims for, is also included and required in order to submit the assignment. The reason for not including a form in this activity, is because submissions regarding an assignment activity are not always a written assignment. One example of such an activity is one assignment included in the course TDDD99, where the student uses an optional digital calendar to plan their studies and everyday life. The student submits the assignment by converting their calendar into a PDF.

Figure 5.23: Submission tab for an assignment

Seminar

There are in total three graded activities available, and the final one is the seminar activity. The seminar in itself is an in-class activity, but information regarding the seminar, as well as the result from it, is shared through this activity.

5.2.4 Result View

As mentioned in previous sections, every graded activity involves a tab where the student can see their result in the different courses. The purpose of this functionality is to replace the platform WebReg, where the students currently can find their results in the course. Figure

5.24 shows an example of how the result is presented for a specific assignment. The result is presented as a table, which shows the different criteria for each grade, as well as which criteria the student has fulfilled. If the student has accomplished a certain criterion, it is marked with a green box in the second column. When every criterion for a specific grade has been achieved, the grade itself is marked green in the first column. The highest grade marked with the colour green is the grade the student receives for the activity. If the student has not quite fulfilled a specific criterion, it is marked as yellow in the second column. This indicates that the student has to do a completion of the assignment and re-submit it to achieve the corresponding grade of that criterion. The student can also be given a failed grade, in which the criterion is marked with a red box.

Moreover, below the result table, the student can see comments regarding their assignment submitted by the teacher. In Figure 5.24, the comment explains what the student needs to change in order to improve their grade from a 3 to a 4. The comment is also shown under the History-tab for a writing and assignment activity.
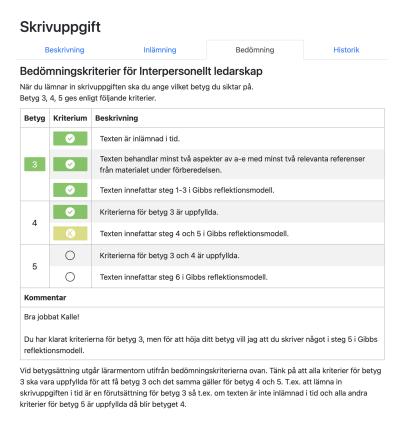

Figure 5.24: Result view for a course assignment

If the student wish to see an overview of their result in the entire course, this information can be found under the link "*Resultat*" (Result), as shown in Figure 5.9. The page presents the user with an overview of their total result in the course, as well as allows them to see their results for the different course topics, see Figure 5.25.

Figure 5.25: Result overview

5.2.5 View for Smaller Screens

The platform was not solely implemented to be used on a desktop sized screen, but also on smaller screens such as smartphones and tablets. Figure 5.26 shows the overview of the student's courses, which, in order to avoid making each course card appear too small, have been placed in a single column rather than three columns. Furthermore, the content on a page has been adapted to automatically fit the current screen size, as seen in Figure 5.27. The sidebar is automatically hidden on the page, in order to make use of the limited space and avoid making elements appear too small. The user is given a clue to where it is hidden, through the blue icon in the top right corner of Figure 5.27. The icon has an affordance which indicates it is a menu, and when it is pressed, the sidebar covers almost the entire page, see Figure 5.28. Moreover, the "Mark as finished" function is minimized and only consists of a circle with a check mark in it. The names of the tabs in a writing assignment, and the titles on a result table, have been replaced with icons to better fit the screen size. The icons have been chosen to match their corresponding name and title, in order to make the interface as intuitive as possible. Figure 5.29 shows the icons used in the writing activity, as well as how the content is displayed on a small screen. A result view on a small screen is seen in Figure 5.30, as well as the icons which have replaced the titles for each column.
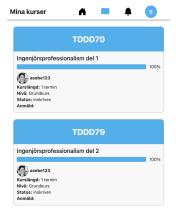

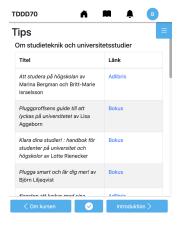Figure 5.26: Course overview

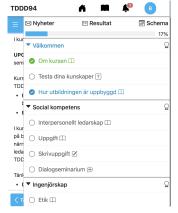Figure 5.27: A content page viewed on a small screen

Figure 5.28: Sidebar viewed on a small screen

Figure 5.29: A writing activity viewed on a small screen

Figure 5.30: Sidebar viewed on a small screen

5.3 Evaluation of the Platform

The platform was evaluated through user tests, which were held for four users within the target audience of the platform. This included students with different amount of experience regarding the course Professionalism for Engineers. The tests, in combination with the User Experience Questionnaire, provided both a qualitative and quantitative result.

5.3.1 User Tests

Comments and thoughts, as well as identified areas of confusion regarding the interface, were transcribed and summarized from each user test. The overall opinion from the users were positive, and they described the interface as intuitive, orderly, coherent, as well as structured. The users appreciated how every part regarding an activity was available on the page, and how the sidebar made it effortless for the user to quickly move between pages, as well as keep track of where they were on the platform and what they were doing.

Navigation

The majority of the users checked under the notification icon when asked to find out whether there were any news in the course, and they all knew that the course listed in the course overview could be used as well.

All users navigated through the platform by choosing links in the sidebar. Although some users noticed it, no one used the bottom navigation bar to navigate between pages. One comment made regarding this function, was that it appeared to be discrete and easy to miss. Furthermore, it was noted how the icons helped the user understand what type of content the links contained.

Content

The users had no difficulties understanding the purpose of the "Mark as finished" function, and expressed a general positive opinion on how it could help remind students of which course materials they have and have not already read. One user explained it to be similar to a to-do list and every time something is checked off the list, the student acquires a sense of having accomplished something, even from just reading information. It can help them receive a push in the right direction, which as a result will make it easier to move forward

to the next task. Regarding the placement of the function, one user explained it to be out of focus and easy to miss unless you know that you are looking for it.

Quiz

The quiz functionality was explained as a useful addition to the platform and how it can help students see what they can improve on. The users appreciated that the feedback given was clear and immediate, and how incorrectly answered questions were marked red and correctly answered were marked green.

One user explained how they first thought that a correctly answered question would automatically bring them to the next question, instead of manually moving forward by pressing a button. They further expressed how the number of clicks required to move forward appeared a bit unnecessary. The button could be hard to miss at first, since the eyes focused on the green and red banner, which looks more exciting than a blue button. The function was not experienced as fully intuitive at the beginning, but this changed after one question. Overall, the majority of the users experienced the functionality as being straightforward.

Regarding the second question, two users missed the final option, which was hidden unless they scrolled down the page. One of them suggested placing the scrollbar on the left side of the sidebar, in order to make it more noticeable to the user that there are more alternatives.

Writing

Without any explanation of the function, the users were given time to explore the writing activity on the platform and explain their interpretation of it. It was appreciated that each part of the written assignment was gathered under the same link.

The participants generally appreciated how each part of the written assignment was given a separate text field in the submission form, and described it as being structured and coherent. An additional thought was that the form could make it easier for the students to aim for a higher grade, since they just need to fill in the belonging text fields for higher grades, as opposed to go back and look at the instructions. However, one user expressed concerns in how the separate fields could create issues if the end of one part is transitioned into the following one.

It was noted during the tests how the users had some troubles understanding what was missing in order to submit the assignment. There were no difficulties in understanding that the fields marked with a red star were required in order to submit the form, but the majority of the users did not immediately, or at all, notice the box showing the number of words. One user, after noticing it, thought it to be a useful function but very discrete and therefore easy to miss. Since the users cannot submit the assignment if the number of words are outside the required range, one suggestion was to give the user more distinctive feedback by, for example, highlighting the box in a red colour, as well as increase its size to be more visible. Regarding the function itself, the general opinion was that it could be useful and make it easier to not miss the requirements for the assignments, which are usually listed in the instructions. Another suggestion regarding this particular function, was to also show the number of words for only the mandatory fields, or for each field. The students are required to write a maximum of 500 words for the mandatory fields in the reflective essay, if they are reaching for a grade higher than a 3. Showing the number of words for only the mandatory fields could then be of advantage.

Furthermore, one student mentioned how the placement of the save and submit button

could appear a bit hidden, since they are placed at the bottom of the submit form and the user needs to scroll down all the way to find these. This could, for example, be annoying for the student if they want to save what they have written so far, but they are located at the top of the page. If the students cannot trust the save-function, they might write their assignment in a separate text editor previous to submitting it, and not use the form as it should be used. One user suggested placing these buttons in a fixed position, meaning that they are available to the user even when they scroll. This can as a result help the students feel less stressful, since they know their progress can be saved at any time. Lastly, the feedback from saving and submitting the assignment were thought to be slightly hidden among the links under the navigation bar, where these are displayed.

Result View

The overall thoughts regarding the result function were positive, and everyone appreciated both being able to see an overview of the result, and more detailed information for each course module. The result table was described as structured and a way for the student to clearly see what grade criteria they have and have not fulfilled. Only one user noticed how the blue arrow lead the user to the specific activity of that result, which they did by mistake since they interpreted the arrow as representing an expandable element. For this reason, they explained how the arrow could be misleading to the user. Furthermore, the user suggested using an arrow to more clearly show that there is an expandable element, and use another icon for navigating to the specific activity of that result.

5.3.2 User Experience Questionnaire, UEQ

The result from the user experience questionnaire, which was sent out at the end of each test session, was assembled for each user and can be seen in Figure 5.31. The corresponding values are listed in Table 5.1.
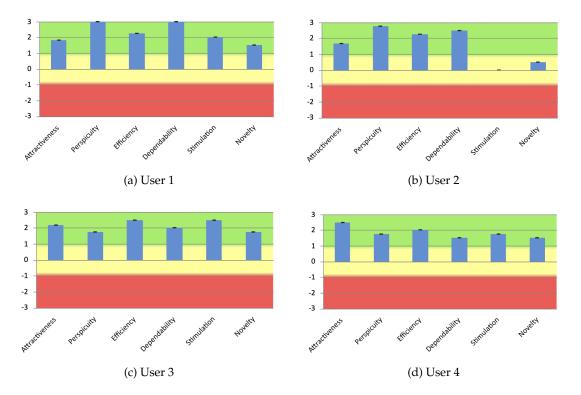

(a) User 1

(b) User 2

(c) User 3

(d) User 4

Figure 5.31: Results from UEQ

Table 5.1: Resulting values from the UEQ

	Attractiveness	Perspicuity	Efficiency	Dependability	Stimulation	Novelty
User 1	1.83	3.00	2.25	3.00	2.00	1.50
User 2	1.67	2.75	2.25	2.50	0.00	0.50
User 3	2.17	1.75	2.50	2.00	2.50	1.75
User 4	2.50	1.75	2.00	1.50	1.75	1.50
Mean	2.04	2.31	2.25	2.25	1.56	1.31

Any result over the value of 0.8 is classified as positive, which all categories for users 1, 3 and 4 shows. The results from User 2 shows a value below 0.8 for the categories stimulation and novelty, which is classified as neutral. Out of all categories, the best mean value was shown for the category perspicuity, as seen in Table 5.1, meaning that the respondents found the platform intuitive and easy to get familiar with. Moreover, the categories attractiveness, efficiency and dependability achieved a mean value of over 2, which indicates that the users overall liked the platform and experienced that the tasks were easy to solve, as well as feeling in control over the interaction. Lastly, the stimulation and novelty categories received slightly lower mean values compared to the other categories. These categories indicate that the user perceives the platform as being exciting and motivating to use, as well as creative and interesting.

5.4 Changes after User Tests

After the evaluation of the results from the user tests, some minor changes were made to the platform. These were implemented in order to solve some of the difficulties regarding the interface which were identified during the user tests.

The participants had troubles with noticing the box which shows the number of words in the submission form for a writing activity. In an attempt to solve this visibility problem, the box in itself was given a responsive size, meaning that the box changes size depending on the screen size. Furthermore, the colour of the box has changed depending on if the number of words are within the required range or not. In accordance with the concept of mapping, a green colour is used to indicate a sufficient number of words, see Figure 5.32, and a red colour is used to inform the user that the number of words is out of range, see Figure 5.33.

Another addition to the submission form, was displaying the number of words for the mandatory fields. This was a suggestion made by one of the users, since the students are required to write a separate maximum amount of words for the mandatory fields, if they are reaching for a grade higher than a 3. This addition along with the updated form can be seen in Figure 5.34. Furthermore, a scrollbar was added and placed on the left side of the sidebar, in order to more clearly suggest that there is additional content hidden on the page.

Figure 5.32: Sufficient number of words
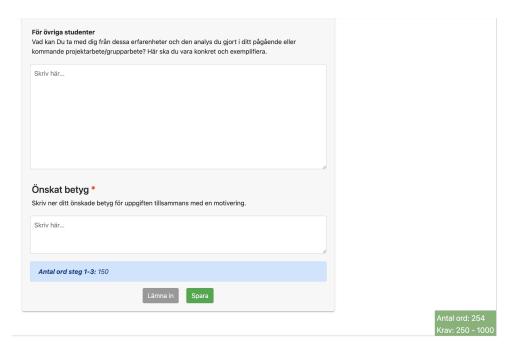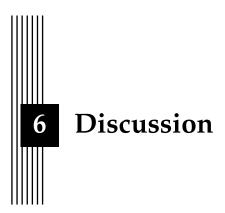

Figure 5.33: Insufficient number of words

Figure 5.34: The updated submission form

6 Discussion

The following chapter discusses the result and methodology of the project, as well as the work in a wider context.

6.1 Results

Norman [16] explained how an intuitive interface can make users feel that they are in control and generally creates a positive experience for them, as referred to in section 3.5. In order to achieve this, the design of the interface were occasionally analysed and adapted to better connect to Norman's fundamental principles of interactions, listed in section 3.5.1. Overall, the test participants were positive regarding the interface of the new platform, which the results from the user tests and the UEQ showed. However, the tests also uncovered some ambiguities with the platform which have to be analysed and discussed further. To begin with, the following section presents a discussion of the resulting platform with respect to the results from the user tests, along with a discussion of the result from the user experience questionnaire.

6.1.1 Navigation

When asked about Lisam[1] during the user needs analysis, the participants expressed how navigating through the website could be slow and frustrating. The project members wanted to avoid this issue when developing the new platform. The navigation should be fast and easy, with no unnecessary pages to pass through when trying to find the target page. Whether this was achieved, was confirmed through the results from the user test, where the users appreciated the simplicity of the platform and how it was easy to find and navigate between pages. As examined by Khan et al. [23], consistency and simplicity in the design is important to create an engaging and successful course. By using a simple design, it makes it easier to navigate through the platform as well.

One thing that was noticed throughout the tests, the users did not at all or barely use the bottom navigation bar. It was further described as not being immediately noticeable. The

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[1]Lisam, https://www.student.liu.se/studenttjanster/lisam-och-studentportalen/?l=sv

tests were all performed using a desktop device, and relative to the entire screen, the bottom navigation bar is quite small. The function is harder to miss on smaller devices, and more useful when the sidebar is automatically hidden. The bottom navigation bar, in that scenario, is a more available option for the user compared to choosing links in the sidebar, while it can appear to be superfluous on larger screens. Furthermore, the concept of mapping suggests that using arrows pointing left and right to move between pages, which are listed vertically in the sidebar, is not a natural and logical choice of icons [16]. On a small device, the sidebar is not visible to the user at all times, and the vertical sidebar with the horizontal navigation is not interfered. However, on a large screen, the sidebar and navigation bar is both visible to the user, meaning that they can see how they move up and down between links in the sidebar when pressing buttons pointing left and right. This aspect of the functionality could also be a factor to why it was not used during the tests. A more natural choice would be icons which points up and down.

6.1.2 Content

As referred to in section 3.2, Barkley [13] mentioned how much effort a student is willing to spend on a task, depends on how likely it is for them to achieve a desired outcome from the task. The course involves the out-of-class activity of individually going through topic material, which is not graded, and the student does not receive any feedback from finishing the activity. The addition of the "Mark as finished" function allows the student to check off a page when they have finished a task, for example, reading the contents of a page. Consequently, as the results from the user tests showed, the aspect of gaining progress from the task can help the student acquire a push in the right direction and become more motivated to move forward to the next task. Furthermore, the section 3.2 refers to how the student's intrinsic motivation can be positively affected if they feel in control of their own behaviours and choices, as defined in the Self-determination theory by Deci and Ryan [10]. The "Mark as finished" function allows the student to check off the different tasks whenever they want, which creates more freedom for the student and a sense of them being in control of their learning. Furthermore, this functionality is intended to acknowledge accomplishment, which as Deci and Flaste [11] refers to, can positively affect one's intrinsic motivation. However, in order for the function to be useful, it must be clearly visible to the user, which the results of the user tests did not completely support. As Norman [16] suggests, if something is not visible, it does not exist. Improving the visibility of the button is therefore important in order to maximize the usefulness of the function.

Moreover, the platform gives the instructor the possibility to add different elements to informative content, such as text, video, images, and embedded files. It allows them to construct contents for students with different learning preferences, as the results presented by Chen et al. [24] shows, which falls in line with the concept of active learning.

6.1.3 Quiz

Barkley [13] refers to quizzes as a self-assessment activity, which allows the students to check for themselves how much of the course content they have understood, as mentioned in section 3.3. Chen et al. [24] also explained how student perceive quizzes as a tool to help them improve their grades. This activity has been implemented to the platform, where much of the functionality was inspired by the application SoloLearn, described in section 5.1.2. With SoloLearn, whenever a user answers a question, they can manually move forward to the next question, or click retry if they have answered the question incorrectly. A similar setup was used for the platform, allowing the user to reflect over a question before moving forward. There were some confusions regarding this setup during the user tests, in that the users did not immediately understand what was required of them in order to move forward. It was

mainly noted during the tests, but nothing the majority of the users commented on, and they generally thought that the function was straightforward. However, one user commented on this confusion and further expressed how the number of clicks needed to complete the quiz seemed unnecessary. Even though the current setup appears to be repetitious, the disadvantage of automatically moving the user forward in the test, is that those who do want to reflect on each question can not do so in their own time. Nevertheless, the placement and visibility of the button could be changed and improved, in order to remove the confusion of finding it, as noted during the tests. Since the eyes are first focused on the banner that shows up when a user has answered a question, the button which tells the user to retry or move forward could be displayed within the banner. The button becomes more visible to the user, and signifies more clearly to them the current functionality of the button.

Additionally, it was noticed during the quiz how it was easy to miss whether there were more alternatives hidden on the page. As one user suggested, a scrollbar was added to solve this and placed on the left side of the sidebar to signify more clearly, how there is more information on the page.

6.1.4 Writing

The purpose with creating a submission form for the reflective essays, and other written assignments, was to remove elements among the requirements that can be hard to miss, which falls within the concept of constraints mentioned by Norman [16]. This includes avoiding handing in an essay containing too few or too many words, or where the student has missed a step from the Gibbs reflective cycle (see section 3.3). Furthermore, by structuring the activity into tabs, where every part in connection to it is available, avoids ambiguities and miscommunication among students and instructors, which supports the results produced by Chen et al. [24].

The participants of the user tests liked how the different parts of the reflective essay were separated. One user, however, mentioned concerns in not being able to intertwine parts when they write. Since the answers from the form is generated into a PDF upon submission, the answers will appear subsequently after one another, which allows the student to begin to write their answer to one question in the previous text field. Therefore, mixing form questions will not be an issue for the student, but it needs to be more clearly explained in the instructions to avoid misunderstandings.

Regarding the box showing the number of words, the project members wanted it to be placed in a fixed position, even on a small device. Since it covered a small part of the submission form on a mobile device, it could not be too distinct, which is why a small size was chosen. However, on a large screen, it did not overlap the submission form and instead became very discrete, resulting in the users not noticing it. This contradicts the concept of discoverability mentioned by Norman [16], in that if something is not visible, it does not exist, which makes the function useless. In order to heighten the visibility of the box, it was both enlarged and given different colours to signify to the user if the number of words is sufficient or not.

Overall the users were positive regarding the submission form, but thought it involved some ambiguities which has to be more clarified in order to make the function more intuitive. Apart from the box showing the number of words, some participants had troubles understanding what was required of them in order to submit the assignment. As Norman [16] suggests through the concept of feedback, the user needs to be informed of the error and how it can be remedied, which is not fulfilled from a disabled button. The disabled button signifies that something is missing, but not what that something is. Instead, by activating

the submit button permanently, feedback can be given to the user both when the submission is successful, and when something is missing. The feedback must be prominent and understandable, in order for the user to know how to resolve eventual errors. This could include highlighting empty text fields with the colour red, which usually indicate warning or danger according to the concept of mapping [16], along with a relevant message to clarify the error. Aside from the lack of feedback regarding the submit button, there were concerns with the save button as well. The placement of the button is, just as the submit button, at the bottom of the form and can only be accessed by scrolling down the page. The issue with this placement is not allowing the user to save whenever they want without having to scroll down to the bottom of the page. Since the user do not want their work to go to waste, having the opportunity to save at any time is important in order to gain their trust. If the user cannot trust that their work will be saved, they will most likely write their essays in another text editor, as one user pointed out, which will lose the full intention and purpose with the function. One suggestion was to replace the disabled "mark as finished" button for the writing activity and display the submit and save button there instead. Hence, the buttons will be placed at a fixed position and accessible at all times.

6.1.5 Result View

The thoughts regarding the result function were mainly positive, as mentioned in 5.3.1. The users appreciated how the results were clearly presented and structured. Currently, the students can find their results in the course through a separate platform WebReg[2], and they saw it as an improvement to combine the result with everything else regarding the course. As the results presented by Chen et al. [24] showed, having clear and structured grade description, can help the student better understand what is required of them and avoids miscommunication. On the result page, the blue button with an arrow was confusing to the user and did not signify to them how it would navigate them to a different page on the platform when pressed. As a user suggested, the button should be changed and placed differently, as to not interfere with the expandable element it is placed on.

6.1.6 User Experience Questionnaire

As presented in section 5.3.2, the result from the UEQ showed overall a positive result, and all aspects received a mean value higher than 0.8. As the result from the category *attractiveness* suggests, the users overall liked the platform and enjoyed using it. The category *dependability* measures whether the user feel in control of the interaction and if the interface is predictable. The mean value for this category was 2.25, which is a highly positive result and indicates that the user did feel in control of the interaction and was not faced with unpredictable behaviour. As Norman suggests [16], if the user feel like they are in control of their actions, it leads to a positive feeling and a pleasant user experience. Similarly, Deci and Ryan [10] explains through the Self-determination theory, how the feeling of being in control can increase intrinsic motivation and actively engage students. Subsequently, students become actively involved in their progress in the course.

The category of *efficiency* received a mean value of 2.25, indicating that the users in general perceived the interaction as fast, and were able to solve the tasks without unnecessary effort. As mentioned in section 5.1.1, the participants had previously, during the user needs analysis, expressed annoyance in the slow reaction of the platform Lisam. The discussion in section 6.1.1, along with the results from the UEQ, shows how the users experienced the platform as being more efficient compared to Lisam.

The highest mean value was given to the category *perspicuity*, meaning that the users

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[2]WebReg, `https://www.ida.liu.se/webreg3/about.sv.shtml`

thought the interface was easy to get familiar with. This connects to Norman's [16] view on good user experience, in that the user understand how the platform works, which results in a pleasurable user experience.

Furthermore, the *stimulation* category was given a mean value of 1.563, which is slightly lower than the ones mentioned, since one user gave a neutral value to this category. Stimulation suggests that the users perceived the platform as exciting and motivating to use. Motivation, as mentioned by Barkley [13], is an important aspect in student engagement, along with active learning. An exciting interface is more likely to carry out engaging learning, as well as if the user feel motivated to further explore the interface. This falls in line with the conclusion made by Williams and Chinn [21], in that the use of web tools can help support student engagement and increase levels of active learning. Subsequently, the platform creates the potential to allow students to achieve an active learning experience whilst using it. It also connects to the study performed by Kim et al. [22], in that users are more positive regarding using E-learning to improve their soft skills if they feel motivated towards E-learning itself. Lastly, the result from the category *novelty*, suggested that the users experienced the platform as being relatively innovative and creative.

6.2 Method

This project has been dependent on what active learning means in theory and what methods have been proven to work well in a similar context. However, whether or not the platform will better support the students' active learning experience, and engage as well as motivate them more, can only be fully measured by students who have used the platform in the course for a while. The participants, who performed in the user tests, did not get to experience the interface in a real scenario, meaning that activities such as writing the reflective essay using the platform could not be tested. Instead, they could only assume how it would be used in reality and how it might affect them. Despite that, the participants in the user tests were familiar with the advantages and disadvantages of the current course structure, which gave them something to compare to when seeing the platform. This at least creates the benefit of avoiding the disadvantages the users have had with the current structure. Additionally, the purpose of applying Norman's principles of interaction [16] to the design, as well as conducting user tests, is to help create effective and intuitive designs, and increase the possibility of presenting a finalized product which works well in practice.

One benefit with the user needs analysis was to get to know the students as well as what they think and do not think works with the current page structure. However, only four people participated in the analysis, and therefore only their opinions and thoughts were noted, which could have given a narrow view of the difficulties and benefits regarding the course, because of how its individually focused content can affect students very differently. Handing out a questionnaire for all students in the course to answer, could have given a larger amount of answers. Although, the answers might not have been elaborate in that case, which could have created misunderstandings in the students' comments.

The participants of the user tests were exclusively presented with one view of the platform. The reason for this decision was to focus on the functions on the interface and not measure the responsiveness of the platform. However, allowing the users to see the version aimed for smaller screens, could have given some comments regarding what works and do not work on a smaller screen. Hence, there is no support to the assumption of the bottom navigation bar being more useful on a smaller screen.

User tests were only performed once during the development of the platform. To begin

with, the idea was to organize two user tests after the user needs analysis, to allow the users to react to changes made to the platform after the first tests. It would have also allowed the users to answer the UEQ twice and compare these results. However, the implementation was more time-consuming than previously thought, and the tests were postponed, which in the end only allowed room for one user test. Therefore, improvements and changes made afterwards were not tested on the users to see if they were in line with their expectations.

The UEQ is a method of measuring the user experience of a product fast and immediate, as mentioned in section 3.6.1, and measures aspects which were seen as relevant to this project. However, the questionnaire is particularly useful for a large amount of test participants, to easier summarize all opinions and thoughts from the tests, which can otherwise be difficult and time-consuming. The number of test participants used for this project were only four, and therefore it was no difficulties in bringing all the users' opinions into the result of the evaluation. Subsequently, this makes the use of the questionnaire less significant to the project and rather just a quantitative way to summarize the users' feelings towards the interface.

6.2.1 Source Criticism

The theoretical study involved widely researched fields, such as motivation and learning. These fields are not newly researched either, which makes it more difficult to find primary sources regarding the matter. In the example of learning, the theories studied for this project strongly relates to motivation and active learning, but the main source used is a secondary source which refers to the theories used, see [7]. To a certain extent, whenever possible, the primary sources used in the secondary sources, were controlled in order to ensure their reliability. Regardless of the sources being primary or secondary, all sources were scholarly literature widely referred to by other authors.

6.3 The Work in a Wider Context

This project focused on developing an E-learning platform to be used in the course Professionalism for Engineers at Linköping University. E-learning has the disadvantage of having personal contact between students and teachers removed altogether, as mentioned by Tomšič et al. [15]. Since the students are not being supervised by a teacher, it can lead to them not doing their tasks properly. As the concept of relatedness suggests, according to the Self-determination theory [10], interacting with others is an important part in increasing motivation and engage students. As a result, it can lower students' motivation in doing the work. However, this refers to distance courses, where the entire course is held through a platform. In the context of the developed platform, it will only be used for the out-of-class activities in the course, just like the course structure used currently. The in-class activities of the course still remains, and do not jeopardize the personal contact between students and teachers.

Furthermore, adjustments could be made to include students with disabilities. Using the colours red and green might be useful in differentiating from right and wrong, but not to those who are colour blind. This information has to be presented differently, or in various ways, to include more students.

7 Conclusion

Bonwell and Eison [21] defined active learning as "*involving students in doing things and thinking about what they are doing*", as mentioned in section 3.3. It is a method which centres around students and allows them to be more engaged and involved in the learning process. The course Professionalism for Engineers relies on this method of learning in order to better focus on the student and help them improve their soft skills. The students participate in active learning activities, such as seminars, written reflection essays and assignments, which centres around the student. The research around this method mainly refers to in-class activities and how to create an engaging environment inside a classroom. This brings up the question whether an engaging environment can be created outside the classroom as well. With focus on the out-of-class activities, if there is possible to change the circumstances regarding these to better support an active learning experience for the student outside the classroom.

The students enrolled in the course Professionalism for Engineers, have experienced difficulties with using several platforms in the course, where they, for example, receive information regarding assignments and essays in one place, but have to submit it on another place. This creates an unstructured environment for the student outside the classroom, and can overturn their engagement and motivation, rather than support it. In order to solve this issue, a new platform has been created. With the new platform, the focus has been on removing obstacles that the students are used to nowadays. This includes putting every part of the course into one single platform, and creating an organized structure and intuitive design. Every information and functionality regarding one activity can be found on one page, instead of three. Thereby, the student can easier keep track of materials and focus on the course, which creates engagement and motivation, and better supports an active learning experience.

Although it is the task of the instructor to create content on informative pages, the platform allows them to construct a variety of content to better support the fact that students have different learning preferences, which is an aspect strongly connected to active learning.

The platform allows the student to take control, by receiving progress from whenever they have finished a task, which both include graded and non-graded tasks. As the Self-determination theory suggests, by allowing students to take charge and control over a course, their intrinsic motivation is likely to increase, and is an important aspect of active learning.
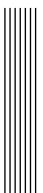
A support has been added to the written assignments and reflective essays, where the students do not have to remind themselves of what is required of them in order to submit these. Subsequently, by avoiding confusions regarding the interface and the requirements of the reflective essays, students can put all their focus on the assignment and be more engaged towards it. Since the reflective essays are in itself active learning activities, the new structure creates a more supporting environment for the student, and removes unnecessary obstacles which can decrease their engagement and motivation towards the activities.

Apart from this, a quiz functionality has been added to be used as a self-assessment tool on the platform, to help students receive an idea of how much they have understood in the course and what they need to work more on. Self-assessment is a concept known to help students identify their strengths and weaknesses, and thereby letting them be more actively involved in their own learning. Furthermore, the student can better focus on the activities in itself if there are no disturbing elements around them, which has been the main purpose when designing the platform, and are more likely engaged towards using it.

Overall, the test users were positive regarding the platform, which was further supported by the results from the User Experience Questionnaire. They saw great potential in letting the platform replace the current structure used in the course Professionalism for Engineers. There are many possibilities for improvements and additions to the platform before it is launched and used in a real scenario. Currently, the platform has the possibility to support the students in their out-of-class activities and thereby create an environment where they can focus on the tasks itself, rather than unnecessary and disturbing elements regarding the interface. Lastly, from the elements created for the platform in combination with the theoretical study, the platform supports an active learning experience for the student, to better support them in improving their soft skills.

7.1 Future Work

The specification of requirements regarding the platform given by the client in the beginning of the project, were extensive and therefore involved features which were not implemented during the duration of the project because of the limited time frame. These included the implementation of the user page and a discussion forum, among others. The discussion forum, which is mentioned in the theory chapter in section 3.3, is an aspect of an E-learning platform which could help bring teachers and students closer together. It is an active learning tool, which can help students gain motivation and engagement knowing that they can always ask for help and that they are not alone in their thoughts and questions. This could be an important part of the platform, since Tomšič et al. [15] refers to how the lack of personal contact in online learning can create misunderstandings in communication between students and teachers. Berglund also mentioned how this is a disadvantage with the current course structure in the course Professionalism for Engineers.

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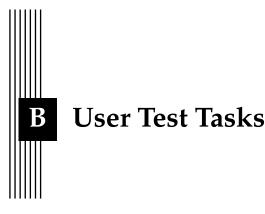
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A Questions from the User Needs Analysis

The following questions were asked to the participants during the user needs analysis. The follow up questions asked by the examiner is not included.

1. What is the best part about the course Professionalism for Engineers?

2. What steps do you take in order to get started with the course, as well as when doing the different assignments?

3. How well do you absorb information from lectures and course materials?

4. Do you perceive that you have evolved during the progress of the course? In what way?

5. Have any of what you have learned in the course been useful to you?

6. What are your opinion on using several systems in the course?

7. What challenges have you experienced with using these systems?

8. How often, would you estimate, do you visit the course web page?

9. Do you feel more or less engaged in the course as a result of working remotely from home?

10. Do you know any examples of courses at Linköping University, or anywhere else, where the course page has been well structured?

11. Have you used an application or a tool with focus on learning? If you have, which ones and do you specifically remember the biggest advantages with them?

12. What are your thoughts regarding the idea of a course page which involves more interactions?

B | User Test Tasks

The following tasks were asked during the user tests. Depending on how the user interpret them, the tasks were sometimes phrased differently, or follow up questions were asked in order to receive more thoughts and feedback from the user. The follow up questions are not listed below.

- Find out if there are any news in the course TDDD94.

- Find out whether or not there are any notifications in the course. *(only asked if the user did not check news through the notification icon in the previous task)*

- What information can you find regarding the course in general?

    1. What do you think is the purpose of the box labeled "Mark as finished"?
    2. Click on the box and explain what happens.

- You want to check your knowledge regarding the course, how do you proceed?

    1. Explain what happens if you answer the first question incorrectly.
    2. What happens if you give a correct answer?
    3. Finish the quiz and explain what happens.

- Read the instructions regarding the written assignment in Ethics.

    1. You want to submit your written assignment, how do you proceed?
    2. Explain your thoughts regarding the function.

- Find out what your result is for the whole course.

    1. Check what your result is for the course part "Social competence".
    2. Examine the page and explain what you see.